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Abstract

The low-participation problem has long been a challenge facing many paid Q&A platforms. Recently, a new business model wherein users, in addition to raising a question and receiving a personalized answer, can pay a small amount of fees to view a non-personalized answer to a question asked by others, has drawn considerable public attention and is considered an effective means to tackling such a challenge. In this paper, we build a theoretical model to explore whether this new business model benefits the key stakeholders (Q&A platform, answerers, and users). We find that the platform is not always better off when the answer-viewing feature is introduced. Another interesting finding is that while answerers may engage in direct competition with the platform, they can sometimes be better off. Additionally, we find that although having a new way to participate in the platform, users may sometimes be worse off under the answer-viewing feature.

Keywords: Answer viewing, Q&A platform, personalization, pricing strategies, consumer surplus

Introduction

Question-and-Answer (Q&A) platforms have emerged as a popular way of knowledge sharing in recent years because the question-answer format makes it easy for users to exchange knowledge (Tracxn 2022). According to Research and Markets (2020), the global Q&A market is projected to grow rapidly at a compound annual growth rate of 8.17% from 2020 to 2027.

The Q&A platforms have adopted various monetization approaches. For example, some sites (e.g., Stack Overflow) generate profits mainly through advertising, and users can access content for free (we hereafter refer to such sites as *free Q&A platforms*), while some platforms (e.g., Quora) charge a subscription fee. A relatively new monetization approach is the pay-per-question pricing model, where knowledge providers (hereafter referred to as *answerers*) charge knowledge seekers (hereafter referred to as *questioners*) a fee for answering the latter's questions. We hereafter refer to the sites adopting this approach as *paid Q&A*

platforms. The primary advantage of such platforms is that the financial incentives for knowledge providers may help improve the relevance of the answers they provide (Kuang et al. 2019).

Motivation

Although paid Q&A services can help improve the quality of answers, many users are still reluctant to spend much money on Q&A services (Aditya 2021). Thus, improving user participation on paid Q&A platforms is an important and challenging question facing the platforms. Recently, some renowned Q&A platforms in China (e.g., Zhihu and Weibo Q&A) have launched a novel feature, namely *answer viewing*, to improve user participation. Specifically, the platforms allow users willing to pay a small fee to view the answers to questions raised by other questioners (we hereafter refer to such users as *viewers*). This answer-viewing fee is typically only a fraction of the price that the user would need to pay to receive an answer if she raised a question by herself on the platform.[1] As shown in Figure 1, users need to pay 100 RMB (we hereafter refer to such a fee as the *consulting price*) for each question they raise. In contrast, under the answer-viewing feature, users only need to pay 1 RMB (we hereafter refer to such a fee as the *answer-viewing fee*) to view the answer to a question raised by another user.[2]

Figure 1: Example of Answer Viewing

With the answer-viewing feature, Q&A platforms can now generate revenue from both questioners and viewers. As before, the platform can still charge a commission from the answerers on the consulting price that questioners pay for getting personalized answers. Additionally, the platform can now directly generate revenue from the answer-viewing fee paid by the viewers. Meanwhile, Q&A platforms are now in a better position to incentivize user participation because users now have an additional low-price option to obtain information on the platforms.

The benefit of the answer-viewing model is that it serves as a tool to price-discriminate between users willing to pay different prices for the knowledge products (i.e., the answers). The answers that viewers obtain under the answer-viewing feature can be regarded as non-personalized services enabled by the platform, whereas the answers that questioners obtain can be regarded as personalized services provided by the answerers.[3] Similar to the literature on product versioning (e.g., Chellappa and Mehra 2018), where consumers have a higher valuation for the premium version than the basic version, under the Q&A setting, users' valuations of the two types of knowledge products (i.e., personalized and non-personalized answers) are different. Specifically, since the answers that viewers obtain may not perfectly suit their needs, the utility derived from non-personalized answers is typically lower than that from personalized ones. For instance, suppose a questioner has raised a legal question specific to her own context. As for a viewer who has a similar issue, viewing the answer to such a question would be helpful, but may not adequately address her concerns since her context may significantly differ from that of the questioner. In contrast, if this user raises

[1] In this paper, we refer to the answerer as *he*, the user as *she*, and the platform as *it*.
[2] In this paper, we sometimes use the term "user" to refer to both questioners and viewers.
[3] In this paper, we refer to the personalized (non-personalized) services as personalized (non-personalized) answers.

a question on her own, the answer she receives is a perfectly personalized one in the sense that the answerer provides solutions/recommendations specific to her context.

Another important difference between the two types of answers is that users may incur different misfit costs when they find the answers received are unsatisfactory. Since questioners pay more to receive personalized answerers, they typically have a higher expectation of the answers they receive than the viewers do and hence incur higher misfit costs when they find the answerers unsatisfactory (Ofei 2022).

By providing questioners with personalized answers, answerers can generate revenue from consulting fees.[4] Moreover, due to considerations of fairness and in the interest of ensuring continued participation by answerers, the platform typically shares part of the answer-viewing fee with the answerers; thus, answerers can also benefit from the answer-viewing feature by taking a share of the answer-viewing revenue. On the other hand, under the answer-viewing model, the platform and answerers actually engage in direct competition in the sense that the platform can convert some questioners into viewers by setting a relatively low answer-viewing fee. In such a case, the number of questioners whom answerers can charge consulting prices may decrease, potentially leading to lower revenue for answerers and the platform.

In this paper, to better understand the impact of this new business model and provide Q&A platforms with guidance on the adoption of the answer-viewing feature, we use the game-theoretic framework to explore the following research questions:

- *Will the adoption of the answer-viewing feature benefit the platform and answerers?*
- *How should the Q&A platform optimally set the answer-viewing fee and the commission on the consulting fee?*
- *How do the consulting prices charged by answerers change when the answer-viewing feature is introduced?*

Key Findings and Contributions

In this paper, we consider a Q&A platform, two asymmetric answerers, and a mass of users. The two answerers are asymmetric in the sense that one of the answerers has monopoly power over some (not all) users because he is more knowledgeable than the other answerer. Before analyzing the impact of the answer-viewing feature on each stakeholder's payoff, we first examine how the introduction of such a feature affects the pricing strategies of answerers and the platform. One may intuit that the introduction of the answer-viewing feature would intensify competition faced by the answerers, thereby reducing the consulting prices they charge. This is because, as previously stated, when the platform introduces the answer-viewing feature, instead of competing directly with each other, the answerers are now competing with the platform in the sense that some questioners of the answerers now become viewers due to the relatively low answer-viewing fee set by the platform. This change in the nature of competition may sometimes result in a decrease in the consulting prices charged by the answerers. However, we find that this is not necessarily the case since the valuation of a personalized answer is greater than a non-personalized one. Such a change in competition also leads the answerers to set a higher consulting price, especially when the benefit from viewing a non-personalized answer is relatively small. Moreover, the platform charges a lower commission under the answer-viewing feature. This is because a higher commission leads answerers to set higher consulting prices, which decreases the number of questioners, leading to a lower total profit for the platform. This result can guide the platform and answerers in making better pricing decisions under the new business model.

Regarding the platform's profit, although the answer-viewing feature provides the platform with another revenue source, interestingly, we find that the platform can sometimes be worse off when launching this new feature. This happens when the valuation derived from viewing a non-personalized answer is relatively low. The intuition is that in such a case, the competitive advantage of the platform over answerers is relatively small; thus, the platform can only charge a relatively low answer-viewing fee. Moreover, as mentioned before, the platform will charge a lower commission with the answer viewing. Therefore, compared to the traditional setting, while the platform can generate additional answer-viewing revenue and the number of questioners may sometimes be larger, these potential benefits cannot offset the loss due to

[4] In this paper, we use the terms "consulting price" and "consulting fee" interchangeably.

the decreased commission. This result sends an important message to Q&A platforms that they should be cautious when considering launching the answer-viewing feature since they may be worse off doing so.

As far as the answerers' profitability is concerned, we find that they are better off only when the valuation of a non-personalized answer is relatively small. This is because although the number of questioners may be lower with the answer-viewing feature, answerers can set higher consulting prices in such a case and enjoy a lower commission charged by the platform, potentially generating higher revenue from consulting fees. Moreover, answerers can gain additional revenue from answer-viewing fees, and thus become better off. Interestingly, we find that unlike the other answerer, the answerer who has monopoly power over some users can also be better off when the valuation of a non-personalized answer is relatively large. The intuition is that in such a case, the market of the monopoly side of this answerer expands substantially, allowing him to generate relatively high answer-viewing revenue. Our result suggests that although the introduction of the answer-viewing feature may cannibalize the number of questioners, both answerers can be better off when the platform introduces such a feature.

Additionally, our result relating to consumer surplus reveals that although users have one more option to obtain the answer and the answer-viewing fee they need to pay is typically small, they are not always better off with the answer-viewing feature. This is because when the answer-viewing feature is introduced, users may sometimes need to pay a higher consulting price and the valuation they derive from viewing a non-personalized answer is lower than a personalized one. In this sense, policymakers should devise appropriate regulation policies to protect the interests of users when Q&A platforms introduce the answer-viewing feature. We also compare all the stakeholders' payoffs with and without answer viewing and find that under certain conditions, the adoption of the answer-viewing feature can benefit all key stakeholders. However, in some cases, the platform is better off while the answerers are worse off with the answer-viewing feature, suggesting that the interests of different stakeholders sometimes conflict with each other.

Our paper contributes to the literature in several aspects. First, our work is among the first to provide a theoretical framework for examining the answer-viewing feature, a new business model for monetizing knowledge products. In particular, our model captures the difference between personalized and non-personalized knowledge products and users' misfit cost towards such products, which jointly determine the benefit of answer viewing. Our articulation of why introducing the answer-viewing feature may help the platform and answerers and when the platform should employ answer viewing along with the optimal pricing strategies is novel to the literature. Second, we contribute to the literature on personalized pricing by examining how the platform can leverage a price discrimination tool to enhance its profitability in the Q&A setting. Instead of offering different products, the platform can strategically induce product differentiation without incurring any additional production costs. Third, we contribute to the platform pricing literature by highlighting the uniqueness of the knowledge product pricing and the role of the answer-viewing feature in enhancing user participation and the platform's profitability.

Literature Review

Our work is mainly related to three streams of literature: (i) Q&A platforms, (ii) personalized pricing and versioning, and (iii) platform pricing strategies. Next, we briefly review the relevant studies and highlight our contributions to each stream of the literature.

Q&A platforms

The Q&A platform is a type of knowledge-sharing platform that matches knowledge providers and seekers (Haas et al. 2015). Prior research mainly examines two types of Q&A settings: corporate Q&A platforms and open Q&A platforms, where the former refers to the closed Q&A communities inside an organization and the latter refers to the open communities facing the public. In the corporate Q&A setting, since the community only opens to users belonging to the organization, one common challenge is how to increase the participation of such corporate platforms. For example, Willi et al. (2014) explore the elements that help the corporate form impression in online communities. In a similar vein, Willi et al. (2019) examine how online community members form impressions of corporate with a particular focus on the social context cues. Although there are some approaches to tackle the above challenge, the low-participation issue in corporate knowledge communities is still worrying. As suggested in Hwang and Krackhardt (2020), the knowledge in a corporate community is still exchanged mostly within a smaller group of employees who are

nearby or have the same specialties. In addition, Pu et al. (2022) investigate employees' incentives to share knowledge with colleagues with higher ranks and find that users are only inclined to respond to questioners whose job ranks are higher than themselves.

In the open Q&A settings, there exists a large body of literature that studies what factors impact the perceived quality of answers and users' incentives to participate in knowledge sharing activities (e.g., Bateman et al. 2011, Lee et al. 2019, Shi et al. 2021). For example, under an online healthcare Q&A context, Khurana et al. (2019) study the impact of introducing doctors' responses on patients' perception of medical services offered. In a similar context, Peng et al. (2020) identify two types of contextual cues that contribute to more valuable answers from a content-context congruence perspective. As paid Q&A platforms are on the rise, many existing works in the literature examine users' payment incentives for Q&A services. For example, Zhao et al. (2018) investigate how answerers' characteristics and reputation create trust, which, in turn, influences users' payment decisions. Chen et al. (2020) take a step further by examining what factors affect the answerers' attractiveness and the payment they receive. In addition to the above paid Q&A literature, some papers specifically explore the answer-viewing business model with a particular focus on questioners' and viewers' incentives to pay for the answers. Zhao et al. (2020) examine the antecedents of questioners' payment intention from the perspective of benefit and cost. Liu et al. (2021) further explore questioners' behavior of switching from free to paid Q&A services. Ye et al. (2021) focus on the unique revenue source of the answer-viewing model and investigate the drivers of the sales of paid viewership.

Prior studies (e.g., Jan et al. 2018) have highlighted the importance of designing the monetary incentives properly on paid Q&A platforms since failing to do so may hurt user engagement and the platform's profitability in the long run. However, to the best of our knowledge, most of the extant literature focuses on studying users' incentives to pay for the answers and the factors that determine the quality of answers. Prior studies have overlooked how to optimally design the monetary incentives for key stakeholders on paid Q&A platforms. Moreover, with the introduction of the answer-viewing feature, the pricing structures of all key stakeholders have changed. In particular, under the answer-viewing feature, the platform can induce a non-personalized knowledge product to attract users and generate revenue, and such a product offered by the platform may compete with the personalized knowledge product provided by answerers. In this paper, we aim to fill these gaps in the literature by capturing the unique market structure, and analytically modeling how the platform should strategically design the answer-viewing feature and how answerers should set their prices accordingly.

Personalized Pricing and Versioning

Price discrimination has been widely adopted in practice, and different forms of price discrimination are in use. First-degree price discrimination, or personalized pricing, is the most effective form of price discrimination. With the recent advances in information technologies, firms can now collect a large amount of consumer data and set personalized prices to discriminate among them. Choudhary et al. (2005) examine personalized pricing under a duopoly setting where two firms are vertically differentiated and find that personalized pricing may aggravate the price competition. Similarly, Matsumura and Matsushima (2015) study whether competing firms should employ personalized pricing. More specifically, they explore a situation where firms can engage in quality-improving activities after determining the pricing strategies.

Personalized pricing can be implemented by using past purchase behavior by consumers. Mehra et al. (2012) examine the competitive upgrade discount pricing in a software upgrades context where previous users enjoy product discounts. Penmetsa et al. (2015) analyze how a monopolist service provider chooses among three price discrimination regimes, i.e., behavioral price discrimination, inter-temporal price discrimination, and a combined one. Choe et al. (2018) examine behavior-based price discrimination in a scenario where two competing firms have asymmetric information about consumers. More recently, Hajihashemi et al. (2022) study how network effects impact the firm's personalized pricing strategies.

A second approach to price discrimination is through versioning. When firms do not have enough information about consumers to implement personalized pricing, versioning can be used. Several papers have investigated conditions when versioning is optimal. For example, Shivendu and Zhang (2015) investigate users' heterogeneous disutilities from using software with low functionality as a driver of versioning. More recently, Chellappa and Mehra (2018) examine the impact of consumer's usage costs, firm's versioning costs, and quality development costs on the firm's versioning strategies. Lahiri and Dey

(2018) provide a new perspective of why a manufacturer should adopt versioning by highlighting the important role of an informed segment of consumers.

The answer-viewing feature is essentially a price discrimination mechanism based on versioning wherein questioners choose between a high-quality service, i.e., a personalized answer to their questions, or a low-quality service which is non-personalized, where they view the answer to similar questions posed by others. Unlike the above literature where a firm decides the price of different versions of their products or services, in our setting, the platform and the answerers both play a role in determining the prices for two different versions of the knowledge products.

Platform Pricing Strategies

There exists a large body of literature on the platform's pricing strategies. Quite a few existing works focus on the impact of entry, integration, and expansion on the pricing strategies of two-sided platforms. For example, Bhargava et al. (2013) examine how the platform's expansion decision (optimal product launch) is affected by network effect intensity and other adoption characteristics. Tan et al. (2020) explore the effect of investment in integration tools on the pricing decisions of the platform. Under a duopoly setting, Adner et al. (2020) examine the compatibility decisions of competing platforms with a focus on the heterogeneous profit foci. Regarding the platform entry issue, Sharma and Mehra (2021) investigate a scenario where the platform enters a complementary hardware access product market. Zhu et al. (2021) examine how network interconnectivity affects the competition between an incumbent platform and an entrant platform.

Under the online retail setting, prior studies have investigated the platform's pricing decision between the agency contract and the wholesale contract under various settings, such as add-on pricing (Geng et al. 2018). In a similar vein, under the agency pricing model, Hao et al. (2017) examine the optimal advertising revenue-sharing contract of a mobile platform, and Guo et al. (2021) study the optimal bundling strategy of a retail platform. The platform's pricing structure in our model is essentially a hybrid model of agency and wholesale pricing in the sense that the platform sets a price for the answer-viewing feature by itself, and in the meantime, takes a share of the consulting revenue where the pricing power is delegated to the supplier side of the platform (i.e., answerers). Such a difference in the pricing structure also leads to price competition between the platform and answerers, which has been largely overlooked in previous studies.

Although there is burgeoning literature on platform pricing strategies in many different contexts (including E-commerce, software, retailing, etc.), the Q&A platforms have rarely been investigated. With several unique features (e.g., reusability and personalization of knowledge product) brought by this context, it is important to systematically examine the pricing strategies of Q&A platforms, and we contribute to the literature by exploring the impact of this new answer-viewing feature on the platform's pricing decisions.

Model Framework

We consider two competing answerers and a mass of users on a Q&A platform. Following the classical Hotelling framework (Hotelling 1990), we consider the users' preferences towards answerers, denoted by x, to be uniformly distributed over $[0, G]$. Without loss of generality, we consider that consumers are distributed over the Hotelling line with unit density. This distribution reflects the fact that different users may prefer different answerers due to certain contextual or personal factors. As suggested in the psychology literature (Stangor 2014), people may form different impressions of the same behavior. For example, some users prefer answers that are explained in an objective way, while others prefer answers with a personal touch. Given this context, we consider duopoly competition between two answerers. We also consider these answerers are asymmetric in the sense that one of the answerers has monopoly power over some (not all) users because he is more knowledgeable than the other answerer. Hence, he can provide answers to a wider variety of questions compared to the other answerer (Gao et al. 2020).

For ease of exposition, we hereafter refer to the answerer who has monopoly power on this platform as the *expert answerer* (denoted by E), and the other as the *regular answerer* (denoted by R). We capture this idea by letting answerers R and E be located at $x = 0$ and $x = 1$, respectively, on the Hotelling line that represents users' distribution. The two answerers directly compete for users located between 0 and 1, and the users located at $[1, G]$ will raise questions to answerer E only if the net benefit of asking a question is non-negative, i.e., answerer E has the monopoly power over these users (as shown in Figure 2). We consider

G to be relatively large such that the market is not fully covered. We summarize all key notations used in this paper in Table 1.

Notation	Definition
p_i	Answerer i's consulting price, $i \in \{R, E\}$
c	Commission charged by the platform
f	Answer-viewing fee
v	Valuation from receiving a personalized answer to a specific question
x	User's preference towards the two answerers
t	Unit misfit cost, $t \geq 1$
d	Discounted value factor of viewing a non-personalized answer, $d \leq 1$
s	Amount of answer-viewing fee shared with each answerer
N_{Qi}	Number of questioners for answerer i, $i \in \{R, E\}$
N_{Wi}	Number of viewers for answerer i, $i \in \{R, E\}$

Table 1. Summary of Key Notations

Benchmark Model: No Answer Viewing

In the benchmark model, we consider the traditional scenario wherein the platform only offers a consulting option for users to raise questions and receive personalized answers. Under such a case, users raise questions if they are willing to pay the answerers consulting prices, and the platform earns revenue from the commission it charges on the consulting prices that answerers receive.

Questioners' Problem

We use v to denote the user's valuation from receiving a personalized answer to the question she raises, and consider it to be homogeneous among all users. For a questioner located at $x \in [0, 1]$, we consider that she derives the utility of $U_{QR} = v - tx - p_R^B$ (resp. $U_{QE} = v - t(1 - x) - p_E^B$) when raising a question to answerer R (resp. answerer E). Here, the superscript B stands for the benchmark model, and the subscript Q stands for the option of raising a question (i.e., consulting option). We use p_i^B to denote the consulting price of answerer i under the benchmark model wherein the subscript $i \in \{R, E\}$ refers to the answerer from whom the question is asked, and t the users' unit misfit cost when asking a question. We consider that a user located at $x \in [1, G]$ derives the utility of $U_{QE} = v - tx - p_E^B$ when asking a question to answerer E. Since answerer E has the monopoly power over users located within $[1, G]$, these users will raise questions and pay the consulting prices to answerer E if their utilities are non-negative. We denote by N_{Qi} the number of users willing to raise questions to the answerer i (hereafter referred to as the *number of questioners for answerer i*).

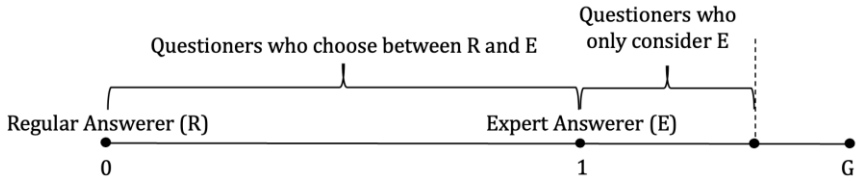


Figure 2. User Segments without Answer Viewing

Answerer's Problem

Under the benchmark model, the answerers can generate consulting revenue by answering personalized questions (hereafter referred to as *consulting revenue*). Each answerer decides his respective consulting price p_i^B. Answerers share $c \geq 0$ (termed the platform's *commission*) among the consulting price with the Q&A platform for each consultation. The commission c is decided by the platform and is typically smaller than the consulting price. Hence, the profit maximization problem for answerer i can be formulated as: $\max_{p_i^B} \pi_i^B = (p_i^B - c^B) N_{Qi}, i \in \{R, E\}$.

Platform's Problem

Following the prior studies (e.g., Zhao et al. 2020), we consider that the platform charges a commission from the answerers, which is also in line with the common practice in the industry. Under the benchmark wherein only the consulting option is offered, the Q&A platform can generate profit by charging the commission on the consulting price, namely the commission revenue. The platform decides the commission c^B to maximize its profit. The profit maximization problem for the platform can be formulated as: $\max_{c^B} \pi_K^B = c^B\left(N_{QR} + N_{QE}\right)$, where subscript K refers to the platform.

Main Model: With Answer Viewing

In reality, some Q&A platforms, such as Zhihu and Weibo Q&A, have introduced the answer-viewing feature wherein users, instead of raising a question to answerers, can pay a small amount of fee to view the answers to the questions raised by other questioners. In this subsection, we analyze this scenario and formulate the optimization problem for each key stakeholder.

Users' Problem

On a Q&A platform enabling the answer-viewing feature, as discussed earlier, there are two types of users, namely questioners and viewers. In addition to raising questions by themselves and receiving personalized answers, users have one more option of viewing non-personalized answers that are specific to the questions raised by other users. Questioners' utilities from raising a question are similar to those in the benchmark model. For a viewer located at $x \in [0,1]$, we consider that she derives the utility of $U_{WR} = dv - x - f$ (resp. $U_{WE} = dv - (1-x) - f$) when viewing a non-personalized answer from answerer R (resp. answerer E). Here, the subscript W stands for the option of viewing an answer, and $f > 0$ is the answer-viewing fee set by the platform. For a viewer located at $x \in [1, G]$, the utility she derives from viewing a non-personalized answer from answerer E is $U_{WE} = dv - x - f$, and these viewers will pay the answer-viewing fee to answerer E if their utilities are non-negative.

With the answer-viewing feature, users can choose between asking a question and viewing a non-personalized answer. Since viewing non-personalized answers may not perfectly suit users' needs, receiving a personalized answer intrinsically brings more value to users than viewing a non-personalized answer; thus, we use $d < 1$ to denote the discounted value factor of viewing a non-personalized answer. Further, compared to second-hand products, consumers have higher expectations of the first-hand ones, and may become more dissatisfied with the first-hand products when they find the products undesirable (Ofei 2022). In a similar vein, under the Q&A setting, if users choose to ask a question and the question is not answered well, they may have a higher misfit cost since they are paying for a personalized answer instead of a second-hand one. Thus, similar to the literature on standard and customized products (Syam and Kumar 2006) that users incur a higher disutility when the customized products do not match their ideal point, we consider the unit misfit cost to be greater than 1 for personalized answers and equal 1 for non-personalized answers. Based on the above discussion, on the competitive side of the Hotelling line, users who are closer to the answerer will choose to raise questions, and those who are in between will decide to view the answer. The same user segmentation pattern applies to the monopoly side of the Hotelling line (as shown in Figure 3). We denote by N_{Wi} the number of users willing to view the answer from answerer $i \in \{R, E\}$ (hereafter referred to as the *number of viewers for answerer i*).

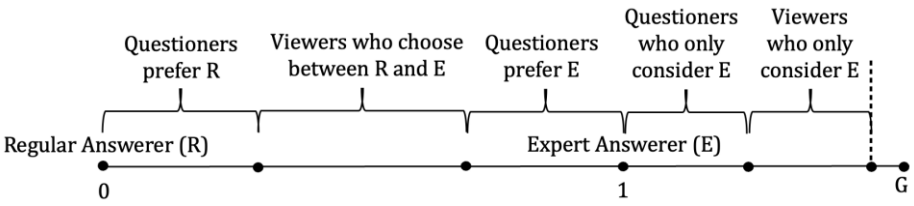


Figure 3. User Segments with Answer Viewing

Answerer's Problem

Similar to the benchmark model, the answerers can generate consulting revenue through providing answers to questioners. Moreover, under the answer-viewing feature, answerers can also generate revenue if their answers are viewed by viewers. We denote by s the amount of answer-viewing fee the platform shares with each answerer. Here, we consider that s is exogenously given and fixed. Thus, the profit maximization problem of answerer i can now be formulated as: $\underset{p_i^M}{max}\, \pi_i^M = (p_i^M - c^M)N_{Qi} + sN_{Wi}, i \in \{R, E\}$.

Platform's Problem

As in the benchmark model, the platform can generate revenue by charging the commission from the consulting revenue. However, the platform has another revenue source through collecting the answer-viewing fee from viewers (hereafter referred to as the *answer-viewing revenue*). Given that, the platform has one more decision with answer viewing, i.e., the answer-viewing fee f. In addition, after collecting the answer-viewing fee f, the platform needs to give s to each answerer, which means that its profit margin from each viewer is $f - s$. Thus, the platform's profit maximization problem can be written as: $\underset{c^M,f}{\max}\, \pi_K^M = c^M\left(N_{QR} + N_{QE}\right) + (f - s)(N_{WR} + N_{WE})$.

In our study, we consider the following multistage game. In stage 0, the platform announces the commission c and the answer-viewing fee f (in the benchmark model, the platform only decides c). In stage 1, answerers simultaneously set their consulting prices p_i. In stage 2, users decide on their knowledge seeking strategies (i.e., raise a question, be viewers, or do not participate).

Equilibrium Analysis

In this section, we first analyze the equilibrium outcomes under the benchmark model and the main model, respectively, and then investigate the impact of the answer-viewing feature on the payoffs of all stakeholders.

Equilibrium Outcomes under the Benchmark Model

Following prior literature (e.g., Sharma and Mehra 2021), we solve for the subgame-perfect equilibrium through backward induction as follows.

Stage 2: Questioners' Decision. In the benchmark model, users decide whether to raise questions. The location along the users' preference spectrum of the marginal user who is indifferent between raising a question to answerers R and E satisfies $v - tx - p_R^B = v - t(1 - x) - p_E^B$. Moreover, as discussed earlier, users at $[1, G]$ decide whether to raise questions to answerer E, and we can further derive the number of questioners who only raise questions to answerer E as $(v - p_E^B)/t$. Thus, we can obtain the number of questioners for answerers R and E as $N_{QR}^B = \frac{-p_R + p_E + t}{2t}$ and $N_{QE}^B = \frac{p_R - 3p_E + t + 2v}{2t}$, respectively.

Stage 1: Answerers' Decision. Plugging back the number of questioners (i.e., N_{Qi}^B) into each answerer's profit function and solving the first-order condition of π_i^B with respect to p_i^B, we can obtain the optimal consulting price set by answerers given the platform's commission.

Stage 0: Platform's Decision. Plugging back the consulting prices into the platform's profit, we can derive the optimal commission c by solving the first-order condition of π_K^B with respect to c. Based on the above analysis, we obtain the equilibrium results under the benchmark model and summarize them in Lemma 1. Due to space limitations, all proofs of lemmas and propositions are omitted.

Lemma 1. Under the benchmark model, the optimal consulting prices set by answerer i are given by: $p_R^{B*} = \frac{85t}{77} + \frac{13v}{22}$ and $p_E^{B*} = \frac{1}{22}(14t + 15v)$. The optimal commission set by the platform is given by: $c^{B*} = \frac{4t}{7} + \frac{v}{2}$.

From Lemma 1, we find that the optimal consulting prices set by two answerers increase with the valuation from receiving a personalized answer (i.e., v) and the unit misfit cost (i.e., t). This is intuitive because as v increases, users perceive a higher valuation of a personalized answer, leading to a higher willingness to pay.

Thus, answerers have an incentive to set higher prices. Moreover, as t increases, two answerers are more differentiated from each other, which helps mitigate the price competition and leads to higher consulting prices. The discussion of the platform's commission can be explained in a similar fashion.

Equilibrium Outcomes under the Main Model

When the platform introduces the answer-viewing feature, the platform has one more decision related to answer viewing. Accordingly, the decisions of users and answerers may be different from those under the benchmark model. We solve for the subgame-perfect equilibrium through backward induction.

Stage 2: Users' Decision. With the answer-viewing feature, users decide whether to raise questions or view the answer. As discussed earlier, users located closer to the answerer will choose to raise a question, whereas those located farther will choose to view the answer from other users' questions. The location along the users' preference spectrum of the marginal user who is indifferent between raising a question and viewing a non-personalized answer to answerer R satisfies $v - tx - p_R^M = dv - x - p_R^M$. Similarly, we can derive the indifferent users for answerer E. Moreover, the marginal user who is indifferent between viewing answerers R and E satisfies $dv - x - f = dv - (1 - x) - f$. As in the benchmark model, we calculate the numbers of questioners and viewers among users located within $[1, G]$. Based on the above discussion, we can obtain the numbers of questioners for answerers R and E as $N_{QR}^M = \frac{-dv+f-p_R+v}{t-1}$ and $N_{QE}^M = \frac{2(-dv+f-p_E+v)}{t-1}$, respectively. The number of viewers for answerers R and E can be computed as $N_{WR} = \frac{(d-1)v-f+p_R}{t-1} + \frac{1}{2}$ and $N_{WE} = \frac{2v(dt+d-2)-2f(t+1)+4p_E+t-1}{2(t-1)}$, respectively.

Stage 1: Answerers' Decision. Plugging back the numbers of questioners (i.e., N_{Qi}^M) and viewers (i.e., N_{Wi}) into each answerer's profit function and solving the first-order condition of π_i^M with respect to p_i^M, we can obtain the optimal consulting price set by answerers given the platform's decisions.

Stage 0: Platform's Decision. Plugging back the consulting prices into the platform's profit, we can derive the optimal commission c and answer-viewing fee f by solving the first-order conditions of π_K^M with respect to those decisions. Based on the above analysis, we obtain the equilibrium results under the answer-viewing feature and summarize them in Lemma 2.

Lemma 2. Under the main model, the optimal consulting price set by answerer i are given by: $p_R^{M*} = p_E^{M*} = \frac{1}{4}(2 + 2s + (3 - d)v)$. The optimal commission and answer-viewing fee set by the platform are given by: $c^{M*} = \frac{1}{2}(1 - s + v)$ and $f^* = \frac{1}{2}(1 + s + dv)$, respectively.

As shown in Lemma 2, when the platform introduces the answer-viewing feature, we find that the optimal consulting price increases with the valuation from receiving a personalized answer (i.e., v). The explanation is similar to the discussion following Lemma 1. Moreover, we find that the two answerers will set the same consulting price under the answer-viewing feature.

Since the consulting prices and commission are directly related to the profits of the platform and answerers, as well as the consumer surplus, it is important to examine how the pricing strategies of answerers will change when the answer-viewing feature is introduced. Based on Lemmas 1 and 2, we then compare the equilibrium consulting prices set by answerers and the commission charged by the platform with and without the answer-viewing feature. We summarize the results in the following proposition.

Proposition 1. Compared to the benchmark model, with the answer-viewing feature,
(i) the regular answerer's consulting price can be higher (i.e., $p_R^{M*} \geq p_R^{B*}$) when $d \leq \frac{154-340t+49v+154s}{77v}$, and the expert answerer's consulting price can be higher (i.e., $p_E^{M*} \geq p_E^{B*}$) when $d \leq \frac{22+22s-28t+3v}{11v}$;
(ii) the commission is always lower under the main model (i.e., $c^{M*} \leq c^{B*}$).

From part (i) of Proposition 1, we find that both answerers' consulting prices are higher with the introduction of the answer-viewing feature when the discounted value factor of viewing a non-personalized answer (i.e., d) is relatively small. The intuition behind this finding is as follows. When the platform adopts the answer-viewing feature, instead of competing with the other answerer in the market, each answerer engages in direct competition with the platform in the sense that some questioners of the answerers now

become viewers. On the one hand, a higher differentiation leads to relatively lower price competition, and the personalized services of the answerers are more differentiated ($t > 1$) than the non-personalized service of answer viewing ($t = 1$), potentially keeping answerers from charging high consulting prices. On the other hand, the valuation of a personalized answer is greater than a non-personalized one, leading the answerers to charge a higher consulting price. When d is relatively small, the competitive advantage of the answerers over the platform is substantial since raising a question is much more appealing to users, which induces answerers to set higher consulting prices. Hence, answerers have incentives to set a higher consulting price under the answer-viewing feature to generate more consulting revenue.

Regarding the commission, when the platform charges a higher commission, the marginal costs for the answerers increase, inducing them to set higher consulting prices, which further reduces the number of questioners. Thus, the platform needs to charge a lower commission under the answer-viewing feature to balance the commission revenue and the answer-viewing revenue.

The above proposition provides important implications for answerers as well as the platform. Specifically, answerers should be aware that in the presence of the answer-viewing feature, they are not only competing with other answerers, but also competing with the platform. Hence, answerers may need to lower their consulting prices under this new feature. For Q&A platforms, it is not always necessary to reduce their commission to compensate for the answer-viewing revenue, especially when users perceive a high valuation of viewing non-personalized answerers.

Comparison of Stakeholders' Payoffs between Benchmark and Main Model

In this subsection, to further investigate the impact of the answer-viewing feature, we compare the payoffs of all stakeholders before and after this feature is implemented.

Platform's Payoff

From Lemmas 1 and 2, we derive the equilibrium commission and the answer-viewing fee set by the platform. We further calculate the platform's profit and summarize the results in Lemma 3.

Lemma 3. The platform's profit

(i) under the benchmark model is given by: $\pi_K^{B*} = \frac{(8t+7v)^2}{308t}$;

(ii) under the main model is given by: $\pi_K^{M*} = \frac{1}{8}(2(-1+s)^2 - 4d(-1+s)v + \frac{(3+d(-6+d+2dt))v^2}{-1+t})$.

While some platforms (e.g., Zhihu and Weibo Q&A) have adopted the answer-viewing feature, other platforms, such as Answeree and JustAnswer, still use the traditional paid Q&A business model. Thus, it remains uncertain whether Q&A platforms should adopt the answer-viewing feature. To examine this issue, we compare the platform's profit across the benchmark and main models and summarize our findings in Proposition 2 (for illustration purposes, we depict the results in Figure 4). The colored lines in Figures 4-6 depict the thresholds identified in propositions and the area above the black line is the feasible region of the related parameters.[5]

Proposition 2. The platform is better off under the answer-viewing feature only when $d \geq \underline{d}$.[6]

At first glance, when the platform introduces the answer-viewing feature, one might think the platform will be better off since it has another revenue source (i.e., answer-viewing revenue) to generate profit. This new feature is essentially a price discrimination tool, which seems to help the platform gain higher revenue. However, as can be inferred from Proposition 2 and Figure 4, we find that the platform can be worse off when the discounted value factor of viewing a non-personalized answer (i.e., d) is relatively small. The intuition behind this finding is as follows.

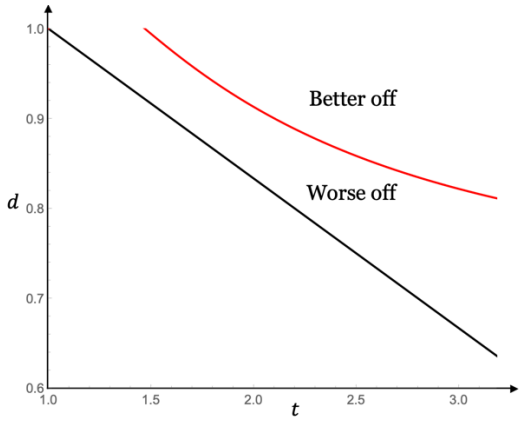
When the relative valuation from viewing a non-personalized answer compared to a personalized one is relatively low (i.e., d is relatively small), the platform has to set a low answer-viewing fee to attract viewers. Thus, although the answer-viewing feature encourages more users to participate in the platform, the

[5] To derive the feasible region, we make several technical assumptions to ensure the concavity of stakeholders' profit functions and non-negativity of our equilibrium results. The details are omitted for brevity.

[6] Due to space limitations, the expressions of all thresholds specified in all propositions are omitted for brevity.

revenue generated from answer viewing is not substantial due to a relatively low profit-margin and few viewers. Moreover, recall that in Proposition 1, the platform charges a lower commission when the answer-viewing feature is introduced. On top of that, we find that the number of questioners is smaller under the main model since the presence of answer viewing may cannibalize the demand for questioners. Therefore, as shown in Figure 4, although the platform can gain additional answer-viewing revenue, the loss of the commission revenue due to a low-profit margin and fewer questioners is more substantial than the gain in the answer-viewing revenue, leading to a lower profit for the platform.

The above proposition characterizes whether and when the Q&A platform will be better off adopting this answer-viewing feature. Our result suggests that Q&A platforms should not rush to embrace such a feature since they may be worse off doing so, which indicates that more options provided by the platform can actually lead to lower profits. In reality, for some platforms that specialize in specific areas, e.g., legal consultation Q&A platforms, the valuation of a non-personalized answer on such platforms may be relatively low since the specific situation can vary substantially from user to user. Platforms in such a case should not adopt the answer-viewing feature. Thus, before adopting such a feature, platforms should have a clear understanding of users' valuations of the non-personalized answers.



(Parameter value: $v = 12; s = 4$)

Figure 4. Platform's Profit Comparison Across Benchmark and Main Model

From a theoretical perspective, the literature on the E-commerce marketplace has examined the scenario wherein the retailer's platform carries products identical to those sold by third-party sellers (Song et al. 2020). In their settings, the retailer's platform generates revenue through charging commissions as well as product sales. However, different from their setups, in Q&A platforms, there are two unique features, i.e., users' valuation difference (captured by d) and misfit cost difference (captured by t) towards personalized versus non-personalized knowledge products. Because of such unique features, users' decisions along with answerers' and the platform's strategies would change accordingly, leading to more valuable insights that cannot be derived from previous studies. Moreover, due to the unique characteristics of knowledge products, the answers are reused by all the questioners and viewers who pay for such answers, whereas products sold on E-commerce platforms usually cannot be reused by different consumers. For the Q&A platform, instead of selling products, it enables a new option for users to participate in the platform. Thus, we contribute to the literature by examining the platform's equilibrium strategies under the Q&A setting and how these strategies are affected by context-specific factors.

Answerer's Payoff

In this subsection, we analyze whether answerers can benefit from introducing the answer-viewing feature. From Lemmas 1 and 2, we obtain the payoffs of both answerers under the benchmark and the main model by plugging back the optimal consulting prices and commission into their profit functions, respectively. We present the results in Lemma 4.

Lemma 4. The answerers' profits

(i) under the benchmark model are given by: $\pi_R^{B*} = \frac{(41t+7v)^2}{11858t}$, $\pi_E^{B*} = \frac{3(5t+14v)^2}{11858t}$;

(ii) under the main model are given by: $\pi_R^{M*} = \frac{1}{16}(8s + \frac{(1-d)^2v^2}{t-1})$, $\pi_E^{M*} = \frac{1}{8}(4dsv - 4s^2 + \frac{(1-d)^2v^2}{t-1})$.

We further compare answerers' profits under the benchmark and the main model and summarize our findings in Proposition 3 (for illustration purposes, we depict the results in Figure 5).

Proposition 3. As compared to the benchmark, the regular answerer can be better off with the answer-viewing feature when $d \leq \frac{77v-2\sqrt{2-\frac{2}{t}}\sqrt{(41t+7v)^2-5929ts}}{77v}$; the expert answerer can be better off when $d \leq d_1$ or $d \geq d_2$.[7]

Intuitively, one might think answerers could be worse off since some users who used to be questioners may become viewers under the answer-viewing feature. However, from Proposition 3 and Figure 4, we find that both answerers can sometimes be better off when the discounted value factor of viewing a non-personalized answer (i.e., d) is relatively small. The intuition is that as shown in Proposition 1, when d is relatively small, the consulting prices set by the answerers are higher and the commission charged by the platform is lower when the answer-viewing feature is adopted. Although the number of questioners may be lower under the answer-viewing feature, the total commission revenue generated by answerers can be higher due to a higher profit margin and the answerers can generate additional answer-viewing revenue, resulting in a higher profit for answerers as compared to the benchmark.

Moreover, different from the regular answerer, we find that the expert answerer can also be better off when d is relatively large. The intuition is that in such a case, the market of the monopoly side of the expert answerer expands substantially, allowing him to generate higher answer-viewing revenue. Thus, when d is relatively large, although the consulting price may be lower under the answer-viewing feature, the expert answerer's gain in the answer-viewing revenue outweighs his loss in the consulting revenue, leaving him better off.

Our results send a clear message to answerers that they may face the challenges of revenue loss due to the introduction of the answer-viewing feature, especially when the valuation obtained from viewing a non-personalized answer is relatively large. In practice, one possible way to get around this issue would be to consider switching to other Q&A platforms that have not yet launched it. Our finding also sends an important message to policymakers that they should devise appropriate policies to protect the interests of answerers on platforms that adopt such a feature.

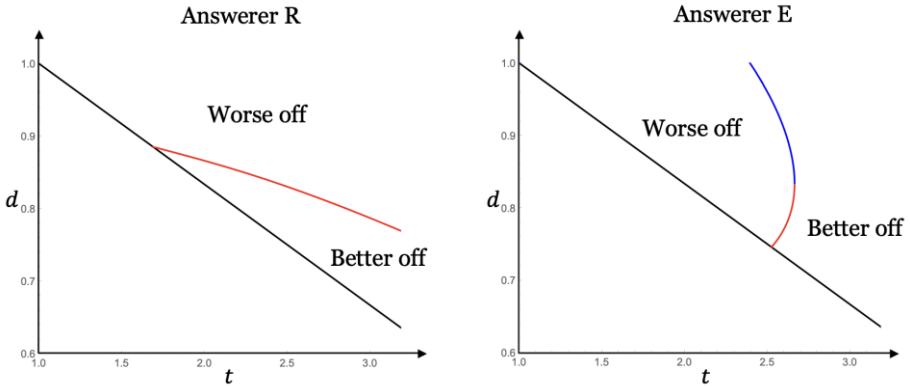


Figure 5. Answerers' Profit Comparison Across Benchmark and Main Model

Consumer Welfare Analysis

In this subsection, we first calculate the consumer surplus and then compare it across the benchmark and the main model. To calculate consumer surplus with and without the answer-viewing feature, we integrate users' utilities based on their locations and calculate the sum over all the user segments (as shown in Figures

[7] It can be analytical shown that $d_2 \geq d_1$.

2 and 3). Specifically, under the benchmark, there are three user segments, and we have $CS^B = \int_0^{\frac{-p_R+p_E+t}{2t}} (v - tx - p_R)\,dx + \int_{\frac{-p_R+p_E+t}{2t}}^{1} (v - t(1-x) - p_E)\,dx + \int_0^{\frac{v-p_E}{t}} (v - t\,y - p_E)\,dy$. Plugging back the equilibrium results derived from Lemma 1 into CS^B, we can calculate total consumer surplus under the benchmark. In a similar vein, we calculate consumer surplus in the main model. We summarize the results in the following lemma.

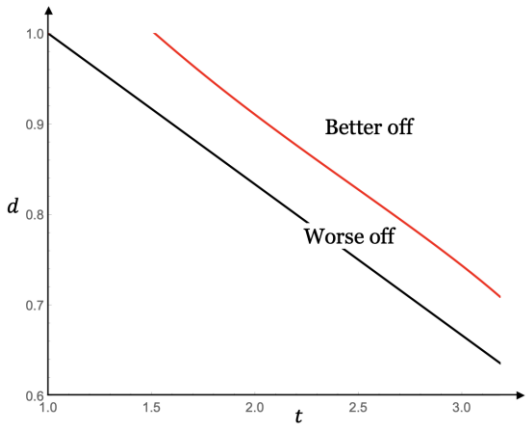
Lemma 5. Consumer surplus under the benchmark and main model is given by: $CS^{B*} = \frac{-40934t^2+6636tv+2499v^2}{47432t}$, $CS^{M*} = \frac{1}{32}(4(-5+(s-2)s) - 8d(s-1)v + \frac{(3+d(-6+d(-1+4t)))v^2}{-1+t})$, where CS^{B*} and CS^{M*} denote the consumer surplus under the benchmark and main model, respectively.

We then compare consumer surplus across the benchmark and the main model, and present the results in the following proposition (for illustration purposes, we depict the results in Figure 6).

Proposition 4. Users as a whole are better off under the answer-viewing feature only when $d \geq \hat{d}$.

Intuitively, one might think users should be better off when the platform adopts the answer-viewing feature since they have one more option of obtaining the answer on the platform and the answer-viewing fee is typically lower than the consulting price. Moreover, the expert answerer can expand his market coverage by converting users who would otherwise leave the platform to viewers, and hence, more users will have non-negative utilities, leading to a higher consumer surplus on the monopoly side. Despite the benefits brought by the answer-viewing feature, as shown in Proposition 4 and Figure 6, we find that users are not always better off, especially when the discounted value factor of viewing a non-personalized answer (i.e., d) is relatively small. The reason is as follows.

As suggested in Proposition 1, when d is relatively small, questioners may need to pay a higher consulting price under the answer-viewing feature. Moreover, when d is relatively small, the valuation of viewing a non-personalized answer is relatively low, and users will derive a lower valuation if not raising a question. All of these contribute to a lower consumer surplus with the answer-viewing feature. Therefore, we find that the answer-viewing feature cannot benefit users when d is relatively small. One key takeaway from this finding is that since users are not always better off with the answer-viewing feature, policymakers should devise appropriate policies to ensure Q&A platforms' adoption of this new feature in carefully selected situations.



(Parameter value: $v = 12; s = 6$)

Figure 6. Consumer Surplus Comparison Across Benchmark and Main Model

Based on Propositions 2-4, we further find that the adoption of the answer-viewing feature can benefit all key stakeholders. Specifically, the platform, answerers, and users can all be better off when both the discounted value of viewing a non-personalized answer (i.e., d) and the amount of answer-viewing revenue share (i.e., s) are relatively large. However, we find that the incentives of the platform and answerers towards the adoption of the answer-viewing feature may sometimes conflict with one another. Specifically, we find that when d is relatively small, answerers are better off with the answer-viewing feature, whereas the platform and consumers may be worse off adopting it. This finding sends an important message to

policymakers that they need to devise appropriate policies to protect answerers under certain circumstances. We also explore several extensions to our model, but their details and insights are omitted due to space limitations.

Conclusion

With the widespread user-generated content and users' increasing awareness of paying for online content, paid Q&A platforms have become a major place for people to share knowledge. Recently, a new feature, i.e., answer-viewing, adopted in the Q&A platforms, has drawn the attention of practitioners in this industry. Although the answer-viewing feature enables the platforms to open a new path for users to engage in knowledge sharing, it is not yet clear how this new feature impacts the platform and answerers. In this paper, we build a game-theoretic model to examine such impacts.

Our study generates several insights about the answer-viewing feature adopted on Q&A platforms. Firstly, although enabling the answer-viewing feature helps the platform generate another revenue source, we find that the platform is not always better off adopting this new feature since the additional answer-viewing revenue cannot offset the loss in commission revenue, especially when the valuation of viewing a non-personalized answer is relatively low. Moreover, one might intuit that answerers' revenue would decrease when the new feature is implemented since some users switch from raising a question to viewing a non-personalized answer. Interestingly, we find that answerers can be better off when the valuation of a non-personalized answer is relatively small since answerers can set a higher consulting price and the platform charges a lower commission on the consulting price. Another interesting finding is that while having a new way of participating on the platform, users are not always better off since they may sometimes pay a higher consulting price when this new feature is introduced. We also find that all key stakeholders can sometimes be better off when the new feature is implemented but their incentives are not always aligned.

Our research makes a few theoretical contributions. First, our work is among the first to analytically examine the impact of the answer-viewing feature, which allows users to pay a small amount of fee to view the non-personalized answers of questions raised by others, on different stakeholders. We add to the literature on Q&A platforms by analyzing the platform's optimal monetary design when the new feature is implemented. Second, prior studies on personalized pricing primarily focus on whether and how firms should use price discrimination strategies for their products. We contribute to this stream of literature by examining a unique type of price discrimination that is jointly provided by the platform and answerers. In addition, our work is one of the earliest attempts to analyze the difference between personalized and non-personalized knowledge products under the Q&A context. Third, on a broader level, our work contributes to the literature on platform pricing strategies by examining an interesting pricing scheme wherein the platform not only charges a commission from the other's product sales (answerer's consulting revenue) but also determines the price of a competitive product (answer-viewing fee). We fill the gap in the literature by exploring this pricing model on a Q&A platform. Our model can also be generalized to a broad context where the platform has a dual role in its pricing decisions.

Our results provide valuable managerial insights for all stakeholders of Q&A platforms. For example, our findings can help Q&A platforms decide whether and when to adopt the answer-viewing feature. Our results also send an important message to platforms that having a new revenue source may actually hurt them since the two revenue sources may sometimes conflict with each other. Furthermore, answerers need to be cautious when the platform adopts such a new feature. One feasible approach for answerers to get around the revenue loss is to switch to other Q&A platforms that have not yet launched the feature. Additionally, our consumer surplus analysis can inform policymakers on the potential dark side of the answer-viewing feature for the long-term health of the Q&A industry. Furthermore, it is possible that the incentives of the platform, answerers, and users are not aligned. In such a case, policymakers should devise appropriate policies to protect answerers and users from being exploited by the platform.

Our work is not without limitations and opens a door for future studies. For example, future research in this area can empirically test whether our theoretical results still hold with real-world data.

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