Do Exclusivity Arrangements Harm Consumers?*

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Abstract

This paper explores welfare implications of exclusivity arrangements, e.g. iPhone's partnership with wireless carriers. Two firms compete in a primary good market, while a monopolistic firm offers a value-adding good. The primary good can be consumed alone, while the value-adding good must be consumed with the primary good. The monopolistic firm forms an exclusivity partnership with one of the primary good providers. Buyers are able to consume the value-adding good only if they patronize the monopolistic firm's exclusive partner. This practice allows the monopolistic firm to extract surplus from the primary good market. Surprisingly, consumers benefit from the exclusivity arrangement. However, overall social welfare declines, despite improvements to consumer welfare.

JEL Nos: L1, L2, L4, L5

Keywords: Exclusivity, Consumer Welfare, Market Efficiency, Hotelling

1 Introduction

Dominant firms are increasingly using exclusivity arrangements to exploit their market power. In particular, substantial public interest has been aroused by Apple's marketing strategy for iPhone. Apple has granted only a few (selected) wireless carriers the exclusive

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right to carry iPhone. For instance, in the U.S., Apple locked its iPhone exclusively into AT&T's network for nearly four years, before it awarded "pseudo exclusivity" to Verizon in early 2011 and eventually allowed Sprint to include iPhone its lineup later that year. China Unicom continues to be the exclusive carrier in China. The suspension of iPhone's exclusivity practice in the European and Singaporean markets is mainly due to the "unfavorable" legal environment which Apple had not foreseen.

In this paper, we provide a stylized analysis of the exclusivity arrangement in a context that, to a large extent, resembles the case of Apple's iPhone. The model includes an assembly between an "upstream" firm (e.g. Apple) that owns a substantially wide niche, and duopolistic "downstream" firms (e.g. wireless carriers). Each of the downstream firms produces a primary (essential) good, which provides a "platform" for consumers to use a value-adding (non-essential) complementary good that is offered by the upstream firm. An exclusivity partnership between the monopolistic firm and one of the duopolistic firms limits the availability of the value-adding good on other platforms. As a result, its buyers will be "forced" to patronize the exclusive partner of the monopolistic firm. We provide an equilibrium analysis of firms' behavior under such an exclusivity arrangement. It allows us to evaluate the ramifications of exclusivity practice on consumer welfare and market efficiency in formal ways.

Exclusivity arrangements can be witnessed in many other contexts. For example, Electronic Arts, a major game developer, has launched games that can only be played on Sony's PlayStation 3 platform. Many publishers sell electronic versions of their works exclusively on selected platforms, e.g. Amazon.com's Kindle. Similar arrangements are also observed in digital media distribution networks, e.g. News Corp's exclusive tablet newspaper The Daily on iPad.

¹The other major wireless carrier, T-Mobile, is still being prevented from including the iPhone into its device lineups.

²Source: "Verizon may pay Apple for iPhone semi-exclusive" by Marguerite Reardon, CNET news (http://news.cnet.com/8301-30686_3-20024767-266.html).

³Source: "German Court Ruling Triggers Major Review for iPhone Sales across Europe", Global Insight, November, 2007.

However, none of these arrangements has caused as much controversy as the iPhone exclusivity deals between Apple and its partner wireless carriers. The latter exhibits unique characteristics that make it fundamentally differ from conventional practice. The primary good provider (e.g. the Kindle and the iPod), rather than the value-adding good provider (e.g. e-books and digital music), typically dominates an exclusivity partnership. The bargaining power of upstream firms is often largely limited by the non-essential nature, functional dependence, and/or the ample supply of close substitutes of the value-adding goods they produce. Their sales typically rely on the extensive consumer base and distribution networks of the primary good (i.e., "platform") providers. Thus, these exclusivity arrangements have little effect on the structure of downstream (platform) markets.

The opposite is observed in the iPhone case. The iPhone's marketing strategy has been widely regarded as an attempt to "change the existing relationship radically between mobile handset manufacturers and mobile operators". Apple's continuing marketing success and unique product image, along with its independently integrated product lines, allow its products (e.g., iPhone) to substantially differentiate themselves from rival devices and to acquire a unique and wide market niche as a "fad". The iPhone has continued to top smartphone sales chart since its initial launch, and this market dominance has allowed Apple to dominate its partnerships with wireless carriers, giving it the upper hand during negotiations. The partnership has substantially affected the balance of power in the downstream wireless market, and has been viewed by carriers as an effective means of preempting their rivals. For instance, the CEO of China Mobile, the leading wireless provider in the massive Chinese telecom market, acknowledged in public that the firm had been under strong pressure to include the iPhone in its lineup in order to please its unhappy customers. See the provider in the massive Chinese telecom market, acknowledged in public that the firm had been under strong pressure to include the iPhone in its lineup in order to please its unhappy customers.

The distinctive exclusivity practice that Apple uses with the iPhone, however, has caused substantial controversy and aroused strong regulatory concerns. In 2009, four U.S. senators

⁴Source: "German Court Ruling Triggers Major Review for iPhone Sales across Europe", Global Insight, November, 2007.

⁵Source: "Updated: China Mobile wants iPhone and iPad", iPhonAsia.com, March, 2010.

led a petition to persuade the Federal Communications Commission (FCC) to investigate the exclusivity arrangement between the iPhone and AT&T.⁶ The FCC and Department of Justice (DOJ) then launched an investigation into exclusionary handset arrangements. In France, a Paris court rejected the iPhone's exclusivity agreement with France Telecom and ordered Apple to unlock the mobile device. This ruling was widely regarded as a victory for French consumers. Despite the high profile debates caused by iPhone's exclusivity, its implications on market efficiency and consumer welfare have yet to be investigated in formal analysis. This paper attempts to fill in the gap and contributes to the ongoing policy debate that surrounds the iPhone's controversial partnerships.

Our paper offers a stylized but potentially useful analysis of an economic relationship that resembles the iPhone context. In our model, consumers are uniformly distributed on a square. Two duopolistic downstream firms, which produce a primary good, are located at opposite ends of a horizontal line that lies across the middle of the square, while a monopolistic upstream firm, which produces a value-adding good, is located at the center of the square. The primary good can be consumed alone, while the value-adding good must be used together with the primary good in a fixed (one-to-one) proportion. In the benchmark case where exclusivity is absent, the monopolistic firm and the duopolistic firms set their prices independently. When the monopolistic firm is allowed to practice exclusivity, the game proceeds as follows. First, the monopolistic firm announces its exclusivity contract, which specifies the price of its value-adding good. Second, it runs an auction to sell its exclusive partnership, and invites the duopolistic primary good providers to bid for the partnership. Under the exclusive arrangement, the monopolistic firm "locks" its product to the primary good offered by its exclusive partner. Finally, the duopolistic firms simultaneously set their prices, and consumer purchases take place subsequently.

⁶They argued that "for many consumers, the end result of these exclusionary arrangements is being channeled to purchase wireless service from a carrier that has monopolistic control over the desired handset and having to pay a premium price for the handset because the market is void of any competition for the particular handset." (Source: "Department of Justice launches review of handset arrangements" by Tom Braithwaite and Richard Waters, Financial Times, July 7, 2009)

We show that the monopolistic firm benefits from exclusivity despite the loss of market share due to exclusion. This practice allows it to "leverage" its market power in the (non-essential) value-adding good market so as to extract surplus from the primary good market. Paradoxically, consumers also benefit from the exclusivity practice. The reasons are as follows.

First, the monopolistic firm engages in a so-called "demarginalization" strategy.⁷ The monopolistic firm strategically "underprices" its value-adding good. The lower price boosts demand for the good and increases the appeal of the primary good offered by its partner. This effect amplifies the rent that accrues to its exclusive partner, which allows the monopolistic firm to recoup the foregone sales revenue (from its value-adding good) through the higher revenue from the bidding contest. Consumers who consume the value-adding product benefit from the low price. Second, exclusivity triggers a "market stealing" effect. The excluded firm is forced to undercut its rival to avoid losing its market share even further, which intensifies price competition and in turn benefits consumers in the primary good market. In addition, the monopolistic firm's demarginalization practice strengthens the "market stealing" mechanism: a lower price would further handicap the excluded firm, thereby compelling it to undercut its rival more.

Our analysis yields interesting policy implications. In contrast to the popular view that exclusivity arrangements jeopardize consumer welfare, our analysis demonstrates otherwise. It sheds some light on the recent debates on exclusivity practices in various markets. For instance, our results cast doubt on the court ruling against iPhone in France on the ground of consumers' interests. Our welfare result, nevertheless, should be interpreted with caution. First, the practice redistributes surplus among different consumers: some gain at the expense of others. Second, social welfare declines despite the gain of consumer welfare. This finding reveals the complexity in evaluating the ramifications of exclusivity arrangement.

⁷This practice is similar to the two-part tariff used to eliminate the double-marginalization problem in a vertical distribution channel.

Relation to Literature

Our analysis is related to the extensive literature on tying and bundling. The conventional framework on tying usually involves a multi-product firm that monopolizes at least one good, and focuses on its incentive to bundle its own products. A tie-in sale has been interpreted as a price-discriminating device (see Adams and Yellen, 1976; McAfee, MacMillian and Whinston, 1984; Bakos and Brynjolfsson, 1999; and Armstrong, 2006), or as a foreclosure or entry-deterrence strategy (Whinston, 1990; Choi and Stefanadis, 2001; Carlton and Waldman, 2002; and Nalebuff, 2004). In a recent paper, Mialon (2011) demonstrates the anti-competitive effect of bundling strategy when it motivates merger.

A handful of papers have identified tying sales as an effective means of altering price competition between firms. These studies typically involve one firm monopolizing one good and competing against others in the market for the other good. Carbajo, De Meza and Seidman (1990) and Chen (1997) demonstrate that a firm may prefer to sell its multiple independent goods in bundles, as that creates product differentiation. In contrast, Carlton, Gans and Waldman (2010) assume that consumers only value a system that consists of two goods, with one (primary good) monopolistically supplied, and the other (complementary good) competitively supplied. They show that a firm that monopolizes the former good may prefer to tie its latter good. Tying allows the monopolist to alter price competition in the complementary good market, thereby shifting rent of that market to its own.⁸ Gans (forthcoming) extends Carlton, Gans and Waldman (2010) to a more general framework in which the primary good offered by the monopolistic firm can be consumed alone. Furthermore, consumers value the complementary good offered by different firms asymmetrically. Both Carlton, Gans and Waldman (2010) and Gans (forthcoming) demonstrate the social cost associated with tying and its ambiguous effects on consumer welfare. More recently, Miao (2010) studies a monopolistic system maker's (e.g. Microsoft) decision to introduce a

⁸In contrast to most existing studies, Carlton, Gans and Waldman (2010) allow for reverse tying, such that consumers can add a second complementary good to the bundle "system".

separate application or an upgraded system that integrates the application (bundle), when the application can be supplied by other firms. Miao (2010) focuses on the intertemporal and compatibility concerns of the monopolist in introducing systems of different generations.

Our paper is related to this set of papers, because we also focus on a mechanism that leverages monopolistic power from one market to alter pricing competition in the other and to "squeeze" its rent. However, there are a few fundamental differences. First of all, unlike these studies, we do not consider multi-product firms. In our context, a monopolistic firm artificially locks its own (non-essential complementary) product to the primary good of its exclusive partner. Rent is shifted through a side payment. Second, the monopolistic firm in our model offers a non-essential good, whose consumption relies on a competitively-supplied essential good, while the competitively-supplied essential good can be consumed alone. This flavor has been rare in the literature. Most existing studies assume either (1) that only the monopolist produces the essential good, or (2) that consumers must consume a system which includes two goods.

Our paper is also related to the literature on exclusivity arrangements. However, this literature has conventionally focused on exclusivity arrangements in vertical distribution channels (e.g. Hart and Tirole, 1990; O'Brien and Shaffer, 1992; McAfee and Schwartz, 1994; Fumagalli and Motta, 2006; and Jing and Winter, 2011). The current paper differs from these studies mainly in two aspects. First, this literature typically studies strategic wholesale contracting between upstream manufacturer and downstream retailers, with the former selling its product to one of the latter and relinquishing control over the retail prices. Our model does not involve "wholesale". The contractual arrangement we consider instead corresponds to the "affiliation" mode (Hagiu and Lee, 2011), under which an upstream firm

⁹One notable exception is provided by Gans and King (2006). They consider the bundling of goods between different firms. In their context, there are two independent and unrelated goods, each produced by two sellers. They show that two coalitions would endogenously arise in equilibrium, each comprising two firms that produce the two goods. Consumers can purchase a bundle of the two goods at discount from either coalition.

¹⁰There is a small amount of research on exclusivity in the context of two-sided markets. In a recent working paper, Chowdhury and Martin (2010) investigate the relevant conditions under which a platform (e.g., newspapers) may bundle a critical product (e.g. columns and comics strips).

(e.g. Apple) retains control over the price of its own product and sells the product directly to consumers, while it can "lock" its product to that of its downstream exclusive partner. As revealed in our analysis, the ability of the monopolistic firm to price its good triggers profound strategic interactions. It also crucially affects downstream market structure and welfare distribution. Second, following Gans and King (2006), we adopt a "square city" framework to model demand structure. It reflects consumers' multi-dimensional preferences and also distinguishes our paper from the majority of the literature on exclusivity.

The seminal work of Hagiu and Lee (2011) is the first to distinguish between an "upright sale" mode (or wholesale) and an "affiliation" mode (e.g. selling TV shows through wholesale to TV channels vs. affiliating video games with specific game consoles). 11 Their analysis reveals how multihoming or exclusivity may endogenously arise when "content" is matched to "platforms", under either of the two modes. Our paper, however, focuses rather on the welfare implications of exclusivity arrangements under "exclusive affiliation". In addition to the different focuses, our modelling approach differs subtly from that of Hagiu and Lee (2011). First, we assume that the monopolistic firm first commits to an exclusivity plan and the two duopolistic firms then bid to become the exclusive partner. Hagiu and Lee (2011) allow competing platforms to offer contracts that specify payments contingent on ultimate affiliation choices (exclusivity or multihoming). Second, Hagiu and Lee (2011) assume that the platform providers set their prices first, while we assume that the non-essential valueadding good provider leads in pricing its goods. 12 These differing modeling nuances fit different contexts of interests. In particular, our model intends to reflect the basic premise that the monopolistic firm dominates in the exclusivity partnership, i.e., with a superior ability to choose and commit to business modes and contractual terms. The two papers thus complement each other. We demonstrate later in this paper (1) that the monopolistic firm benefits from such practice in the current context; and (2) that these modelling flavors are

¹¹The "wholesale" mode requires the content provider to relinquish pricing control while the "affiliation" mode does not.

 $^{^{12}}$ In a sense, both papers assume that dominant firms move first in pricing their goods.

consistent with stylized facts.

The rest of the paper is organized as follows. The model is set up in Section 2 and analyzed in Section 3. Section 4 demonstrates the welfare implications. Section 5 concludes the paper.

2 Setup

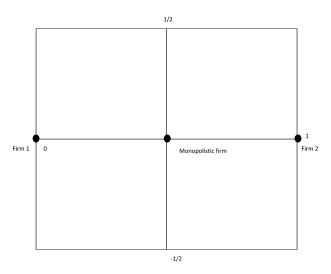


Figure 1: The Market of a "Square City"

Following Gans and King (2006), we consider a two-good market as a square city. The structure of the market is illustrated in Figure 1. A unit mass of consumers is uniformly distributed within the square. Two competing firms (i = 1, 2) provide a primary good X, while a monopolistic firm sells a value-adding good Y. The primary good X can be consumed alone. The value-adding good Y, however, must be consumed along with X in a one-to-one proportion. To provide an analogy, suppose that X represents voice and data services in the wireless market, while Y represents a premium smart handset (e.g., iPhone). Furthermore, the marginal costs of producing these products are normalized to zero.

As depicted in Figure 1, the two competing firms are located at the end points of the x- axis, 0 and 1. The monopolistic firm is located at the center of the square, i.e., the

¹³It is reasonable to assume that each consumer possesses a basic phone that allows him/her to enjoy basic voice and data services.

point with the coordinate $(\frac{1}{2}, 0)$. Each consumer's preference is characterized by his position (x, y). If a consumer purchases primary good X from firm 1, he incurs a travel cost of $d_X x$, while he incurs a travel cost of $d_X (1-x)$ if he purchases the good from firm 2. Similarly, if a consumer purchases product Y from the monopolistic firm, he bears a travel cost of $d_Y |y|$.

It is assumed that each consumer has inelastic demand of up to one unit of each good. He receives a utility u if he consumes product X, and v if he consumes product Y. It is assumed that u is sufficiently large to sustain full market coverage of X.

In order to focus our attention on the most relevant case, it is further assumed that (marginal) travel costs are sufficiently large, and that the value of Y to consumers is in an intermediate range. These assumptions are stated as follows.

Assumption 1 $v \leq d_X$.

Assumption 2 $2v < d_Y < 4v$.

The first assumption rules out the possibility of full foreclosure in equilibrium. That is, when the monopolistic firm locks Y to the primary good offered by one firm, the other firm will not lose its most loyal consumers (i.e. those who are located in the vicinity of the position of that firm).

The condition $2v < d_Y$ implies that the market for Y is never fully covered. Exclusivity does not pay off otherwise and welfare analysis would become less interesting when the monopolistic firm does not implement the strategy in the first place. However, d_Y is also assumed not to be prohibitively high, i.e. $d_Y < 4v$.¹⁴ Under this condition, the monopolistic firm still retains sufficient market coverage, and thus our analysis focuses on the case where the monopolistic firm serves a nontrivial "market niche".

¹⁴Or, equivalently, the complementary good is assumed to substantially add to consumers' utility.

3 Analysis

A benchmark case without an exclusivity agreement is first considered. The equilibrium when the monopolistic firm is allowed to practice exclusivity is then derived.

3.1 Benchmark: Mandatory Unlocking

We consider a case where the monopolistic firm is prohibited from locking its product to the primary good offered by either of the duopolistic firms (e.g., iPhone in France). In the benchmark case, all firms price and sell their products independently. Consumers who purchase Y can purchase X from either duopolistic firm.

The competition in the primary good market is analogous to that in a conventional Hotelling model. The demand for firm 1 is then determined by the equation $u - p_1^X - d_X x = u - p_2^X - d_X (1-x)$, and we then have

$$D_i = \frac{(p_j^X - p_i^X) + d_X}{2d_X}. (1)$$

Hence, a firm i's profit function $\pi_i(\mathbf{p}) = p_i^X \cdot \frac{(p_j^X - p_i^X) + d_X}{2d_X}$. A unique equilibrium exists that firms each charge $p_1^{X*} = p_2^{X*} = d_X$, and earn $\pi_1^{X*} = \pi_2^{X*} = \frac{d}{2}$.

In the market for product Y, the type of marginal consumer is determined by setting $v - p^Y - d_Y y = 0$. The monopolistic firm thus faces a demand of $\frac{2(v-p^Y)}{d_Y}$ and its profit is given by $\pi(p^Y) = \frac{2p^Y(v-p^Y)}{d_Y}$. In equilibrium, it charges $\frac{v}{2}$, and earns a profit of $\frac{v^2}{2d_Y}$.

3.2 Exclusivity

We now allow the monopolistic firm to form an exclusivity partnership with one of the duopolistic firms.¹⁵ We consider a three-stage game. The timing of moves is as follows.

1. The monopolistic firm announces its exclusivity plan (p^Y) , and runs an auction to

¹⁵For the purpose of this paper, we do not consider the option of "outright sale" by the monopolistic firm in the model.

sell its exclusive partnership. Specifically, the monopolistic firm commits to locking its product to the primary good offered by the winning firm. The monopolistic firm requires its consumers, who have purchased Y at a price $p^Y \geq 0$, p^{16} to purchase X from its exclusive partner. The term and condition can be alternatively interpreted: only consumers of the partner firm are eligible to purchase the value-adding good (at a price p^Y).

- 2. Upon observing the exclusivity plan (p^Y) , the two competing firms bid for the partnership. The higher bidder wins and enters the exclusive partnership with the monopolistic firm. A tie would be broken randomly.
- 3. The duopolistic firms simultaneously announce their prices for X, p_i^X (i=1,2).
- 4. Consumers observe p^Y and (\mathbf{p}_i^X) , and then make their purchases.

A few remarks are in order before we proceed to solve for the equilibrium. First, the bargaining between the monopolistic firm and the two downstream firms is modelled as a bidding game. The duopolistic firms submit their bids of "subsidies" for the exclusivity partnership. Second, we assume that the monopolistic firm commits to its price p^Y as part of the terms that it demands for the exclusivity deal, and that the duopolistic firms price their products after exclusivity partnership is formed. This modelling nuance closely mirrors Apple's marketing practice for the iPhone and is consistent with casual observations from the U.S. wireless market.¹⁷ For instance, Apple announced (e.g., in preorder) the price of the iPhone and its network technology long before the associated wireless plan was revealed.^{18,19} Wireless carriers, however, keep on updating the details of their service

¹⁶For the sake of analytical convenience and expositional efficiency, it is assumed that the monopolistic firm is unable to price Y below its marginal cost, i.e., $p^Y \in [0, \infty)$. This assumption allows for tractability. It can also be interpreted as a regulatory restriction.

¹⁷Source: "Verizon Deal May Expose iPhone Flaws," by Joe Nocera, New York Times, January 14, 2011.
¹⁸For example, when Verizon announced its iPhone launch in January 2011, it only discussed the price, which started at \$199, for the phone, but "wouldn't discuss service plans" (Source: "Verizon Unwraps iPhone," by Shayndi Raice and Yukari Iwatani Kane, Wall Street Journal, January 12, 2011.

¹⁹Source: "Verizon Unwraps iPhone," by Shayndi Raice and Yukari Iwatani Kane, Wall Street Journal, January 12, 2011.

plans for the iPhone and other wireless devices. This setting reflects the superior bargaining power of the monopolistic firm. Indeed, the stylized facts are evidence that wireless carriers have been "more willing to give in to Apple's terms" and to concede to Apple's demands.²⁰ Furthermore, we discuss later (see in Proposition 2) that it is in the monopolistic firm's best interest to bundle the price of the value-adding good p^Y into the contract, when practicing the exclusivity strategy.

3.2.1 Price Competition in the Primary good Market

Without loss of generality, let firm 1 be the winner. Each consumer faces one of three purchase options: (1) purchasing X from firm 2; (2) purchasing X only from firm 1; or (3) purchasing the "bundle" of both X (from firm 1) and Y (from the monopolist). Figure 2 illustrates the market segmentation with an exclusivity arrangement.

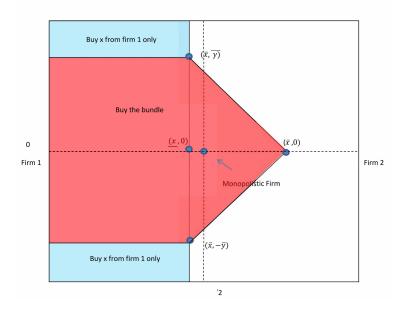


Figure 2: Market Fragmentation under Exclusivity

Firm 1 secures a larger market share. As Figure 2 shows, some consumers who would otherwise patronize firm 2 (i.e., those who are located in the right half of the square city),

²⁰Source: "Analyst: Verizon Wants Pseudo-Exclusive on iPhone," by John Paczkowski, Digital Daily, December 6, 2010.

may switch to firm 1 if they highly value product Y, i.e., when they are located sufficiently close to the center of the square city in the vertical dimension.²¹

Let D_i denote a firm i's market share. The consumers of firm 1 can be split into two groups. One group of them purchase X only, which we denote by D_1^X ; while the other group purchase both X and Y, which we denote by D_1^{XY} . The following lemma depicts the equilibrium in the primary good market under an exclusivity plan (p^Y) .

Lemma 1 (i) The partner firm (firm 1 by default) charges $p_1^X = d_X + \frac{(v-p^Y)^2}{3d_Y}$ for the primary good and secures a market share of $D_1 = \frac{1}{2} + \frac{(v-p^Y)^2}{6d_Xd_Y}$. A share of consumers $D_1^{XY} = \frac{(v-p^Y)}{d_Y} - \frac{2(v-p^Y)^3}{3d_Xd_Y^2} + \frac{(v-p^Y)^2}{2d_Xd_Y}$ purchase both X and Y. Firm 1 earns a total profit of $\pi_1^* = \left(d_X + \frac{(v-p^Y)^2}{3d_Y}\right) \cdot \left(\frac{1}{2} + \frac{(v-p^Y)^2}{6d_Xd_Y}\right)$ from the primary good market.

- (ii) Firm 2 charges a price $p_2^X = d_X \frac{(v p^Y)^2}{3d_Y}$, secures a market share of $D_2 = \frac{1}{2} \frac{(v p^Y)^2}{6d_X d_Y}$, and earns a profit of $\pi_2^* = \left(d_X \frac{(v p^Y)^2}{3d_Y}\right) \cdot \left(\frac{1}{2} \frac{(v p^Y)^2}{6d_X d_Y}\right)$.
 - (iii) Firm 1 secures a greater market share than firm 2, i.e., $D_1 > D_2$.

Proof. See Appendix.

3.2.2 Equilibrium at the Bidding Stage

As Lemma 1 indicates, exclusivity allows the winning firm to obtain a competitive edge in the primary good market. For given p^Y , it earns an extra profit of $\Delta \pi = \pi_1 - \pi_2 = \frac{2(v-p^Y)^2}{3d_Y}$. The bidding subgame boils down to a two-player symmetric complete-information auction. As a standard result, each firm bids $\Delta \pi$ in the unique pure-strategy equilibrium, and one firm (firm 1 by default) is chosen as the exclusive partner.

3.2.3 Equilibrium Exclusivity Plan

Now we turn our attention to the equilibrium strategy of the monopolistic firm. It collects a profit of $\pi^Y(p^Y)$ from selling Y. It also receives revenue through the partner firm's bid

²¹For the sake of brevity, we do not consider the case in which a *foreclosure* (i.e., one firm drives the other out of the market by undercutting price) can arise in the equilibrium. This possibility is precluded by the two regularity assumptions stated in Section 2.

 $\Delta \pi$. Hence, the overall profit of the monopolistic firm is given by $\pi^m = \pi^Y(p^Y) + \Delta \pi$. At the beginning of the game, the monopolistic firm chooses $p^Y \in [0, \infty)$ to maximize π^m , internalizing its effect on primary good market competition. Standard technique yields the solution to the subgame perfect equilibrium of the game.

Proposition 1 (a) In the unique subgame perfect equilibrium of the game, the monopolistic firm charges $p^Y = 0$ for the value-adding good, and receives a profit (from the winning bid) of $\pi^{m*} = \frac{2v^2}{3d_Y}$, which is higher than it would receive in the benchmark case $(\pi^* = \frac{v^2}{2d_Y})$.

(b) The partner firm (firm 1 by default) secures a market share $D_1^* = \frac{1}{2} + \frac{v^2}{6d_X d_Y}$, and earns $\pi_1 = \left(d_X + \frac{v^2}{3d_Y}\right) \cdot \left(\frac{1}{2} + \frac{v^2}{6d_X d_Y}\right)$ from the primary good market, while the losing firm (firm 2 by default) secures a market share $D_2^* = \frac{1}{2} - \frac{v^2}{6d_X d_Y}$, and earns $\pi_2 = \left(d_X - \frac{v^2}{3d_Y}\right) \cdot \left(\frac{1}{2} - \frac{v^2}{6d_X d_Y}\right)$.

Proof. See Appendix.

As Proposition 1(a) indicates, the monopolistic firm gets better off when it is allowed to exercise exclusivity. In equilibrium, the monopolistic firm simply charges the marginal cost ($p^Y = 0$) to consumers, and earns zero profit from retailing the product. The foregone revenue from selling Y is compensated for through a higher bid from the auction. The logic will be further elaborated upon in Section 4.1.

We define this pricing strategy as "demarginalization", a practice similar to a two-part tariff scheme to combat the double-marginalization problem in the vertical distribution channel literature (Sudhir and Datta, 2008). The monopolistic firm charges the value-adding product at its marginal cost and does not profit from retailing its own product. The low price, however, allows its exclusive partner to acquire a greater advantage in the downstream primary-good market. The extra profits that the exclusive partner receives under the contract eventually find their way back to the monopolistic firm through a higher bid, which compensates for the sales revenue that the monopolistic firm has sacrificed.

The prediction of the monopolistic firm's underpricing is largely consistent with the stylized facts in the iPhone case. For instance, the price of an iPhone 4 ranges from \$199 to

\$299, depending on the model specifications. Apple pays approximately \$244 on average for each iPhone to the manufacturers, according to Apple's financial filings.^{22,23} Although the details of iPhone's exclusivity contracts have not been disclosed, it was estimated that AT&T paid Apple approximately an average of \$550 for each iPhone under exclusivity contract.²⁴

3.2.4 Discussion

In setting up the model, we have assumed that the monopolistic firm moves first in pricing its product and that it bundles its price in the exclusivity contract. This assumption inarguably reflects the monopolistic firm's superior ability to dominate its negotiation with the downstream duopolistic firms.

We now relax this assumption and allow the monopolistic firm not to commit to p^Y during the bargaining process, but to announce it after the bidding. The underlying question is whether it pays for the monopolistic firm to include p^Y as a part of the terms in the exclusivity contract. Next, we consider a case where the three firms are allowed to set their prices after exclusivity contract is awarded to the winning bidder. Our analysis leads to the following.

Proposition 2 The monopolistic firm strictly prefers to bundle its price p^Y into the exclusivity contract.

Proof. See Appendix.

If the monopolistic firm sets the price after settling the amount of transfer in exchange for the exclusivity partnership, it would then be tempted to charge a higher price for its own

²²Source: "Does Apple Enjoy a Licensing Loophole on iPhone?" by Don Clark, Wall Street Journal, November 20, 2009 (http://blogs.wsj.com/digits/2009/11/20/does-apple-enjoy-a-licensing-loophole-on-iphone).

²³When iPhone was initially introduced to the market, it had a price tag of \$499. The high price, as a typical marketing tool to sell "hot" new products, contained a premium that early adopters are willing to pay. The price of iPhone quickly declined and stabilized. The current price schedules should be considered as a more appropriate benchmark as they are set to target at mainstream consumers, instead of a small group of "early adopters". The price dynamics of iPhone is consistent with those of many other popular electronics products as newer models are released and technology advances. Our model, however, is not designed to capture the dynamic feature of Apple's pricing strategy.

²⁴Source: "Is There a Method in Cellphone Madness?" by Saul Hansell, New York Times, November 15, 2009.

good. The higher price leads to a further loss of market share for the monopolistic firm. Anticipating that, the duopolistic firms would bid less for the partnership, which jeopardizes the overall profit of the monopolistic firm. We conclude that the monopolistic firm prefers to commit to its price and include it in the exclusivity contract.

4 Who Benefits from an Exclusivity Arrangement?

The above equilibrium result allows us to explore the welfare implications of exclusivity arrangements.

4.1 Consumer Welfare

Primarily, we investigate the effect of exclusivity on consumer welfare. Consumers derive utility from consuming X and Y. They make payments to these firms in exchange for the products, and also bear the travel costs. Let W_0 and W_1 denote consumer welfare in the benchmark case (without exclusivity) and in the exclusivity arrangement case, respectively. Our analysis allows us to conclude the following.

Proposition 3 Consumers as a whole benefit from exclusivity arrangements, i.e. $W_1 > W_0$.

Proof. See Appendix.

The overall consumer surplus increases when exclusivity is in place. In contrast to the prevailing views, our analysis suggests that banning exclusivity arrangements may paradoxically hurt consumers. A number of effects loom large in the presence of exclusivity arrangements.

On the one hand, exclusivity generates two positive effects on consumer welfare. First, the monopolistic firm strategically "underprices" Y. Under exclusivity, customers who patronize the exclusive partner (firm 1) receive not only the primary good but also the privilege of enjoying the value-adding good Y (at an additional price p^Y). Hence, a lower p^Y makes firm

1's X more appealing than its rival's, which amplifies the rent from the exclusivity arrangement, thereby inflating firms' bids. By underpricing Y, the monopolistic firm sacrifices its retailing revenue but is "subsidized" by firm 1 through its bid. This practice allows a subset of consumers (D_1^{XY}) to enjoy the value-adding good Y at a lower price. The mechanism is referred to as a "demarginalization" effect.

Second, this practice intensifies price competition in the primary good market. In equilibrium, firm 2 charges a lower price than it does in the benchmark case. Handicapped by firm 1's exclusivity partnership, firm 2 undercuts its rival to protect its clientele. Firm 1, as the exclusive partner, demands a premium price for its X. However, its product also entitles a consumer the privilege to buy Y at a low price, which could also improve consumer welfare. In the benchmark case, consumers pay a total of $d_X + \frac{v}{2}$ if they buy both X and Y; while they pay only $d_X + \frac{v^2}{3d_Y}$ in the exclusivity arrangement case. ²⁵ In summary, exclusivity intensifies price competition in the primary good market, thereby allowing (a subset of) consumers to pay less for their consumption of Y. This mechanism is referred to as a "market-stealing" effect.

Furthermore, the market-stealing effect has positive interaction with the demarginalization effect. Note by Lemma 1 that p_2^X and p^Y are strategic complements, i.e., $\frac{\partial p_2^X}{\partial p^Y} > 0$. The market-stealing effect is magnified when the price of Y is lower. A lower p^Y exacerbates firm 2's disadvantage, which adds downward pressure to its pricing of X.

On the other hand, this practice distorts market competition and consumer behavior, thereby resulting in disutility to consumers as well. Exclusivity inflicts welfare loss on four subsets of consumers. First, a subset of firm 1's "loyal customers" (those who are located sufficiently close to zero along the x- axis) purchase X only. They end up paying more for X, because firm 1 charges a premium price. Second, a subset of firm 2's initial customers in the benchmark case, who highly value Y, would switch to firm 1. The benefit these consumers receive from a lower p^Y can be offset by the higher travel costs required for

²⁵By Assumption 1, we must have $\frac{v}{2} > \frac{v^2}{3d_Y}$.

consuming X. Third, a subset of firm 1's initial customers, who purchase X only, would switch to firm 2 because of its lower price for X. These consumers bear a higher travel cost to take advantage of paying less for X. Finally, a subset of firm 2's "loyal customers" are excluded from consuming Y.

Taken together, the positive effects unambiguously dominate the negative ones. Consumers, as a whole, benefit from the practice.²⁶ This result adds new insight into the widely-debated exclusivity practice of the iPhone. However, the result must be interpreted with caution, as exclusivity triggers welfare redistribution among consumers: some gain at the expense of others.

4.2 Primary good Industry

The effects of exclusivity on the profitability of the primary good industry are explored now. The following is obtained.

Proposition 4 In the primary good market, both firms are worse-off when the monopolistic firm is allowed to practice exclusivity.

Proof. See Appendix.

With a higher product price and an expanded market share, firm 1 receives higher profits from its sales in the primary good market in the exclusivity arrangement case. However, the two duopolistic firms are left in a prisoner's dilemma in the fierce bidding war. By practicing exclusivity, the monopolistic firm is able to leverage its market power to extract surplus from the primary good market, as the winning firm surrenders its rent in the primary good market through its bid. Meanwhile, the losing firm responds by aggressively undercutting the price. The ability of the monopolistic firm to practice exclusivity jeopardizes the profitability of both firms in the primary good market.

 $^{^{26}}$ Additional analysis reveals the intricate redistribution of consumer surplus. More specifically, consumers (as a whole) realize a gain from the market of Y, but suffer a loss in the market of X due to the distortion. However, the gain dominates the loss, leading to an overall rise in welfare. We do not include the detail in order to economize on the presentation.

Our results are consistent with the stylized facts. It has been reported that AT&T had suffered a loss from its exclusive iPhone deal with Apple. Despite the fact that the wireless carrier had successfully lured subscribers away from its competitors, such as Verizon, Sprint, and T-Mobile, the company ended up with a dip in its profits. In the second quarter of 2009, the company's profit fell by \$0.27 billion as compared to its profit in the same quarter a year earlier.²⁷ AT&T's loss was mainly due to "the heavy subsidy" it paid for the iPhone. Although the details of the exclusivity contract are not publicly available, on average, AT&T was estimated to have "subsidized" \$550 of the price of each iPhone. This is \$200 to \$300 higher than the estimated cost of other smartphones.²⁸ Meanwhile, AT&T's major competitors' profits also dipped during the same period.

4.3 Social Welfare

In sum, both the monopolistic firm and consumers (as a whole) benefit from exclusivity arrangements, while the duopolistic firms in the primary good market lose. Despite the gain in consumer surplus, the overall social surplus declines under exclusivity, which is stated as follows.

Proposition 5 Social welfare declines as a result of an exclusivity arrangement.

Proof. See Appendix.

The cost of this practice in the primary good market (on the two duopolistic firms) more than offsets the gains that accrue to consumers and the monopolistic firm. Our analysis thus indicates the complexity in evaluating the ramifications of exclusivity arrangements.

²⁷Source: CNET News: *iPhone Buys AT&T Subscriptions-But Hurts Profit*, by Marguerite Reardon, July 23, 2009.

²⁸Source: "IPhone May Cost Verizon \$5 Billion in First Year," by Amy Thomson, Bloomberg Businessweek, February 16, 2011.

5 Conclusion

In this paper, we construct a stylized model to investigate the welfare implications of exclusivity arrangements, quoting iPhone as a motivating example given the wide influence and unique characteristics of its marketing practice. We demonstrate that this practice distorts competition and leads to market inefficiency. Consumers as a whole, however, benefit from it. The practice leads to redistribution among consumers, as some gain at the expense of others. Meanwhile, the monopolistic firm extracts additional surplus from the primary good market, which makes the two firms in that industry strictly worse off. Overall, social welfare declines.

Our analysis has useful regulatory implications. It reveals the complex welfare implications of an exclusivity arrangement. Banning this practice may hurt consumers instead of protecting their interests, although doing so would improve social welfare, taking into account the profits of the two competing firms in the primary good market.

Our paper offers one possible perspective for examining the controversial practice of exclusivity arrangements. There is much room for future extensions. For instance, richer results might be obtained from a more general model that includes firms' innovation activities. Alternatively, the monopolistic firm's opportunistic concerns may also be included in the model. Another equally reasonable setting is one in which the duopolistic firms collude in bidding for the exclusivity partnership. In that case, substantially more extensive strategic interactions can be expected, although modeling the subtle interaction can be technically difficult. Finally, it is necessary to stress that our model does not intend to capture the dynamics of the fast-changing iPhone market, where the remaining major wireless carriers are about to join the competition in the coming months. A substantially richer setup, which incorporates dynamic elements, is required to provide a complete account of the development of the market structure. Such an extension is far beyond the scope of the current study, but will remain the priority of the authors in future research.

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Appendix

Proof of Lemma 1

Proof. The mass of consumers who purchase X alone from firm 1 is $D_1^X = 2(\frac{1}{2} - \overline{y})\underline{x} = \left(1 - \frac{2(v - p^Y)}{d_Y}\right) \cdot \frac{(p_2^X - p_1^X) + d_X}{2d_X}$, and the mass of consumers who purchase both X and Y is $D_1^{XY} = 2\underline{x}\overline{y} + \overline{y}\Delta x = \frac{(p_2^X - p_1^X) + d_X}{d_X} \cdot \frac{(v - p^Y)}{d_Y} + \frac{1}{2} \cdot \frac{(v - p^Y)}{d_X} \cdot \frac{(v - p^Y)}{d_Y}$. Adding these together, the entire market share for Firm 1 is given by $D_1 = \frac{(p_2^X - p_1^X) + d_X}{2d_X} + \frac{(v - p^Y)^2}{2d_X d_Y}$.

A firm i, i = 1, 2, earns from the primary good market a profit $\pi_i = D_i p_i^X$. We now derive the equilibrium in this market. The first-order condition for firm 2's profit function is given by $\frac{d\pi_2}{dp_2^X} = D_2 + p_2^X \frac{dD_2}{dp_2^X} = \left[1 - \frac{(p_2^X - p_1^X) + d_X}{2d_X} - \frac{(v - p^Y)^2}{2d_X d_Y}\right] - \frac{p_2^X}{2d_X}$. It follows in the equilibrium

$$\frac{p_2^X}{2d_X} = 1 - D_1. (2)$$

Firm 1 maximizes π_1 by choosing an optimal price p_1^X . The first-order condition is then given by $\frac{d\pi_1}{dp_1^X} = D_1 + p_1^X \frac{dD_1}{dp_1^X} = 0$, which yields $\frac{p_1^X}{2d_X} = D_1 = \frac{(p_2^X - p_1^X) + d_X}{2d_X} + \frac{(v - p^Y)^2}{2d_X d_Y}$.

Hence, we must have in equilibrium $p_1^X + p_2^X = 2d_X$, which is equivalent to $p_2^X = 2d_X - p_1^X$. Insert it into (2), and we obtain $\frac{p_1^X}{2d_X} = \frac{(2d_X - 2p_1^X) + d_X}{2d_X} + \frac{(v - p^Y)^2}{2d_X d_Y}$, which leads to $p_1^X = d_X + \frac{(v - p^Y)^2}{3d_Y}$, and $p_2^X = d_X - \frac{(v - p^Y)^2}{3d_Y}$. Thus, it follows that $p_2^X - p_1^X = -\frac{2(v - p^Y)^2}{3d_Y}$. Hence, we have $D_1 = \frac{(p_2^X - p_1^X) + d_X}{2d_X} + \frac{(v - p^Y)^2}{2d_X d_Y} = \frac{1}{2} + \frac{(v - p^Y)^2}{6d_X d_Y}$, and $D_2 = 1 - \frac{1}{2} - \frac{(v - p^Y)^2}{6d_X d_Y} = \frac{1}{2} - \frac{(v - p^Y)^2}{6d_X d_Y}$.

We also need to find out the demand for the add-on product Y, or D_1^{XY} , which is given by $D_1^{XY} = \frac{-\frac{2(v-p^Y)^2}{3d_Y} + d_X}{d_X} \cdot \frac{(v-p^Y)}{d_Y} + \frac{(v-p^Y)^2}{2d_Xd_Y} = \frac{(v-p^Y)}{d_Y} - \frac{2(v-p^Y)^3}{3d_Xd_Y^2} + \frac{(v-p^Y)^2}{2d_Xd_Y}.$

To see whether firm 1 ends up with a higher demand for X under exclusivity, we simply compare $\overline{y}\Delta x$ and $\frac{1}{2} - \underline{x}$. We have $\overline{y}\Delta x = \frac{v-p^Y}{d_Y}\frac{v-p^Y}{2d_X} = \frac{(v-p^Y)^2}{2d_Xd_Y}$, and $\frac{1}{2} - \underline{x} = \frac{1}{2} - \frac{-\frac{2(v-p^Y)^2}{3d_Y} + d_X}{2d_X} = \frac{(v-p^Y)^2}{3d_Xd_Y}$. It is straightforward to show that $\frac{1}{2} - \underline{x} < \overline{y}\Delta x$ since $\frac{(v-p^Y)^2}{2d_Xd_Y} - \frac{(v-p^Y)^2}{2d_Xd_Y} = \frac{(v-p^Y)^2}{3d_Xd_Y}$.

 $\frac{(v-p^Y)^2}{3d_Xd_Y} = \frac{(v-p^Y)^2}{6d_Xd_Y}$. Thus, firm 1 gains demand for X under exclusivity arrangement than in the benchmark case, at the expense of firm 2. The computation of equilibrium profits is straightforward by simple algebra.

Proof of Proposition 1

Proof. In the add-on product Y market, we first search for the optimal price p^Y of the monopolistic firm. We have

$$\begin{array}{lcl} \frac{d\pi^m}{dp^Y} & = & \frac{d\Delta\pi}{dp^Y} + D_1^{XY} + p^Y \frac{dD_1^{XY}}{dp^Y} \\ & = & -\frac{4}{3} \frac{(v-p^Y)}{d_Y} + \left(v-2p^Y\right) \left(\frac{1}{d_Y} - \frac{2(v-p^Y)^2}{3d_X d_Y^2} + \frac{(v-p^Y)}{2d_X d_Y}\right) + \left(\frac{4(v-p^Y)}{3d_Y} - \frac{1}{2}\right) \frac{(v-p^Y)p_Y^Y}{d_X d_Y^{(3)}} \end{array}$$

When $p^Y = 0$, the last equation becomes

$$\frac{d\pi^m}{dp^Y} = -v\left[\frac{1}{3d_Y} + \frac{2v^2}{3d_X d_Y^2} - \frac{v}{2d_X d_Y}\right] \tag{4}$$

We now establish the following: whenever the condition $\frac{1}{3d_Y} + \frac{2v^2}{3d_Xd_Y^2} - \frac{v}{2d_Xd_Y} > 0$ is met, $\frac{d\pi^m}{dp^Y}$ must be negative for all $p^Y \in [0, v]$. We rewrite (3) as

$$\frac{d\pi^{m}}{dp^{Y}} = -v\left[\frac{1}{3d_{Y}} + \frac{2(v - p^{Y})^{2}}{3d_{X}d_{Y}^{2}} - \frac{(v - p^{Y})}{2d_{X}d_{Y}}\right] + \frac{4}{3}\frac{p^{Y}}{dy}$$

$$-2p^{Y}\left(\frac{1}{d_{Y}} - \frac{2(v - p^{Y})^{2}}{3d_{X}d_{Y}^{2}} + \frac{(v - p^{Y})}{2d_{X}d_{Y}}\right) + \left(\frac{4(v - p^{Y})}{3d_{Y}} - \frac{1}{2}\right)\frac{(v - p^{Y})p^{Y}}{d_{X}d_{Y}}$$

$$= -v\left[\frac{1}{3d_{Y}} + \frac{2(v - p^{Y})^{2}}{3d_{X}d_{Y}^{2}} - \frac{(v - p^{Y})}{2d_{X}d_{Y}}\right] + p^{Y}\left(-\frac{2}{3d_{Y}} + \frac{8(v - p^{Y})^{2}}{3d_{X}d_{Y}^{2}} - \frac{3(v - p^{Y})}{2d_{X}d_{Y}}\right) (5)$$

The assumption $v < \frac{d_Y}{2}$ leads to $0 < \frac{(v-p^Y)}{2d_Xd_Y} - \frac{2(v-p^Y)^2}{3d_Xd_Y^2} < \frac{v}{2d_Xd_Y} - \frac{2v^2}{3d_Xd_Y^2}$ for all $p^Y \in [0,v)$. Hence, we must have $\frac{1}{3d_Y} + \frac{2(v-p^Y)^2}{3d_Xd_Y^2} - \frac{(v-p^Y)}{2d_Xd_Y} > 0$. We now claim that $-\frac{2}{3d_Y} + \frac{8(v-p^Y)^2}{3d_Xd_Y^2} - \frac{3(v-p^Y)^2}{2d_Xd_Y} < \frac{1}{3d_Y} + \frac{2(v-p^Y)^2}{3d_Xd_Y^2} - \frac{(v-p^Y)}{2d_Xd_Y}$. We establish it by verifying $\frac{3(v-p^Y)}{2d_Xd_Y} - \frac{8(v-p^Y)^2}{3d_Xd_Y^2} > \frac{(v-p^Y)^2}{3d_Xd_Y^2} > \frac{(v-p^Y)^2}{2d_Xd_Y} - \frac{2(v-p^Y)^2}{3d_Xd_Y^2}$, which is equivalent to $\frac{(v-p^Y)}{d_Xd_Y} > \frac{2(v-p^Y)^2}{d_Xd_Y^2}$. The last inequality obviously holds iff $\frac{2(v-p^Y)}{d_Y} < 1$ (by Assumption 1). Hence, we must have the expression in equation

$$(5) < -(v - p^Y) \left[\frac{1}{3d_Y} + \frac{2(v - p^Y)^2}{3d_X d_Y^2} - \frac{(v - p^Y)}{2d_X d_Y} \right] < 0.$$

We then need to verify the condition $\frac{1}{3d_Y} + \frac{2v^2}{3d_X d_Y^2} - \frac{v}{2d_X d_Y} > 0$. It boils down to $\frac{1}{3} - \frac{v}{d_X}(\frac{1}{2} - \frac{2v}{3d_Y})$. Because $d_X \ge v$ and $d_Y < 4v$, $\frac{1}{3} - \frac{v}{d_X}(\frac{1}{2} - \frac{2v}{3d_Y}) > \frac{1}{3} - (\frac{1}{2} - \frac{1}{6}) = 0$.

Proof of Proposition 2

Proof. We now allow the monopolistic firm to set p^Y after striking the exclusivity deal. In this case, the monopolistic firm sets p^Y to maximizes its sale revenue $p^Y D_1^{XY}$, instead of $\Delta \pi + p^Y D_1^{XY}$. It should be noted that for a given p^Y , D_1^{XY} is still the same as that in the basic setting, with $D_1^{XY} = \frac{(v-p^Y)}{d_Y} - \frac{2(v-p^Y)^3}{3d_Xd_Y^2} + \frac{(v-p^Y)^2}{2d_Xd_Y}$. In this case, the monopolistic firm must set $p^Y > 0$. For a given p^Y , the monopolistic firm still receives a total profit of $\pi^m(p^Y) = \Delta \pi + p^Y D_1^{XY} = \frac{2(v-p^Y)^2}{3d_Y} + p^Y \left[\frac{(v-p^Y)}{d_Y} - \frac{2(v-p^Y)^3}{3d_Xd_Y^2} + \frac{(v-p^Y)^2}{2d_Xd_Y}\right]$. As we have established in the proof of Proposition 1, any p^Y must be strictly suboptimal, because $\frac{d\pi^m(p^Y)}{dp^Y}$ strictly decreases with p^Y when $p^Y \in [0, v]$. We then conclude that the monopolistic firm prefers to include p^Y in its contract.

Proof of Proposition 3

Proof. The equilibrium results allow us to compute the values of $\overline{x}, \underline{x}$ and \overline{y} . Hence, $\Delta x = \overline{x} - \underline{x} = \frac{v}{2d_X}$. The position of \overline{y} is given by $\frac{v}{d_Y}$. We have, respectively, $\overline{x} = \frac{(p_2^X - p_1^X) + d_X + v}{2d_X} = \frac{1}{2} + \frac{v}{2d_X} - \frac{v^2}{3d_X d_Y}$, and $\underline{x} = \frac{1}{2} - \frac{v^2}{3d_X d_Y}$. Hence, $\Delta x = \overline{x} - \underline{x} = \frac{v}{2d_X}$. The position of \overline{y} is given by $\frac{v}{d_Y} < \frac{1}{2}$.

In the benchmark case, consumers pay in total d_X to the two firms that provide product X. The consumption of X entails traveling cost $\frac{d_X}{4}$. The consumption of product Y yields a surplus $\frac{v^2}{d_Y} - \frac{v^2}{4d_Y} - \frac{v^2}{2d_Y} = \frac{v^2}{4d_Y}$. Hence, consumers' welfare can be written as $W_0 = u - d_X - \frac{d_X}{4} + \frac{v^2}{4d_Y}$. Under exclusivity, consumer welfare is given by $W_1 = u - M_X - T_X + D_1^{XY}v - T_Y$.

Let M_X denote their payments to Firms 1 and 2, and T_X and T_Y give their travel costs for X and Y respectively. We now compute each component separately.

First consider the total payment in the base product market, M_X . We have M_X

 $(d_X - \frac{v^2}{3d_Y}) + \frac{2v^2}{3d_Y}(\frac{1}{2} - \frac{v^2}{3d_Xd_Y} + \frac{v}{2d_X} \cdot \frac{v}{d_Y}) = d_X + \frac{v^4}{9d_Xd_Y^2}$. Apparently, consumers pay more to firms 1 and 2 under exclusivity arrangement, since $M_X > d_X$.

Next, the overall travel cost for the consumption of product X is given by $T_X = \left[\frac{\underline{x}^2}{2} + \frac{(1-\underline{x})^2}{2}\right]d_X + T_t - T_t'$, where $T_t - T_t'$ is given by $T_t - T_t' = 2d_X \int_{\underline{x}}^{\overline{x}} (2x-1) \int_0^{\overline{y} - \frac{\overline{y}}{\Delta x}(x-\underline{x})} 1 dy dx = 2d_X \int_{\underline{x}}^{\overline{x}} (2x-1) \left[\overline{y} - \frac{\overline{y}}{\Delta x}(x-\underline{x})\right] dx = 2d_X \overline{y} \left[(\Delta x + \underline{x} + \frac{1}{2})(\overline{x} + \underline{x}) - \frac{2}{3}(\overline{x}^2 + \overline{x}\underline{x} + \underline{x}^2) - (\Delta x + \underline{x})\right] = \frac{d_X \overline{y}}{3} \left[2\overline{x}^2 - 4\underline{x}^2 + 2\overline{x}\underline{x} - 3\Delta x\right].$

Hence,

$$T_X = d_X \left[\left(\underline{x}^2 - \underline{x} + \frac{1}{2} \right) + \frac{\overline{y}}{3} \left(2\overline{x}^2 - 4\underline{x}^2 + 2\overline{x}\underline{x} - 3\Delta x \right) \right]. \tag{6}$$

We can rewrite equation (6) as $\frac{T}{d_X} = \left[\frac{\underline{x}^2}{2} + \frac{(1-\underline{x})^2}{2}\right] + \frac{\overline{y}}{3}\left[2\overline{x}^2 - 4\underline{x}^2 + 2\overline{x}\underline{x} - 3\Delta x\right] = \left[\frac{(\frac{1}{2} - \frac{v^2}{3d_Xd_Y})^2}{2} + \frac{(\frac{1}{2} + \frac{v^2}{3d_Xd_Y})^2}{2}\right] + \frac{v}{3d_Y}\left(2\left(\frac{1}{2} + \frac{v}{2d_X} - \frac{v^2}{3d_Xd_Y}\right) + 4\left(\frac{1}{2} - \frac{v^2}{3d_Xd_Y}\right) - 3\right)\frac{v}{2d_X} = \frac{1}{4} + \frac{v^3}{6d_X^2d_Y} - \frac{2v^4}{9d_X^2d_Y^2}.$

Clearly, $T_X = \frac{d_X}{4} + \frac{v^3}{6d_Xd_Y} - \frac{2v^4}{9d_Xd_Y^2} > \frac{d_X}{4}$ given $d_Y > \frac{4}{3}v$. Thus, compared to the benchmark case, consumers incur higher transportation cost in the base product market. Overall, consumers in the X market are worse off.

To purchase the value-adding good Y, consumers incur travel cost $T_Y = \underline{x}\overline{y}^2d_Y + 2d_Y \int_0^{\overline{y}} y \int_x^{\overline{x} - \frac{\Delta x}{\overline{y}}y} 1 dx dy = \underline{x}\overline{y}^2d_Y + \frac{d_Y \Delta x \overline{y}^2}{3}$.

Finally, we examine the consumer surplus for consuming Y, which is given by $W_Y = D_1^{XY}v - T_Y = \left[\frac{v}{d_Y} - \frac{2v^3}{3d_Xd_Y^2} + \frac{v^2}{2d_Xd_Y}\right]v - \left[\underline{x}\overline{y}^2d_Y + \frac{d_Y\Delta x\overline{y}^2}{3}\right] = \frac{v^2}{2d_Y} + \frac{v^3}{3d_Xd_Y} - \frac{v^4}{3d_Xd_Y^2}.$

Compared to the benchmark case, consumer surplus from consuming the add-on product Y is higher under exclusivity arrangement. It can be easily shown that $\frac{v^2}{2d_Y} + \frac{v^3}{3d_Xd_Y} - \frac{v^4}{3d_Xd_Y^2} > \frac{v^2}{4d_Y}$ since $d_Y > \frac{v}{3}$.

Now we are at the position to compare the overall consumer welfare under both cases. Now we can rewrite equations for W_0 and W_1 as $W_0 = u - \frac{5d_X}{4} + \frac{v^2}{4d_Y}$, and $W_1 = u - M_X - T_X + W_Y = u - \left(\frac{d_X + \frac{v^4}{9d_X d_Y^2} + \frac{d_X}{4} + \frac{v^3}{6d_X d_Y} - \frac{2v^4}{9d_X d_Y^2}}{-\frac{v^2}{2d_Y} - \frac{v^3}{3d_X d_Y} + \frac{v^4}{3d_X d_Y^2}}\right) = u - \left(\frac{5d_X}{4} + \frac{2v^4}{9d_X d_Y^2} - \frac{v^3}{6d_X d_Y} - \frac{v^2}{2d_Y}\right).$ Comparing them yields $W_1 - W_0 = -\frac{5d_X}{4} - \frac{2v^4}{9d_X d_Y^2} + \frac{v^3}{6d_X d_Y} + \frac{v^2}{2d_Y} + \frac{5d_X}{4} - \frac{v^2}{4d_Y} = \frac{v^3}{6d_X d_Y} + \frac{v^2}{4d_Y} - \frac{2v^4}{9d_X d_Y^2} > 0$. The last inequality holds if $d_Y > \frac{4}{3}v$, which follows Assumption 1. \blacksquare

Proof of Proposition 4

Proof. Recall that in the equilibrium, both firms bid $\Delta \pi$. The duopolistic firms end up with the same overall profit although firm 1 earns more from the primary good market. Compare π_2^* with the equilibrium profit of $\frac{d_X}{2}$ in the benchmark case. The claim is straightforward.

Proof of Proposition 5

Proof. We now consider the overall change in social welfare. We have $\Delta W = \frac{v^3}{6d_Xd_Y} + \frac{v^2}{4d_Y} - \frac{2v^4}{9d_Xd_Y^2} + \frac{v^2}{6d_Y} + \frac{2v^2}{3d_Y} \left(\frac{v^2}{6d_Xd_Y} - 1\right) = -\frac{v^2}{4d_Y} + \frac{v^3}{6d_Xd_Y} - \frac{v^4}{9d_Xd_Y^2} = -\frac{v^2}{36d_Xd_Y} \left(\frac{4v^2}{d_Y} - 6v + 9d_X\right).$ Note that $\frac{4v^2}{d_Y} - 6v + 9d_X \geqslant \frac{4v^2}{d_Y} - 6v + 9\frac{2}{3}v = \frac{4v^2}{d_Y} > 0$ given Assumption 2. Thus, we have $\Delta W < 0$.