How the source of the entrant's advantage limits entry-deterring tying

Kenneth S. Corts*
Rotman School of Management
University of Toronto

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Abstract

I revisit a simple model of entry-deterring tying–Example 1 from Whinston's (1990) seminal paper–but allow the potential entrant to have either a cost advantage or a willingness-to-pay (WTP) advantage relative to the incumbent. I show that, compared to the usual case in which the potential entrant is cost-advantaged, tying is less effective against an entrant with a WTP advantage because an entrant with a large WTP advantage may be able to induce the buyer to buy both the tied bundle and the entrant's product. I also show that tying but failing to deter entry can be less costly when facing an entrant with a WTP advantage than when facing an entrant with a cost advantage. For a firm facing uncertainty about, for example, the entrant's entry costs, this makes tying a more attractive entry deterrence strategy against a WTP-advantaged entrant. These results shed light on the important policy question of which markets are most likely to be susceptible to entry-deterring tying.

1 Introduction

Whinston (1990) remains the seminal paper illuminating the anti-competitive, entry-deterring effect an incumbent monopolist may achieve by tying its product in a

*Rotman School of Management, 105 St. George St., Toronto, Ontario M5S 3E6; kenneth.corts@rotman.utoronto.ca. I thank Adam Brandenburger for extensive collaboration on co-authored teaching materials that developed many of the ideas in this paper. I also thank Scott Masten, Michael Waldman, seminar participants at the University of Hong Kong, INSEAD, IESE, and the 2012 International Industrial Organization Conference, and especially Pankaj Ghemawat for helpful comments.

monopoly market to its offering in a potentially contested market. Example 1 from that paper, which features unit demand and a representative consumer, is perhaps the simplest model for describing how this effect arises. When firms have identical products but vary in costs, the entrant can offer the buyer surplus of up to the amount of value generated by the contested product alone, while the incumbent can offer them surplus far greater than this, as long as the monopoly product's value is large relative to the cost difference on the contested product. As a result, the entrant expects to make no sales and does not enter. The incumbent, in turn, need not cut price at all and can extract the full value created by the transaction. However, if the entrant does enter, this decision to tie can be very costly to the monopolist, who would rather untie the products and extract the full value created by the monopolized product alone.

I revisit this model and allow the firms to vary not only in costs, but also in the willingness-to-pay of buyers for their respective products. Two broad sets of results follow. First, the deterrent effect of tying is in general less powerful when the entrant's advantage is derived significantly from a higher willingness-to-pay. When the buyer has a sufficiently high willingness-to-pay for the entrant's product, tying is ineffective in deterring entry. The deterrent effect of tying persists only when the difference in willingness-to-pay for the entrant's and incumbent's products is less than the potential entrant's unit costs. This intuitive condition provides additional insight into the kinds of markets in which tying is likely to be effective. In particular, tying is a more powerful entry deterrent for an incumbent facing an entrant with a cost advantage than for an incumbent facing an entrant with a willingness-to-pay advantage. Alternatively, for a given WTP advantage of the entrant, tying is a more powerful entry deterrent in settings where unit costs are higher.

Second, tying that fails to deter entry remains costly in this model, but just how costly depends on the source of the potential entrant's advantage. An incumbent facing an entrant with a cost advantage always has to discount its tied bundle by the full amount of surplus offered by the entrant. In contrast, for an incumbent facing an entrant with a willingness-to-pay advantage that is so large that the buyer buys from both firms, the maximum discount required is capped by the incumbent's ability to set price at willingness-to-pay in the monopoly market. As a result, tying that fails to deter entry may be less costly to the incumbent when facing an entrant with a willingness-to-pay advantage. This implies that an incumbent contemplating tying as an entry deterrence strategy in the face of uncertainty about the potential entrant's entry costs will be more willing to risk the adverse consequences of tying (should it fail to deter entry) when facing an entrant with a willingness-to-pay advantage. These results together enrich our understanding of the basic economic logic of entry-deterring tying and its limits in particular settings.

Antitrust scrutiny of tying arrangements has a long history.[1] Well-known cases date back to the United Shoe cases of the 1910s and 1920s and extend up to the Microsoft cases of the 1990s and early 2000s. A few quick examples give a sense of the kinds of behavior construed (by at least one party) as problematic tying. In the 1950s, Times-Picayune Publishing sold ads in its afternoon paper (the contested market) only in a bundle with ads in its morning paper (the monopoly market). In the 1960s, motion picture distributor Loew's licensed its movies to television stations primarily in bundles including both hit movies (the monopoly market) and less popular movies (the contested market). In the 1990s, Microsoft required PC manufacturers that installed its Windows operating system (the monopoly market) to also install its Internet Explorer browser (the contested market). And in a pair of merger cases in the early 2000s, concerns about potential tying led competition authorities to challenge two mergers: the GE/Honeywell merger, in which GE's aircraft engine business was viewed as the monopoly market and Honeywell's avionics business was viewed as the contested market; and the Tetra/Sidel merger, in which Tetra's carton-packaging equipment business was viewed as the monopoly market and Sidel's PET bottle equipment business was viewed as the contested market. These cases also reflect the diversity of the regulatory and judicial treatment of tying over the years. The Times-Picayune policy was found not to be an antitrust violation (due to a lack of market power in the morning newspaper); the Loew's policy was found to be a violation; Microsoft's practices were found by some authorities at some points to be problematic and by other authorities and at other times not to be; the GE/Honeywell merger was approved by US authorities but blocked by the EC based largely on these concerns about tying; and the Tetra/Sidel merger was initially blocked by the EC based largely on these concerns about tying, but then allowed when the EU Court overturned the EC's decision. Thus, policy attitudes toward tying remain in active evolution. This paper seeks to provide insight into the understanding of what environments give rise to the most valid concerns about tying.

A large theoretical literature has studied the issue of tying and entry deterrence, emphasizing many different logics in many kinds of models.[2] Whinston's (1990) pa-

[1] This brief description of cases is distilled from the following sources: Neven, 2008; Justia.com; Whinston, 1990; Rowles, 2000; U.S. Department of Justice, 2008.

[2] Many other papers of course consider the logic of tying for the purpose of smoothing demand to extract surplus, price discriminating, softening competition, reducing innovation by a rival, or influencing competition in complementary product markets in some way.

per alone includes examples with a representative consumer with unit demand, with heterogeneous preferences for the contested market product, with heterogeneous preferences for the monopoly market product, for complementary products, and for complementary products with an alternative product in the "monopoly" market. Martin (1999) shows that a parallel result to that of Whinston's main model also arises with Cournot competition. Nalebuff (2004) shows that tying can effectively lower an entrant's potential profits and thereby deter entry in either of the two markets when consumers have (possibly correlated) heterogeneous valuations for the two products, and can raise the incumbent's profits in the face of entry, yielding it credible. Peitz (2008) extends Nalebuff's results to a model in which the contested products are imperfect substitutes. Mathewson and Winter (1997) shows that tying can be profitable when demands are independent in prices but stochastically correlated, and that this can be exclusionary when the contested market is not too competitive. Choi and Stefanadis (2001) show how tying can limit entry and innovation by specialist firms when products are complementary. Carlton and Waldman (2002) show that tying can have a similar entry deterring effect on a potential entrant capable of producing a superior system of complementary products by entering in both markets. This vast diversity of logics explored in the literature may lead some to conclude that tying is ineffective as an entry deterrent except in very special circumstances, or that it relies on specific modeling assumptions or functional forms. One objective in presenting the incredibly simple model of this paper is to emphasize that the core logic behind entry-deterring tying is in fact easy to grasp, quite robust, and evident in the most basic of models. In addition, while these many papers sometimes examine entrants with cost advantages and sometimes examine entrants with willingness-to-pay advantages, the importance of this difference is not emphasized and is not easily seen due to the other factors that also change between models. By embedding both types of advantage in a single model, I seek to clarify in this paper the role that the source of the entrant's advantage plays in determining the effectiveness and attractiveness of tying.

Section 2 lays out the basic model. Section 3 presents the central analysis, which is illustrated with a numerical example in section 4. Section 5 discusses extensions and limitations of the model, demonstrating that the model also makes contributions to our understanding of the credibility of tying, its effects in the presence of product complementarities, its use as a predatory rather than exclusionary tactic, and its welfare consequences. Section 6 concludes by revisiting the some of the cases mentioned above, as well as an example involving a vertical "content-distribution" merger, to illustrate the application of the model's insights.

2 Model

Consider a game in which an incumbent I offers products in two distinct markets and faces potential entry by an entrant E in one of those markets. Let market M be the monopoly market, in which the incumbent faces no potential entry, and let C be the contested market. Unit demand by homogeneous consumers is modeled as a representative consumer's willingness-to-pay, denoted w for the incumbent's product in the monopoly market and v_i for the product of firm i ($i \epsilon \{I, E\}$) in the contested market. I assume throughout that the tying of the bundle does not prevent the additional purchase and effective use of the rival's product. Conditional on the purchase of the tied bundle, the willingness-to-pay for the entrant's product under the unit demand assumptions is $v_E - v_I$, since the use of the entrant's product displaces the use of the incumbent's product.[3]

The unit cost of production is $a > 0$ for the incumbent's product in the monopoly market and $c_i > 0$ for the product of firm i in the contested market. I assume that every product is potentially value-creating: $w > a$ and $v_i > c_i$. The entrant incurs a sunk cost $k > 0$ upon entry.

I assume that the entrant has a sufficient advantage over the incumbent in the contested market that entry is socially desirable:

$$(v_E - c_E) - (v_I - c_I) > k. \qquad \text{(A1: entry efficient)}$$

This implies that the entrant would in fact enter with unrestricted competition, making the question of entry deterrence relevant and interesting. Note that the entrant's advantage can come from a pure cost advantage ($c_E < c_I$ and $v_E = v_I$), a pure WTP advantage ($v_E > v_I$ and $c_E = c_I$), a dual advantage ($v_E > v_I$ and $c_E < c_I$), a cost advantage not fully offset by lower product quality ($c_E < c_I$ and $v_E < v_I$), or a WTP advantage not fully offset by higher costs ($v_E > v_I$ and $c_E > c_I$). Finally, I assume that the value created in the monopoly market is large relative to the value created in the contested market, which is important in capturing the idea that the incumbent's

[3]While some forms of technological and contractual tying may prevent this additional consumption of the rival's product, many examples, including all of those discussed in the conclusion, do not. Most papers in the tying literature either rule out the possibility of buying from both the tying firm and the rival or study cases in which this would not arise. Exceptions to this include two recent papers that address tying in the context of systems of complementary products. Choi (2010) shows that tying a critical component to one of two rival platforms increases the set of consumers that adopt both platforms, and also increases the profits of the tying firm. Carlton, Gans, and Waldman (2010) show that a monopolist that ties an inferior complementary good can transfer profit from the rival complementary good provider to the monopolist. Both papers differ from the present paper in that they consider complementary products and do not focus on exclusionary motives for tying.

monopoly position gives it significant clout with consumers. Specifically, I assume:

$$(w - a) > (v_E - c_E) - (v_I - c_I). \qquad \text{(A2: monopoly market valuable)}$$

I maintain assumptions (A1) and (A2) throughout the paper and do not restate them in each proposition.

The game proceeds as follows. First, the incumbent decides whether to tie its offerings in the two markets or not. This decision is irreversible. Second, the entrant decides whether to enter or not; if it does enter, it incurs the irrecoverable entry cost k. Third, the two firms simultaneously set prices. The entrant, if it has entered, sets a single price p_E. If the incumbent has tied its products, it sets a single price p_I^B. If it has not, it sets two prices p_I^M and p_I^C. The analysis proceeds by determining the (unique) subgame perfect equilibrium to each simultaneous pricing game at the third stage, and then applying backward induction to the first two stages of the game (yielding the unique subgame perfect equilibrium of the entire game).

Before characterizing the equilibria of the pricing subgames, it is convenient to name some conditions that turn out to be important to the unfolding of competition. First, when (conditional on entry) the entrant's product creates more value than the incumbent's product, I will say that the entrant is "viable":

$$v_E - c_E > v_I - c_I. \qquad \text{(C1: viability)}$$

This condition implies that the entrant (rather than the incumbent) will make a sale at equilibrium prices in single-product competition (that is, when there is no tying). Note that it is necessarily satisfied as a result of assumption (A1). Second, when (conditional on entry) the entrant's product creates value even when the consumer is exogenously given (or, equivalently, compelled to purchase) the incumbent's product, I will say that the entrant is "incrementally viable":

$$v_E - v_I > c_E. \qquad \text{(C2: incremental viability)}$$

An additional condition that will prove useful in analyzing this game is a similar but stronger condition that ensures the entrant can cover entry costs, not only production costs, with the premium it can earn from its superior willingness-to-pay. Because this implies that entry is efficient even when the buyer is given (or is compelled to purchase) the incumbent's offering in the contested market, I will say that such an entrant is "incrementally efficient":

$$v_E - v_I > c_E + k. \qquad \text{(C3: incremental efficiency)}$$

Note that (C3) immediately implies (C2).

3 Analysis

The analysis proceeds in three steps. In the first subsection I determine the equilibrium outcomes of all possible pricing subgames. In the second and third subsections I derive the two main sets of results.

3.1 Pricing subgames

With these assumptions and conditions, it is straightforward to characterize prices and profits in the equilibria of the four possible pricing subgames.

If the incumbent does not tie and the entrant does not enter, then the incumbent is a monopolist in both markets and sets both prices to equal willingness-to-pay (WTP). This results in prices of $p_I^M = w$ and $p_I^C = v_I$; as a result, profits are $\pi_I = (w - a) + (v_I - c_I)$ and $\pi_E = 0$. If the incumbent does tie and the entrant does not enter, then the incumbent is a monopolist and sets a single price equal to the sum of the WTPs for the two products: $p_I^B = w + v_I$. As a result, profits are $\pi_I = (w - a) + (v_I - c_I)$ and $\pi_E = 0$.

If the incumbent does not tie and the entrant enters, then the incumbent is a monopolist in only one market, where it sets $p_I^M = w$, and competes with the entrant in the contested market. Because the entrant creates more value (is "viable", in the sense of (C1) above), competition drives the incumbent's price to its cost, $p_I^C = c_I$, and the entrant sets the price that leaves the buyer with just enough surplus to choose the entrant over the incumbent: $p_E = v_E - (v_I - c_I)$. These prices imply profits of $\pi_I = w - a$ and $\pi_E = (v_E - c_E) - (v_I - c_I) - k$.

If the incumbent does tie and the entrant enters, then the equilibrium of the pricing subgame depends on whether the entrant is incrementally viable, as defined in (C2). The buyer faces three choices, given a set of prices, resulting in the associated surpluses for the buyer (in parentheses): buy the tied bundle alone $(w + v_I - p_I^B)$, buy the entrant's offering alone $(v_E - p_E)$, or buy both the tied bundle and the entrant's product $(w + v_E - p_I^B - p_E)$. Comparing these surpluses reveals that buying both the tied bundle and the entrant's product dominates buying the tied bundle alone if and only if $v_E - v_I > p_E$. Since $p_E \geq c_E$, buying both the tied bundle and the entrant's product in equilibrium is possible only if the entrant is incrementally viable, as defined above.

If the entrant is not incrementally viable, then the entrant cannot price low enough to induce the buyer to buy the entrant's product in addition to the tied bundle. The relevant comparison is then whether the buyer chooses only the tied bundle or chooses only the entrant's product. Since the value created in the monopoly market is assumed to be large, competition drives the entrant's price to its cost ($p_E = c_E$), and the incumbent sets the price that leaves the buyer with just enough surplus to prefer buying the tied bundle, $p_I^B = w + v_I - (v_E - c_E)$. Note that the assumption (A2) that the value of the monopoly market is large is precisely the assumption required to ensure that this tied bundle price is greater than the incumbent's cost of producing the tied bundle. (Rearranging $p_I^B = w+v_I-(v_E-c_E) > a+c_I$ yields $w-a > (v_E-c_E)-(v_I-c_I)$.) These prices yield profits $\pi_I = (w - a) + (v_I - c_I) - (v_E - c_E)$ and $\pi_E = -k$.

If the entrant is incrementally viable, then such prices will not constitute an equilibrium because, for any tied bundle price, the entrant can choose a price that induces a profitable sale. Specifically, for any tied bundle price that induces purchase of the tied bundle, the optimal price for the entrant is $p_E = v_E - v_I$. Similarly, given any price that induces purchase of the entrant's product, the incumbent's optimal price for the tied bundle is simply w since its contested market offering is of no incremental value to the buyer. These prices yield profits $\pi_I = w - a - c_I$ and $\pi_E = (v_E - v_I) - c_E - k$. Note that the assumption that the value of the monopoly market is large ensures that this equilibrium price is greater than the incumbent's cost of producing the tied bundle. (What is needed is $w - a > c_I$, while the assumption on the value of the monopoly market (A2) can be rearranged to $w - a > c_I + (v_E - v_I) - c_E$. The latter implies the former as long as $v_E - v_I > c_E$, which is precisely the maintained assumption that the incumbent is incrementally viable.)

3.2 Tying and entry deterrence

With the subgames solved for equilibrium prices and profits, it is now possible to characterize the subgame perfect equilibrium of the full game. First examine the incentives for entry. Note that by assumption (A1), the entrant enters if the incumbent does not tie. If the incumbent does tie, the entrant earns $-k$ if it is not incrementally viable ((C2) fails) and earns $(v_E - v_I) - c_E - k$ if it is incrementally viable ((C2) holds). Since the entrant can achieve profit of 0 by not entering, the entrant enters in the presence of tying if and only if the entrant is both incrementally viable ((C2) holds) and incrementally efficient ((C3) holds).

Now examine incentives for tying. The entrant always enters absent tying, and thus the incumbent always earns $w - a$ when it does not tie. Tying yields the incumbent $(w-a)+(v_I-c_I) > w-a$ when the entrant does not enter ((C3) fails) and $(w-a)-c_1 < w - a$ when the entrant does enter ((C3) holds). Thus, tying is an effective entry deterrent if and only if (C3) fails.

Proposition 1 *Assume that (A1) and (A2) hold. Then the incumbent ties and deters entry if and only if the entrant is not incrementally profitable ((C3) fails). If the entrant is incrementally profitable ((C3) holds), the incumbent does not tie and the entrant does enter.*

The key to this proposition is the buyer's assessment of the value of a purchase from the entrant. (A2) ensures that at any equilibrium prices the buyer certainly buys the incumbent's tied bundle. When (C2) holds (which is implied by (C3)), the buyer views the entrant's product as so attractive that it is willing to buy (at a price that is profitable for the entrant) the entrant's contested-market product in addition to the incumbent's tied bundle. In this case, tying is simply incapable of deterring entry. Thus, a large willingness-to-pay advantage for the entrant prevents tying from deterring entry. A number of corollaries follow directly from this proposition.

Corollary 2 *(Whinston, 1990: Example 1) Assume that the entrant's advantage derives entirely from a cost advantage (i.e., $v_I = v_E$). Then the incumbent always ties and succeeds in deterring entry.*

Corollary 3 *Assume that the entrant's advantage derives at least in part from a WTP advantage (i.e., $v_I > v_E$). Then entry deterrence is not certain; whether the incumbent ties and deters entry depends on whether the entrant's WTP advantage ($v_I - v_E$) exceeds the sum of the entrant's unit costs and entry costs ($c_E + k$).*

These corollaries follow from inspection of (C3), the failure of which is required for entry-deterring tying. (C3) implies the clearly false $c_E + k < v_E - v_I = 0$ when the entrant's advantage derives entirely from costs as in the first corollary. Since (C3) is false, tying does deter entry. This is exactly a replication of Whinston's Example 1. Whether (C3) holds depends on the source of the entrant's advantage, and it is possible when (A1) holds for (C3) to either fail or hold (and thus for tying to be effective or not), depending on the source of this advantage, even if $v_E - v_I > 0$ as in the second corollary. This analysis can also be re-stated in the following corollaries regarding the limits on tying's effectiveness.

Corollary 4 *The incumbent cannot deter entry through tying if the entrant's WTP advantage is large enough.*

Corollary 5 *The incumbent cannot deter entry through tying if the entrant has a strictly positive WTP advantage and the entrant's total costs are low enough.*

3.3 Uncertainty and entry deterrence

In this model, tying that is effective in deterring entry is costless to the incumbent. The incumbent extracts the full value in both markets through a single tied bundle price $p_I^B = w + v_I$ and earns the maximum possible profit given its WTP and costs, $\pi_I = (w-a)+(v_I-c_I)$. However, tying that fails to deter entry is costly. In this model, this cost can arise in one of two ways. When the entrant is not incrementally viable, the incumbent sells the tied bundle and the entrant makes no sale, but the presence of the entrant drives down the price of the tied bundle to $p_I^B = w + v_I - (v_E - c_E)$, while the incumbent still incurs both production costs $a + c_I$. When the entrant is incrementally viable, the incumbent sells the tied bundle and the entrant also sells its product in the contested market, with the incumbent setting a price to extract only the value of the monopoly market product, $p_I^B = w$, while it still incurs both production costs $a + c_I$. If it had not tied, it would have sold at this same price but incurred only the production cost a of the monopoly market product. In either case, the incumbent's decision to tie lowers profits relative to its profits in untied competition, and such an incumbent that ties but then faces entry always would prefer to untie its products. For this reason, the irreversibility of tying is an important underpinning of its effectiveness as an entry deterrent; this point is frequently emphasized in the existing literature.

If one introduces uncertainty into the model, then this potential loss of profit becomes a relevant cost (i.e., one that is incurred on the equilibrium path) that limits the attractiveness of tying as an entry deterrent. Especially interesting for the present analysis is the fact that the magnitude of this cost varies with the source of the entrant's advantage. When the entrant's advantage is derived wholly from a cost advantage (i.e., $v_E = v_I$), the entrant is not incrementally viable and the loss of profit due to tying (relative to facing entry but not having tied) is $(v_E - c_E) - (v_I - c_I)$. This results from the combination of incurring the cost of the contested market product and lowering the price of the tied bundle to induce sale. However, when the entrant's advantage is derived sufficiently from a WTP advantage so that the entrant is incrementally viable, the loss of profit due to tying is c_I. Note that the latter loss is smaller than the former when the entrant is incrementally viable. Thus, an incumbent facing an uncertain threat of entry will find tying a more attractive entry deterrence strategy (because it is less costly in the event that the deterrence is ineffective) when the potential entrant derives its advantage from WTP (that is, the entrant is more likely to be incrementally viable).

To formalize this, consider a game in which the entrant's entry cost is determined (and becomes known to both firms) after the incumbent's tying decision and before the entrant's entry decision. With some probability p, this cost is revealed to be 0; otherwise it is revealed to be $k > 0$. I will assume that entrants with an entry cost of 0 break payoff ties in favor of entering. That is, entrants with entry cost of 0 enter even if they will not make a sale or will make a sale at exactly break-even pricing. Uncertainty over this parameter can be thought of as uncertainty over the broader strategic context of the game. An entry cost of 0 and assumed entry in the face of 0 profits can be thought of as representing the possibility that the entrant has other strategic rationales for entering this business (e.g., they can profitably sell the same product to a different set of buyers who do not have access to the incumbent).

In order to examine the effect of the source of the entrant's advantage on the attractiveness of attempted entry deterrence through tying, the following analysis considers two competitive scenarios that are highly similar. Let Δ denote the magnitude of the entrant's advantage ($\Delta = (v_E - c_E) - (v_I - c_I)$). These two scenarios share in common some w, a, k, c_E, v_E, $\Delta > 0$. However, the scenarios vary in the source of the entrant's advantage. In scenario A, the advantage comes wholly from a cost advantage (as in Whinston's Example 1): $\widehat{v}_I = v_E$ and $\widehat{c}_I = c_E + \Delta$. In scenario B, the advantage comes wholly from a WTP advantage: $\widetilde{v}_I = v_E - \Delta$ and $\widetilde{c}_I = c_E$. In order to ensure that $v_I > c_I$ in both models, I assume

$$v_E - c_E > \Delta. \tag{A3}$$

The effect I seek to illustrate here arises when entry is efficient and therefore profitable absent tying ((A1) is satisfied, which also implies (C1) is satisfied, for both scenarios); entry may be deterred through tying ((A2) is satisfied and (C3) fails for both scenarios); and entry in the face of tying has different effects on equilibrium prices in the two scenarios ((C2) fails for scenario A and holds for scenario B).

Consider a set of parameters satisfying these conditions. To see that such parameters exist, note that they can be constructed in the following manner. Pick some w', a', k', and Δ' such that $w' - a' > \Delta' > k'$. This ensures that (A1), (A2), and (C1) hold. Next pick some c'_E such that $\Delta' - k' < c'_E < \Delta'$, which ensures that (C2) holds for scenario B and (C3) fails for scenario B. Finally, pick some v'_E such that $v'_E > c'_E + \Delta'$, which ensures that (A3) holds.

These assumptions ensure that in both scenarios a decision not tie products leads to profit of $\widehat{\pi}_I^{NO\ TIE} = \widetilde{\pi}_I^{NO\ TIE} = w' - a'$. In both scenarios a decision to tie followed by a realization on the entry cost of k leads to effective entry deterrence and a resulting profit of $\widehat{\pi}_I^{TIE,DETER} = \widetilde{\pi}_I^{TIE,DETER} = w' - a' + v'_E - c'_E - \Delta'$. The profits diverge between the two scenarios when a decision to tie is followed by a realization of 0 entry cost and entry occurs despite the (irreversible) decision to tie. Substituting into the expressions for equilibrium prices and profits derived earlier implies the scenario A profit is $\widehat{\pi}_I^{TIE,ENTRY} = w' - a' - \Delta'$ and the scenario B profit is $\widetilde{\pi}_I^{TIE,ENTRY} = w' - a' - c'_E$.

The ex ante *expected* profit resulting from tying is given in scenario A by $E\widehat{\pi}_I^{TIE} = p\widehat{\pi}_I^{TIE,ENTRY} + (1-p)\widehat{\pi}_I^{TIE,DETER}$ and in scenario B by $E\widetilde{\pi}_I^{TIE} = p\widetilde{\pi}_I^{TIE,ENTRY} + (1-p)\widetilde{\pi}_I^{TIE,DETER}$. The trade-off that determines whether tying is profitable ex ante involves weighing the benefit of tying, which is the probability $1-p$ of successful entry deterrence, against the cost of tying, which is the probability p of facing an entrant while constrained by the decision to tie. Successful deterrence yields in both scenarios an incremental increase in profit of $\pi_I^{TIE,DETER} - \pi_I^{NO\ TIE} = v'_E - c'_E - \Delta'$. Tying that is unsuccessful in deterring entry yields an incremental decrease in profit of $\widehat{\pi}_I^{TIE,ENTRY} - \widehat{\pi}_I^{NO\ TIE} = -\Delta'$ in scenario A and of $\widetilde{\pi}_I^{TIE,ENTRY} - \widetilde{\pi}_I^{NO\ TIE} = -c'_E$ in scenario B. The assumptions above imply that $c'_E < \Delta'$, so the profit loss is greater in scenario A than in scenario B. Whether the weighted average of the cost and benefit is positive and therefore whether tying is attractive ex ante depends on the magnitudes of these parameters. With additional algebra it is straightforward to prove the following propositions.

Proposition 6 *Assume the parameters satisfy the assumptions of this subsection. Then tying is a more attractive entry deterrence strategy for the incumbent when the potential entrant's advantage is WTP-based than when it is cost-based. (Specifically,* $E\widetilde{\pi}_I^{TIE} - \widetilde{\pi}_I^{NO\ TIE} > E\widehat{\pi}_I^{TIE} - E\widehat{\pi}_I^{NO\ TIE}$*.)*

Proposition 7 *Assume the parameters satisfy the assumptions of this section. Then tying is an ex ante profitable entry deterrence strategy for some parameters in each* *scenario, and tying is ex ante profitable in scenario B (WTP advantage) for a strict superset of parameters for which it is ex ante profitable in scenario B (cost advantage).*

The former proposition follows immediately from comparing the relevant expressions. To prove the latter proposition not that $E\widetilde{\pi}_I^{TIE} - \widetilde{\pi}_I^{NO\ TIE} > 0$ when $v_E' > \Delta' + \frac{1}{1-p}c_E'$, while $E\widehat{\pi}_I^{TIE} - E\widehat{\pi}_I^{NO\ TIE} > 0$ when $v_E' > c_E' + \frac{1}{1-p}\Delta'$. Since both inequalities are stricter than what is required by the maintained assumptions of this section, the set of parameters for which tying is ex ante profitable is non-empty. In addition, since $c_E' < \Delta'$ by assumption, the set of parameters for which $E\widetilde{\pi}_I^{TIE} - \widetilde{\pi}_I^{NO\ TIE} > 0$ is a strict superset of the parameters for which $E\widehat{\pi}_I^{TIE} - E\widehat{\pi}_I^{NO\ TIE} > 0$.

The intuition for this set of results is that it is more costly to err by tying in an unsuccessful bid to deter entry when the potential entrant has a cost advantage than when the potential entrant has a WTP advantage. When the entrant has a cost advantage, the buyer chooses between buying only the tied bundle or only the entrant's product. As a result, the incumbent is forced to discount the price of the tied bundle by the amount of surplus the buyer can get from purchasing from the entrant alone. In contrast, when the entrant has a sufficient WTP advantage, the buyer opts to buy from both the incumbent and the entrant, capping the required discount on the incumbent's tied bundle. This makes a mistaken decision to tie less costly and increases the ex ante incentive to engage in tying as an entry deterrence strategy.

4 A Numerical Example

Consider two scenarios. In scenario A, the potential entrant has a cost advantage of 4:

$$\begin{aligned} w &= 12;\ a = 2 \\ v_I &= 8;\ c_I = 7 \\ v_E &= 8;\ c_E = 3. \end{aligned}$$

With no tie and entry, price competition leads to pricing at the monopoly price for the monopoly product, $p_I^M = 12$, at cost for the incumbent's contested market product, $p_I^C = 7$, and at the maximum price the entrant can charge that still gives the buyer surplus of 1, $p_E = 7$. Profits are therefore $\pi_I = (12-2)+0 = 10$ and $\pi_E = (7-3)-k = 4-k$. With tying and entry, price competition leads to pricing at cost for the entrant,

$p_E = 3$, and at the maximum price that the incumbent can charge that still gives the buyer surplus of 5, $p_I^B = 15$. Profits are therefore $\pi_I = 15 - 9 = 6$ and $\pi_E = 0 - k$. Tying therefore deters entry for any $k > 0$, and the incumbent earns the monopoly profit of $\pi_I = 11$.

In scenario B, the potential entrant again has an advantage of 4, but this comes entirely from a willingness-to-pay advantage:

$$\begin{aligned} w &= 12;\ a = 2 \\ v_I &= 4;\ c_I = 3 \\ v_E &= 8;\ c_E = 3. \end{aligned}$$

With no tie and entry, price competition leads to pricing at the monopoly price for the monopoly product, $p_I^M = 12$, at cost for the incumbent's contested market product, $p_I^C = 3$, and at the maximum price the entrant can charge that still gives the buyer surplus of 1, $p_E = 7$. Profits are therefore $\pi_I = (12-2)+0 = 10$ and $\pi_E = (7-3)-k = 4-k$. These profits are exactly the same as in scenario A, where the entrant had a cost advantage. With tying and entry, the buyer buys from the entrant regardless of the bundle price, and the entrant can charge the full difference in willingness-to-pay, $p_E = 4$. The incumbent charges a bundle price that extracts the full surplus from only the monopoly product, $p_I^B = 12$. Profits are therefore $\pi_I = 12 - 5 = 7$ and $\pi_E = (4-3)-k$. These profits are different from those in scenario A because now the buyer buys both versions of the contested market product. Tying here deters entry for $k > 1$.

This example readily illustrates the two main results of the paper. First, tying deters entry for any $k > 0$ when the entrant has a cost advantage, but only for $k > 1$ when the entrant has a willingness-to-pay advantage. Thus, tying is a less effective deterrence strategy against a WTP advantage. Second, when the incumbent ties and nonetheless faces entry, the incumbent's profit is 6 in scenario A and 7 in scenario B. Thus, tying against an actual entrant is less costly (compared to the untied profit of 10) when the entrant has a WTP advantage than when the entrant has a cost advantage. When there is uncertainty over whether the entrant will enter, tying is therefore a less risky and more attractive strategy against an entrant with a WTP advantage than against an entrant with a cost advantage.

This numerical example can also provide additional insight into the way in which competition with a WTP-advantaged entrant caps the discount required of the tied incumbent that nonetheless faces entry. To see this, consider the prices and profits realized by a tying incumbent as the advantage of the entrant gets larger and larger, using a slight variation on the above example. In both scenarios, it remains true that $w = 12$ and $a = 2$.

In scenario A', begin with $v_I = 8$, $c_I = 7$ and $v_E = 8$, $c_E = 4$. Thus, the entrant has a pure cost advantage of a magnitude of 3 (and is therefore not incrementally viable no matter how low its costs fall). It is easy to check that this implies $p_I^B = 16$ and $\pi_I = 7$; that is, the incumbent prices at the bundle WTP of 20 less the surplus of 4 offered by the entrant. Now increase the entrant's advantage to 4 by lowering its cost to 3. Now, $p_I^B = 15$ and $\pi_I = 6$. Similarly, when the entrant's cost falls to 2 and its advantage rises to 5, $p_I^B = 14$ and $\pi_I = 5$. As the surplus offered by the entrant increases, the incumbent's equilibrium price (and therefore profit) keeps falling to induce the buyer to buy the bundle rather than the entrant's contested market product.

Now consider in contrast a scenario B'. Begin with $v_I = 5$, $c_I = 4$ and $v_E = 8$, $c_E = 4$, yielding the entrant a pure WTP advantage of a magnitude of 3. It is easy to check that (C2) fails, and this therefore implies $p_I^B = 13$ and $\pi_I = 7$; that is, the incumbent prices at the bundle WTP of 17 less the surplus of 4 offered by the entrant. Comparing scenarios A' and B', this yields the same incumbent profit (7) at the same entrant's advantage (3). Now increase the entrant's advantage to 4 by raising its WTP to 9. Now, (C2) does hold (with equality), and the entrant is incrementally viable. As a result, the incumbent's bundle price becomes the monopoly market WTP: $p_I^B = 12$ and $\pi_I = 6$. Again comparing scenarios A' and B', this yields the same incumbent profit (6) at the same entrant's advantage (4). At this point the scenarios diverge. Now, let the entrant's advantage rise to 5 with increase in WTP to 10. Here, with (C2) continuing to hold, the incumbent's bundle price remains at $p_I^B = 12$, and it profits remain at $\pi_I = 6$. That is, despite the continued increase in the advantage of the entrant, the tied incumbent's pricing remains unchanged and its profit do not continue to fall. This is precisely the sense in which incremental viability (which is possible only with a positive WTP advantage) caps the discount required of a tied incumbent who faces entry. This is the mechanism by which the downside of a failed tie, or the riskiness of the tying strategy as an entry deterrent, is mitigated when facing a WTP-advantaged entrant.

5 Extensions and Discussion

This section considers four extensions to the model that illustrate how the logic of the paper's results can be extended to consider related phenomena. I show that the argument pertaining to the riskiness of a failed tie can be reinterpreted as a statement about the credibility of tying, that the results do not extend to complementary products for a very intuitive and clear reason, that the results can be reinterpreted as pertaining to predatory (with respect to an actual competitor) rather than exclusionary (of a potential entrant) behavior, and that the interpretation of this paper's welfare results should be treated as very limited.

5.1 Credibility

An alternative way of interpreting the relevance of the finding that a "failed tie" is less costly when employed against a WTP-advantaged entrant is to reconstrue this as a matter of the credibility of the tying strategy. Virtually every paper in the tying-as-deterrent literature (Nalebuff (2004) being the notable exception) demonstrates that a firm that ties but then faces entry would prefer to untie its products. For this reason, these papers typically assume an irreversibility of the tying decision. In fact, what is needed is more precisely that the cost of untying the products (whether this "reversal cost" is some literal cost of redesign or repackaging, a menu cost, or a reputational cost, etc) exceeds the profit penalty that a tied incumbent bears relative to competing with untied products. Since this paper demonstrates that this profit penalty can be smaller when facing an incrementally viable entrant (for which it is a necessary condition that the entrant have a WTP advantage), this can be reinterpreted as a finding that tying becomes credible (or "endogenously irreversible", in a sense) at a lower level of "reversal costs" when facing a WTP-advantaged entrant.

To formalize this, consider a model in which an additional stage is added after the entry decision but before simultaneous price-setting, in which the incumbent decides whether to "untie" its products at cost c_U. In such a model entry deterrence is chosen by the incumbent if (1) tying is credible (the profit penalty to tying is smaller than c_U), and (2) credible tying is effective and desirable (that is, (C3) fails, as argued in the main body of the paper). Note that the magnitude of the entrant's advantage $\Delta = (v_E - c_E) - (v_I - c_I)$ can be rewritten $(v_E - v_I) + (c_I - c_E)$; one can therefore say that the entrant is "relatively more WTP-advantaged" the smaller is c_I. A smaller c_I, given Δ, either implies a larger $v_E - v_I$ or implies a corresponding decrease in c_E, in which case $v_E - v_I$ is becoming larger relative to costs. Note also that one can say that tying is "more credible" when the minimal cost of reversal that achieves credibility is smaller.

Proposition 8 *For any given magnitude of the entrant's advantage* $\Delta = (v_E - c_E) - (v_I - c_I)$*, tying is a more credible and therefore more attractive strategy the relatively more WTP-advantaged is the potential entrant. Specifically, given* Δ*, the minimal* c_U *for which tying is employed is weakly increasing in* c_I *(and strictly increasing in* c_I *for some* c_I*).*

To see this, recall from the main body of the paper that tying that is credible is chosen by the incumbent when (C3) fails. By algebraic manipulation, it is straightforward that the failure of (C3) is equivalent to $\Delta < c_I + k$, or $c_I > \Delta - k$. (C2), the condition for incremental viability, is equivalent to $c_I > \Delta$. We therefore must consider the effect of changes in c_I in three regions. In the first range, $c_I > \Delta$. Here, (C3) necessarily fails and credible tying does profitably deter entry. In addition, (C2) holds, and the entrant is incrementally viable. Thus, the (tie, enter) profit of the incumbent is $w - a - c_I$, implying a penalty relative to untied competition of c_I. Credibility thus requires $c_U > c_I$. Over this range, therefore, the minimal cost of reversibility that leads to adoption of entry-deterring tying does strictly decrease as the entrant becomes relatively more WTP-advantaged. In the second range, $\Delta - k < c_I < \Delta$. Here, (C3) fails, so credible tying would profitably deter entry. (C2) fails here, and the entrant is not incrementally viable. Thus, the (tie, enter) profit of the incumbent is $w - a - \Delta$, implying a fixed penalty relative to untied competition of Δ. Over this range, therefore, the minimal cost of reversibility that leads to adoption of entry-deterring tying is invariant to c_I. In the third range, $c_I < \Delta$. Here, (C3) holds; the entrant is incrementally efficient and even credible tying will not deter entry. Again, the minimal cost of reversibility that leads to tying is invariant to c_I, which proves the proposition.

5.2 Complementary Products

Tying sometimes arises when products are complementary. It is worth briefly considering how complementarity of products would affect the analysis of this paper. Given the unit demand model employed here, complementarity is most readily modeled as a strict complementarity in which both products (the monopolized product and one version of the contested market product) must be used together to create value. Creating as close an analogy as possible to the prior notation, let the buyer's WTP for both products of the incumbent be $w + v_I$; let the buyer's WTP for the incumbent's monopoly product and the entrant's contested product be $w + v_E$; and let the buyer's WTP for any of the products alone be 0.

While this model presents some analytical difficulties, with the natural extension of the solution concepts already employed it is possible to arrive at a clear prediction about the desirability and effectiveness of tying in this model. Simply put, regardless of whether tying would be effective as a deterrent, there is never any reason in this model to attempt deterrence by any means, tying or otherwise. The reason is simple: a monopolist of a component of a strictly complementary system wants to encourage efficient entry in order to maximize the total value created, extracting a portion of that value through the price of the monopolized strictly complementary component.

The analytical difficulty that arises is that there are multiple equilibria in the pricing subgames that follow entry when there is a strictly complementary system. For example, consider the case in which the entrant has a superior WTP and an identical cost position: $v_E > v_I$ and $c_E = c_I$. With simultaneous price setting by the two firms in the case in which the incumbent is not tied, there is a continuum of equilibria. For example, the following prices constitute an equilibrium for any $\delta \in [0, v_E - c_E]$: the incumbent sets its contested market price at $p_I^C = v_I$; the incumbent sets its monopoly market price at $p_I^M = w + \delta$; and the entrant sets its price at $p_E = v_E - \delta$. At such prices, the buyer gets negative surplus from buying both products from the incumbent and gets exactly 0 surplus from buying one product from each firm. There is no profitable change in price for either firm. This game thus has multiple equilibria, making its analysis by the methods in the body of the paper inconclusive. However, it is easy to adapt the solution concept to capture the essence of this competitive scenario but retain unique solutions about the division of value.

Note that the essence of these multiple equilibrium solutions is that the incumbent can capture some fraction of the incremental value $v_E - v_I$ that the entrant brings to the industry, through a higher price on the monopoly component. Standard bargaining solution concepts such as the Nash bargaining solution when applied to this model assign to each of the firms one half of the incremental value created by the use of the more efficient entrant's contested market product. That is, each firm receives a price giving it profit equal to its profit it can earn on its own and in addition one half of the excess of the total industry profit beyond the sum of those go-it-alone profits. (The assumption throughout is that the buyer is replaceable and receives no surplus.) Substituting this solution concept in the final stage in lieu of equilibrium in a simultaneous price-setting game yields a tractable model that provides unique backward induction outcomes in the earlier stages of the game.[4]

First consider the case in which there is no tie and no entry. There is no entrant with whom to divide the surplus, and the incumbent captures the entire surplus. The incumbent therefore earns $\pi_I^{NO\ TIE,DETER} = w - a + v_I - c_I$. Next consider the highly similar case in which the incumbent ties but faces no entry. Again the incumbent captures all the surplus: $\pi_I^{TIE,DETER} = w - a + v_I - c_I$.

Now consider the case in which there is no tie and entry occurs. The incumbent can generate surplus of $w - a + v_I - c_I$ on its own, while the entrant can generate no surplus. Together, the firms can generate surplus of $w - a + v_E - c_E$, where the increment generated by their joint participation is $\Delta = (v_E - c_E) - (v_I - c_I)$. Thus, profits are $\pi_I^{NO\ TIE,ENTRY} = w - a + v_I - c_I + \Delta/2$ and $\pi_E^{NO\ TIE,ENTRY} = \Delta/2 - k$.

Note that for none of these results does anything about the nature of the entrant's advantage matter for determination subgame profits. When the incumbent does tie and nonetheless faces entry, the outcome assigned by the bargaining solution does depend on whether (C2) holds–ie, whether the entrant is incrementally viable.

First consider the case in which (C2) fails. Then the incumbent alone can create surplus of $w - a + v_I - c_I$, while the entrant alone can create surplus of 0. Together they can create maximal surplus of $w - a + v_I - c_I$, because having the buyer consume the entrant's product in addition to the bundle would increase total value by $v_E - v_I - c_E$, which is by definition negative when (C2) fails. Thus, in this case the $\pi_i^{TIE,ENTRY(C2FAILS)}$ profits are the same as $\pi_i^{NO\ TIE,DETER}$ profits. This already proves that the incumbent does not wish to tie when (C2) fails; the highest profits available to the entrant under any of the four bargaining subgames are those that arise under {NO TIE, ENTRY}. Moreover, this is achievable since (A2) implies that the entrant will in fact enter following a decision by the incumbent not to tie.

Now consider the case in which (C2) holds. Again the incumbent alone can create surplus of $w - a + v_I - c_I$, while the entrant alone can create surplus of 0. Together they can create maximal surplus of $w - a + v_E - c_I - c_E$. Here, it maximizes total surplus to have the buyer consume the entrant's product in addition to the bundle; this increases total surplus by $v_E - v_I - c_E$, which is by definition positive when (C2) holds. Thus, in this case the profits are $\pi_I^{TIE,ENTRY(C2HOLDS)} = w - a + v_I - c_I + (\Delta - c_I)/2$ and $\pi_E^{TIE,ENTRY(C2HOLDS)} = (\Delta - c_I)/2$. This proves that the incumbent does not wish to tie when (C2) holds; the highest profits available to the entrant under any of the four bargaining subgames are again those that arise under {NO TIE, ENTRY}.

[4]In fact, one can see immediately that the analysis goes through with *any* split of the surplus. I employ the equal division rule only for simplicity.

Moreover, this is achievable since (A2) implies that the entrant will in fact enter following a decision by the incumbent not to tie. This analysis can be summarized in the following proposition.

Proposition 9 *Assume that products are strictly complementary and that the entrant's and incumbent's profits are given by the Nash bargaining solution. Then the incumbent never ties.*

5.3 Predation versus entry deterrence

While the model of this paper formally considers only the case of entry deterrence, in which an incumbent attempts to restrict demand for a potential entrant, the logic applies similarly to the case of an incumbent facing actual competition in the contested market, where that incumbent seeks to restrict demand of the rival in order to drive it from the market.

In the model, incremental viability directly implies that a firm in the contested market that has already sunk the entry cost will remain in the market and in fact will continue to make sales. Even when incremental viability fails, such a firm will make no sales but also incur no costs; it therefore does not have a strict incentive to exit. Thus, in the model tying does not necessarily induce exit, regardless of whether incremental viability holds.

This possibility can be addressed by enriching the model with a fixed cost f of remaining in the market, separate from the marginal cost k modeled in the main body of the paper (for now, assume that only the contested market rival faces such a fixed cost). Assume that an extant rival in the contested market has already sunk the entry cost k, but decides whether to incur this additional fixed cost f after observation of the incumbent's tying decision and prior to simultaneous price setting. In this modified model, tying always induces exit when incremental viability fails. The contested market rival, by the failure of incremental viability, anticipates making no sales against a tied incumbent and thus finds it preferable to exit rather than to incur this fixed cost f. When incremental viability holds, this firm would be induced to exit only if this fixed cost was large enough. Such a firm does anticipate making a sale against a tied incumbent, with a profit before the fixed cost of $v_E - v_I - c_E$; if and only if f exceeds this quantity would the firm therefore be induced to exit the market. Thus, the qualitative results of the model do apply to the case in which tying may be used to induce exit, as summarized in the following proposition.

Proposition 10 *Assume that an extant contested market rival has already sunk the entry cost k, but must incur a fixed cost f after observing the incumbent's tying decision in order to remain active in the market. Then the incumbent induces exit of the contested market rival through tying if incremental efficiency fails. Thus, if incremental viability fails, the incumbent always ties and induces exit. If incremental viability holds, the incumbent ties and induces exit of the contested market rival if and only if the fixed cost is positive and the entrant's fixed and marginal costs together exceed the entrant's WTP advantage ($f + c_E > v_E - v_I$).*

5.4 Welfare effects

In this paper I take a deliberately narrow view of the welfare implications of the paper's results. The unit demand assumption implies that there are neither quantity distortions due to monopoly nor quantity effects due to competition; as a result, total welfare depends only on the WTP and cost position of the most efficient firm in the contested market. (A1) implies that the entrant increases value created in that market by more than its cost of entry; thus, entry is always welfare-enhancing, and entry-deterring tying is necessarily welfare-reducing. This clearly rules out many alternative rationales for the welfare-enhancing effects of tying–among them, smoothing demand to eliminate quantity distortions and improving product performance through integration. In addition, the simple model of post-entry price competition with unit demand rules out the possibility that the entrant might capture more in profit than it creates in social value. If this were the case then, as in Mankiw and Whinston (1986), "free entry" would lead to excess entry. This would in turn imply that entry deterrence could potentially increase social welfare by eliminating the redundant fixed costs associated with that excess entry. This potential welfare-enhancing effect is precluded in this paper by the simple model of post-entry competition with unit demand.

Such a phenomenon does arise in this model with a simple extension, along the lines of the extension described to study predatory tying. Consider a model in which a fixed cost f must be incurred by the incumbent to remain in the market for the contested good, where this decision whether to remain and incur f occurs after the entrant's decision to enter (which triggers for the entrant the expenditure of both f and k for the entrant). In addition, assume that the entrant has an advantage over the incumbent once entry costs are sunk, but not so large an advantage as to make entry socially efficient: $0 < v_E - c_E - (v_I - c_I) < k$. The first inequality ensures that the entrant does have an advantage and will win unrestricted (untied) head-to-head competition with the incumbent, while the second ensures that the incremental value created by the entrant is not sufficient to warrant entry from a social welfare perspective. Finally, assume that $v_E - c_E > f + k$ (that is, that the *absolute* value created by the entrant is large enough that an entrant who becomes a monopolist in the "contested" market finds entry profitable) and that $v_I - c_I > f$ (which ensures that the incumbent would find it profitable to remain active in the "contested" market absent entry).

In such a model, the entrant will enter if the incumbent does not tie. Once the entrant commits to entry, the incumbent exits that market, knowing that it will fail to make a sale, and preferring therefore not to incur the fixed cost f. As a result, the entrant is a monopolist in the "contested" market, earning a net profit of $(v_E - c_E) - (f + k) > 0$. Note that, due to the exit of the incumbent when faced with a fixed cost, this is now a model where the entrant captures more value $((v_E - c_E) - (f + k) > 0)$ than it adds to social welfare $(v_E - c_E - (v_I - c_I) - k < 0)$. Thus, deterrence of entry in this setting would increase social welfare. In fact, tying does deter entry for many parameter values, most obviously when the entrant is not incrementally viable (for example, has only a cost advantage) and knows that it will not make any sales against a tied bundle from the incumbent.

Proposition 11 *Assume that the incumbent must incur a fixed cost f to remain active in the contested market, and that the decision whether to incur this cost occurs after the observation of the entrant's decision whether to incur entry and fixed costs c_E and f. Assume also that the entrant has an advantage over the incumbent ignoring sunk costs; that its entry is not socially efficient; and that for both the entrant and the monopolist, profits as the monopoly seller in the contested market more than cover the relevant entry and fixed costs. Then entry-deterring tying, which is possible (and which always arises when incremental viability fails), always increases total social surplus.*

This is but one example of a mechanism that might lead to excess entry, which in turn might make entry deterrence socially desirable. Considering in addition the myriad non-deterrence logics for tying, one must take a cautious view of any welfare interpretations of models of tying as an entry deterrent. This paper's contribution is better understood as being about the effectiveness and (private) attractiveness of tying as an entry deterrent than about its social desirability.

6 Conlcusion

This paper demonstrates that tying can be an effective and profitable entry deterrence strategy under simple and plausible assumptions, and that the effectiveness and attractiveness of this strategy depend on the source of the potential entrant's advantage. Interestingly, relative to a cost-based advantage, a WTP-based advantage for the entrant makes tying both *less effective* as an entry deterrent (as an additional constraint on parameters arises, highlighting the potential viability of an entrant despite tying) and *more attractive* in the face of uncertainty over whether it is likely to be effective (as the cost of mistakenly tying is mitigated). These results shed light on the important policy question of what markets and circumstances are most susceptible to inefficient entry deterrence through tying.

6.1 Incremental viability in practice

Revisiting some of the cases described in the introduction illustrates how this paper's emphasis on incremental viability can cast tying in a new light. Recall that incremental viability of a potential entrant follows from two aspects of the competitive environment. The potential entrant is incrementally viable if its WTP advantage over the incumbent exceeds its unit costs. Thus, incremental viability is more likely when WTP advantages are larger and when variable unit costs are lower. And, incremental viability can be assessed in a practical setting by asking whether it is reasonable to think that a buyer might buy the bundle *and also* the entrant's offering, where this is affected by both the incremental WTP and the level of costs.

Consider the Times-Picayune, Loew's, and Microsoft cases described in the introduction. Arguably, these cases seem likely to satisfy the incremental viability condition. There is plausibly some significant and positive WTP difference for ads in a different afternoon newspaper that has demographics that better suit some advertiser, for different movies to show in lieu of the weaker ones included in the Loew's bundle, and for browsers that offer different features or better plug-in compatibility than Internet Explorer. Moreover, in each of these cases variable unit costs are quite low: the marginal cost of printing a newspaper ad, licensing an existing movie, or allowing a browser to be downloaded are minimal compared with the potential WTP advantages. Thus, incremental viability likely holds. Intuitively, it is easy to imagine buyers buying both the tied bundle and contested market rival's offering (at a price that covers the rival's unit costs) in each of these scenarios. The results of this paper then imply that (1) tying might be expected not to be a particularly effective entry deterrent in these settings, (2) tying might not seem particularly risky, since the tying incumbent can always just resort to monopoly pricing for the monopolized good and absorb the low marginal cost of the contested good. Of course, a full analysis would be much more complex, accounting for, among other factors, the segmentation of the buyer market, the credibility of the tying decision, and the magnitude and recoverability of the entry costs. Nonetheless, the emphasis on incremental viability does shed some light on a common feature of these settings, especially when contrasted with some of the other cases mentioned in the introduction.

In particular, consider in contrast two other examples: the GE/Honeywell and Tetra/Sidel mergers. In these cases, while there might still be plausible WTP advantages for better-performing or more efficient avionics or PET bottle industrial equipment, these are likely to be much smaller in comparison to the variable unit cost of producing a sophisticated piece of machinery, especially when contrasted with the other examples described just above. Thus, it seems far less plausible to imagine a buyer buying the bundle and then replicating the purchase in the contested market while a portion of the bundle purchase lies idle. Thus, incremental viability is less likely to hold in these settings, with the implication that (1) tying might be expected to be more powerful as an entry deterrent, and (2) tying might seem very risky and therefore unattractive to the incumbent, since the paper suggests that the penalty to tying and facing entry in this setting is more severe. (Coincidentally, note that the attractiveness of tying was especially relevant in these cases since the tying behavior was entirely hypothetical at the time of the pre-merger analysis.) Again, a complete analysis would involve many other factors, but the emphasis on incremental viability highlights common features of these settings that might not have otherwise been apparent.

6.2 An application to vertical integration

It is also possible to reinterpret the results of the paper to shed light on the long-standing debate in the policy and business strategy literatures over the consequences of vertical integration between "content" and "distribution". An important question in these literatures is whether it makes sense for a firm to make its content exclusive to its distribution channel; note that this is analogous to the type of tying described in this paper, where the unique content is the monopoly market and the distribution channel is the contested market. Here, exclusivity implies that the consumer must buy the tying firm's distribution in order to access its content. These literatures ask whether one should expect the vertically integrated firm to engage in this kind of a tie, and whether it should be profitable. The message of this paper is that one should frame the question around incremental viability. If it is reasonable to think that buyers might buy access to a second distribution channel in order to access its unique offerings (i.e., the competitors/entrants in the contested market are incrementally viable), then this tie is less likely to be effective in foreclosing the market to those competitors.

Now consider a specific example. Rogers Communications, Canada's largest cable company, owns the Toronto Blue Jays, Canada's only major league baseball team. Rogers also owns the Sportsnet cable channels, which are effectively the exclusive broadcaster of Blue Jays games in Canada. Sportsnet is included in Rogers's basic cable bundle, but is available only in premium sports bundles through other services such as satellite TV. Though of course this real-world setting is more complex than the model due to segmented markets and other factors, this (the underlying pricing strategy that led to this dichotomy) is arguably analogous to a tie as modeled in this paper. At least for someone with a moderate WTP for baseball broadcasts, this effectively ties Rogers' cable service and Blue Jays broadcasts. Now consider the question of incremental viability of alternative distribution channels. Individuals may have a positive incremental WTP differential for satellite service if, for example, it offers access to a better selection of recent movies or a better user interface. However, it seems unlikely that that differential would exceed the marginal cost of satellite service, which includes the up-front cost of installing the dish, as well as the ongoing costs of per-subscriber fees paid by the satellite broadcaster and the user's receiver rental. Thus, the logic of this paper would imply that this tie might be quite effective in foreclosing a significant market to the alternative distribution channel.

Now consider in this light the effect of the emergence of a technology such as AppleTV. Again, individuals might have a positive WTP differential for AppleTV's user interface and selection of recent movies, relative to cable; in addition, given the much lower marginal cost of using AppleTV (because of the more modest equipment required, the likely presence of already sufficient broadband access, and the fact that the users pay only for the content viewed) it now seems much more reasonable to think that incremental viability is satisfied (that is, that cable customers would also own an AppleTV). It would follow, by the logic of this paper, that the tie would be much less likely to be effective in foreclosing competitors with this business model from the distribution market. The paper's focus on the condition of incremental viability, which pinpoints the WTP advantage relative to entrant's unit costs as the crucial characteristic of the market, helps structure the analysis of the likely effectiveness of this kind of content-distribution tie.

6.3 Future research

Despite a large literature on the effectiveness of tying under a wide variety of demand assumptions, there remains much to be learned from an approach that acknowledges the importance of the source of the entrant's advantage, and in particular the condition of incremental viability. While this paper has made some progress in this direction, it has done so in the context of an extremely simple demand model. Further work that considered richer demand structures, segmented markets, and situations of complementarity falling short of strict complementarity would undoubtedly further enrich our understanding of tying's effectiveness as an entry deterrent.

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