A Comparison of the Wholesale Structure and the Agency Structure in Differentiated Markets

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We compare the wholesale structure and the agency structure characterizing a supply and distribution chain in a bilateral duopoly model with differentiation, based on which we examine firms' preferences over the two structures. Suppliers gain from the wholesale structure whereas retailers are better off under the agency structure as long as the degree of differentiation at supplier level is not too low. That is, while the high degrees of differentiation at one level of the market in general benefit firms at that level and harm firms at the other level under the wholesale structure, the two parties' incentives are better aligned under the agency structure.

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1. Introduction

Retailers are in power. Dobson and Waterson (1999) have delivered such message through their summary of retailer power development, in which they also predict that "further significant changes are on the way as a result of Internet retailing". 16 years later, it is not dull at all to repeat – retailers are indeed in power. This trend has been reinforced and accelerated by the rise of online markets. Whilst the wholesale structure remains the common business format in a bricks-and-mortar environment, the dominance of the agency structure in online markets indicates some transformations in the supply and distribution chains. By examining and comparing the two structures, we show that the different preferences of suppliers and retailers over business format, together with their relative degrees of differentiation, can explain the popularity of one structure in certain markets.

Since vertical relations in business do not all operate in identical ways and firms in a particular industry may have preferences over how they wish the market operates, the chosen structure in turn tells us something about the industry, making it important to understand how vertical relations are structured and how different outcomes are under different structures. Under the wholesale structure, retailers buy from suppliers and resell to final consumers, e.g., florists buy roses at flower markets and resell them in store. Under the agency structure, suppliers set prices and retailers merely help to make transactions happen. In return, retailers receive shares of revenue specified by themselves, e.g., eBay sets a "final value fee" rate and receives a fraction of sellers' total revenues.[1]

The dominance of the agency structure in online markets could arguably be driven by the nature of such markets where concerns about inventory and asymmetric information tend to mitigate. One cannot tell the whole story, however, without justifying retailers' decision to give up control over pricing. Since retailers specify revenue sharing rates before suppliers set prices, one argument could be that the agency structure is retailer-advantaged, therefore many giant online retailers such as Amazon marketplace, Apple, eBay, Google and various booking websites have adopted it.

Recent papers studying the agency structures are overwhelmingly inspired by the (in) famous e-book case. In April 2010, five large book publishers in the US switched from the wholesale structure, which they used to have with Amazon, of selling e-books to the agency structure put forward by Apple. Following the price rise of e-books after the switch, the *Department of Justice* has lodged a complaint against Apple and publishers for their

[1] See eBay Seller Centre http://sellercentre.ebay.co.uk/introduction-ebay-fees.

contractual agreements.[2] Motivated theoretical studies tend to examine the agency structure alongside other aspects, some of which relate closely to the e-book market: i) Device, e.g. smartphones and tablets (Gans, 2012; Gaudin and White, 2014); ii) The Most Favoured Nation (MFN) clause (Foros, *et al*., 2013; Johnson, 2013a); iii) Consumer lock-in (Johnson, 2013b); iv) Asymmetric information (Hagiu and Wright, 2014; Condorelli *et al*., 2013).

Meanwhile, there is a lack of research providing systematic analysis of the agency structure per se as well as detailed comparisons of the wholesale and agency structures, which constitutes the basis of understanding the changes in vertical relations. We take the initial steps towards this goal by comparing the outcomes under the two structures and examining firms' preferences in relation to the choice of business format. We then analyse how these preferences can be determined by the relative degrees of differentiation in vertically related markets.

Set as vertical price restriction, Resale Price Maintenance (RPM) is often induced as a means to dampen retailer competition. Supplier pricing under the agency structure could be seen as an extreme case of RPM; instead of imposing certain rules on pricing, suppliers directly set prices. Since RPM could arguably increase efficiency, one may tempt to expect lower retail prices under the agency structure. Johnson (2014) clarifies that it is incorrect to assume so and double-marginalization may exist also under the agency structure because of revenue sharing. Revenue sharing reduces suppliers' per-unit profit, suppliers therefore perceive marginal costs to be higher, which leads to the first mark-up. Therefore it is not straightforward to tell whether the wholesale structure or the agency structure yields higher prices.

Dobson and Waterson (2007) suggest that the effects of RPM depends on the degree of competition and product differentiation, based on which Foros *et al*. (2013) study the effect of RPM on pricing under the agency structure. By comparing supplier pricing and retailer pricing under the agency structure, they find that prices are higher under retailer pricing if the degree of competition is relatively higher among suppliers and are higher under supplier pricing if the degree of competition is relatively higher among retailers. This result rationalizes retailers' decision to give up price control, but the study does not consider the standard wholesale structure and does not offer complete analytical results with regard to differentiation and competition. Also, demand in their paper is assumed to decrease as the

[2] See *Competition Law Journal* Concurrences No.3-2012 on "e-Books and the Boundaries of Antitrust" http://ssrn.com/abstract=2140778.

degree of differentiation increases, that is, they consider the effect of product substitution on demand, but not the effect of price.

We apply the same demand system to the wholesale structure and compare the symmetric equilibrium outcomes under the two. In equilibrium, retail prices are lower and quantities demanded are higher under the agency structure, irrespective of the degree of differentiation. Regarding profitability, we find that suppliers always prefer the wholesale structure whereas retailers prefer the agency structure for a wider range of degrees of differentiation. Immediately, this explains why in real life the agency structure is initiated by retailers – suppliers never have the incentive to switch away from the wholesale structure. For instance, it appears that it was Apple who persuaded publishers to adopt the agency structure.

Furthermore, we find that for retailers, the relative profitability of the alternative schemes is sensitive to the degree of differentiation at the supplier level: as long as it is not too low, retailer are better off under the agency structure. This is interesting because it contrasts with our conventional understanding of the relationships between firms' profitability and degrees of differentiation at different levels of the market. Given that they do not collude, firms in general would benefit from high degrees of differentiation at their own level and low degrees of differentiation at the other level of the market, such that they can exercise market power. This is true under the wholesale structure but not under the agency structure. Since retailers under the agency structure can benefit from high degrees of differentiation at the supplier level, the two parties' incentives are better aligned under the agency structure. As the degree of differentiation at the supplier level increases, retailer profits increase given the condition that the agency structure is in place, though this condition becomes more difficult to satisfy.

Moreover, since competition intensifies as the degrees of differentiation at both levels of the market decrease, we are also interested to see how price and demand are affected as a result. We find that under both structures, retail prices always decrease with competition, whereas demand first decreases then increases with competition. Demand is decided by two forces – price effect and substitution effect. As goods become more substitutable, the average purchase goes down, which is reflected by the initial fall in demand. Nevertheless retail price is also lower due to the reduction in differentiation, which leads to higher demand. After a critical point, price effect dominates substitution effect and demand increases with competition.

We also highlight the role of imperfect competition at the retailer level as the crucial factor for generating difference in the outcomes of the two structures. When the retailer level is perfectly competitive, suppliers under the wholesale structure can easily impose contractual

obligations including RPM. If suppliers exercise RPM and directly set retail prices, the two structures would be identical in terms of pricing. Consequently, as the degree of competition at the retailer level increases, equilibrium outcomes under the two structures converge, and are eventually equal, to each other.

Johnson (2014) also finds lower equilibrium prices under the agency structure and that suppliers earn higher profits under the wholesale structure. Regarding retailer profits, he suggests the agency structure to be always retailer-advantaged whereas it is not necessarily so in the current paper. The difference arises since demand is modelled differently and market coverage is assumed differently. Johnson assumes full market coverage, implying that the effect of change in demand is omitted; hence any increase in prices can be directly translated to increase in profits. We take into account the change in demand and the countervailing effect explains why results are not as straightforward.

Santos and Wildenbeest (2014) analyze e-book pricing empirically and suggest that final price is higher under the agency structure. This result however may plausibly have been driven by, among other factors, the MFN clause adopted alongside the agency structure and which directly undermine the incentives for rival retailers to cut price. In a broader literature of vertical restraints, whether RPM leads to higher or lower final price also depends on consumers' relative sensitivity towards price competition and service competition (Winter, 1993).

The rise of online markets is also studied in the literature of intermediary. The typical question being asked is: which form is more profitable, the intermediary acts as a "dealer" (the wholesale structure) or as an "agent" (the agency structure)? Belleflamme and Peitz (2010) suggest, based on Hagiu (2006), that the answer is ambiguous. We show that it is possible to obtain some clear results, at least in a stylized environment.

The paper proceeds as follows. Section 2 presents a bilateral duopoly model with differentiation at both levels of the market. We characterize the vertical relation first by the wholesale structure and then by the agency structure. Section 3 compares the symmetric equilibria under the two structures to find out preferences of suppliers and retailers over business formats. We then explore further in Section 4 on how these preferences are determined by the degrees of differentiation at both levels of the supply and distribution chain. Section 5 delivers a general discussion.

2. Model

We employ a bilateral duopoly framework to incorporate differentiation at both the supplier level and the retailer level. In a vertically related market, there are two suppliers, $j = 1, 2$ and two retailers, $i = 1, 2$. Each supplier produces a single good j and each retailer i presents final consumers with goods from both suppliers, i.e., $q_i^j > 0$. For simplicity we assume that firms face zero cost.

We use the differentiated demand system by Dobson and Waterson (1996, 2007)

$$q_i^j = \frac{(1-\beta)(1-\gamma) - p_i^j + \gamma p_i^{-j} + \beta(p_{-i}^j - \gamma p_{-i}^{-j})}{(1-\beta^2)(1-\gamma^2)}. \quad (1)$$

The quantity demanded for good j at retailer i is a function of its own price, p_i^j, price of the other good at the same retailer, p_i^{-j}, price of the same good at the other retailer, p_{-i}^j, price of the other good at the other retailer, p_{-i}^{-j}, and two parameters capturing the degrees of competition at both degrees. Parameter $\beta \in [0, 1)$ measures the degree of competition between retailers and $\gamma \in [0, 1)$ measures the degree of competition between goods.[3] When $\beta = 0$, services at the two retailers are perceived as independent, but as β approaches 1, they are perceived as close substitutes. Similarly, when $\gamma = 0$, the two goods are independent; but as γ approaches 1, they become more and more substitutable. That is, as the value of a parameter increases, the degree of differentiation in the associated level decreases. As goods and services become more substitutable, ceteris paribus, average demand decreases and competition intensifies.

Given that suppliers cannot directly reach final consumers, the manner in which the vertical relation is characterized depends on whether the wholesale structure or the agency structure is in place.

2.1 The Wholesale Structure

We continue using the florist business as an example to describe a simple form of the wholesale structure. Assume that we have the flower wholesalers or florist suppliers who grow their own flowers and plants and do not buy from anyone else. They set wholesale

[3] Dobson and Waterson (1996) assume $\gamma \in (-1, 1)$ where a negative γ indicates that the goods are complements. We do not consider this case in the current paper.

prices and sell to florists who then set retail prices and deal with final consumers. Therefore the timing under the wholesale structure is as follows

1. Suppliers set wholesale prices simultaneously. The wholesale price set by supplier j to retailer i is w_i^j,
2. Retailers set retail prices simultaneously. The price set by retailer i for good j is p_i^j.

Retailer i, denoted as R_i, faces the following optimization problem

$$\max_{p_i^1,\ p_i^2} \pi_{R_i} = \max_{p_i^1,\ p_i^2} [(p_i^1 - w_i^1)q_i^1 + (p_i^2 - w_i^2)q_i^2], \tag{2}$$

from R_i's first-order condition we get

$$p_i^j = \frac{(1-\beta)(1-\gamma)+\beta\left(p_{-i}^j - \gamma p_{-i}^{-j}\right)+2\gamma p_i^{-j}+w_i^j-\gamma w_i^{-j}}{2}. \tag{3}$$

The second-order condition is fulfilled; $\partial^2\pi_{R_i}/\partial(p_i^j)^2 = -2/\left(1-\beta^2\right)(1-\gamma^2) < 0$. Given the non-cooperative nature of the game, the symmetry between retailers means that retail prices differ only if the two retailers face different wholesale prices. This reduces the complexity in solving the problem, and we can write the retail price as p^j, a function of only w^j and the two parameters

$$p^j = \frac{1-\beta+w^j}{2-\beta}. \tag{4}$$

Supplier j, denoted as S^j, faces the following optimization problem

$$\max_{w_1^j,\, w_2^j} \pi^{S^j} = \max_{w_1^j,\, w_2^j} (w_1^j q_1^j + w_2^j q_2^j). \tag{5}$$

Given the symmetry between retailers and thereafter equation (4), optimization problem (5) is reduced to

$$\max_{w^j} \pi^{S^j} = \max_{w^j} 2w^j q^j. \tag{6}$$

Due to the symmetry between suppliers, the wholesale prices charged by two suppliers are different only if they face different marginal costs. Since we assume zero cost, the symmetric equilibrium level of wholesale price is

$$w^* = \frac{1-\gamma}{2-\gamma}, \tag{7}$$

which depends only on γ, the degree of competition between goods. The second-order condition is fulfilled.

Putting Equation (7) back into Equation (4), the symmetric equilibrium level of retail price is

$$p^* = \frac{(1-\beta)(2-\gamma)+1-\gamma}{(2-\beta)(2-\gamma)}, \tag{8}$$

which is determined by the degrees of competition at both levels of the market. We will examine in details about how competition affects equilibrium outcomes in Section 3. For now we present the complete set of symmetric equilibrium under the wholesale structure including demand and profits in the following lemma.

Lemma 1. *Under the wholesale structure, there exists a symmetric equilibrium in which wholesale price* $w^* = (1-\gamma)/(2-\gamma)$, *retail price* $p^* = [(1-\beta)(2-\gamma)+1-\gamma]/(2-\beta)(2-\gamma)$, *quantity demanded (per good at per retailer)* $q^* = 1/(1+\beta)(2-\beta)(1+\gamma)(2-\gamma)$, *supplier j's profit* $\pi^{S^j} = 2(1-\gamma)/(1+\beta)(1+\gamma)(2-\beta)(2-\gamma)^2$ *and retailer i's profit* $\pi_{R_i} = 2(1-\beta)/(1+\beta)(1+\gamma)(2-\beta)^2(2-\gamma)^2$.

2.2 The Agency Structure

Now consider the agency structure widely used in online markets. For example, eBay as an online agent, does not buy goods from sellers and resell to consumers. Instead, eBay specifies a revenue sharing rate and is in a role of distributing sellers' listings to potential consumers where sellers themselves set prices of the fix price listings. Every time a good is successfully sold, eBay gets a share of the total revenue of selling that good from the seller. Therefore the timing under the agency structure is as follows

1. Retailers declare the revenue sharing rates simultaneously. The revenue sharing rate set by retailer i is $\alpha_i \in [0,1]$.
2. Suppliers set prices simultaneously. The price set by supplier j to retailer i is p_i^j. Revenue generated is split according to α_i.

Here we allow retailers to set a sharing rate that applies to both suppliers, and it is for two reasons. First, in real life it is common for retailers to specify one sharing rate and apply it to all suppliers as if it is universal knowledge. For example, Apple claims the same rate to all book publishers, eBay claims the same rate to all sellers and Google claims the same rate to

all apps developers. Therefore it is not necessary for a retailer to specify different rates to different suppliers. Also, technically, due to the symmetry in the model, this assumption does not impose much change to the results but would reduce the complexity in calculation.

Moving backwards, S^j obtains the price control and faces the following optimization problem

$$\max_{p_1^j, p_2^j} \pi^{S^j} = \max_{p_1^j, p_2^j} [(1 - \alpha_1)p_1^j q_1^j + (1 - \alpha_2)p_2^j q_2^j]. \quad (9)$$

Due to the symmetry between suppliers, prices for good j differ only if the two retailers require different sharing rates; a higher α_i would further squeeze suppliers' profit margin thus induce suppliers to increase price to that retailer. Hence we can write price as p_i and S^j's best response function from the corresponding first-order condition is

$$p_i = \frac{(1-\beta)(1-\gamma)(1-\alpha_i)+\beta p_{-i}[(1-\alpha_{-i})+(1-\gamma)(1-\alpha_{-i})]}{(2-\gamma)(1-\alpha_i)}. \quad (10)$$

Following a symmetric equilibrium in which $\alpha_i = \alpha_{-i}$, we can solve Equation (10) in a simple manner and the equilibrium price under the agency structure is

$$p_A^* = \frac{1-\gamma}{2-\gamma}. \quad (11)$$

Note again this decision by suppliers depends only on γ. That is, no matter it is under the wholesale or the agency structure, when making decisions, suppliers care only about the competition at their own level, leave the competition between retailers disregarded.

R_i faces the following optimization problem

$$\max_{\alpha_i} \pi_{R_i} = \max_{\alpha_i} \alpha_i(p_i^1 q_i^1 + p_i^2 q_i^2). \quad (12)$$

Since R_i rationally anticipating S^j's decision, equation (12) is reduced to

$$\max_{\alpha_i} \pi_{R_i} = \max_{\alpha_i} 2\alpha_i p_i q_i. \quad (13)$$

The corresponding first-order condition is given by

$$\frac{\partial \pi_{R_i}}{\partial \alpha_i} = 2p_i q_i + 2\alpha_i \left[p_i \frac{\partial q_i}{\partial \alpha_i} + q_i \frac{\partial p_i}{\partial \alpha_i}\right]. \quad (14)$$

Setting $\alpha_i = \alpha_{-i}$, the symmetric equilibrium revenue sharing rate is

$$\alpha^* = \frac{(2-\gamma)(1-\beta^2)}{2-\gamma(1+\beta)}. \quad (15)$$

Foros *et al*. (2013) prove α^* to be a Nash equilibrium if $\beta > \gamma$.[4] The following lemma summarizes a complete set of symmetric equilibrium under the agency structure.

Lemma 2. *Under the agency structure, there exists a symmetric equilibrium in which revenue sharing rate* $\alpha^* = (2-\gamma)(1-\beta^2)/[2-\gamma(1+\beta)]$ *, retail price* $p_A^* = (1-\gamma)/(2-\gamma)$*, quantity demanded (per good at per retailer)*$q_A^* = 1/(1+\beta)(1+\gamma)(2-\gamma)$ *, supplier j's profit* $\pi_A^{S^j} = 2\beta(1-\gamma)[2\beta-\gamma(1+\beta)]/(1+\beta)(1+\gamma)(2-\gamma)^2[2-\gamma(1+\beta)]$*and retailer i's profit* $\pi_{R_iA} = 2(1-\beta)(1-\gamma)/(1+\gamma)(2-\gamma)[2-\gamma(1+\beta)]$.

3. Comparison

Given *Lemmata 1* and *2* obtained above, we have two sets of symmetric equilibrium. In this section we are going to compare the two and find out how different firms' preferences are under different structures.[5] Although intuitive, some of the comparisons are not straightforward to show mathematically. Hence we conduct simulations and illustrate comparisons with 3D plots to support the observations below. We first compare the equilibrium prices and quantities demanded under the two structures.

Proposition 1. *In equilibrium, retail prices are lower and quantities demanded are higher under the agency structure, irrespective of the degrees of differentiation at both levels of the supply and distribution chain.*

Proof: See Appendix A.

Proposition 1 is also illustrated in Figure 1 which contains two 3-D plots of β, γ and equilibrium outcomes. The dark (blue) area represents the outcome under the wholesale structure and the light checked area (yellow) represents the outcome under the agency structure. The light checked (yellow) area is always on the left with reference to retail price

[4] Foros *et al*. (2013) show that when $\beta > \gamma$, R_i has no incentive to undercut and offer $\alpha_i < \alpha^*$.

[5] Although Foros *et al*. (2013) also look at the agency structure as in Section 2.2 and make comparisons, the benchmarks used are different. They compare the standard agency structure with suppliers pricing and retailers revenue sharing ("the agency model" and "RPM" in their study) to an alternative agency structure with retailers pricing and retailers revenue sharing ("no RPM" in their study). In contrast, the current study compares the standard agency structure to the standard wholesale structure.

and is always on the right with reference to demand, which means lower retail prices and higher demand under the agency structure.

Retailers seem to be more aggressive when competing in revenue shares than competing in prices, which results in lower retail prices under the agency structure. The total mark-up under the agency structure is $(1-\gamma)/(2-\gamma)$, which is identical to the first mark-up (wholesale price over marginal cost) under the wholesale structure. That is, if double mark-ups do occur under the agency structure, each of them is small compared to those under the wholesale structure. Since demand is higher under the agency structure, despite lower retail prices, the agency structure does not necessarily yield lower industry profit.

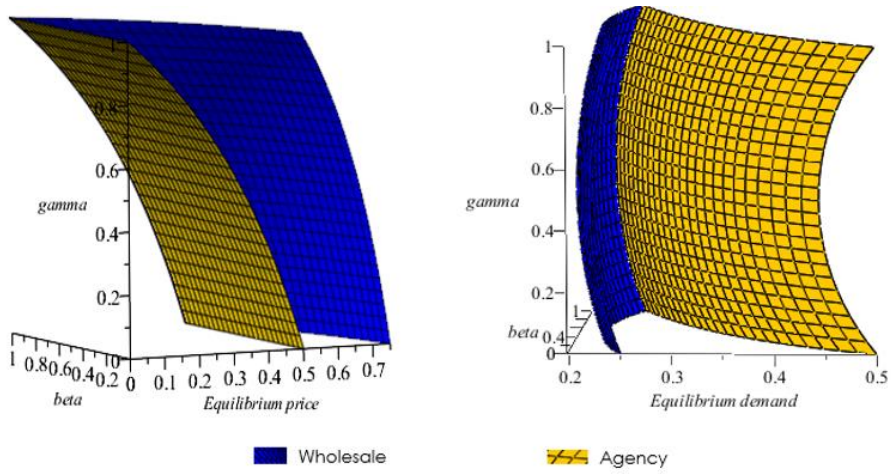

Figure 1. Equilibrium Price and Demand under the Wholesale and Agency Structures

Next we compare supplier profits, retailer profits and industry profits under the two structures. 3-D plots illustrating comparisons are shown in Figure 2.

Proposition 2. *In equilibrium, suppliers always prefer the wholesale, irrespective of the degrees of differentiation at both levels of the supply and distribution chain.*

Proof: See Appendix B.

We have already mentioned that revenue sharing reduces suppliers' per-unit profits. To show this: with no costs, under the wholesale structure, suppliers' per-unit profits are precisely equilibrium wholesale prices, $(1-\gamma)/(2-\gamma)$; under the agency structure, suppliers' per-unit profits are their shares of equilibrium prices, $(1-\alpha)(1-\gamma)/(2-\gamma)$. Clearly, supplier's per-unit profits are lower under the agency structure, which is a fraction of the same under the wholesale structure. Under the agency structure, however, equilibrium demand is higher. The 3-D plot of equilibrium per supplier profit (left panel in Figure 2) shows that suppliers always earn higher profits under the wholesale structure, indicating that

the effect of higher per-unit profits under the wholesale structure outweighs the effect of higher demand under the agency structure, and suppliers prefer the wholesale structure.

This potentially explains why, in real life, it is retailers who initiate the agency structure and suppliers could be vulnerable and have no choice. More specifically, for large online retailers with strong network and negotiation power, a preferred business format may be part of the "take it or leave it offer" they have for suppliers. Whenever suppliers possess relatively higher market power, they stick with the wholesale structure.

Observation 1. *Suppose that both β and γ are independently and equally likely to take up any value over the interval* $[0,1)$. *Then there are more combinations of β and γ such that retailers prefer the agency structure.*

Since we observe an intersection on the 3-D plot of equilibrium per retailer profit (middle panel in Figure 2), one cannot conclude that the agency structure is always retailer-advantaged. Note however the area where the agency outcome is higher is much larger than the area where the wholesale outcome is higher, meaning that retailers are more likely to be better off under the agency structure. Also retailer profits are initially higher under the wholesale structure and then higher under the agency structure. That is, higher range of profits can only be pursued by retailers adopting the agency structure, given that β and γ are both sufficiently low.

Observation 2. *Suppose that β and γ are independently and equally likely to take up any value over the interval* $[0,1)$. *Then there are more combinations of β and γ such that industry profit is higher under the wholesale structure.*

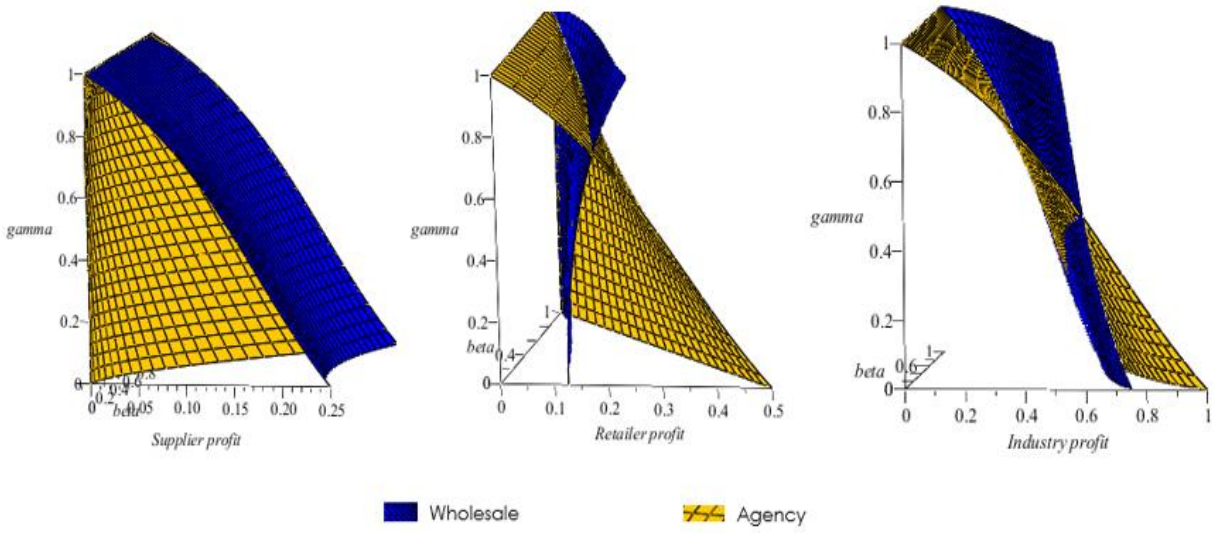

Figure 2. Equilibrium Profits under the Wholesale and Agency Structures

There is also an intersection on the 3-D plot of equilibrium industry profits (right panel in Figure 2). Note that since there are two suppliers and two retailers in the model, industry profits are the sum of profits of all four firms. The area where the wholesale outcome is higher is larger than the area where the agency structure is higher, meaning that the wholesale structure is more likely to lead to higher industry profits. Industry profits are initially higher under the wholesale structure and then higher under the agency structure. That is, despite lower retail prices under the agency structure, industry profits are maximized under that structure. To achieve this goal, the agency structure needs to generate high enough retailer profits to compensate for the loss of supplier profits which is always higher under the wholesale structure.

Observation 3. *When the degree of differentiation (competition) at supplier level is not too low (high), a retailer always prefers the agency structure, irrespective of own degrees of differentiation.*

We are able to observe clearer relationships if the differentiation parameters are within a specified ranges. As shown in Figure 3 below, we have 3 plots of equilibrium retailer profits under the two structures where β and γ have different ranges. *Observation 1* describes the left panel where β and γ can take up any value over the interval $[0,1)$. If we restrict γ to be between 0 and 0.75 (middle panel in Figure 3), that is when the degree of differentiation at supplier level is not too low, retailer profits are always higher under the agency structure. So an interesting point is how γ affects retailer profits under the agency structure. It increases retailer profits under the agency structure because higher γ means higher revenue shares for retailers while it decreases retailer profits because it decreases retail prices. The role of the parameters will be analyzed in more details in Section 4. If we restrict parameters further and allow the degrees of differentiation at both levels to be higher, e.g., $\beta \in [0, 0.5)$ and $\gamma \in [0, 0.5)$ (right panel in Figure 3), the gap between the two structures becomes larger.

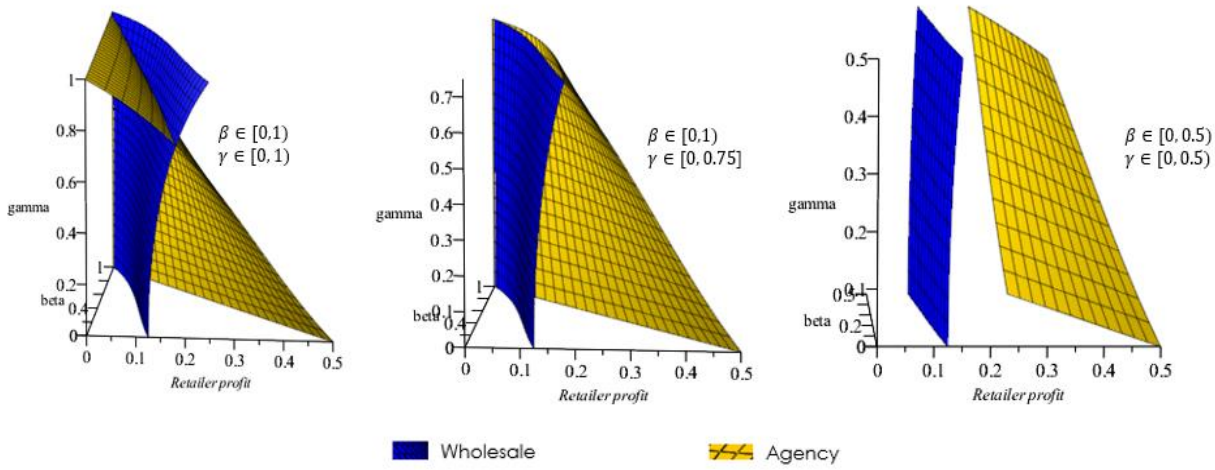

Figure 3. Equilibrium Retailer Profits under the Wholesale and Agency Structures

To sum up, prices are higher under the wholesale structure and quantities demanded are higher under the agency structure. Suppliers gain from the wholesale structure whereas retailers are better off under the agency structure as long as the degree of differentiation at supplier level is not too low.

These results are in the similar line but are not fully consistent with Johnson (2014) in which retailer profits are predicted to always be higher under the agency structure. Differences are driven by different models used and the considerations on demand. As mentioned earlier, the assumption of full market coverage in Johnson's paper implies that any change in prices can be directly translated to changes in profits; higher per-unit profits equal higher total profits. In the current paper, results are not as straightforward. In fact, all equilibrium outcomes depend on the degrees of differentiation, which are discussed next.

4. The Role of Differentiation

In this section we first highlight the importance of the presence of imperfect competition in distinguishing the wholesale structure and the agency structure, then assess the role of differentiation within the supply and distribution chains to better understand firms' preferences presented in Section 3. We start with the following lemma.

Lemma 3. *If the retailer level of the market is approaching perfect competition, i.e., $\beta \to 1$, then the outcomes under the wholesale structure and the agency structure become the same.*

Proof: See Appendix C.

Lemma 3 says that imperfect competition at the retailer level is crucial in generating difference in equilibrium outcomes between the two structures. When the retailer level of the market is perfectly competitive, the difference in contractual arrangements is no longer in place. The key reason is that the agency structure could be seen as an extreme case of RPM under the wholesale structure. RPM usually involves suppliers imposing certain price restrictions, an extreme case of which would be that suppliers directly set retail prices for retailers. The less power individual retailers have, the more likely the extreme case would occur. When the retailer level is perfectly competitive, suppliers under the wholesale structure can easily impose contractual obligations including directly setting retail prices, and then the two structures would be identical with regard to pricing. Consequently, as the degree of competition at the retailer level increases, equilibrium outcomes under the two structures converge, and are eventually equal, to each other.

As stated in *Lemmata 1* and *2*, all equilibrium outcomes are functions of β and γ, making it important to understand the effects of the two parameters.

Lemma 4. *Under the wholesale structure, equilibrium retail prices decrease in β and γ, and equilibrium quantities demanded first decrease and then increase in β and γ. Under the agency structure, equilibrium retail prices depend only on and decrease in γ. Equilibrium quantities demanded decrease in β whereas they first decrease and then increase in γ.*

The way β and γ affect retail prices is straightforward and monotonic; as goods and services become more substitutable, competition is fiercer and prices are lower. Demand, however, is determined by two countervailing effects. As β and γ increase, on one hand, retail prices decrease which leads to rises in demand; on the other hand, substitutability increases which leads to a fall in average demand.

Figure 4 illustrates the countervailing effects that β and γ have on demand under the wholesale structure as an example. Holding β constant, when $\gamma \in [0, 1/2)$, substitution effect dominates and equilibrium demand is decreasing in γ; when $\gamma \in [1/2, 1)$, price effect dominates, and equilibrium demand is increasing in γ. Therefore we observe a U-shape relationship, the lowest point of which is at $\gamma = 1/2$. Parameter β affects demand under the wholesale structure in the identical way. Under the agency structure, the U-shape relationship between γ and demand stays whereas demand is strictly decreasing in β. Since β is not in the function of equilibrium retail price, it affects demand only through the negative substitution effect.

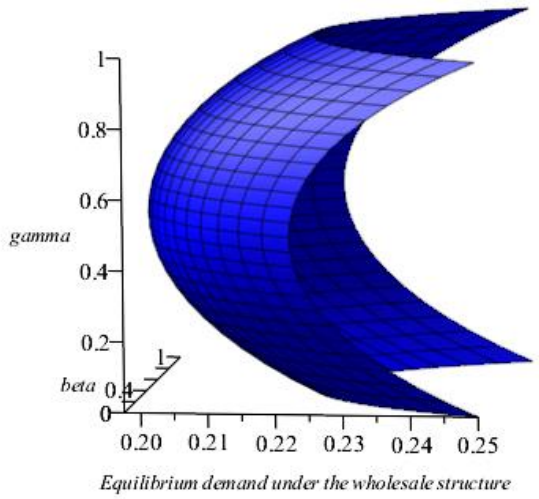

Figure 4. Demand Changes with β and γ under the Wholesale Structure

Although there are trade-offs in the way β and γ affecting profits, under the wholesale structure, we are able to observe clear relationship as shown below

$$\left.\begin{aligned}
&\frac{\partial \pi^{S^j}}{\partial \gamma} = 2\left\{\underbrace{w'(\gamma)q}_{-} + \underbrace{wq'(\gamma)}_{+/-}\right\} < 0 \\
&\frac{\partial \pi_{R_i}}{\partial \beta} = 2\left\{\underbrace{[p'(\beta) - w]q}_{-} + \underbrace{(p-w)q'(\beta)}_{+/-}\right\} < 0 \\
&\frac{\partial \pi_{R_i}}{\partial \gamma} = 2\left\{\underbrace{[p'(\gamma) - w]q}_{-} + \underbrace{p - w'(\gamma)]q}_{+} + \underbrace{(p-w)q'(\gamma)}_{+/-}\right\} > 0 \\
&\frac{\partial \pi^{S^j}}{\partial \beta} = 2w\left\{\underbrace{q'(\beta)}_{+/-}\right\} \gtreqless 0
\end{aligned}\right\}, \tag{16}$$

which leads to the following lemma.

Lemma 5. *Suppose that the wholesale structure is in place. Retailers will unambiguously prefer a market where the degree of differentiation (competition) at the supplier level is low (high) and the degree of differentiation (competition) at the retailer level is high (low). Suppliers will unambiguously prefer a market where the degree of differentiation (competition) at the supplier level is high (low) and the degree of differentiation (competition) at the retailer market is very low (high).*

Under the wholesale structure, an increase in the degree of competition at one level of the market always reduces profits at that level, and generally increase profits at the other level. It is not surprising that supplier profits are decreasing in γ and retailer profits are decreasing in β, which means that firms are always suffer more from price falls. γ increases retailer

profits through decreasing wholesale prices and increasing per-unit profits. β does not affect wholesale prices while it affects demand, thus whenever β increases demand, i.e., $\beta \in [1/2, 1)$, it increases supplier profits and whenever it decreases demand, i.e., $\beta \in [0, 1/2)$, it decreases supplier profits. Therefore retailers prefer competition at the supplier level to be high in general, whereas suppliers prefer competition at the retailer level to be specifically higher than $1/2$.

Unlike those under the wholesale structure, most relationships between profits and β and γ are non-monotonic and unclear under the agency structure. It is because in addition to price and demand, the degrees of differentiation also determine revenue sharing rates, thus there are more forces affecting profits in possibly different directions.

To be more specific

$$\left.\begin{aligned}
\frac{\partial \pi^{S^j}}{\partial \gamma} &= 2\left\{\underbrace{[1-\alpha'(\gamma)]pq}_{-} + \underbrace{(1-\alpha)p'(\gamma)q}_{-} + \underbrace{(1-\alpha)pq'(\gamma)}_{+/-}\right\} \gtrless 0 \\
\frac{\partial \pi_{R_i}}{\partial \beta} &= 2\left\{\underbrace{\alpha'(\beta)pq}_{-} + \underbrace{\alpha pq'(\beta)}_{-}\right\} < 0 \\
\frac{\partial \pi_{R_i}}{\partial \gamma} &= 2\left\{\underbrace{\alpha'(\gamma)pq}_{+} + \underbrace{\alpha p'(\gamma)q}_{-} + \underbrace{\alpha pq'(\gamma)}_{+/-}\right\} \gtrless 0 \\
\frac{\partial \pi^{S^j}}{\partial \beta} &= 2\left\{\underbrace{[1-\alpha'(\beta)]pq}_{+} + \underbrace{(1-\alpha)pq'(\beta)}_{-}\right\} \gtrless 0
\end{aligned}\right\}. \qquad (17)$$

The only clear relationship observed is between retailer profits and β, which is strictly decreasing. This is because β does not affect retail prices while it affects revenue sharing rates and demand in the same direction. As parameters affect more variables in different directions, relationships are difficult to determine, nevertheless they are intuitive. Supplier profits could decrease in β as it decreases demand, or increase in β as it increases suppliers' shares. Retailers could gain from higher γ as it increases retailers' shares, or lose from it as it decreases retail price. These non-monotonic relationships provide an explanation of the intersections on Figure 2 in Section 3, that we cannot compare some part of the supply chain in a simple manner.

Interestingly, unlike the situation in *Lemma 5* that retailers always prefer differentiation at the supplier level to be low under the wholesale structure, retailers under the agency structure can actually benefit from high degrees of differentiation at the supplier level, if we address Observation 3 further. As Figure 3 shows, the only condition for retailer profits to be higher under the agency structure is a high enough degree of differentiation at the supplier

level. That is to say, suppliers and retailers' incentives are better aligned under the agency structure. In fact, retailer profits, as well as industry profits, are maximized at the point of perfect differentiation at both levels of the supply and distribution chain characterized by the agency structure.

5. Discussion

This study is motivated by the seeming prevalence of the agency structure in some supply and distribution chains in the recent years. We seek to provide a baseline comparison of the wholesale structure and the agency structure in a simple framework, which is not yet provided but constitutes the basis of understanding firms' preferences over business formats in vertically related markets. We do so by employing a bilateral duopoly differentiated demand system, in which we examine firms' preferences and how these preferences could be determined by parameters characterizing the degrees of differentiation in the market.

We find that suppliers are always better off under the wholesale structure whereas retailers are better off under the agency structure given that the degree of differentiation at the supplier level is not too low. Industry profits are maximized at the point of perfect differentiation at both levels of the supply and distribution chain characterized by the agency structure. That is, if the degrees of differentiation at both levels are high enough, the agency structure is effectively a more efficient business format. While competition authorities in general believe that competition benefits consumers, we show that, although firms engaging in the agency structure may have incentives that are better aligned, consumers can still benefit from lower prices compared to those under the wholesale structure, ceteris paribus.

Unlike the traditional views on vertical relations where retailers are often considered to be perfectly competitive and possess little market power, the rise of the agency structure implies that retailers are in a strong position. Since suppliers are always better off under the wholesale structure thus have no incentive to switch, retailers wanting to impose the agency contracts have to possess relatively higher market power. As the degree of differentiation at supplier level increases, retailer profits increase given the condition that the agency structure is in place, though this condition becomes more difficult to satisfy. This further indicates the considerable network and bargaining power of some online retailers.

Results of the current paper can be applied to examine and understand the choice of business formats. The typical values of parameters can be calibrated for the purpose of

empirical studies. Furthermore, the basic model can be extended to include industry-specific issues such as complementary goods and side payments.

Moreover, besides the two common vertical structures discussed in this paper, there are some other structures adopted in practice, which worth examining. For example, in film distribution, film production companies and cinemas engage in a "reversed" agency structure where the suppliers (film production companies) set revenue sharing rates and the retailers (cinemas) set retail prices. Exploration on more vertical contracts would add to results of the current paper and provide a broader picture.

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Appendices

A. Proof of *Proposition 1*, Section 3

Given the equilibrium retail prices under the wholesale structure $p^* = \frac{(1-\beta)(2-\gamma)+(1-\gamma)}{(2-\beta)(2-\gamma)}$ and the equilibrium retail prices under the agency structure $p_A^* = \frac{1-\gamma}{2-\gamma}$, $p^* > p_A^*$ holds if $\frac{(1-\beta)(2-\gamma)+(1-\gamma)}{(2-\beta)(2-\gamma)} - \frac{1-\gamma}{2-\gamma} > 0$. That is if

$$\frac{(1-\beta)(2-\gamma)+(1-\gamma)-(2-\beta)(1-\gamma)}{(2-\beta)(2-\gamma)} > 0,$$

which always holds given $\beta, \gamma \in [0, 1)$ since the left-hand side of the inequation can be simplified to $\frac{1-\beta}{(2-\beta)(2-\gamma)}$.

Given the equilibrium demand under the wholesale structure $q^* = \frac{1}{(1+\beta)(1+\gamma)(2-\beta)(2-\gamma)}$ and the equilibrium demand under the agency structure $q_A^* = \frac{1}{(1+\beta)(1+\gamma)(2-\gamma)}$, it is straightforward to tell that $q^* < q_A^*$ always holds given $\beta, \gamma \in [0, 1)$. □

B. Proof of *Proposition 2*, Section 3

Given the equilibrium supplier profits under the wholesale structure $\pi^{S^j} = \frac{2(1-\gamma)}{(1+\beta)(1+\gamma)(2-\beta)(2-\gamma)^2}$ and the equilibrium supplier profits under the agency structure $\pi_A^{S^j} = \frac{2\beta(1-\gamma)[2\beta-\gamma(1+\beta)]}{(1+\beta)(1+\gamma)(2-\gamma)^2[2-\gamma(1+\beta)]}$, $\pi^{S^j} > \pi_A^{S^j}$ if $\frac{2(1-\gamma)}{(1+\beta)(1+\gamma)(2-\beta)(2-\gamma)^2} - \frac{2\beta(1-\gamma)[2\beta-\gamma(1+\beta)]}{(1+\beta)(1+\gamma)(2-\gamma)^2[2-\gamma(1+\beta)]} > 0.$

That is if

$$\underbrace{\frac{2(1-\gamma)}{(1+\beta)(1+\gamma)(2-\beta)(2-\gamma)^2(2-\gamma-\beta\gamma)}}_{>0}[2-\gamma(1+\beta)-\beta(2-\beta)(2\beta-\gamma-\beta\gamma)] > 0.$$

It is straightforward to tell the first part of the left-hand side of the inequation is positive given $\beta, \gamma \in [0,1)$, it followers that the inequation holds if the term inside the square brackets is also positive. The term is positive if $\gamma < \frac{2(1-\beta^2+\beta)}{1-\beta^2}$, which always holds given $\beta, \gamma \in [0,1)$. Therefore the equilibrium supplier profits are higher under the wholesale structure. □

C. Proof of *Lemma 3*, Section 4

If we allow β to equal 1, then at $\beta = 1$

$$p^* = \frac{(1-1)(2-\gamma)+(1-\gamma)}{(2-1)(2-\gamma)} = \frac{1-\gamma}{2-\gamma} = p_A^*,$$

$$q^* = \frac{1}{(1+1)(1+\gamma)(2-1)(2-\gamma)} = \frac{1}{(1+\beta)(1+\gamma)(2-\gamma)} = q_A^*,$$

$$\pi^{S^j} = \frac{2(1-\gamma)}{(1+1)(1+\gamma)(2-1)(2-\gamma)^2} = \frac{(1-\gamma)}{(1+\gamma)(2-\gamma)^2},$$

$$\pi_A^{S^j} = \frac{2\times 1\times(1-\gamma)[2\times 1-\gamma(1+1)]}{(1+1)(1+\gamma)(2-\gamma)^2[2-\gamma(1+1)]} = \frac{(1-\gamma)}{(1+\gamma)(2-\gamma)^2},$$

$$\pi_{R_i} = \frac{2(1-1)}{(1+1)(1+\gamma)(2-1)^2(2-\gamma)^2} = 0,$$

$$\pi_{R_iA} = \frac{2(1-1)(1-\gamma)}{(1+\gamma)(2-\gamma)[2-\gamma(1+1)]} = 0.$$

That is, $\pi^{S^j} = \pi_A^{S^j}$ and $\pi_{R_i} = \pi_{R_iA}$. As shown, the equilibrium outcomes under the two structures are the same given $\beta = 1$. □