How Add-on Pricing Interacts with Distribution Contracts

Xianjun Geng*
Jindal School of Management, The University of Texas at Dallas, Richardson, Texas 75080, USA, geng@utdallas.edu

Our third finding focuses on the relationship between the commission rate and channel member profit under the agency contract. We show that a higher commission rate always results in a lower firm profit. Interestingly, a higher commission rate does not always result in a higher platform profit: This is because that, when the commission rate is already high, further increasing the rate triggers a strong loss-

result in a setting with downstream competition (Tan et al. 2016). Recent studies have focused on agency pricing in a broader setting. Abhishek et al. (2016) find that the cross-channel effect (i.e., brick-and-mortar retailing and online retailing) will influence the retailer's choice over the agency pricing and wholesale pricing. Kwark et al. (2016) show that the retailer can leverage the pricing model, wholesale or agency, as a strategic tool to benefit from online product reviews. Tian et al. (2017) find that the wholesale pricing will outperform the agency pricing in terms of profitability when the upstream competition between suppliers becomes intense. Hao et al. (2016) find that the advertising revenue-sharing contract under agency pricing for app sales leads to a higher app price than would be offered by the integrated platform found in traditional advertising. Unlike the aforementioned studies, the study investigates add-on pricing with the agency contract, which is prevalent in many industries. The interplay between these two components leads to new and important practical implications for managers.

Add-on pricing is a special case of unbundling where the add-on is valuable to a consumer only upon core-product purchase. Adams and Yellen (1976) and Schmalensee (1984) show that a firm can benefit from pure bundling when consumer valuations of products are either negatively correlated or independent. McAfee et al. (1989) show that mixed bundling almost always benefits a monopoly more than unbundling. Fang and Norman (2005) and Geng et al. (2005) consider the optimality of bundling a large number of products. Banciu et al. (2010) consider bundling of vertically differentiated products. Prasad et al. (2010) study bundling under network effects. Three recent papers consider bundling in a distribution channel and show that channel conflict may weaken a firm's incentive to bundle (Bhargava 2012), and bundling can serve as a channel-coordination mechanism (Cao et al. 2015a) and may improve firm profit under supply constraint (Cao et al. 2015b). Unlike the above papers, we consider agency pricing and are the first to show when and how channel contracts including agency pricing interact with add-on pricing.

3. M

We consider a distribution channel consisting of an upstream firm that provides products, a downstream online platform that intermediates sales, and a continuum of consumers.

3.1. F

charge a 30% commission fee for e-books (WSJ 2012). To reflect the fact that, in business practice, the firm

and bundling in stage 2, there are four possible subgames from stage 3 onward that differ in how prices are set:

- In the wholesale add-on (

firm charges a high add-on price $p_a^{WA} = v_a$ to extract the maximum possible amount of surplus from these consumers. A high add-on price is a signature dynamic in the add-on pricing literature: For example, the seminal papers Lal and Matutes (1994) and Gabaix and Laibson (2006) also find that the optimal add-on price equals the maximum add-on valuation. Intuitively, once a consumer purchases the core product, the consumer is locked in to the firm, and thus, the firm has no incentive to leave any add-on surplus to the consumer.[5] We next summarize equilibrium prices, demands, and profits under the wholesale bundle model.

LEMMA 2. *In the wholesale bundle model, the firm and the platform charge wholesale price* $w^{WB} = \frac{1}{2}(1 + \alpha v_a)$ *and retail price* $p^{WB} = \frac{3}{4}(1 + \alpha v_a)$ *for the bundle, respectively. The corresponding market demand is* $D^{WB} = \frac{1}{4}(1 + \alpha v_a)$. *The firm, platform and system's profits are* $\pi_F^{WB} = \frac{1}{8}(1 + \alpha v_a)^2$, $\pi_P^{WB} = \frac{1}{16}(1 + \alpha v_a)^2$, *and* $\pi_S^{WB} = \frac{3}{16}[1 + \alpha v_a]^2$, *respectively.*

For consumers who purchase both the core product and the add-on, it is straightforward from Lemmas 1 and 2 that they pay a lower total price under the wholesale bundle model (i.e., $\frac{3}{4} + \frac{3}{4}\alpha v_a$) than under the wholesale add-on model (i.e., $\frac{3}{4} + v_a - \frac{1}{4}\alpha(v_a - c_a)$). This is because the high-add-on-price strategy under

$p_c^{AA} = \frac{1}{2}\left[1 - \frac{\alpha(v_a - c_a)}{(1-\beta)}\right]$ vs. $w_c^{WA} = \frac{1}{2}[1 - \alpha(v_a - c_a)]$). Second, the higher the commission rate under the agency contract is, the stronger the loss-sharing effect becomes. Consequently, the firm cuts its price of the core product even deeper (as p_c^{AA} decreases in β) in order to capture an even larger revenue from the add-on (as D_a^{AA} increases in β). Overall, the loss-sharing effect positively affects the firm's profit as it keeps all revenue generated from the add-on, yet shares the loss caused by the price cut on the core product with the platform. Under the agency contract, this loss-sharing effect dominates the bundling effect; thus, the firm benefits more from add-on pricing than from bundling.

Note that Proposition 2 holds when the operational cost is not too high (i.e., $c_a \leq \beta v_a$ as assumed in the model setup). That is, it is not too expensive for the firm to sell the core product and the add-on separately. Otherwise, the firm would prefer bundling to add-on pricing to avoid the high operational cost of the latter.

The loss-sharing effect is unique to the agency contract, as the gain and loss between the firm and platform are tied together. The commission rate β governs the allocation of the revenue and has important implications on the profitability of both the firm and the platform, which we investigate next.

PROPOSITION 3. *In the agency bundle model, the firm's profit decreases while the platform's profit increases in β. In the agency add-on model, the firm's profit decreases in β. However, there exists a β_P^{AA} such that the platform's profit increases in β for $\beta \in \left(0, \beta_P^{AA}\right)$ and decreases in β for $\beta \in \left(\beta_P^{AA}, 1 - \alpha(v_a - c_a)\right)$.*

β is the proportion that the platform can keep from sales. An increase in this value suggests an additional gain by the platform but an additional loss for the firm. Consistent with this intuition, we find that as β's value increases, the platform's profit improves, while the firm's profit shrinks under the agency bundle model. Similarly, under the agency add-on model, we find that the firm's profit also decreases with the value of β.

Nevertheless and interestingly, the platform's profit is not monotonic in the value of β under the agency add-on model: Profit first increases and then decreases in β. To understand the intuition behind this result, note that there are two opposite dynamics, one direct and one indirect, that drive the platform's profit. First, a higher β directly results in a higher proportional cut of the core-product revenue, which benefits the platform profit. Second, a higher β also results in a stronger loss-sharing effect, which in turn causes the firm to further cut the price of the core product, thus indirectly hurting the platform's profit. Furthermore, this indirect dynamic strengthens when β increases: The firm's rate of price cutting accelerates as β gets larger, that is, $\frac{\partial p_c^{AA}}{\partial \beta} < 0$. Therefore, when β is relatively small (i.e., $\beta \leq \beta_P^{AA}$), an increment in β only triggers a mild price cut by the firm, the impact of which on the platform is dominated by the higher proportion of commission collected. When β becomes relatively large (i.e., $\beta > \beta_P^{AA}$); however, the firm gets aggressive in price cutting on the core product (due to the loss-sharing effect), which becomes the dominating dynamic that hurts the platform. As a result, we observe that the platform's profit first increases and then decreases in the commission rate.

4.3. [illegible] C [illegible] D [illegible] C [illegible]

We are now ready to analyze the platform's stage-1 strategy over the distribution contract, namely, whether to adopt the wholesale contract or the agency contract. As we have shown in propositions 1 and 2, on one hand, if the platform adopts the wholesale contract, then the firm will respond by choosing bundling. On the other hand, if the platform adopts the agency contract, then the firm will respond by choosing add-on pricing. As a result, the platform's strategy (i.e., wholesale or agency) boils down to the comparison of its profits under two subgames: the wholesale bundle model and the agency add-on model.

To proceed, we will first analyze a special case in which we set $c_a = 0$. This is followed by a discussion on how a positive operational cost c_a influences the findings. Examining this special case offers two benefits. First, it allows us to isolate and highlight how the commission rate β and market potential of add-ons αv_a shape the choice facing the platform. Second, we can leverage the insights derived from the special case to better illustrate the results obtained from the general case. In the following proposition, we summarize the platform's contract choice when the operational cost c_a is negligible. For convenience, define $u_P(\beta) \equiv \left[2\beta(1-\beta)\sqrt{2+\beta} - (1-\beta)^2\right]/(1+\beta)^2$ and $\frac{du_P(\beta)}{d\beta} > 0$.

PROPOSITION 4. *When $c_a = 0$, by comparing the platform's profits under the wholesale bundle model (π_P^{WB}) and the agency add-on model (π_P^{AA}), we have:*

(*i*) *If $\beta \leq 1/4$, then $\pi_P^{WB} > \pi_P^{AA}$.*
(*ii*) *If $\beta > 1/4$, then $\pi_P^{WB} > \pi_P^{AA}$ for $\alpha v_a > u_P(\beta)$, and $\pi_P^{WB} \leq$*

channel inefficiency. In the agency bundle model, however, the firm and platform are "virtually" vertically integrated, where the friction between the parties is resolved through the alignment of interest.

More importantly, Proposition 6 illustrates that the interaction between add-on pricing and distribution contracts will actually lead to a profit loss for the channel, as only the wholesale bundle and agency add-on strategies are possible in equilibrium. This result is new to the literature and has important practical implications as it demonstrates the influence of channel structure on add-on pricing. In the wholesale bundle model, it is clear that the double marginalization effect causes the channel performance to be suboptimal. In the agency add-on model, although the agency contract tends to mitigate the double marginalization effect and add-on pricing improves the firm's price discrimination, the combination of these two phenomena does not resolve the channel inefficiency. The root cause is again the loss-sharing effect: The firm tends to set the core product price low to lure more customers to purchase the add-on, which in turn results in the inefficiency of channel performance.

Collectively, the above results demonstrate that the interaction between add-on pricing and distribution contracts plays a critical role in channel performance. More specifically, it will lead to the inefficiency of the supply chain performance. Thus, one natural and intriguing question arises. What should be an appropriate commission rate to improve channel performance? The answer to this question will not only be theoretically interesting but also provide practical guidance to the managers in the relevant industries. We summarize our finding in the following proposition.

PROPOSITION 7. *When the operational cost c_a is relatively small, there exists a Pareto-improvement region of β such that both firm and platform profits are higher under the agency add-on model than under the wholesale bundle model.*

We reach this result by comparing both firm and platform profits under the wholesale bundle model and the agency add-on model. Although the agency contract can potentially improve channel performance by reducing double marginalization, it also needs to balance the allocation such that the channel improvement can pass to both platform and firm. Interestingly, we find that as long as the operational cost c_a is relatively small, a carefully chosen β value under the agency add-on model will lead to higher profits for both the firm and the platform (as compared to the wholesale bundle model). Consequently, the overall channel performance also improves. We illustrate this result in the following Figure 3 with different values of αc_a.

consumers are aware of the add-on price during their

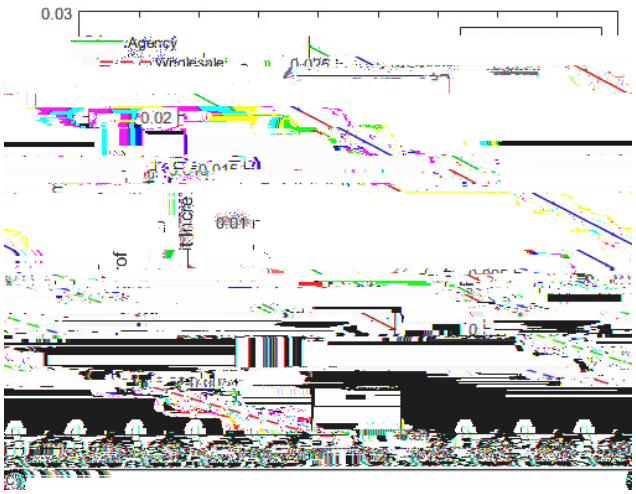
contract because the platform takes away a share of the core-product revenue under the agency contract. Consequently, the firm is more aggressive in cutting the core product price and raising the add-on price under the agency contract.

Case 1 in Lemma 6 represents the interior solution where the add-on price is not set to its upper bound v_a. This is the case when only a small proportion of consumers value the add-on (i.e., $\alpha < \frac{(1-\beta)(2v_a-2c_a-\beta)}{(2-\beta)(v_a-c_a)}$); thus, the strategy of aggressively cutting core price and raising add-on price will not lead to a significant increase in add-on revenue.

Next, we analyze the impact of this alternative timing structure on firm and platform strategies. Due to the complexity of the equilibrium results, we resort to a numerical study, which allows the main insights to take center stage rather than the technical complexities inherent to this alternative timing structure. Our objective here is to examine whether this alternative timing structure affects the key insight in our base model that add-on pricing synergizes better with the agency contract than the wholesale contract. To do so, for each of the contracts we numerically calculate the difference between the firm's profits under add-on pricing and bundling. We refer to this difference as the *profit increment*. For a given distribution contract, if the profit increment is positive, the firm then prefers add-on pricing. Figure 4 below provides a representative illustration of the profit increment under agency and wholesale contracts, respectively. We used parameter values $\alpha = 0.5$, $\beta = 0.3$, and $v_a = 0.3$ in this plot. We also tried a wide variety of parameter values for this plot, and the results are robust to the different parameter values.

In Figure 4, we observe that the profit increment under the agency contract (the blue line) is above the profit increment under the wholesale contract (the red dotted line). This numerical study thus confirms that our key insight in the base model, that is, that add-on pricing is more attractive to the firm (as compared to bundling) under the agency contract than under the wholesale contract, continues to hold in this model extension. Furthermore, Figure 4 clearly illustrates that there exists a range of values for c_a under which the profit increment is positive under the agency contract and negative under the wholesale contract. In other words, within this range of values for c_a, the firm will choose bundling under the wholesale contract but will choose add-on pricing under the agency contract, a result qualitatively in line with our propositions 1 and 2 under the base model.

Figure 4 Profit Increment under Agency and Wholesale Contracts [Color figure can be viewed at wileyonlinelibrary.com]



5.2. C 7w C A -

In our base model, we treated core product valuation and add-on valuation as two independent variables. One may argue that a customer who values the core product more tends to also value the add-on more, or alternatively, less, which corresponds to the positive and negative correlation cases, respectively.[9] We analyze both cases of correlated valuations in this extension. To capture the heterogeneity among consumers, we still assume that α proportion of the consumers value the add-on while the remaining consumers do not. For consumers who value the add-on, we allow their valuation of the add-on to take the form of $v_a + k\theta$, where the correlation strength k can take both positive and negative values. Recall that θ is a uniformly distributed random variable representing a consumer's valuation of the core product. Therefore, the above new form of add-on valuation immediately implies that the valuations of the add-on and the core products are correlated. In particular, if $k > 0$ $(k < 0)$, they are positively (negatively) correlated. All other model parameters remain the same as in the base model.

We next present the results of positive correlation and negative correlation separately. This is because the derivations for positive correlation and negative correlation are quite different. Specifically, the negative correlation case will significantly alter consumer behavior so that high valuation consumers may no longer purchase the add-on as in the positive correlation case.

5.2.1. , C . We first consider the case where core product valuation and add-on valuation are positively correlated (a consumer who values the core product more also values the add-on more). For example, it is reasonable to argue that a business traveler who is willing to pay more for a flight ticket (i.e., core product) is also likely to be willing to pay more for expedited check-in (i.e., add-on). We

demonstrates the robustness of our base model. Further, our analysis reveals that positive correlation can synergize with add-on pricing, which allows the firm to extract the revenue from the add-on; on the other hand, negative correlation is better allied with bundling, which can benefit the firm due to the reduction of valuation heterogeneity.

5.3. A

In this extension, we consider the scenario where the platform, in addition to receiving a commission

cases where the platforms choose not to enter the market, we assume that these reservation profits are smaller than any of the platform profits listed in Lemmas 1 to 4.

Given the contractual choices by both platforms in stage 0, there are four possible subgames: both platforms adopt wholesale, P1 adopts wholesale and P2 adopts agency, P1 adopts agency and P2 adopts wholesale, and both platforms adopt agency. Our next finding shows that, in equilibrium, the only sur-

under the wholesale contract, the firm prefers bundling because bundling enables the firm to better price discriminate consumers. Under the agency contract, however, the firm prefers add-on pricing. Our research shows that this result is driven by a loss-sharing effect that is unique to add-on pricing under the agency contract: The firm has incentive to cut the

[6]Our intuition that bundling can serve as a better tool for price discrimination (as compared to unbundling) is consistent with prior work in the bundling literature, such as the seminal papers Adams and Yellen (1976) and Schmalensee (1984).

[7]If the firm does not incur any operational cost when implementing add-on pricing, that is, if $c_a = 0$, the firm will earn the same profit under bundling and add-on pricing.

[8]Interestingly, while prior research often focuses on how a platform gains from agency pricing, little attention has been paid to the fact that a platform also loses when its member firms cut prices.

[9]We thank the SE and the three anonymous referees for

Tan, Y., J. Carrillo, H. K. Cheng. 2016. The agency model for digital goods. *Decis. Sci.* 47(4): 628–660.

Tian, L., A. Vakharia, Y. Tan, Y. Fan. 2017. Marketplace, reseller, or hybrid: A strategic analysis of an emerging e-commerce model. Working Paper.

Trejos, N. 2012. Travelers hit with fees every step of the trip. *USA Today*, October 15, 2012.

Verboven, F. 1999. Product line rivalry and market segmentation anpplictatin. to. ianeomob henlinepricieng. 47(4): Econ3998