WHY TIE A PRODUCT CONSUMERS DO NOT USE?*

by

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ABSTRACT

I. INTRODUCTION

Because of the attention paid to Microsoft’s behavior in the marketing of Windows and its various applications programs, significant theoretical attention has recently been directed at why a primary-good monopolist would tie a complementary good. Most of this recent literature as well as earlier literature on the subject is based on either efficiency, price discrimination, or exclusionary motivations for tying.

are purchased as a tied product rather than purchased separately (either because of savings on installation costs or because tying improves functionality); with a tied Windows and WMP

In this paper, we consider a model that captures and extends the logic of the above example. In our model, there is a monopolist of a primary product and a complementary product that can be produced both by the monopolist and an alternative producer. Also, consumers have a valuation only for systems, where a system consists of one primary unit and one or more complementary units (although from the standpoint of consumption an individual uses only one complementary unit even if he owns more than one). At the beginning of the period the monopolist chooses whether or not to tie or sell individual products, where we assume ties are *reversible*

The outline for the paper is as follows. Section II discusses how our analysis is related to the previous literature on tying. Section III presents the main model and then analyzes an illustrative example that demonstrates our argument in a setting characterized by identical consumers who prefer the rival's complementary good to the monopolist's. Section IV investigates the model considering both the one- and two-group cases, where our focus in the superior complementary product. Carlton and Waldman show that, given either entry costs or complementary-good network externalities, the monopolist may tie in order to preserve its monopoly position in the primary market in the second period. The logic is that tying can stop entry into the complementary market by reducing its return and, in their model, the alternative producer does not enter the primary market if it does not plan to enter the complementary market.

The idea captured by the above cited papers that tying is used to exclude competition is certaintly a plausible explanation for various important real-world cases. For example, Microsoft's tying of Internet Explorer with the Windows operating system does seem to have eliminated Netscape's Navigator as a serious competitor in the browser market and, to the extent that Navigator posed a threat to the Windows monopo first put forth in Whinston (1990). Whinston showed that tying cannot increase profits when the monopolist's primary good is essential, i.e., as is the case in our analysis the primary good is required for all uses of the complementary good.[10] The monopolist can ensure itself profits at least as high as the profits associated with tying by selling the products separately, pricing the complementary good at marginal cost, and pricing the primary good at the optimal bundle price minus the complementary good's marginal cost. Hence, tying in that case will typically not increase profitability.

But when, in the absence of an alternative producer, consumers prefer the monopolist's tied good to purchasing the products individually, then there are a number of cases in which the monopolist ties with no effect on entry and exit decisions but the result is increased monopoly profitability and lower alternative producer profitability and social welfare. The simplest of these cases, as in our example in the Introduction, is when consumers are identical, product qualities are given exogenously, and all consumers prefer the alternative producer's complementary good. In this setting, there exists a range of parameterizations in which the monopolist ties, consumers purchase the monopolist's tied good and the alternative producer's complementary good, and the tie decreases social welfare because of the cost the monopolist incurs in producing complementary units when the product is not used by consumers in equilibrium. We find a similar result when we introduce consumer heterogeneity.

To understand why tying can be profitable, it is helpful to understand why Whinston's (1990) argument that shows no return to tying when the monopolist's primary good is essential does not apply.[11] In Whinston's argument the monopolist can sell its products individually and price the goods in such a way that it ensures itself profits equal to tying profits. Hence, the monopolist cannot increase its profits by tying. But here, because of the extra utility consumers derive from the tied product when the alternative producer's product is not purchased (when the alternative producer's product is purchased and used there is no extra utility associated with the

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profitable only when the monopolist's cost of producing the tied product is strictly below its cost for producing the two goods separately.

[10] This argument in some sense formalizes the earlier Chicago School argument that a monopolist would never tie a complementary good to its monopolized primary good because it can extract all of the potential profits through the pricing of the monopolized good. See, for example, Director and Levi (1956), Bowman (1957), Posner (1976), and Bork (1978). Also, see Ordover, Sykes, and Willig (1985) for a formal theoretical analysis related to Whinston's.

tie), the monopolist cannot ensure itself tying profits without in fact tying. The result is cases in the main results of our paper is to show that Whinston's result concerning essential primary goods is not robust to the introduction of efficiencies such as increased functionality or reduced installation costs associated with tying.

Finally, Farrell and Katz (2000) examine a market structure similar to ours with a single monopoly provider of a primary good and one or more independent suppliers of a complementary good. They consider various strategies the monopolist might engage in, most notably, vertical integration, R&D and exclusionary deals, in order to squeeze rival producers of the complementary good and appropriate greater profits. They do not consider the possibility of tying43(h0021715(n)-3.7162( )-161.196a43(h0021715(n)-3.7162(0 g q 8.33333 0 0 8.33333.71631(g)683761( )

Primary and complementary goods are consumed together in what is referred to as systems, where a system consists of either *M*'s primary and complementary products, *M*'s primary good and *A*'s complementary good, or *M*'s primary good and both complementary products. In the last case, although the consumers own both complementary goods, they use and, thus, derive direct benefit from only one of the complementary products. Think of, for example, the primary good as a computer operating system and the complementary good as a media player applications program. The assumption that primary and complementary products are consumed only together means that the monopolist's primary good is essential in this model, i.e., it is required for all uses of each of the complementary products.

At the beginning of the period the monopolist decides whether to offer the products individually, sell a tied product consisting of its primary and complementary goods, or sell both tied and individual products.[14] In contrast to most of the previous theoretical literature on tying used to disadvantage rival producers such as Whinston (1990), Choi and Stefanadis (2001), Carlton and Waldman (2002), and Nalebuff (2004), we assume that ties are *reversible*. That is, a consumer that purchases *M*'s tied product can add *A*'s complementary good to create a system consisting of *M*'s primary good and both complementary goods. Especially in terms of Microsoft whose behavior is the motivation for much of the recent attention to tying behavior, the assumption of reversible ties is quite realistic.

There is a continuum of consumers on the unit interval. We make several assumptions on the gross benefits derived by a consumer from various combinations of purchases. First, *M*'s primary good is *essential* for all uses of the complementary good and vice versa. Hence, consumer benefits are zero if they only consume one or the other of the primary and complementary goods. Second, if a consumer uses the primary and complementary goods each bought separately from *M*, their gross benefit is V^M where we assume that $V^M > c_P + c_C$. Third, if *P* and *C* are purchased and consumed as a tied product from *M*, the consumer's gross benefit equals $V^M + \Delta$, $\Delta \geq 0$. Note, $\Delta = 0$ means that consumers derive no direct added benefit from consuming a tied product, while $\Delta > 0$ means that a consumer with a system consisting of *M*'s

[13] Miao (2007) does consider the role tying might hav

primary and complementary goods does derive a strictly positive added benefit from having purchased and consumed a tied product. For example, Δ could represent increased functionality made possible through the tie. Notice that this means that, given there are no additional costs beyond $c_P + c_C$ to producing a tied product, when Δ > 0, tying would, in fact, be privately and socially desirable if no alternative complementary product existed.[15]

What happens if the consumer purchases *A*'s complementary product? First, by consuming a system consisting of *M*'s primary good and *A*'s complementary good, then the consumer's gross benefit equals V^A. We also assume that $V^A > V^M$, i.e., in the absence of tying *A*'s product is superior. Second, if the individual consumes a system consisting of *M*'s primary good and both complementary goods (as may occur if *M* only sells a tied product), then the complementary good that yields the highest gross benefit is used. For example, if a consumer adds *A*'s complementary good to *M*'s tied product then the consumer's gross benefit is given by $\max\{V^M + \Delta, V^A\}$.[16] Note, in this specification, even when Δ > 0, the tie is only valuable in terms of gross benefits when the consumer uses the monopolist's complementary good.

We assume Bertrand competition, but there is frequently a continuum of equilibria to the pricing subgame. The difference between the equilibria is the division across the two sellers of the surplus associated with *A*'s superior complementary product. Similar to the approaches taken in Choi and Stefanadis (2001) and Carlton and Waldman (2002), we assume that *λ* of the surplus is captured by the monopolist and (1–*λ*) is captured by the alternative producer, where $0 \leq \lambda < 1$.[17]

The timing of events in the model is as follows. First, the monopolist decides whether to offer a tied product, individual products, or both tied and individual products. Second, the firms simultaneously choose the prices for their products. Third, consumers make their purchase decisions. Note that throughout the paper we 0.441715(i)4.-3.71443(a)1.96262(p)6.563(s)-1. 1715(i)40 0 1 80.04

given by $P_M^P = 140$, $P_M^C = 10$, $P_A^C = 60$

producer to itself. This inefficient investment in tying raises the monopolist's profits by altering the outcome of the subsequent pricing game involving the rival's complementary product.[21]

As mentioned briefly above, Farrell and Katz (2000) also consider behavior that a monopolist of a primary good can employ in order to shift profits from rival producers of a complementary good to itself. They consider the value of vertical integration, though not tying. In their analysis of integration, they show that integration can be beneficial for the monopolist because it allows the monopolist to increase the price of A by pricing B low, and this, in turn, squeezes the other producers of B. This logic implies that tying cannot be better than integration because tying eliminates the ability to price A high and B low. This result is correct, however, only in a world in which tying is irreversible and there are no efficiencies associated with tying. As we show above, when one adopts the more reasonable assumptions that tying is reversible and that there can be efficiencies from tying this result vanishes and one can obtain the further result that it can be profitable to tie a good that efficiency standpoint, consumers purchase and use a

Table 1. It is readily apparent that not tying is profitable for the monopolist. In words, since the surplus is lower under tying because of the cost of producing an extra unit of the complementary good while the monopolist receives the same share of the surplus across the two cases, monopoly profitability is lower when the monopolist ties.

Table 1: Equilibrium Outcomes (Δ = 0, $V^A - V^M > c_C$)

Variable	No tying	Tying
P_M^P, P_M^T	$V^M - c_C + \lambda(V^A - V^M)$	$V^M + \lambda(V^A - V^M - c_C)$
$P_M^C \geq$	$c_C - \lambda(V^A - V^M)$	n.a.
P_A^C	$c_C + (1-\lambda)(V^A - V^M)$	$c_C + (1-\lambda)(V^A - V^M - c_C)$
π_M	$V^M - c_P - c_C$ $+\lambda(V^A - V^M)$	$V^M - c_P - c_C$ $+\lambda(V^A - V^M - c_C)$
π_A	$(1-\lambda)(V^A - V^M)$	$(1-\lambda)(V^A - V^M - c_C)$

We now consider what happens when Δ > 0. Here we begin by taking as fixed *M*'s choice concerning whether to sell tied or individual products and describe the equilibrium to the subgame that follows. When *M* sells individual products the subgame equilibrium is the same as described above for the case Δ = 0 since the positive Δ is immaterial if *M* sells individual products. That is, consumers purchase *M*'s primary good and *A*'s complementary good, while

Table 2: Outcomes under Tying ($\Delta > 0$)

Variable	$V^M + \Delta > V^A - c_C$	$V^M + \Delta \leq V^A - c_C$
P_M^T	$V^M - \Delta$	$V^M + \Delta + \lambda(V^A - V^M - \Delta - c_C)$
P_A^C	$V^A - (V^M + \Delta)$	$c_C \quad (1 \quad \lambda)(V^A \quad V^M \qquad c_C)$

in (i) Δ is sufficiently large that consumers derive the hi monopolist ties, this surplus is negative so the alternative producer does not sell complementary units.

As a final point, it is interesting to consider the impact of the sharing rule. First, note that if we shifted all power away from *M* to *A* – i.e., set $\lambda = 0$ – then, under Proposition 2, *M* the Introduction, the tying in these parameterizations is not driven by any of the standard

In this case, not offering a tied product is suboptimal as *M* can always add a tied product alongside independent products and capture $V^A + \Delta$ from the new consumer group without harming sales to the original group. When *n* is low, *M* also finds offering both tied and independent products profitable.

When *n* is high, *M* finds it optimal to commit to having just a tied product and no stand-alone product. In so doing, it is able to put competitive pressure on *A* and extract more surplus from it. This is not possible when it offers both a tied and stand-alone product and simply segments the market between original and new group consumers. Of course, while having a tied product was optimal with identical consumers when $(1-\lambda)\Delta \geq \lambda c_C$, it can be shown that this threshold is higher when there are heterogeneous consumers of the kind modeled here. Thus, the presence of a group of dedicated *M*-users, reduces incentives to offer a tied product exclusively but raises incentives to offer tied products alongside stand-alone ones.

In summary, in this subsection, we have shown that when consumers are heterogeneous there are parameterizations in which the monopolist ties, where the tying is efficient for some consumers but not for others. For the consumers who are indifferent between the two complementary goods in the absence of tying, tying increases welfare because of the benefit of the tie when an individual consumes *M*'s primary and complementary goods. But for the consumers who prefer the alternative producer's complementary good, the tie reduces welfare either because of the unnecessary production of redundant complementary units or because the tie results in these individuals consuming less preferred systems.

V.

R&D that affects the functionality of the tie can be privately optimal because of the manner in which it alters the outcome in the subsequent pricing game between the monopolist and the alternative producer.

Relative to the model considered in Section IV.A, we make the following change; the added functionality associated with consuming *M*'s tied product rather than it's primary and complementary goods purchased individually can now be either high or low. Let Δ^L be the increased gross benefit when the added functionality is low while Δ^H, $\Delta^H > \Delta^L$, is the increased gross benefit when the added functionality is high. Further, whether the increased gross benefit associated with consuming *M*'s tied product is high or low is a function of an R&D choice *M* makes at the beginning of the game. To be exact, at the beginning of the game *M* chooses an R&D expenditure denoted *R*, where $p(R)$ is the probability the increased gross benefit associated with the tie equals Δ^H while $(1–p(R))$ is the probability it equals Δ^L. We further assume $p(0) = 0$, $p'(0) = \infty$, $p'(R) > 0$ for all $R \geq 0$, and $p''(R) < 0$ for all $R \geq 0$. Following the realization of uncertainty, *M* decides whether to offer a tied product or not.

As suggested above, our focus in this section is on parameterizations in which *M* sometimes or always ties but when tying occurs consumers proceed to purchase and use the alternative producer's complementary good. Based on the analysis of the previous section, this translates into focusing on parameterizations for which $V^M + \Delta^H \leq V^A - c_C$ and $(1-\lambda)\Delta^H \geq \lambda c_C$;

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In contrast to the first best, actual equilibrium behavior is characterized both by tying and by a positive investment in R&D. For both actions, the deviation from first-best behavior is driven by a desire by *M* to alter in its favor the outcome of the subsequent pricing game played between *M* and *A*.

We formalize this argument as follows:

Proposition 4. *If* $V^M + \Delta^H \leq V^A - c_C$ *and* $(1-\lambda)\Delta^H \geq \lambda c_C$*, then R > 0 and (i) through (iii) describe M's product choice decision and consumer purchase decisions.*

(i) If $(1-\lambda)\Delta^L \geq \lambda c_C$*, then M ties whether or not the R&D investment is successful and*

even though it's complementary good is never consumed in equilibrium because a positive investment increases the probability the R&D investment is successful and, thus, increases the return to tying.[28]

As a final point, above we focus on R&D distortions when *M* ties but it's complementary good is not used by consumers in equilibrium. But building on (ii) of Proposition 2, there is also a range of parameterizations in which there is overinvestment in R&D relative to the first best but, when *M* ties, consumers purchase it's tied product only. For example, suppose $V^A > V^M + \Delta^H > V^M + \Delta^L > V^A - c_C$ and $\Delta^L \geq \lambda(V^A - V^M)$. Given $V^A > V^M + \Delta^H$, for these parameterizations the first best is characterized by $R = 0$ and no tying since consuming a system with *A*'s complementary product yields a higher gross benefit. But consistent with (ii) of Proposition 2, in equilibrium *M* ties whether or not the R&D investment is successful. In turn, since *M* sells its tied product for a higher price when the R&D investment is successful, there is a positive return to investing so $R > 0$. In other words, the R&D investment exceeds the first-best level.

VI. EFFECTS OF COMPETITION AND ANTITRUST IMPLICATIONS

In previous sections, we showed how a monopolist of a primary good may tie an inferior complementary good that consumers do not use, where the goal is increased profits through a more advantageous outcome in the pricing game between the monopolist and the complementary good's alternative producer. Further, this behavior can lower social welfare by both forcing the production of units that are purchased but not used in equilibrium and also causing distortions in the monopolist's R&D decisions. In this section, we discuss how competition affects our results concerning tying and decreased social welfare. We then discuss the implications of our results for antitrust policy.

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[28] The logic for why $R > 0$ in the parameterizations covered by (ii) and (iii) is closely related. The return to tying can be expressed as the probability *M* ties multiplied by the average return to tying given that it ties. In the above discussion, the return to having $R > 0$ is that it increases this average return to tying. For the parameterizations covered by (ii) and (iii), having $R > 0$ does not change the average return to tying when *M* ties but rather increases the probability that it ties.

The first question we examine is how our results change if we introduce competition. To

The prices for the complementary goods mirror those in the monopoly case with $\lambda = 0$. Notice that in the subgame perfect equilibrium of the sequential game, the producer of the complementary good has market power and can succeed in earning rents, while the primary producer cannot. Compared to the monopoly case, the consumer benefits from the competition between the primary producers and therefore enjoys additional surplus. The producers of the complementary goods exploit the lock-in effect in their pricing. This exploitation would not occur if there could be com[illegible] The (p)1.96262(m)-3.27522(e)1.

distortions concerning the monopolist's R&D choices). Allowing a merger between the firms in this setting may raise welfare by avoiding these unnecessary and inefficient production costs.[32] Similar considerations arise in evaluating contracts between the firms that allow the monopolist, for example, to tie the alternative producer's superior complementary good to its monopolized good. The same insights hold true when there is competition between primary producers. In such a case, allowing mergers or contracts between primary producers and the supplier of the superior look kindly on certain types of vertical contracting and mergers because they may improve welfare.

APPENDIX

A. Proof or Proposition 1

Suppose first that *M*

P_A^C	$c_C+(1-\lambda)(V^A-V^M)$	$c_C+(1-\lambda)(V^A-c_C-V^M-\Delta)$	$c_C+(1-\lambda)(V^A-V^M)$
π_M	$\max\left\{\begin{array}{l}(1-n)(V^A-c_C-c_P),\\ V^A-c_P-c_C-(1-\lambda)(V^A-V^M)\end{array}\right\}$	$\max\left\{\begin{array}{l}(1-n)(V^A+\Delta-c_P-c_C),\\ V^A-c_P-2c_C\\ -(1-\lambda)(V^A-c_C-V^M-\Delta)\end{array}\right\}$	$(1-n)(V^A+\Delta-c_P-c_C)$ $+n(V^A-c_P-c_C-(1-\lambda)(V^A-V^M))$ $=V^A-c_P-c_C+(1-n)\Delta$ $-n(1-\lambda)(V^A-V^M)$

First, it is easy to see that offering both products is more profitable for *M* than offering no tied

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