On the Agency Model and the Wholesale Model

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Abstract

Agency model and wholesale model are the most widely adopted vertical contractual agreements in practice. The recent wide adoption of the agency model by online platforms gives rise to heat debate on its anti-competition effect. This paper compares the private incentives and social welfare between the agency and wholesale models by highlighting move order and price structure as their key differences. We show that both merchants and platform(s) have weaker incentives in adopting the agency model than the socially optimal level no matter whether there is platform competition. Switching to the agency model can improve social welfare under monopoly platform and subconvex demand (and unconditionally under duopoly platforms). Moreover, monopoly platform has a stronger incentive in adopting the agency model than merchants, but duopoly platforms collectively prefer the wholesale model. We apply our findings to antitrust cases and examine existing results obtained from less general demand.

Keywords: vertical relationship, agency model, wholesale model, successive oligopoly, antitrust

JEL codes: L1, L2, L4, D43

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1 Introduction

This paper characterizes a set of important and clear-cut results regarding the comparison of incentives and social welfare under the wholesale model and the agency model as contractual agreements between platform(s) and merchants. These two business models are the most widely adopted contractual forms between vertically related merchants (suppliers, upsteam firms) and platforms (retailers, downstream firms) in practice.

Following the definitions by Johnson (2017), under the wholesale model (WM), the platform procures products from the merchants and acts as a reseller; under the agency model (AM), the platform acts as an agent of the merchants and receives a proportion of the final price of the products as commission. There are two important distinctions between these two business models: move order (the late mover sets the price faced by consumers) and price structure (wholesale pricing or revenue sharing).

WM is a traditional reselling format of both brick-and-mortar retailers and online platforms. However, with the rise of e-commerce, several world largest online platforms such as Amazon and Taobao have broken away from WM and embraced AM. The wide adoption of AM by e-commerce platforms has raised some controversy and the attention from regulators. In 2012, the U.S. Department of Justice (DOJ) sued Apple and five major publishers for conspiring to raise ebook prices.[1] In the settlement, Apple and the publishers agree to return the price setting decision to the platforms (Apple and Amazon). Essentially, it forced the ebook industry to switch from AM back to WM. In 2018, the Supreme Court conducted a hearing concerning Apple App Store raised prices of apps by its monopoly position.[2] Apple argued that it does not set the retail prices of the apps under AM and is just a distributor,[3] so it cannot be sued by consumers.

In this paper, we investigate several important questions regarding the AM and WM. When do platform(s) prefer AM to WM? Is the platform's preferences aligned with the merchants and the consumers? Does switching from WM to AM improve or jeopardize social welfare as? Is the social welfare consistent with merchants or/and platforms' private interest selecting between AM and WM? Does having competing platforms change the answers to the above questions? The results from these questions clarify the private incentives of merchants and platforms in choosing their contractual agreements. With these results, we can examine the welfare implications of related antitrust cases. For example, from a welfare perspective, is it reasonable for DOJ to forge AM in the ebook case? Can Apple App Store use its market power to exploit consumer through AM given that there is competition from Android.

[1] See *United States of America v. Apple Inc., et al.*, 12 Civ. 2862, `www.justice.gov/atr/file/809946/download`. DOJ argued that AM played the key role in the conspiracy and won the case. The conspiracy between Apple and publishers is well documented with clear evidence. We do not tackle the collusion issue in this paper. Gu et al. (2018) show how upstream collusion can benefit downstream firms.

[2] See *Apple Inc. v. Robert Pepper, et al.*, US Supreme Court, No. 17-204 (2018) (`www.supremecourt.gov/oral_arguments/argument_transcripts/2018/17-204_32q3.pdf`).

[3] Apple charges a 30% proportional fee of the final price.

Taking move order and price structure as key distinctions between the WM and AM, we build a general model that formally investigates the private incentives and social welfare implications of AM and WM. We consider the cases of multiple merchants selling through a monopoly platform and duopoly platforms. Our main findings are as follow. First, with a monopoly platform, the private incentive of merchants and platform(s) in adopting AM is always weaker than socially optimal level. Adopting AM improves social welfare over WM under subconvex demand, but AM reduces social welfare under superconvex demand. However, when there are duopoly platforms, switching to AM always improves social welfare.

Second, when the platform is a monopoly, its incentives of adopting AM is much stronger than that of the merchants (though weaker than socially optimal level). Their incentives are partially coincide with each other. Conversely, with duopoly platforms, the merchants collectively prefer AM, while platforms prefer WM. Their preferences cannot be reconciled.

To understand these results, let us see the effect of move order and price structure on each party. Under either business model, there is a first mover (merchants in WM, platform(s) in AM) who sets the term of trade, and a second mover (platforms in WM, merchant(s) in AM) who sets the retail price (Johnson, 2017). The move order plays a crucial role in each party's incentive in choosing the equilibrium output level. The second mover makes its decision by taking the first mover's wholesale price (in WM) or commission rate (in AM) as given, which becomes part of the second mover's cost. Naturally, to produce more, the first mover has to set a lower wholesale price or commission rate. This results in a smaller marginal cost and a larger profit for the second mover, which also leads to a larger equilibrium output in the market.

Regarding the price structure, switching from wholesale pricing to revenue sharing shifts profit of second mover to first mover, but does not qualitatively alter the shape of profit functions. Hence, when equilibrium output is small, the merchants are worse off but the platforms are better off under AM. The situation reverses when equilibrium output is large. These is a set of such quantity that equalizes the profit of each party. These results are robust in the scenarios of monopoly platform and duopoly platforms.

With these results, we can analyze the incentive of the platform(s) and merchants as well as the social welfare by simply comparing a few important quantities: the equilibrium outputs under AM and WM, and the profit-equalizing output levels of each party. The comparison can be pinned down by the production costs together with the shape of demand function, more specifically, whether the demand is subconvex or superconvex (Mrázová and Neary, 2013, 2017).

Our results show that, with a monopoly platform, adopting AM should be able to improve social welfare over WM.[4] More importantly, it is not necessary, if not problematic, to ban the adoption of AM, as it must be improving social welfare if AM is adopted according to the self-interest of each party. Duopoly platforms have the incentive to both adopt WM. It is also beneficial to the society if the regulator promote AM.

[4]However, Gaudin and White (2014) find that adopting AM may exacerbate upstream collusion.

Literature review

The existing literature mainly focuses on the impact of the business model on retail prices and discuss factors affecting platforms' choice of adopting different business models.

Regarding the impact on retail prices, Johnson (2013) considers the lock-in effect of pricing and argues that, compared to AM, retailers who employ WM will initially set low prices but raise prices in the long run. Gaudin and White (2014) emphasize the importance of competition on complementary goods. They show that platforms under WM are willing to set low retail prices if the profit can be taken back from complementary goods. Similarly, Abhishek et al. (2015) find that AM leads to lower retail prices unless there are positive externalities from sales of complementary products. Foros et al. (2017) focus on the competition among platforms or merchants and find that AM results in higher prices than that under WM if competition among platforms is stronger than among merchants. Johnson (2017) consider the impact of "most favored nation" clause on retail prices and shows that such clause would undermine the efficiency gain of switching from WM to AM. De los Santos et al. (2018) show whether WM or AM results in higher retail prices depends on the relative bargaining power of the platform and merchant. The aforementioned papers are quite different in focus with ours.

As for factors affecting platforms' choice of business models. Hagiu and Wright (2014) consider the control right to be the key difference between these two models. The platforms have the control right under WM while the merchants are given the control right under AM. They point out control right should be given to the party whose information is more important in term of marketing activities. Condorelli et al. (2018) endogenize intermediaries' choice of WM and AM under asymmetric information. They show that intermediaries prefer AM when they have privileged information about consumers' valuations. Our paper emphases move order and price structure as the key differences between WM and AM, and show the choice depends on demand curvature, production costs, and platforms competition.

Since the impact of business models on retail price is in fact related to social welfare, our paper contributes to two strands of literature by combining them together. In the literature, Johnson (2017) is the closest to our paper. With general demand as ours, Johnson (2017) classifies four types of business models based on who set retail price and price structure. His most important findings include identifying a sufficient condition under which AM improves platform's profit, consumer surplus as well as social welfare, at the expense of merchants' profit. Our finding fully characterizes the sufficient and necessary conditions of platforms', merchants' as well as social welfare's incentive in adopting different business models, and show their incentives can be fully aligned with each other, or it was the incentive of merchants rather than platform is aligned with social welfare.

Our article is organized as follows. Section 2 analyzes the incentive of platform and merchants in adopting different business models under monopoly platform environment, which is extended in Section 3 to duopoly platforms case. Section 4 discusses application of our results and Section 5 concludes.

2 Monopoly Platform

Consider a monopoly platform (she) and $m \geq 1$ merchants (he/they) selling a homogeneous product. All merchants have the same constant marginal cost of production, $c \geq 0$. The platform controls the access to a group of consumers because of the distributional channels and/or information technologies, so the merchants must sell their products through the platform. Providing such intermediary service, the platform incurs a constant marginal cost of f for each unit of product transaction.

Merchants engages in quantity competition á la Cournot (1838). Denote the inverse demand of the product as $p(Q)$, where Q is the total quantity of all the merchants, i.e., $Q = \sum_{i=1}^{m} q_i$. Define Q_{max} as the minimum quantity that makes the price drops to zero, i.e., $Q_{max} \equiv \inf\{Q : p(Q) = 0, Q > 0\}$. The demand function is decreasing ($p'(Q) < 0$), continuous, and three-times differentiable. Assume that in the neighborhood of equilibrium, (i) the elasticity of demand, $\varepsilon(Q) \equiv \frac{-p(Q)}{p'(Q)Q} \geq 1$, so that marginal revenue is non-negative; and (ii) the concavity of demand, $\rho(Q) \equiv \frac{p''(Q)Q}{p'(Q)} > -2$, which implies that marginal revenue decreases with output.

At the beginning of the game, The platform chooses a contractual agreement with the merchants that leads to different timing and price structures. She either chooses the wholesale model or the agency model defined as follows:

Wholesale model (WM). Merchants move first by choosing their quantities simultaneous, which leads to an equilibrium wholesale price $t \geq 0$. Given t, the platform purchases Q units of products from the merchants and resales these products to the consumers.

Agency model (AM). The platform moves first by setting a proportional fee (or commission rate) $\tau \in (0, 1)$ of the price of the product. Given τ, merchants choose their quantities simultaneously, which leads to an equilibrium price p of product.[5]

Hence, if the platform chooses WM, she is the second mover, while the merchants are the first mover. In contrast, if she becomes the first-mover under AM.

2.1 Equilibrium under WM

We solve the game from backward, starting with the platform's program. Suppose the merchants sell the product to the platform at the wholesale price t. Given t, the platform determines how much to procure from the merchants by its derived demand $Q^w(t)$ from the market of final consumers. The platform's profit is

$$\Pi_P^w = [p(Q) - t - f]Q.$$

[5]For example, iOS users can only purchase apps from developers through the Apple App Store. Apple charges a 30% proportional fee as commission.

The first-order condition (FOC) yields[6]

$$p'(Q)Q + p(Q) = f + t. \tag{1}$$

The wholesale market demand, $Q^w(t)$, is derived from the final product market. By condition (1), the inverse demand of the wholesale market is

$$t^w(Q) = p(Q) - f + p'(Q)Q.$$

Consider a generic merchant i. His profit is

$$\pi_i^w(Q) = (t^w(Q) - c)q_i = \left[p(Q) + p'(Q)Q - c - f\right] q_i \tag{2}$$

The equilibrium quantity is determined by Cournot competition among m merchants with the above profit function. The FOC of merchant i's problem is

$$p'(Q)Q + p(Q) - c - f + q_i\left[p''(Q)Q + 2p'(Q)\right] = 0.$$

In the symmetric equilibrium,[7] each merchant produce $1/m$ of the total quantity, so

$$c + f = p'(Q)Q + p(Q) + \frac{1}{m}\left[p''(Q)Q + 2p'(Q)\right] Q. \tag{3}$$

Condition (3) determines a unique optimal output, Q_O^w, under WM. Other endogenous variables such as wholesale price and final-product price can be calculated based on Q_O^w.

2.2 Equilibrium under AM

Under AM, the platform is the first-mover and sets a proportional fee, $\tau \in (0,1)$, that claims a share of merchants' final price, so her profit is $\Pi_P^a = [\tau p(Q) - f]\, Q$. Given τ, merchants simultaneously chooses quantity of supply based on Cournot competition of final consumers. Merchant i's profit is

$$\pi_i^a = [(1-\tau)p(Q) - c]\, q_i.$$

With symmetry, the FOC yields

$$(1-\tau)\left[\frac{1}{m}p'(Q)Q + p(Q)\right] = c.$$

[6] $\varepsilon \geq 1$ and $\rho > -2$ are sufficient to guarantee platform's profit functions are well behaved, i.e., the equilibrium is unique and stable.

[7] By assuming $\frac{\partial^2 \pi_i^w}{\partial q_i^2} < 0$ and $\frac{\partial^2 \pi_i^w}{\partial q_i \partial q_k} < 0$ for all $k \neq i$, this equilibrium is unique and stable.

This FOC implies that, given merchant's best responses, the platform's unit revenue is

$$\tau p(Q) = p(Q) - c + \frac{cp'(Q)Q}{p'(Q)Q + mp(Q)}. \tag{4}$$

The platform's profit is

$$\Pi_P^a(Q) = [\tau p(Q) - f]\,Q = [p(Q) - c - f]\,Q + \frac{cp'(Q)Q^2}{p'(Q)Q + mp(Q)}.$$

Treating Q as the choice variable, the platform's FOC is

$$\begin{aligned} c + f &= p'(Q)Q + p(Q) - \frac{c\,[p''(Q)Q + (m+1)p'(Q)]\,p'(Q)Q^2}{[p'(Q)Q + mp(Q)]^2} + \frac{c\,[p''(Q)Q + 2p'(Q)]\,Q}{p'(Q)Q + mp(Q)} \\ &= p'(Q)Q + p(Q) - \frac{c\left[\frac{p''(Q)Q}{p'(Q)} + m + 1\right]}{\left[1 + m\frac{p(Q)}{p'(Q)Q}\right]^2} + \frac{c\left[\frac{p''(Q)Q}{p'(Q)} + 2\right]}{1 + m\frac{p(Q)}{p'(Q)Q}} \\ &= p'(Q)Q + p(Q) - \frac{c(\rho + m + 1)}{(1 - m\varepsilon)^2} + \frac{c(\rho + 2)}{1 - m\varepsilon} \end{aligned} \tag{5}$$

Condition (5) determines the optimal output, Q_O^a, under AM. The assumption of $\rho(Q) \equiv \frac{p''(Q)Q}{p'(Q)} > -2$ implies that $\Pi_P^a(Q)$ Q_O^a is strictly concave, so Q_O^a is unique.

2.3 Comparison

Profit functions

To make comparison, we first derive some properties of profit functions under different business models. Under WM, by plugging condition (1) into Π_P^w, the platform's profit is

$$\Pi_P^w(Q) = -p'(Q)Q^2,$$

which obviously is increasing with Q. For merchants, by (2), the joint profit of merchants is

$$\Pi_M^w(Q) = m\pi_M^w(Q) = \left[p(Q) + p'(Q)Q - c - f\right]Q,$$

which is an inverse U-shaped function of quantity.

Under AM, the platform's profit is

$$\Pi_P^a(Q) = [p(Q) - c - f]\,Q + \frac{cp'(Q)Q^2}{p'(Q)Q + mp(Q)},$$

which is inverse U-shaped function of quantity. By plugging (4) into $\pi_M^a(Q)$, the merchants' joint profit can be written as

$$\Pi_M^a(Q) = m\pi_M^a(Q) = -\frac{cp'(Q)Q^2}{p'(Q)Q + mp(Q)},$$

which increases in quantity.

With these expressions, we can easily show that:

Lemma 1. *For $Q \in [0, Q_{max}]$,*

(i) the platform's profit increases in Q under WM, but exhibits an inverse U-shaped in Q under AM;

(ii) the merchants' joint profit exhibits an inverse U-shaped in Q under WM, but increases in Q under AM.

Based on $\Pi_P^w(Q)$ and $\Pi_P^a(Q)$, the platform's profits have the following features. First, $\lim_{Q\to 0}\Pi_P^w(Q) = \lim_{Q\to 0}\Pi_P^a(Q) = 0$ and $\lim_{Q\to 0}\frac{\partial \Pi_P^w(Q)}{\partial Q} = 0 < \lim_{Q\to 0}\frac{\partial \Pi_P^a(Q)}{\partial Q} = p(0) - c - f$, indicating that AM yields higher profit to the platform when quantity is small. Second, $\lim_{Q\to Q^{\max}}\Pi_P^w(Q) > \lim_{Q\to Q^{\max}}\Pi_P^a(Q) = 0$, indicating that WM is preferred when quantity is large. Because both $\Pi_P^w(Q)$ and $\Pi_P^a(Q)$ are continuous in Q, we can conclude that, as quantity Q increases, $\Pi_P^w(Q)$ should first cross $\Pi_P^a(Q)$ from bottom and finally become larger than $\Pi_P^a(Q)$.[8] It guarantees the existence of a quantity, Q^c, that equalizes the profits under two business model, i.e., $\Pi_P^w(Q) = \Pi_P^a(Q)$, or equivalently,

$$p'(Q)Q + p(Q) + \frac{cp'(Q)Q}{p'(Q)Q + mp(Q)} = c + f. \tag{6}$$

Because the joint profit of the platform and merchants is the same under both business models,

$$\Pi_P^w(Q) + \Pi_M^w(Q) = \Pi_P^a(Q) + \Pi_M^a(Q) = [p(Q) - c - f]\,Q, \tag{7}$$

Q^c also equalizes the merchants' profit under two contractual agreements. In summary, condition (6) is a necessary and sufficient condition for both $\Pi_P^w(Q) = \Pi_P^a(Q)$ and $\Pi_M^w(Q) = \Pi_M^a(Q)$.

Note that the left-hand side of (6) can be non-monotone in Q, so there may be multiple solutions. More precisely, when demand is subconvex,[9] the equation has a unique solution. However, when demand is superconvex,[10] the equation might have multiple solutions. We denote the set of solution

[8] They may cross each other multiple times.

[9] A demand function is *subconvex* if it is less convex than the constant elasticity (CES) demand function (Mrázová and Neary, 2013, 2017). Subconexity implies that demand elasticity decreases with the quantity of consumption, which means that consumers are more responsive to price changes when they consume more. Subconvexity is also known as the Marshall's second law of demand. Marshall (1920) argues that subconvex demand is the normal case, and Krugman (1979) shares the same view. Subconvexity encompasses many widely-used non-CES preferences such as linear, quadratic (to be considered further below), Stone-Geary, and translog preferences.

[10] A demand function is *superconvex* if it is more convex than the CES demand function, which implies that demand elasticity increases with the quantity of consumption. CES preference is both weakly subconvex and superconvex.

to (6) as $\Omega = \{Q^c : \Pi_M^w(Q^c) = \Pi_M^a(Q^c)\}$. Let $Q^c_{\min} = \min \Omega$ and $Q^c_{\max} = \max \Omega$. The following proposition summarizes the results above.

Proposition 1. *There exists a non-empty set of quantity Ω of which every element $Q^c \in \Omega$ satisfies $\Pi_P^w(Q^c) = \Pi_P^a(Q^c)$ and $\Pi_M^w(Q^c) = \Pi_M^a(Q^c)$. Moreover,*

(i) for $Q < \min\{Q^c\} = Q^c_{\min}$, $\Pi_P^w(Q) < \Pi_P^a(Q)$, $\Pi_M^w(Q) > \Pi_M^a(Q)$;

(ii) for $Q > \max\{Q^c\} = Q^c_{\max}$, $\Pi_P^w(Q) > \Pi_P^a(Q)$, $\Pi_M^w(Q) < \Pi_M^a(Q)$.

Proposition 1 links profit comparison to quantity comparison: When quantity is small ($Q < \min\{Q^c\}$), AM is more preferred to platforms but not merchants; when quantity is large ($Q > \max\{Q^c\}$), WM is more preferred to merchants but not platforms.

Welfare

Under Cournot competition, comparing welfare under two business models is equivalent to comparing the equilibrium quantities, Q_O^a and Q_O^w. These two quantities are determined by conditions (3) and (5), respectively. AM generates a higher welfare if and only if $Q_O^a > Q_O^w$. By substituting (3) into (5),

$$Q_O^a > Q_O^w \Longleftrightarrow f > -p(Q_O^w)\frac{\left[\varepsilon\left(\rho+1\right)+1\right]\left(\rho+m+1\right)}{\varepsilon\left\{m\left[\varepsilon\left(\rho+2\right)+1\right]-1\right\}} = \hat{f}_O, \tag{8}$$

where ε and ρ are demand elasticity and concavity. Because Q_O^w, ε, and ρ are endogenous, the relative magnitude of Q_O^a and Q_O^w depends on m, c and f.

Under the assumptions that $\varepsilon \geq 1$ and $\rho > -2$, both $\rho + m + 1$ and $\varepsilon\left\{m\left[\varepsilon\left(\rho+2\right)+1\right]-1\right\}$ are positive. However, the sign of $\varepsilon\left(\rho+1\right)+1$ is ambiguous. According to Mrázová and Neary (2013, 2017), CES preferences imply $\varepsilon(\rho+1)+1 = 0$. If demand is subconvex, then $\varepsilon(\rho+1)+1 > 0$; Conversely, if demand function is superconvex, then $\varepsilon(\rho+1)+1 < 0$.

Therefore, when demand is subconvex, $\hat{f}_O < 0$, so (8) always holds. It implies that AM yields higher equilibrium quantity and social welfare. When demand is superconvex, condition (8) fails when f is sufficiently small such that $f \leq \hat{f}_O$. In this case, WM results in higher welfare. Therefore, we have the following Proposition.

Proposition 2. *With a monopoly platform, AM leads to a greater social welfare than WM if and only if condition (8) holds. The demand function being subconvex is a sufficient condition for (8).*

Platform's profit

With Proposition 1, we are able to compare the platform's equilibrium profit under two business models by comparing the quantities Q^c, Q_O^w and Q_O^a. As Proposition 2 characterizes the comparison of Q_O^w and Q_O^a, we only need to compare Q^c with Q_O^a and Q_O^w, respectively.

Strict superconvexity is less widely encountered; an example is where the inverse demand function has a constant elasticity relative to a displaced or "translated" level of consumption. For example, $p = a(Q-\gamma)^{-1/\eta}$ with strictly positive γ (Mrázová and Neary, 2013).

Firstly, we compare an arbitrary $Q^c \in \Omega$ with Q_O^a. These two quantities are characterized by conditions (6) and (5). We can show that

$$Q^c > Q_O^a \Longleftrightarrow \varepsilon(\rho+1)+1>0. \tag{9}$$

Hence, the demand function being subconvex is a necessary and sufficient condition for $Q^c > Q_O^a$.

Secondly, we compare an arbitrary $Q^c \in \Omega$ with Q_O^w. These two quantities quantities are characterized by conditions (6) and (3), so

$$Q^c > Q_O^w \Longleftrightarrow f > -p(Q_O^w)\frac{\varepsilon(\rho+1)+1}{\varepsilon} = \tilde{f}_O. \tag{10}$$

When demand is subconvex, this condition always holds as the right-hand side is negative. Moreover, $\tilde{f}_O > \hat{f}_O$ when demand is superconvex.

Combining conditions (8), (9) and (10), we have the following conclusion.

Proposition 3. *With a monopoly platform,*

(i) if demand is subconvex or constant-elasticity, i.e., $\varepsilon(\rho+1)+1 \geq 0$, *then* $Q_O^w < Q_O^a \leq Q^c$ *and* $\Pi_P^w(Q_O^w) < \Pi_P^a(Q_O^a)$*;*

(ii) if demand is superconvex, i.e., $\varepsilon(\rho+1)+1<0$, *there exists two thresholds* $0 < \hat{f}_O < \tilde{f}_O$*:*

- *(a) for* $f \leq \hat{f}_O$, $Q^c < Q_O^a \leq Q_O^w$ *and* $\Pi_P^w(Q_O^w) > \Pi_P^a(Q_O^a)$*;*
- *(b) for* $\hat{f}_O < f < \tilde{f}_O$, $Q^c < Q_O^w < Q_O^a$ *and* $\Pi_P^w(Q_O^w) \gtrless \Pi_P^a(Q_O^a)$*;*
- *(c) for* $\tilde{f}_O \leq f$, $Q_O^w \leq Q^c < Q_O^a$ *and* $\Pi_P^w(Q_O^w) < \Pi_P^a(Q_O^a)$.

Proposition 3 unambiguously compares platform's equilibrium profits under AM and WM except for the case that $\hat{f}_O < f < \tilde{f}_O$. When $\hat{f}_O < f < \tilde{f}_O$, by switching from AM to WM, on one hand, the platform increases profit at the same quantity; on the other hand, such switch reduces equilibrium quantity ($Q_O^w < Q_O^a$), which reduces platform's profit at WM. Therefore, the profit comparison relies on the net effect of these two forces.

Figure 1 demonstrates the platform's profit comparison and the relationship of Q^c, Q_O^a and Q_O^w in a special case when platform has zero cost.

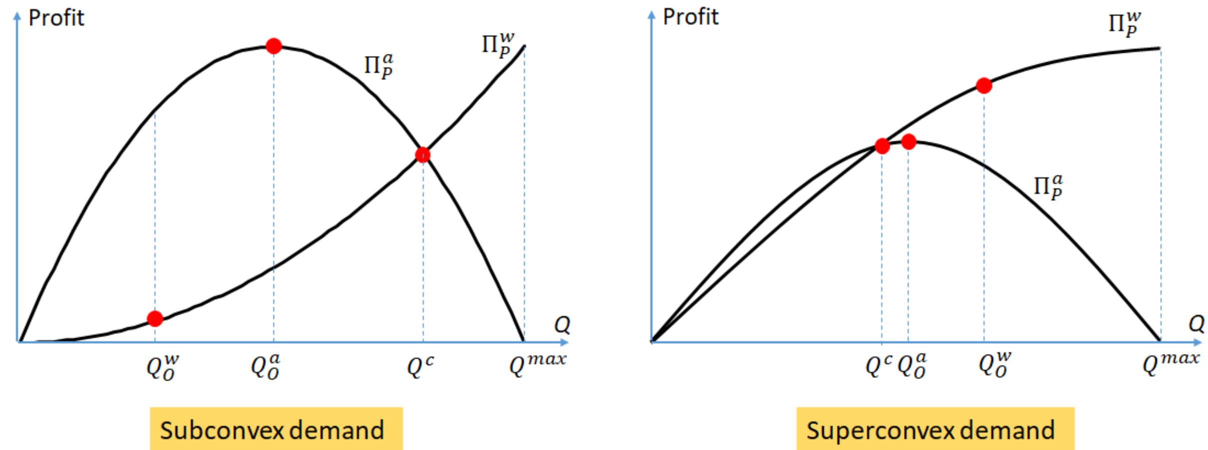

Figure 1: Platform's Profit When f=0

Merchants' profit

Similarly, by combining conditions (8), (9), and (10), we have the following Proposition that compares merchants' equilibrium profits under AM and WM.

Proposition 4. *With a monopoly platform,*

(i) if demand is subconvex or constant elasticity, i.e., $\varepsilon\,(\rho+1)+1 \geq 0$, *then* $\Pi^w_M(Q^w_O) > \Pi^a_M(Q^a_O)$*;*

(ii) if demand is superconvex, i.e., $\varepsilon\,(\rho+1)+1 < 0$, *there exists two thresholds* $0 < \hat{f}_O < \tilde{f}_O$*:*

- *(a) for* $f \leq \hat{f}_O$, $\Pi^w_P(Q^w_O) \gtrless \Pi^a_P(Q^a_O)$*;*
- *(b) for* $\hat{f}_O < f < \tilde{f}_O$, $\Pi^w_M(Q^w_O) < \Pi^a_M(Q^a_O)$*;*
- *(c) for* $\tilde{f}_O \leq f$, $\Pi^w_M(Q^w_O) \gtrless \Pi^a_M(Q^a_O)$*.*

When demand is subconvex, merchants collectively prefer WM. Conversely, when demand is superconvex and $\hat{f}_O < f < \tilde{f}_O$, merchants prefer AM. On the other cases, when $f < \hat{f}_O$, switching from WM to AM, on one hand, increases merchants' profit at the same quantity; on the other hand, such switch reduces equilibrium quantity ($Q^a_O < Q^w_O$), which reduces merchants' profit at AM. Similarly, when $\tilde{f}_O \leq f$, switching from WM to AM, on one hand, reduces merchants' profit at the same quantity; on the other hand, such switch increases equilibrium quantity (i.e., $Q^w_O < Q^a_O$), which increases merchants' profit at AM. Therefore, the profit comparison relies on the net effect of these two forces.

Figure 2 illustrates the merchants' profit comparison and the relationship of Q^c, Q^a_O, and Q^w_O when $f = 0$.

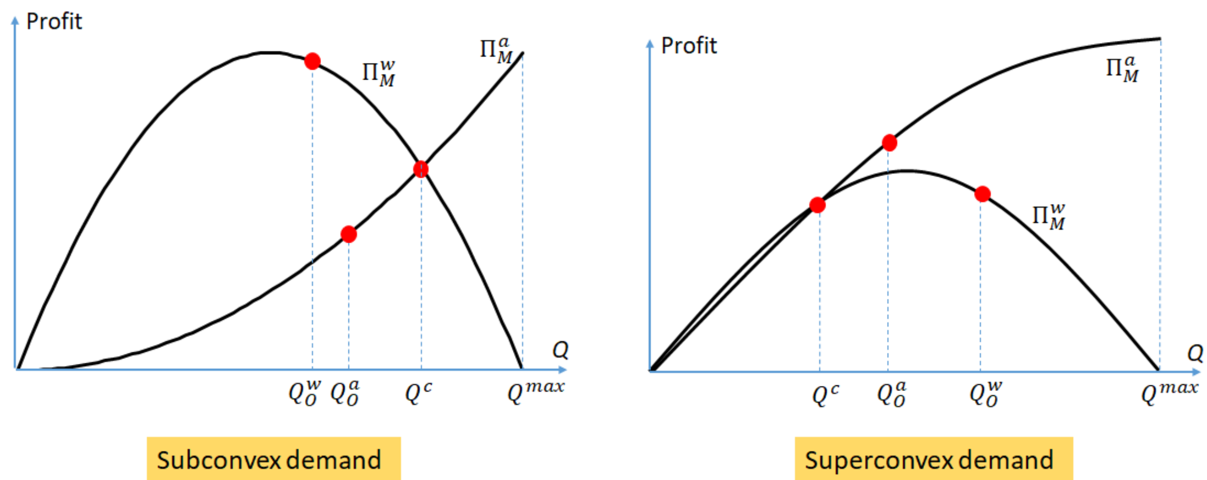

Figure 2: Merchants' Joint Profit When f=0

2.4 Discussion

Propositions 2-4 uncover the conflict and alignment among the platform's profit, the merchants' interests, and the social welfare in the selection of AM and WM. In summary, our main results are as follows.

1. When demand is subconvex or constant-elasticity, AM leads to larger social welfare ($Q_O^w < Q_O^a$); platform chooses AM, but merchants prefer WM.

2. When demand is superconvex and $f \leq \hat{f}_O$, WM results in larger social welfare ($Q_O^w > Q_O^a$). Platform chooses WM. Merchants prefer AM when quantity increment ($Q_O^w - Q_O^a$) is small, and prefer WM when quantity increment is large.

3. When demand is superconvex and $\hat{f}_O < f < \tilde{f}_O$, AM leads to larger social welfare ($Q_O^w < Q_O^a$). Platform prefers WM when quantity increasing ($Q_O^a - Q_O^w$) is small, but prefers AM when quantity increasing is large. Merchants prefers AM.

4. When demand is superconvex and $\tilde{f}_O \leq f$, AM results in larger social welfare ($Q_O^w < Q_O^a$). Platform chooses AM; merchants prefer WM when quantity increasing ($Q_O^a - Q_O^w$) is small, but prefer AM when quantity increasing is large.

The above results show that the monopoly platform's incentive in choosing AM is weaker than social optimal level. This conclusion has explicit policy implications. Compared to WM, the monopoly platform employing AM based on its self-interest always improves social welfare. Therefore, when dealing with merchants' complaint about AM, the regulators should aware that AM leads to more output and greater social welfare despite that AM might harm the merchants. However, when merchants complaint about WM, regulators should investigate the case seriously as it may reduce social welfare as well.

This observation has an important implication on the ebook case: The publisher's desire for AM might improve social welfare. It causes concerns on the DOJ's settlement with publishers that prohibit the use of AM because it may actually harm the consumers. In that case, before the entry of Apple to the ebook market, Amazon is the monopoly platform chooses WM while publishers prefer AM. According to the model prediction, when $\hat{f}_O < f < \tilde{f}_O$ and $Q_O^a - Q_O^w$ is small, WM will reduce both publishers' profit and social welfare. Therefore, given that collusion has been prohibited, banning AM directly might reduce social welfare. The publishers' desire for AM should be taken into consideration carefully.

3 Duopoly Platforms

In many markets, there is platform-level oligopolistic competition. For instance, in the ebook market, there is Amazon versus Apple; in the mobile app market, there is Apple App Store versus Google Android. In this section, we investigate whether platform competition affect the incentives and welfare implication in selecting AM and WM.

Consider the case of duopoly platforms indexed by $j = 1, 2$. Each platform affiliates with $m/2$ merchant(s), where m is an even integer greater than two. Each merchant can only sell to final consumers through its affiliated platform, i.e., seller-side multi-homing is not allowed. Under WM, merchants within each platform first engage in Cournot competition in selling their products to their affiliated platform, and then, two platforms compete for the same group of consumers á la Cournot. Under AM, each platform first sets a proportional fee to their affiliated merchants, and then all merchants compete with each other á la Cournot for final consumers. Other settings remain the same as Section 2.

3.1 Equilibrium under WM

Under WM, suppose the $m/2$ competing merchants on platform $j \in \{1, 2\}$ sell product to platform j at price t_j, then the platform j's profit is $\Pi_j^w = [p(Q) - t_j - f]\, Q_j^w$, where Q_j^w is the platform j's output. The FOC, $\frac{\partial \Pi_j^w}{\partial Q_j^w} = 0$, leads to:

$$p'(Q)Q_j^w + p(Q) = f + t_j. \tag{11}$$

Summing up over j to have:

$$\frac{1}{2}p'(Q)Q + p(Q) = f + \frac{t_1 + t_2}{2}. \tag{12}$$

The profit of merchant i' in platform j is $\pi_{ij}^w = [t_j(Q_j^w) - c]q_{ij}$. When the merchants in platform j compete with each other, as the first movers, they need to consider the responses by both the affiliated platform and the non-affiliated one. Mathematically, differentiate (12) with respect to Q_j^w

to capture the response from non-affiliated platform, we have

$$\frac{\partial Q}{\partial Q_j^w} = \frac{1}{p''(Q)Q + 3p'(Q)} \frac{\partial t_j}{\partial Q_j^w}.$$

Then, differentiate (11) with respect to Q_j^w and plug in $\frac{\partial Q}{\partial Q_j^w}$ to capture the effect of merchants adjusting quantity on wholesale price, we have

$$\frac{\partial t_j}{\partial Q_j^w} = \frac{2p'(Q)\left[p''(Q)Q + 3p'(Q)\right]}{p''(Q)Q + 4p'(Q)}.$$

This can be further plug into merchant i's FOC $\frac{\partial \pi_{ij}^w}{\partial q_{ij}} = 0$. Because $Q_j^w = \sum_{i=1}^{\frac{m}{2}} q_{ij}$ and $\frac{\partial t_j}{\partial q_{ij}} = \frac{\partial t_j}{\partial Q_j^w}$, by symmetry, we obtain

$$c + f = p'(Q)Q + p(Q) - \frac{p'(Q)Q\left[(m-4)\,p''(Q)Q + 4\,(m-3)\,p'(Q)\right]}{2m\left[p''(Q)Q + 4p'(Q)\right]}, \tag{13}$$

which will determine a unique equilibrium total output Q_D^w.

Let Q^{**} be the quantity that maximize the joint profit of merchants and two platforms, $\Pi = [p(Q) - f - c]Q$. Q^{**} is determined by the FOC

$$c + f = p'(Q)Q + p(Q) \tag{14}$$

Compare (13) and (14, we find that $Q_D^w > Q^{**}$ if $m \geq 4$. To ensure that the duopoly market produce results in a greater equilibrium output than the fully integrated monopoly market, we assume that $m \geq 4$ (each platform is affiliated with at least two merchants) for the rest of the analysis.

3.2 Equilibrium under AM

Under AM, the profit of merchant i in platform j is $\pi_{ij}^a = \left[(1-\tau_j)\,p(Q) - c\right] q_{ij}$. The FOC leads to

$$(1-\tau_j)\left[\frac{2}{m}p'(Q)Q_j^a + p(Q)\right] = c. \tag{15}$$

Summing up the above equation over j to have:

$$\frac{1}{m}p'(Q)Q + p(Q) = \frac{c}{2}\left(\frac{1}{1-\tau_1} + \frac{1}{1-\tau_2}\right). \tag{16}$$

Differentiate (15) and (16) with respect to τ_j, we have

$$\begin{aligned}\frac{\partial Q}{\partial \tau_j} &= \frac{\left[p'(Q)Q + mp(Q)\right]^2}{2mc\left[p''(Q)Q + (m+1)p'(Q)\right]} \\ \frac{\partial Q_j^a}{\partial \tau_j} &= \frac{\left[p'(Q)Q + mp(Q)\right]^2\left[p''(Q)Q + (m+2)p'(Q)\right]}{4mcp'(Q)\left[p''(Q)Q + (m+1)p'(Q)\right]}.\end{aligned}$$

Platform j's profit is $\Pi_j^a = \left[\tau_j p(Q) - f\right] Q_j^a$. Plugging $\frac{\partial Q}{\partial \tau_j}$ and $\frac{\partial Q_j^a}{\partial \tau_j}$ into the FOC $\frac{\partial \Pi_j^a}{\partial \tau_j} = 0$, by symmetry, we obtain

$$\begin{aligned} c + f &= p'(Q)Q + p(Q) - p'(Q)Q\frac{p''(Q)Q + (m+1)p'(Q)}{p''(Q)Q + (m+2)p'(Q)} \\ &\quad + cp'(Q)Q\frac{\left[p''(Q)Q + 2p'(Q)\right]\left[p'(Q)Q + mp(Q)\right] + 2mp(Q)\left[p''(Q)Q + (m+1)p'(Q)\right]}{\left[p'(Q)Q + mp(Q)\right]^2\left[p''(Q)Q + (m+2)p'(Q)\right]} \end{aligned} \tag{17}$$

which will determine a unique equilibrium output Q_D^a.

3.3 Comparisons

Similar to the monopoly platform case, we are going to compare the social welfare and profits of platforms and merchants under two business models.

Welfare

The welfare comparison between WM and AW is equivalent of comparing the equilibrium quantities, Q_D^a and Q_D^w. By substituting (13) into (17), we find that

$$Q_D^a > Q_D^w \Longleftrightarrow f > -p(Q_D^w)\kappa(\varepsilon, \rho, m) = \hat{f}_D, \tag{18}$$

where $\kappa(\varepsilon, \rho, m) = \frac{(\rho+2)\left\{(\rho+2)\varepsilon\left[\left(m^2-2\right)\varepsilon+(m+6)\right]+\left[m\varepsilon^2\left(m^2-4\right)+m(2\varepsilon+1)+2\right]\right\}+\left[2m\varepsilon^2(m-2)^2+4\varepsilon(m-2)+2m\right]}{2\varepsilon(\rho+4)\left[(m\varepsilon-1)(\rho+2)+2m\varepsilon(\rho+m+1)\right]} > 0$ for $m \geq 2$, given $\varepsilon \geq 1$ and $\rho > -2$. Therefore, we have $\hat{f}_D < 0$ and then always have $f > \hat{f}_D$, and thus $Q_D^a > Q_D^w$. Hence, we can conclude that

Proposition 5. *When there is duopoly platforms, AM leads to a greater social welfare than WM.*

Platforms' profit

Notice, because two platforms are symmetric, the profit comparison of platforms between different business models is equivalent to compare the profit of the joint platforms. Recall that the profit equalizing quantity Q^c is determined by (6), that is, $c+f = p'(Q)Q+p(Q)+\frac{cp'(Q)Q}{p'(Q)Q+mp(Q)}$. Compared Q^c with $Q^c < Q^{**}$ determined by (14), because $\frac{cp'(Q)Q}{p'(Q)Q+mp(Q)} < 0$, we have $Q^c < Q_D^w < Q_D^a$.

Based on the quantities comparison and Figure 3, we can conclude that (i) when demand is subconvex, $\Pi_P^a(Q_D^a) < \Pi_P^w(Q_D^w)$; (ii) when demand is superconvex, $\Pi_P^a(Q_D^a) < \Pi_P^a(Q_O^a) <$

$\Pi_P^w(Q_O^a) < \Pi_P^w(Q_D^w)$. For (ii), the first inequality results from that monopoly platform achieves larger profit than joint profit of duopoly platforms; the second inequality results from that $Q_O^a > Q^c$ when demand is superconvex; and the third inequality results from that $\Pi_P^w(Q)$ increases in Q, and $Q_D^w > Q^{**} > Q_O^a$. Therefore, no matter the demand function is subconvex or superconvex, the platforms must be better off if they adopt WM.

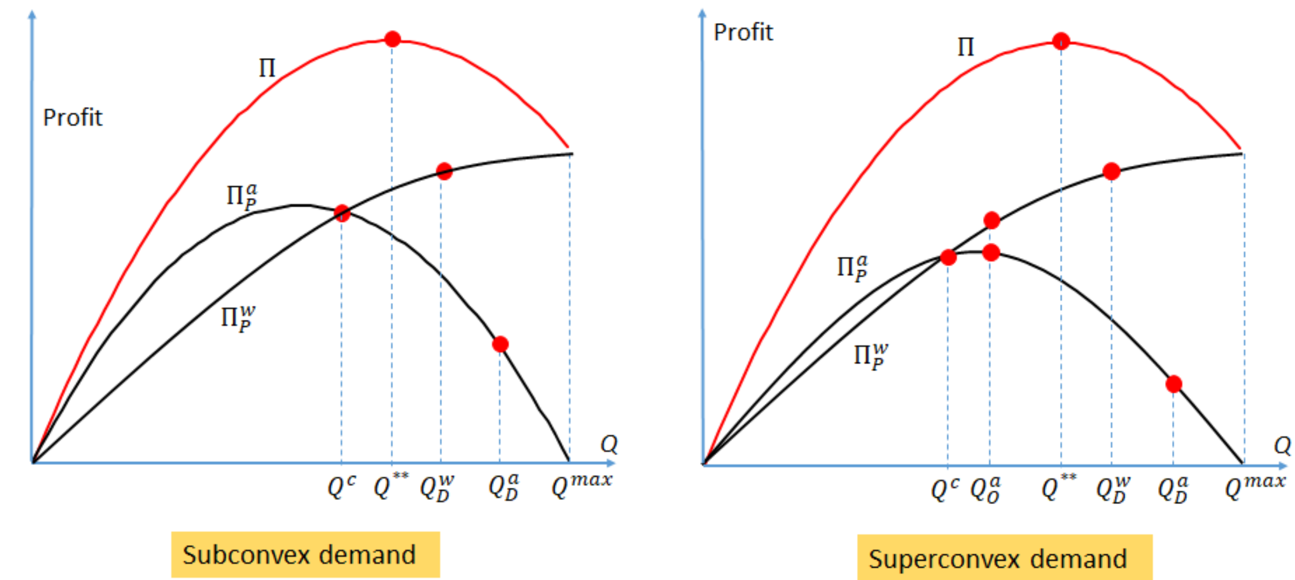

Figure 3: Profit Comparisons under Duopoly Platforms (f=0)

In sum, we have the following Proposition about profit comparison Figure 3:

Proposition 6. *When there is duopoly platforms, each platform achieves a larger profit under WM as compare to under AM.*

Merchants' profit

The question of merchants' profit comparison is reverse to that of the platforms. As illustrated in Figure 2, when demand is subconvex, we have $\Pi_M^a(Q_D^a) > \Pi_M^w(Q_D^w)$; when demand is superconvex, it must be $\Pi_M^a(Q_D^a) > \Pi_M^a(Q_O^a) > \Pi_M^w(Q_O^a) > \Pi_M^w(Q_D^w)$. In the second half, the first inequality comes from observations that $\Pi_M^a(Q)$ increases in Q and duopoly output Q_D^a is larger than monopoly output Q_O^a; the second inequality comes from the fact that $Q_O^a > Q^c$ when demand is superconvex; the third inequality comes from observation $Q_D^w > Q_O^a$ and both of them are larger than the quantity maximizes $\Pi_M^w(Q)$. Therefore, no matter the demand function is subconvex or superconvex, the merchants must be better off if the platforms choose AM.

In sum, we have the following Proposition:

Proposition 7. *When there is duopoly platforms, the merchants achieve a larger joint profit under AM than that under WM.*

3.4 Discussion

Propositions 6 and 7 together demonstrate the strong conflict of interests between platforms and merchants in choosing business model. When there is duopoly platforms, AM always leads to larger social welfare. However, platforms are collectively prefer WM instead of AM, while the latter is preferred by merchants. However, unlike the case of monopoly platform, it was now the merchants' interest consistent with the social welfare.

This result has clear policy implications: In a market with duopoly platform, platforms collectively have no incentive in choosing AM, while consumers and social welfare improve under AM. Therefore, the regulators should response the merchants' complaint about WM and promote AM.

As to the ebook case, the observation indicates, when Apple entered into the ebook market, both Apple and Amazon collectively should have no incentive in adopting AM.[11] Given collusion is forbidden, and Apple entered into ebook market and carry out duopoly competition with Amazon, the DOJ's settlement of prohibition on the use of AM between publishers and platforms will not harm consumers and reduce social welfare.

4 Extension and Application (in progress)

4.1 Game in choosing AM and WM

4.2 New insights into the existing literature

4.3 Seller or distributor?

If the platform adopts WM, it sets the price of final product and is considered as the seller to final consumers. However, if the platform employs AM and charge proportional commission rate, it does not set the price of the product. Under the current antitrust regulation in the US, a platform employing AM is immune from lawsuits raised by final consumers because it is treated as a distributor instead of a seller.

This principle was set up by the Supreme Court's 1977 decision on *Illinois Brick Co. v. Illinois*,[12] which said that indirect purchasers cannot sue a company for antitrust damages. This "Illinois Brick doctrine" was later applied to *Campos v. Ticketmaster*:[13] The appeals court dismissed the claim against Ticketmaster with the reason that concert ticket buyers were indirect purchasers and therefore they cannot sue Ticketmaster, who was the distributor for concert venues.

Recently, in November 2018, the Supreme Court conducted a hearing of oral arguments for the antitrust case *Apple v. Pepper*. Robert Pepper, representing app consumers, complaints that Apple monopolizes the market and drives up prices. The focus of the case is not on App Store's

[11] However, if publishers are able to raise ebook price by collusion, Apple and Amazon might benefit by switching from WM to AM.

[12] *Illinois Brick Co. v. Illinois*, 431 U.S. 720 (1977) (`supreme.justia.com/cases/federal/us/431/720/`).

[13] *Campos v. Ticketmaster Corp.*, 140 F.3d 1166 (1998) (`http://static.reuters.com/resources/media/editorial/20170113/Campos%20v%20Ticketmaster%20Corp.pdf`).

monopoly position but whether iPhone users have the legal position to sue Apple at all.[14] Apple argues that prices are set by the third-party software developers, not by Apple. APP store serves as a distributor, so its customers are app developers, not the iOS users.[15] The Supreme Court's ruling regarding whether consumers can sue Apple is expected to come in June 2019.

This ruling may potentially impose a fundamental impact on many digital platforms relying on the AM such as Amazon marketplace, Uber, and Airbnb. If these "toll-keepers"[16] are all treated as distributors instead of sellers, then they become much less accountable toward their consumers. However, it will provide an extra advantage of adopting AM. If the previous principle is kept, then AM may become more popular.

5 Conclusion (in progress)

This paper highlights the conflicting and aligned interests among the merchants, the platforms, and the society under two vertical contractual agreement, WM and AM. When there is a monopoly platform, the platform's interest is aligned with the social welfare in employing the AM when the demand satisfies the usual subconvex property. However, when there is duopoly platform, the merchant's interest and social welfare are aligned. Merchants prefer the WM, while platforms prefer the AM. These clear-cut results provide several important policy implications.

[14] `www.cnbc.com/2018/11/26/apple-to-tell-supreme-court-it-cant-be-sued-in-app-store-dispute.html`.

[15] Developers could sue Apple, but they don't have a strong incentive as most of them benefit from the exclusive ecosystem.

[16] A name given by *Reuters* (`www.reuters.com/article/us-otc-apple/9th-circuit-apple-antitrust-ruling-splits-with-8th-`

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