The Role of Cost in Determining When Firms Offer Bundles [*]

By

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Abstract: We incorporate marginal cost savings from bundling, fixed costs of product offerings, and variation in customer preferences into a model of bundling and tying. To focus on cost effects, we assume perfectly contestable markets and analyze sustainable product offerings. Pure bundling can arise either because few people demand only one component or because, with high fixed costs, a single product is the efficient way to satisfy customers with diverse tastes. We conclude with an empirical analysis of the bundling of pain relievers with decongestants. We document a sizeable discount for the bundled product and argue that our model provides a more compelling explanation for it than the demand-centered approach that has dominated the bundling literature.

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I. Introduction

The formal economics literature on bundling and tying has focused on how bundling affects demand[1] and thereby facilitates price discrimination, and on how tying can be used to leverage or extend monopoly power.[2] Many treatments observe that bundling and tying are common and that cost savings explain many, and probably even most, cases of bundling. A common example is that shoes are sold in pairs. Yet, the practical importance of cost savings notwithstanding, most of the models abstract away from them,[3] as if the effects are too trivial to merit formal treatment.

For at least three reasons, however, a more careful treatment of cost effects is warranted. First, the casual observations about cost savings rarely distinguish tying[4] from mixed[5] bundling. True, most people want shoes in pairs; and it is almost surely cheaper, for example, to place the pair into a single box rather than two. But that only explains why, for the vast majority of people who want a matching pair of left and right shoes, the pair comes in a single box. The marginal cost savings cannot explain why individual shoes are not available for the occasional person who wants to purchase just one shoe. A cost explanation for tying requires that some sort of scale economy be present.

Second, and related, the literature has not adequately explored the different types of scale economies that might affect bundling and tying. To the extent that scale economies have entered the literature at all, it has been those associated with the production of the components.[6] It is not, however, scale economies in the production of, say, right shoes that can explain why shoes are sold only in pairs. Rather, it is scale economies associated with making right shoes available as a distinct product offering. Tying represents a restriction on the set of available products;[7] so a cost-based explanation for tying must rest on the cost of distinct product offerings. We incorporate this effect into our model by assuming a fixed cost of each product offering, with the bundle and each component each constituting a separate offering. If all are to be offered, a fixed cost must be incurred for each one.

Third, and most importantly, once one accounts for these fixed costs of product offerings, the cost-based explanation for tying becomes more complex than has been appreciated. In particular, pure bundling arises for two distinct reasons in our model. One is that most people want all components of the bundle; bundling lowers marginal costs, and the combination of some fixed costs of distinct product offerings and insufficient demand for the individual components makes it unprofitable to offer the components separately. Shoes are the prototypical example of this class. The other is when the fixed cost of a product offering is very high, in which case tying occurs because companies try to find a single product that meets the needs of diverse groups of customers. In these cases, pure bundling, which is a form of tying, can arise even if no one wants all the components[8] and bundling does not lower marginal costs.[9]

In order to focus entirely on costs, we assume that markets are perfectly contestable, which implies that prices equal average cost. We acknowledge that the assumption is extreme, and that a more complete model would incorporate demand effects as well. We offer some thoughts on how to do so in section III. We believe, though, that the extreme assumption is justified by the insights it yields into why tying occurs in practice.

This paper is one of three we have done that report theoretical, empirical, and legal analysis of bundling in general and tying in particular. The primary focus of this paper is a thorough exposition of the theory. However, since part of assessing the theory is whether it yields useful predictions, we briefly mention one of the cases that we discuss at greater length in Evans and Salinger (2004, 2006). For various kinds of ailments, one might take more than one medicine. For example, someone with a sinus headache might want a pain reliever and a decongestant. The different medicines are available separately, but one can also purchase tablets that combine two or more of the active ingredients needed for a particular condition. For example, both Tylenol Sinus and Sudafed Sinus Headache tablets contain both the pain reliever acetaminophen and the decongestant pseudoephedrine hydrochloride. The key empirical feature of this case is that the prices consumers pay for the combination tablets are substantially lower than the sum of the prices for the same active ingredients sold in separate tablets. We will argue that our model provides a more compelling explanation for the strong stylized fact than the demand-based models that have dominated the literature to date.

The remainder of the paper is organized as follows. Section II presents our theory. Section III discusses how the model could be expanded to incorporate demand and market power effects. Sections IV returns to the cold medicine case. Section V concludes.

II. The Theory of Cost-Based Bundling in Contestable Markets

In this section, we present our theoretical model. Part II(i) lays out the assumptions. Part II(ii) analyzes market outcomes. Part II(iii) derives efficient outcomes and compares them to the results from part II(ii).

II(i). Assumptions

We make what we believe are the simplest possible assumptions to capture the essential features of cost-based rationales for tying and bundling. There are two goods that can be sold either separately or bundled. There are three classes of customers. Type 1 customers want just good 1, type 2 customers want just good 2, and type B customers want both. Let X_1, X_2, and X_B be the number of each type of customer. In the body of the article, we assume that each group's demand for the good(s) they want is perfectly inelastic, so they buy the good(s) they want in some form.[10] This simplifies the exposition. In the appendix, we allow demand to be sensitive to price.

We allow for the possibility that members of each group have a preference for how they buy the good. For example, those who want both goods might get a convenience value, v, from buying them in bundled form. Those who want just one of the goods might have to pay a cost, d, to dispose of the unwanted component. We assume that these premiums are the same for all members of a group and, to conserve on notation, that the disposal cost is the same for the two components.[11]

Let c_1 and c_2 be the constant marginal costs of producing goods 1 and 2, and c_B be the constant marginal cost of producing the bundle. We assume that $c_B \leq c_1 + c_2$. We also consider the possibility that bundling enables firms to lower fixed costs. We could assume generally that $F_B \leq F_1 + F_2$. However, to simplify the presentation we consider the special case in which each product offering has the same fixed cost F; this case corresponds to the situation in which a product offering requires shelf-space, inventory control, and other similar costs. The fixed cost may provide an opportunity to obtain scale economies by offering only the bundle. But if the firm offers the two separate products, it will have to incur an additional fixed cost to offer the bundle and it must weigh this fixed cost against the marginal cost savings from bundling discussed above.

To focus on costs, we assume a degree of competition that drives prices down to some notion of cost. We cannot assume perfect competition given the existence of product-specific scale economies. Instead, as noted in the introduction, we model markets as being perfectly contestable in the sense of Baumol, Panzar, and Willig (1982). This assumption implies that price equals average cost.

The objective of the model is to analyze what products are offered.[12] There are five possibilities.[13] With mixed bundling, the bundle of the two goods and both individual goods are offered. Under "components selling," both goods are offered but the bundle is not. With pure bundling, the bundle is offered but the separate goods are not; good 1 and good 2 are tied to each other. There are two remaining cases of tying: the bundle and good 1 are offered; and the bundle and good 2 are offered. We note that, with the exception of mixed bundling, all of the possibilities entail some limitation on product choice (including pure components where the consumer loses the opportunity to have someone else package them together). Table I contains the prices for each product in each possible set of product offerings.

Given the fixed cost, the average cost of an offering depends on how many customers buy it, which in turn depends on which products are available in the market. Compare the price of good 1 under mixed bundling and components selling. In the former outcome, only group 1 buys good 1, so the price is $c_1 + F/X_1$. In the latter, both group 1 and group B buy good 1. With additional purchasers to "share" the fixed cost, the price is $c_1 + F/(X_1 + X_B)$.

[INSERT TABLE I.]

II(ii). Sustainable market outcomes

We model market outcomes as "sustainable prices."[14] Sustainable prices must be equal to average cost to prevent entry from an identical good at a lower price. They must also prevent entry by firms that offer alternative combinations of the goods. To ascertain whether an outcome is sustainable, we first determine the average cost for each set of product offerings (and allocation of customers to products). We then check to see whether it would be possible either to enter with a product not offered or to cut the price of an existing product to attract an additional group of customers.[15]

We provide a simple numerical example of our approach here. Suppose $c_1 = c_2 = 2$, $c_B = 3$, $v = d = 0$, $X_1 = X_2 = X_B = 1$, and $F = 1$. With mixed bundling, the price of the bundle would be 4 and the price of each component would be 3. If a firm just sold components, the prices would be 2.5 each and the components combined would cost 5 to consumers who wanted both. If a firm sold just a bundle then the average cost would be 3 1/3.[16] That price would not, however, be low enough to attract groups 1 and 2 because it is not less than 3, the prices of the separate components under mixed bundling. Mixed bundling is therefore the only sustainable outcome.

More generally, whether a set of product offerings is sustainable depends on a set of "stand-alone" conditions. These are conditions that determine whether a particular potential good must be included in a sustainable outcome. Good i must be part of a sustainable outcome if:

(1) $$c_i + \frac{F}{X_i} < c_B + \frac{F}{X_1 + X_2 + X_B} + d \qquad i = 1, 2 .$$

The left-hand side of condition (1) is the price of good i when the only group purchasing it is group i. That is the highest possible price for good i if it is offered. The right-hand side of condition (1) is the price of the bundle when all three groups buy it plus the cost of disposing of the unwanted component. That is the lowest possible "total price" of obtaining just good i by buying the bundle. If the highest possible price for good i is lower than the lowest possible total price (including disposal cost) of obtaining good i by purchasing the bundle, pure bundling is not sustainable because it would be subject to entry with good i. Condition (1) is sufficient for good i to be part of a sustainable offering, but it is not necessary. Suppose, for example, that condition (1) holds for good 1 but not for good 2. Since good 1 would be included in any sustainable outcome, the right-hand side of (1) does not give a possible total price of obtaining good 2 by buying the bundle. In this case, the condition that ensures that good 2 must be included in a sustainable outcome is (for i = 2):

$$(2) \qquad c_i + \frac{F}{X_i} < c_B + \frac{F}{X_i + X_B} + d \qquad i = 1, 2$$

The left-hand side of (2) is the same as (1). The right-hand side is the price of the bundle when groups i and B buy the bundle plus the disposal cost. Condition (2) says that if good 1 and the bundle were the only goods available, entry with good 2 would be profitable. As a result, the outcome in which good 2 is tied to good 1 would not be sustainable. We refer to condition (1) as the "strong stand-alone condition" for good i, and condition (2) as the "weak stand-alone condition."

The stand-alone condition for the bundle is:

$$(3) \qquad c_B + \frac{F}{X_B} < c_1 + c_2 + \frac{F}{X_1 + X_B} + \frac{F}{X_2 + X_B} + v$$

The left-hand side of (3) is the price of the bundle when only group B buys the bundle. That is the highest possible price of the bundle. The right-hand side of (3) is the sum of the components prices under components pricing plus the convenience value group B gets from buying the components in bundled form. Condition (3) says that if the components were the only goods available, entry with the bundle would be profitable. If so, pure components selling is not a sustainable outcome.

Condition (3) determines whether it is profitable to offer the bundle at a price that attracts just group B. Pure components selling is also potentially subject to entry by a firm selling the bundle at a price that attracts all three groups. Such entry would be profitable if the following condition holds for both goods 1 and 2:

$$(4) \qquad c_B + \frac{F}{X_1 + X_2 + X_B} + d < c_i + \frac{F}{X_i + X_B} \qquad i = 1, 2$$

The left-hand side of condition (4) is the total price (again, including disposal cost) of obtaining good i by buying the bundle. The right-hand side is the price of the component goods under components selling. If condition (4) holds for both goods, then pure components selling is not sustainable. For entry with the bundle to be profitable, condition (4) must hold for both goods because the price for the bundle on the left-hand side of (4) is profitable only if both groups buy the bundle. Because pure bundling is the only sustainable outcome when condition (4) holds, we refer to it as the "pure bundling sufficiency condition."

With these four conditions as background, we can now establish our basic result about which outcomes are sustainable for each possible set of parameters.

> *Theorem 1*: When condition (4) holds, pure bundling is the only sustainable outcome. When condition (4) does not hold, then the sustainable outcomes are given by Table II.

Note that Table II is divided into two panels, A and B. The first covers those cases when the bundle stand-alone condition, condition (3), holds. The second covers when it does not. Within each panel, the entries in the rows and columns indicate which of the stand-alone conditions for the individual goods holds.

[INSERT TABLE II.]

The logic behind Table II is simple. There are three possible products. When all three stand-alone conditions hold, all must be offered in a sustainable configuration, so mixed bundling results.[17] When the stand-alone conditions for two of the goods hold but the other does not, then those two are offered in a sustainable configuration and the other is not. When the bundle stand-alone condition holds and neither strong stand-alone condition holds for the individual goods, pure bundling is the only sustainable outcome.[18] When the strong stand-alone condition for one of the separate goods (good 1, say) holds but none of the other stand-alone conditions holds, then there are two sustainable outcomes.[19] Good 1 is offered in both, with the other good being either good 2 or the bundle. When neither the bundle stand-alone condition nor either of the strong stand-alone conditions for the separate goods holds, either pure bundling or pure components selling are the two sustainable equilibria.

To provide some intuition for the results, we present two types of graphs. In the first, we hold constant the composition of demand (X_1, X_2, and X_B) and then show how the outcome depends on the cost structure. In figure 1, the underlying parameters are $X_1 = X_2 = 2$, $X_B = 1$, $c_1 = c_2 = 1$, and $d = v = 0$. The axes capture the two key aspects of the cost structure. The horizontal axis measures the marginal cost savings from bundling c_B. We show the range from 1 to 2. When $c_B = 2$, the marginal cost of the bundle equals the sum of the component marginal costs, so there are no marginal cost savings from bundling. In contrast, when $c_B = 1$, the marginal cost of the bundle equals the marginal cost of just one of the components, so the marginal cost savings are substantial.[20] The vertical axis measures fixed costs, which is the other key aspect of the cost structure.

[INSERT FIGURE 1.]

The three lines on the graph are conditions (1) (the strong component stand-alone condition), (3) (the bundle stand-alone condition), and (4) (the pure bundle sufficiency condition). The symmetry of the parameter assumptions simplifies the graph substantially. Condition (2), the weak component stand-alone condition, plays no role because condition (1), the strong component stand-alone condition, holds for both goods or for neither. Also, conditions (1) and (4) are each two conditions, but they coincide with symmetric parameters.

In the upper left hand region of the graph, region A, pure bundling is the only sustainable outcome. In this region, fixed costs are high enough that it is cheaper to provide all customers with the bundle than to sell the individual components to those who want just one of them. The border of the region is upward sloping because the level of fixed costs needed to make it efficient to offer just the bundle depends on the extent of marginal cost savings from bundling.[21]

As in region A, pure bundling is the only sustainable outcome in region B, but for a different reason. The pure bundling sufficiency condition does not hold. However, the bundle stand-alone condition does, and the component stand-alone conditions do not. In this region, there are large marginal cost savings from bundling and moderate fixed costs. In region C, the component stand-alone conditions hold (as does the bundle stand-alone condition). Mixed bundling is the only sustainable outcome. The bundle stand-alone condition does not hold in region D, but the component stand-alone conditions do. As a result, components-selling is the only sustainable outcome. While there are some marginal cost savings from bundling, the fixed costs are too high to justify offering it (in light of the relatively small number of consumers who want both goods).[22]

In region E, both pure bundling and components selling are sustainable. Given our assumptions about demand, either the bundle must be offered or both components must be. Yet, neither the bundle stand-alone nor the component stand-alone conditions hold. Thus, if the bundle is offered, the components will not be and vice versa.

Figures 2 (a) and (b) provide a different perspective on the results. Rather than holding the structure of demand constant and letting key aspects of the cost structure vary, these graphs hold constant the cost parameters and explore variations in the composition of demand. The underlying parameters are $c_1 = c_2 = 1$, $c_B = 1.8$, $X_B = 1$, and $F = 1$. Thus, there are some marginal cost savings from bundling (because $c_B < c_1 + c_2$), but there is also a substantial marginal cost to providing a customer with an additional component. The axes measure X_1 and X_2. There are two key aspects of the demand structure to consider. The first is the fraction of customers wanting both goods rather than just one. Lines with a slope of -1 are isoquants for the number of people who want just one good. Since X_B is held constant at 1 as a normalization, the fraction of people that want both goods is large near the origin and gets smaller as one moves away from it. The second key aspect is, among the people who want just one good, the number that want good 1 and the number that want good 2. Along the 45^0 line from the origin, an equal number of customers want just good 1 and just good 2. Below the line, more people want just good 1; above the line more want just good 2.[23]

As this perspective is more complicated (because it does not impose symmetry), we present the graph in two steps. Figure (2a) shows conditions (1) – (3). We do not show condition (4) because, given these parameters, there are no values for X_1 and X_2 for which both conditions in the pure bundle sufficiency condition hold. Note that Conditions (1) and (2) are both two inequalities, one for each good. Consider the good 1 stand-alone conditions. The inequalities hold in the region to the right of the lines since the greater number of people who want just good 1 lowers the price at which it can be offered.[24] Similarly, the good 2 stand-alone conditions hold above those lines. The bundle stand-alone condition, which is a rectangular hyperbola, holds below the line. When people who want both goods buy them as components, they "contribute" to the two fixed costs; when they buy the bundle, they contribute to one. If enough people want the separate components, however, then those fixed costs get spread over enough of a customer base that paying a fraction of two fixed costs is cheaper than paying all of just one. Near the origin, not many people demand the separate components. All else equal, that makes the price of the components higher and the bundle more attractive for those who want both. .

[INSERT FIGURE 2A.]

[INSERT FIGURE 2B.]

Figure 2b shows the regions defined by conditions (1) - (3). (In this figure, we show only the portions of the conditions that define boundaries between regions.) In region A, pure-components is sustainable. That region is the farthest from the origin, indicating that most customers want just one of the goods. In region B, mixed bundling occurs. Here, there are enough customers who want just one good to make it profitable to offer them separately, but not enough to make it possible to offer the individual components so as to attract customers who want both components. In region C, pure bundling is the only sustainable outcome. Most customers want both goods. There are too few who want just good 1 or good 2 for them to be offered separately. In D1, a substantial number of customers want just good 1 but very few want good 2, so the sustainable set of offerings is the bundle and good 1. (The reverse is true in D2). In E1, most customers want just good 1, so it is definitely offered. There is some demand for good 2, both by people who want it separately and by those who want good 1 as well. The mix is such that either the bundle or good 2 could be offered, but not both.

A complication in presenting the results of the model in graphical form is that the effects of variation in cost structure shown in figure 1 depend on the composition of demand and the effects of variation in demand composition depend on cost structure. We do not attempt here to provide a complete graphical representation. We do, however, present one additional case, because it illustrates one of our key results – i.e., that pure bundling can emerge for two distinct reasons. In figures (2a) and (2b), we excluded the pure bundling sufficiency conditions because, given the parameters underlying the graph, there is no portion of the graph in which both parts of the condition hold. As a result, pure bundling arises in that graph in the region where most customers want both goods. The famous shoe example is at or near the origin in figure 2b.

Figures 3a and 3b rest on the same underlying parameters as figures 2a and 2b except that the level of fixed costs, F, is 5.5 instead of 1. Like figure 2a, figure 3a shows the relevant conditions over their entire range. The higher fixed costs create two fundamental differences between figures 2a and 3a. First, there is a range of parameters for which both parts of the pure bundle sufficiency condition, condition 4, holds; so we include those lines. Second, the intersection of the two strong stand-alone conditions lies outside the bundle stand-alone condition.

[INSERT FIGURE 3A.]

[INSERT FIGURE 3B.]

The effect of these differences can be seen in figure 3b which, like figure 2b, shows only the portions of the conditions that serve as a boundary between regions in which a particular type of outcome is sustainable. As in figure 2a, pure components is the only sustainable outcome in region A. That is the region in which the demand for just good 1 and just good 2 are large relative to demand for both goods. In region B, both pure bundling and pure components selling are sustainable. Like region B in figure 2a, the number of people who want both goods is larger relative to the number of people who want just one than in region A. With the lower fixed costs in figure 2b, this region entails mixed bundling. With the higher fixed costs in figure 3b, mixed bundling is not sustainable; the set of product offerings has to be limited in some way – either by not having the bundle or not having the individual components. Regions C, D1, D2, E1, and E2 are similar to those in figure 2b. [25]

Region F, however, does not have a counterpart in figure 2b. In this region, part of which lies outside the region where the bundle stand-alone condition holds, the pure bundle sufficiency condition holds. In the portion of this region that lies outside the bundle stand-alone condition, most customers want just one of the goods. Yet, pure bundling is the only sustainable outcome because the single bundled product is the cheapest way to satisfy the needs both of customers who want just good 1 and those who want just good 2.

Figure 3b illustrates one of our central findings. Pure bundling can occur for two distinct reasons. One is that most customers want both goods. The conditions for this type of bundling are that the bundle stand-alone condition holds and both strong component stand-alone conditions do not. The other is that a single bundled product is the efficient way to meet the needs of customers who want different goods. In the graph, this is the region where both parts of the bundle stand-alone condition hold. In figure 3b, the two regions overlap, but that is not always the case. In figure 2b, the second region does not exist. The only reason for pure bundling is when most customers want both goods. If we were to assume $X_B = 0$ and $c_B = 2$ (while keeping the other parameter values fixed), the bundle stand-alone condition would disappear. In that case, the only reason for pure bundling would be to have a single good that meets a diverse set of preferences.

Once one sees the distinction in the model between these two types of pure bundling, it is obvious that both types exist. Shoes are sold in pairs because virtually everyone wants both a right and a left shoe. Newspapers are sold as a bundle because it would be prohibitively expensive to customize what sections each reader gets. Obvious as the distinction may be, discussions of efficiencies from tying have failed to make it.

The intuition behind these results is straightforward. Firms consider fixed costs, marginal costs, and demand for different product offerings in making their decisions on how to design a product – what bundle of features to include – and whether to offer different combinations of components as separate goods instead of, or in addition to a bundle of those components. When fixed costs of offering goods separately are low relative to demand, firms find that it is profitable to satisfy that demand with a specific product offering. When fixed costs are high relative to demand firms find that it is more profitable to either not serve customers that would like a component, or to require these to buy a bundled good that contains some features they do not want.

II(iii). Welfare Analysis

Given the assumption that all customers buy, the efficient outcome is the one that minimizes total cost. In turn, this depends critically on which of the following conditions hold:

(5) $$F < \left(c_B + d - c_i \right) X_i \quad i = 1, 2$$

(6) $$F < \left(c_1 + c_2 + v - c_B \right) X_B$$

Condition (5) is an efficiency stand-alone condition for the individual goods. It says that the fixed cost of offering good i is less than the extra marginal cost (including possible disposal costs) from having group i purchase the bundle. When it holds, it is efficient to offer good i whether or not the bundle is also offered. Condition (6) is an efficiency stand-alone condition for the bundle. If it holds, then the fixed cost of adding the bundle is less than the additional marginal cost (including the loss of any convenience from bundling) from having group B buy the components separately.

If all three conditions (i.e., condition (5) for both goods and condition (6)) hold, then mixed bundling is efficient. If two of the conditions hold and one does not, then it is efficient to offer the two goods for which the condition holds. For example, if condition (5) holds for both goods but condition (6) does not, then components selling is efficient. On the other hand, if condition (6) holds and condition (5) holds for good 1 but not for good 2, then it is efficient to offer the bundle and good 1; and anyone who wants good 2 must purchase good 1 along with it.

If condition (6) holds and condition (5) does not for either good, then pure bundling is efficient. When condition (5) holds for just one good (good 1, say) and condition (6) does not, then it is efficient to offer good 1 and either the bundle or good 2. Which of the two should be offered depends on:

$$(7) \qquad (c_1 + c_2 + v - c_B)\, X_B > (c_B + d - c_2)\, X_2$$

The left-hand side is the increment to marginal cost from selling components to the group that wants both goods. The right-hand side is the increment to marginal cost of providing the bundle to those who want just good 2. If condition (7) holds, the bundle should be offered along with good 1. If it does not, pure components is the efficient outcome.

When none of the three efficiency stand-alone conditions holds, then pure bundling is efficient if:

$$(8) \qquad F > (c_B + d - c_1)X_1 + (c_B + d - c_2)X_2 - (c_1 + c_2 + v - c_B)\, X_B\,,$$

and components selling is efficient if it is not. The right-hand side of (8) is the net marginal cost savings of offering components rather than the bundle. It is the difference between the marginal cost savings to groups 1 and 2 from being able to buy the separate good less the marginal cost of meeting the needs of group B with the separate components rather than the bundle. The condition states that these savings are less than the fixed cost of the additional offering involved in components selling as compared to pure bundling.

Figure 4 is based on figure 1 and includes the relevant efficiency conditions. As in figure 1, the underlying parameters are $X_1 = X_2 = 2$, $X_B = 1$, $c_1 = c_2 = 1$, and $d = v = 0$. The lines that are not in bold are identical to those in figure 1. The bold lines are efficiency conditions. As these lines are not identical to those that determine which set of product offerings is sustainable, they subdivide some of the regions in figure 1. In those cases, the label of the sub-region has the same letter as the region from figure 1 and a number.

[INSERT FIGURE 4.]

In figure 4, the region in which mixed bundling is efficient (C1) is a subset of the region in which mixed bundling is the sustainable outcome (C1, C2, and C3). This result is a general result because the stand-alone conditions, conditions (1) and (3), are weaker than the efficiency stand-alone conditions, conditions (5) and (6). The difference arises from a type of externality associated with entry. Suppose, for example, that the two components are offered. For it to be efficient also to offer the bundle, the marginal cost savings must be greater than the entire fixed cost of the additional offering. For entry with the bundled product to be profitable, however, the marginal cost savings must merely exceed the increase in fixed costs born by the group that wants both goods, i.e., the fixed cost of the additional offering minus that group's contribution to the fixed costs of the components under components selling. Since the avoided contribution to fixed costs of the components enters the private benefit of the bundle but does not reflect social savings, there is a bias toward too many distinct offerings.

Sections A and B, the two regions of pure bundling, are not subdivided. That reflects a general result. When pure bundling is the unique sustainable outcome, it is efficient. Like the result about excessive mixed bundling, this result arises because of a bias toward too many distinct offerings. Given that bias, it is not efficient to offer a component if it cannot be offered profitably.

Figure 4 does indicate that pure bundling can be sustainable even when components selling would be efficient. In regions E1 and E2, which correspond, to region E in figure 1, both components selling and pure bundling are sustainable. The efficient outcome turns on condition (8), represented by the line that divides E1 from E2. In region E1, components selling is sustainable even though pure bundling is efficient. The reverse is true in E2. Thus, in this model, inefficient tying can occur.

III. Incorporating Market Power into the Model

While many of the seminal articles on bundling and tying have abstracted away from cost effects to highlight the effect of bundling on demand in the presence of market power, the model presented here abstracts away from demand and market power effects to bring the effect of costs into sharp relief. Ultimately, of course, a general model of bundling and tying would allow for demand and cost effects as well as for market power.

There are two distinct ways in which market power can be incorporated into the model. One would be to combine the cost structure assumed here with the assumptions that one firm has a monopoly over two goods and demand is characterized by a statistical distribution of reservation values. Given demand, one could ascertain the maximum revenue net of marginal cost for each possible set of product offerings. Absent fixed costs, the model would resemble McAfee, McMillan, and Whinston (1989). One would generally expect mixed bundling,[26] which would maximize the scope for price discrimination.[27] However, with fixed costs of product offerings, some limitation on the set of distinct offerings will arise if the additional revenue that can be achieved from mixed bundling over a more limited set of offerings does not justify all the fixed costs.

A limitation of that approach and with much of the literature on bundling and tying is that it makes the extreme assumption of monopoly. Ideally, one would like to capture intermediate market structures. While a variety of approaches are worth exploring, one possibility would be to assume that prices can exceed average cost but only by a certain percentage (that would be a parameter of the model). This approach might be labeled "near contestability." While such a reduced-form approach is currently out of fashion, it might prove to be a tractable way to model markets in which incumbents have some market power short of monopoly. It might be particularly compelling when the principal (but imperfect) constraint on market power is the threat of entry.

Modifying the above model to allow prices to exceed average cost would expand the conditions under which each good could be offered. Mixed bundling would therefore arise under a broader set of circumstances. With perfect contestability, mixed bundling is the unique sustainable outcome whenever it is efficient and is also sustainable under some conditions when it is not. Any additional conditions under which mixed bundling is sustainable would be those under which it is inefficient.

Even in the reduced form approach, allowing prices to exceed average cost could give rise to interesting strategic decisions. Firms would earn economic profits and might therefore find strategic behavior – either limit pricing or perhaps altering its product mix – to deter entry. We believe that there is potentially a great deal of interesting work to be done to extent this model to allow for market power.

IV. The Cold Remedy

In the introduction, we asserted that consumers pay much less for tablets that combine more than one active ingredient than they would if they purchased the ingredients separately. Table III illustrates the point. It lists the prices that we downloaded from www.cvs.com[28] for 24-tablet packages of Extra Strength[29] Tylenol, Maximum Strength[30] Sudafed, and Tylenol and Sudafed brand tablets that combine both. We also downloaded the prices of the CVS versions of the same products. As shown in Table III, the prices of the branded combination products are $5.99, whereas the sum of the prices of the separate branded items is $8.58; for the CVS brand, the price of the combination product is $3.99, whereas the sum of the prices of the separate products is $6.48. These savings are a substantial percentage of the prices of the items.

[INSERT TABLE III.]

In Evans and Salinger (2006), we use a larger sample of drug prices (collected at a drug store) to show that the steep discount for bundled products illustrated by Table III is a quite general phenomenon. Moreover, the same pattern holds true for headache and sinus medicines sold by wholesalers.

To provide a compelling explanation of this case, a model must predict not only that the bundled product sells for some discount relative to the separate products but also that the discount is so large; it must also explain why that pattern originates in what we shall see below is a highly competitive wholesale sector. Our cost-based model provides a remarkably simple explanation for the size of the bundle discount. The active ingredients in these products represent only a small fraction of the total price. For example, the price of bulk acetaminophen is approximately $8/kilogram.[31] A package of 24 pills with 500 milligrams of acetaminophen has 12 grams of acetaminophen, which comes to $0.096 for the package. While this price excludes the cost of purchasing and handling the acetaminophen, the cost of producing, packaging, and selling a package of 24 tablets with pseudoephedrine HCl and acetaminophen is probably only slightly higher than the costs of the comparable package with pseudoephedrine HCl alone. Our cost-based model predicts, therefore, that the price of the sinus headache medicine will be only slightly above the price of the decongestant, which is what we observe. Thus, the model predicts not only a qualitative bundle discount, but it also predicts that we should expect the discount to be quite large.

In the absence of information on patterns of demand, it is always possible to construct a price-discrimination explanation for the observed prices. There is no doubt some pattern of consumer demand that in combination with some degree of market power could give rise to the pricing pattern we observe.

The demand explanation is a stretch though. One has to argue that people who have both headaches and colds have more elastic demand than people who have just one of these ailments. Moreover, the bundled product provides convenience. Not only does it require the user to take fewer pills, but also the labeling of the product as “Sinus headache” medication provides information. Not everyone knows that the active ingredients that relieve the symptoms of a sinus headache are a pain reliever and a decongestant. The packaging saves the effort of determining which component products to buy. A monopoly seller of these products might well charge a premium for the convenience and the information. This conjecture on our part rests on an efficiency from bundling, which the bundling models tend to exclude. But the fact that we do not observe a premium for convenience supports our general approach of modeling prices as being primarily cost-based.

The market facts also make price discrimination an implausible explanation. The market for over-the-counter generic drug manufacturing is highly competitive[32] due to low barriers of entry after the patent expires.[33] The wholesale drug industry is considered highly competitive[34] despite high concentration (with top three drug wholesalers accounting for about 90 percent of the market[35]). It has very thin margins.[36,37] It is therefore interesting to examine whether the pattern of markups originates entirely at the retail level or also at the wholesale level.

Table III presents the average wholesale prices[38] for a package of 24 tablets of Pseudoephedine HCL 30mg, a package of 24 tablets of Acetaminophen 500mg, and a package of 24 tablets of the combination drug Pseudoephedrine HCL 30 mg/Acetaminophen 500mg.[39] We observe the same pattern of cost-savings from buying the combined medication than buying the two active ingredients separately. While one could always construct some possible configuration of demand to explain this pattern, it would seem quite implausible for what is in effect a commodity business that faces large sophisticated buyers.

The contestability model is just meant as an approximation. The prices of the cold relief medicines probably do not literally equal average cost, and the prices of the branded products include a brand premium. To the extent that prices are not entirely cost-based, perhaps some price discrimination is present. It is also possible that cold and headache medicines are provided separately because customers cannot freely dispose of a component they do not want and because that component may in fact have a negative value to them. Nevertheless, the model provides the most plausible explanation for the deep discount that is available for the bundle of cold and headache medicines. And for this, the most important effect at play is the cost savings,[40] and the price discrimination is at most secondary.[41]

V. Conclusions

Cost effects by themselves can explain a richer set of bundling and tying behavior than had previously been recognized in the formal economics literature. The model presented here suggests that tying can occur for two distinct types of reasons. One is that most people want all the components of a bundle and demand for the individual components is insufficient in light of the fixed costs of a product offering to offer them.

The other is that when fixed costs are high, a single product might meet the needs of consumers with diverse tastes. Once put that way, both the theoretical explanation and practical examples might seem obvious. Virtually no one reads an entire newspaper or watches all the channels in basic cable television service. Previously, such cases have been attributed to demand effects; and, given that the products are sold bundled, demand effects may be present as well. But likely costs play a more important and subtle role in those cases and others than had previously been realized.

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APPENDIX

Contestable Prices and Sustainability Conditions with Price-Sensitive Demand

The exposition in the text is based on the simplifying assumption that demand by each group is perfectly inelastic with respect to price within the range of prices that would be observed under competition. This assumption simplifies the exposition, but the results do not depend critically on it. With price-sensitive demand, we cannot solve for the contestable prices (conditional on the set of product offerings) in closed form. We can, however, characterize them and then state the stand-alone conditions and pure bundle sufficiency condition in terms of them.

To handle price sensitive demand, we first need to establish an expanded notation. Let $P_{i,s}$, $i \in \{1,2\}$, $S \in \{M,B,C,T1,T2\}$, be the price of component i for the set of product offerings S, where M indicates mixed bundling, B indicates pure bundling, C indicates components selling, T1 indicates that the bundle and good 1 are offered, and T2 indicates that the bundle and good 2 are offered. Similarly, let $P_{b,S}$ be the price of the bundle for a possible set of offerings. (When a good is not offered, its price is infinite. For example, $P_{1,B} = \infty$.)

Demand by each group will depend on the total cost of purchasing the component(s) they want. This cost includes disposal costs for groups 1 and 2 if they buy the bundle. We also include an "inconvenience" cost, v, to group B if it buys the components separately. Let $E_{i,S}$, $i \in \{1,2,b\}$ and $S \in \{M,B,C,T1,T2\}$, be the total cost to each member of group i when the set of product offerings is S. For example, under mixed bundling, group b purchases the bundle, so $E_{b,M} = P_{b,M}$. Under components selling, group b purchases both components, so $E_{b,C} = P_{1,C} + P_{2,C} + v$. Table A1 gives the complete set of $E_{i,S}$ as functions of prices, disposal cost, and the bundle convenience value.

[INSERT TABLE A1.]

Given these total costs, we can now define the demand relationships as follows. Let $X_i(E_{i,S})$, $i \in \{1,2\}$, $S \in \{M,C,B,T1,T2\}$ be the quantity of good i purchased (either separately or as part of the bundle) by group i when the set of products offered is S. Similarly, let $X_{b,S}(E_{b,S})$ be the quantity of both good 1 and 2 purchased (either separately or in bundled form) purchased by group b.[42]

The equations that characterize prices impose the condition that price equal average cost. For mixed bundling, the equations are:

(A1) $$P_{1,M} = c_1 + \frac{F}{X_1(P_{1,M})}$$

(A2) $$P_{2,M} = c_2 + \frac{F}{X_2(P_{2,M})}$$

(A3) $$P_{b,M} = c_b + \frac{F}{X_b(P_{b,M})}$$

For pure components selling, the prices are determined by the following pair of simultaneous equations:

(A4) $$P_{1,C} = c_1 + \frac{F}{X_1(P_{1,C}) + X_b(P_{1,C} + P_{2,C} + v)}$$

(A5) $$P_{2,C} = c_2 + \frac{F}{X_2(P_{2,C}) + X_b(P_{1,C} + P_{2,C} + v)}$$

Under pure bundling, the price of the bundle is determined by:

(A6) $$P_{b,B} = c_b + \frac{F}{X_1(P_{b,B} + d) + X_2(P_{b,B} + d) + X_b(P_{b,B})}$$

When the bundle and good i are offered, the price of the separately-available component is the same as under mixed bundling: $P_{i,Ti} = P_{i,M}$. The price of the bundle is given by:

(A7) $$P_{b,Ti} = c_b + \frac{F}{X_j(P_{b,Ti}) + X_b(P_{b,Ti})} \qquad i, j \in \{1, 2\}, j \neq i$$

We can now state the stand-alone conditions and the pure-bundle sufficiency condition with reference to these more general pricing conditions. For example, the more general version of the strong good i stand-alone condition, Condition (1), is $P_{i,M} < P_{b,B.}$+ d. Table A2 gives the generalized version of each of the conditions underlying Theorem 1.

[INSERT TABLE A2.]

The same arguments about sustainable product offerings and prices now apply to these generalizations of the conditions. If both pure bundle self-sufficiency conditions hold, then pure bundling is the only sustainable outcome. If it does not hold for both goods, then we need to consider which stand-alone conditions hold, as summarized in Table 2.

Table I. Offerings and Prices

Available Goods	*Outcome*	*Price* 1	2	B
All	Mixed Bundling	$c_1+\frac{F}{X_1}$	$c_2+\frac{F}{X_2}$	$c_B+\frac{F}{X_B}$
1 and 2	Components	$c_1+\frac{F}{X_1+X_B}$	$c_2+\frac{F}{X_2+X_B}$	
Bundle only	Pure Bundling			$c_B+\frac{F}{X_1+X_2+X_B}$
Bundle and Good 1	Good 1 tied to Good 2	$c_1+\frac{F}{X_1}$		$c_B+\frac{F}{X_2+X_B}$
Bundle and Good 2	Good 2 tied to Good 1		$c_2+\frac{F}{X_2}$	$c_B+\frac{F}{X_1+X_B}$

Table II. Sustainable Scenarios

(A) Bundle Stand-Alone Condition Holds

		Good 1 Stand-Alone Conditions		
		Neither	Weak	Strong
Good 2	Neither	B	B	T1
Stand-Alone	Weak	B	B	M
Conditions	Strong	T2	M	M

(B) Bundle Stand-Alone Condition Does Not Hold

		Good 1 Stand-Alone Conditions		
		Neither	Weak	Strong
Good 2	Neither	B or C	B or C	C or T1
Stand-Alone	Weak	B or C	B or C	C
Conditions	Strong	C or T2	C	C

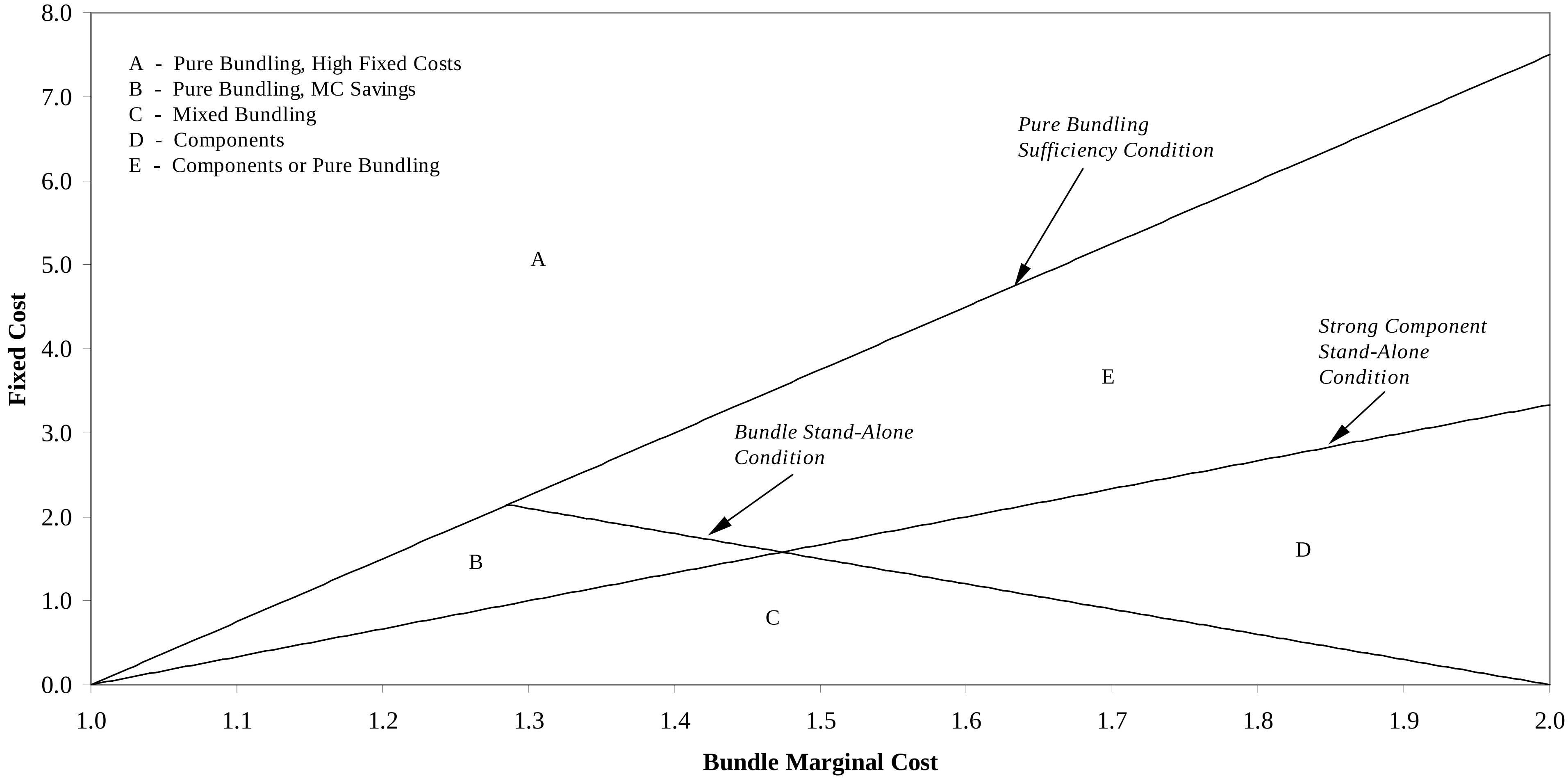
Legend:
B: Pure bundling
C: Components selling
M: Mixed bundling
T1: Tying – bundle and good 1 available
T2: Tying – bundle and good 2 available
Panels (A) and (B) assume that the pure bundling sufficiency condition (Condition (4) in the text) does not hold. The strong and weak stand-alone conditions for the individual goods are conditions (1) and (2), respectively. The stand-alone condition for the bundle is condition (3).

Table III. Prices for 24 Tablet/Caplet Packages

Brand	Combination	Pseudoephedrine HCl alone	Acetaminophen alone
Tylenol	$5.99	NA	$3.99
Sudafed	$5.99	$4.59	NA
CVS	$3.99	$3.49	$2.99
AWP	$3.50	$3.14	$2.59

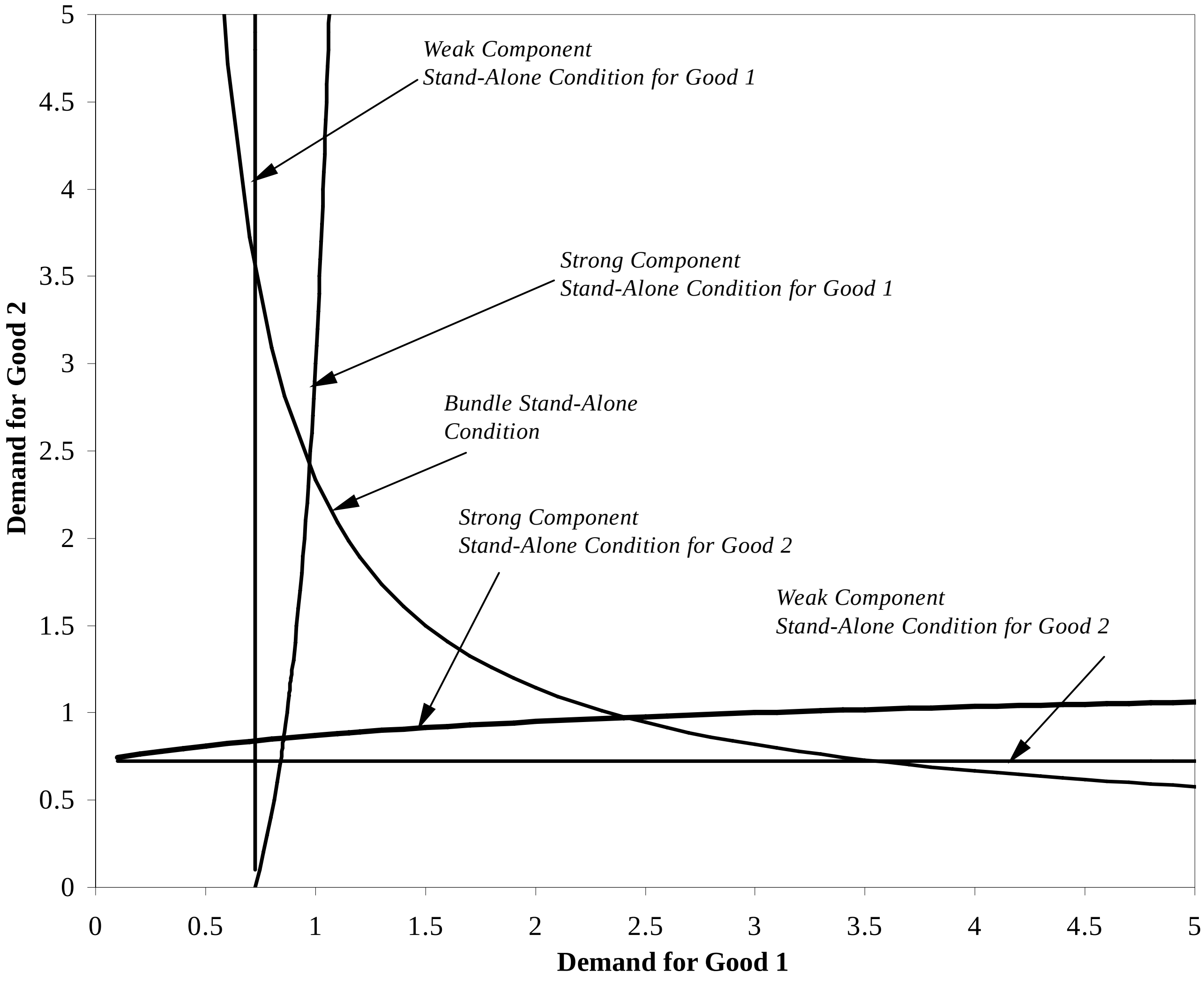
Notes: Tylenol: “Tylenol Sinus Caplet” (the combination product) and “Tylenol Extra Strength Caplets.”
Sudafed: “Sudafed Sinus and Headache Caplet” (the combination product) and “Sudafed Sinus & Cold.”
CVS: “Non-Aspirin Sinus Caplets Maximum Strength” (the combination product), “Nasal Decongestant Tablets Maximum Strength,” and “Non-Aspirin Caplets Extra Strength.” NA denotes a combination that was not offered.
Doses are 30mg of Pseudoephedrine HCl and 500mg of acetaminophen.
Source: Downloaded from CVS Web site, http://www.cvs.com, Feb. 11, 2004.
AWP: AWP refers to the Average Wholesale Prices of packages of 24 tablets of Pseudoehedrine HCL 30mg, Acetaminophen 500mg, and the combination drug Pseudoephedrine HCL 30 mg/Acetaminophen 500mg. Source: Red Book©, Thomson Healthcare, 2005 edition.

Figure 1. Cost Structure and Sustainable Outcomes.



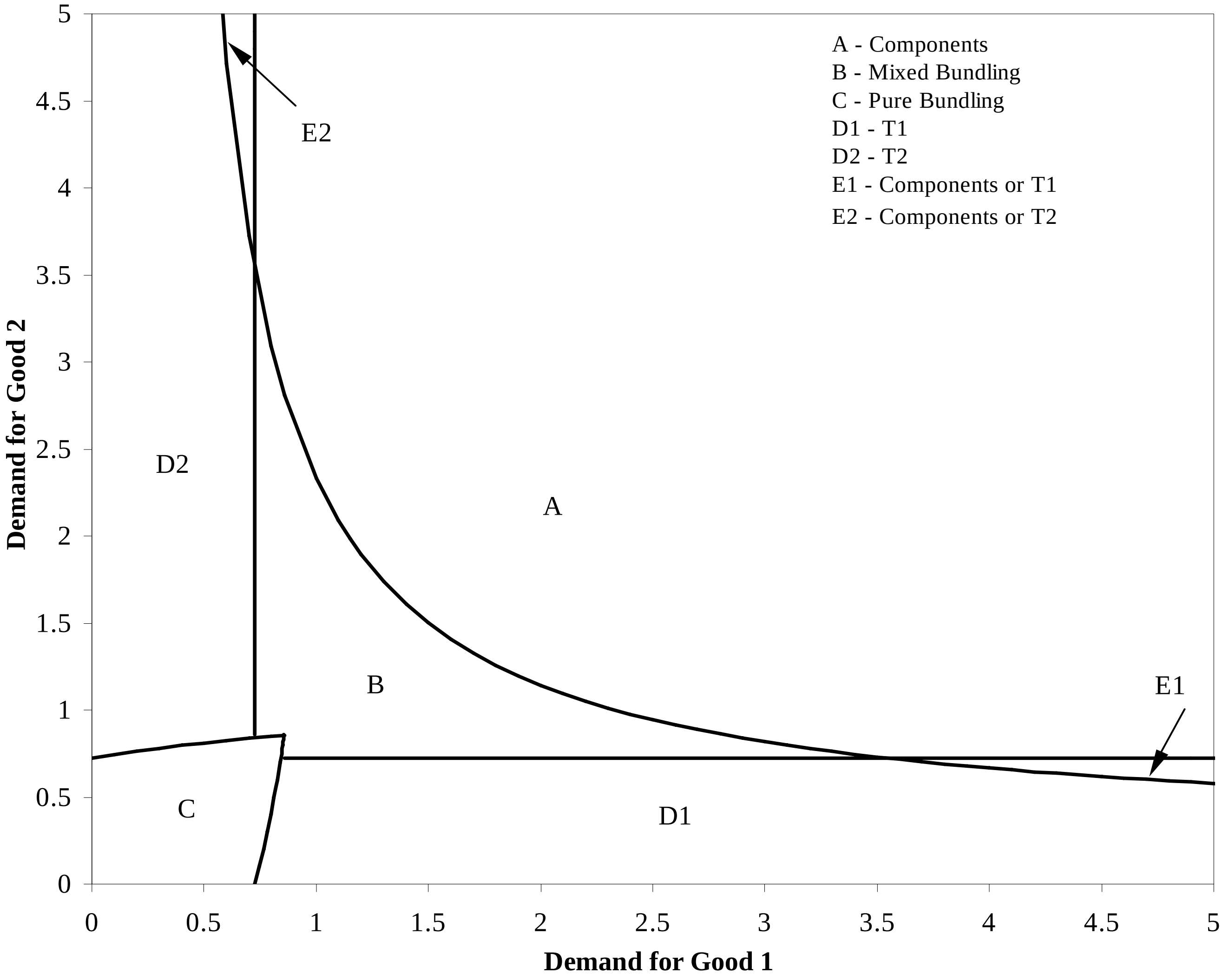
Note: X_1=X_2=2, X_B=1, and c_1=c_2=1.

Figure 2a. Stand-Alone Conditions: Moderate Fixed Costs.



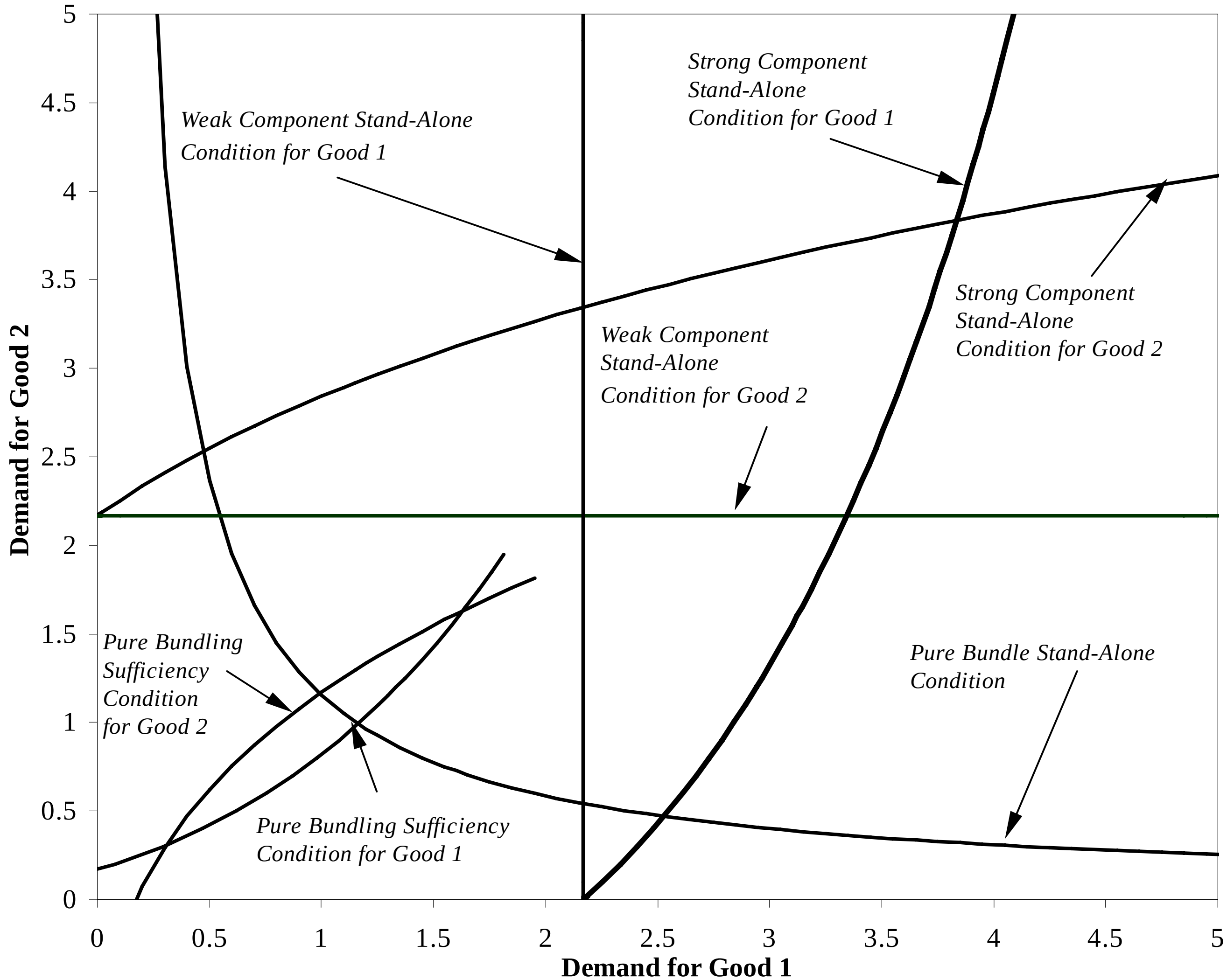
Note: c_1=c_2=1, c_B=1.8, and F=1.

Figure 2b. Sustainable Outcomes: Moderate Fixed Costs.



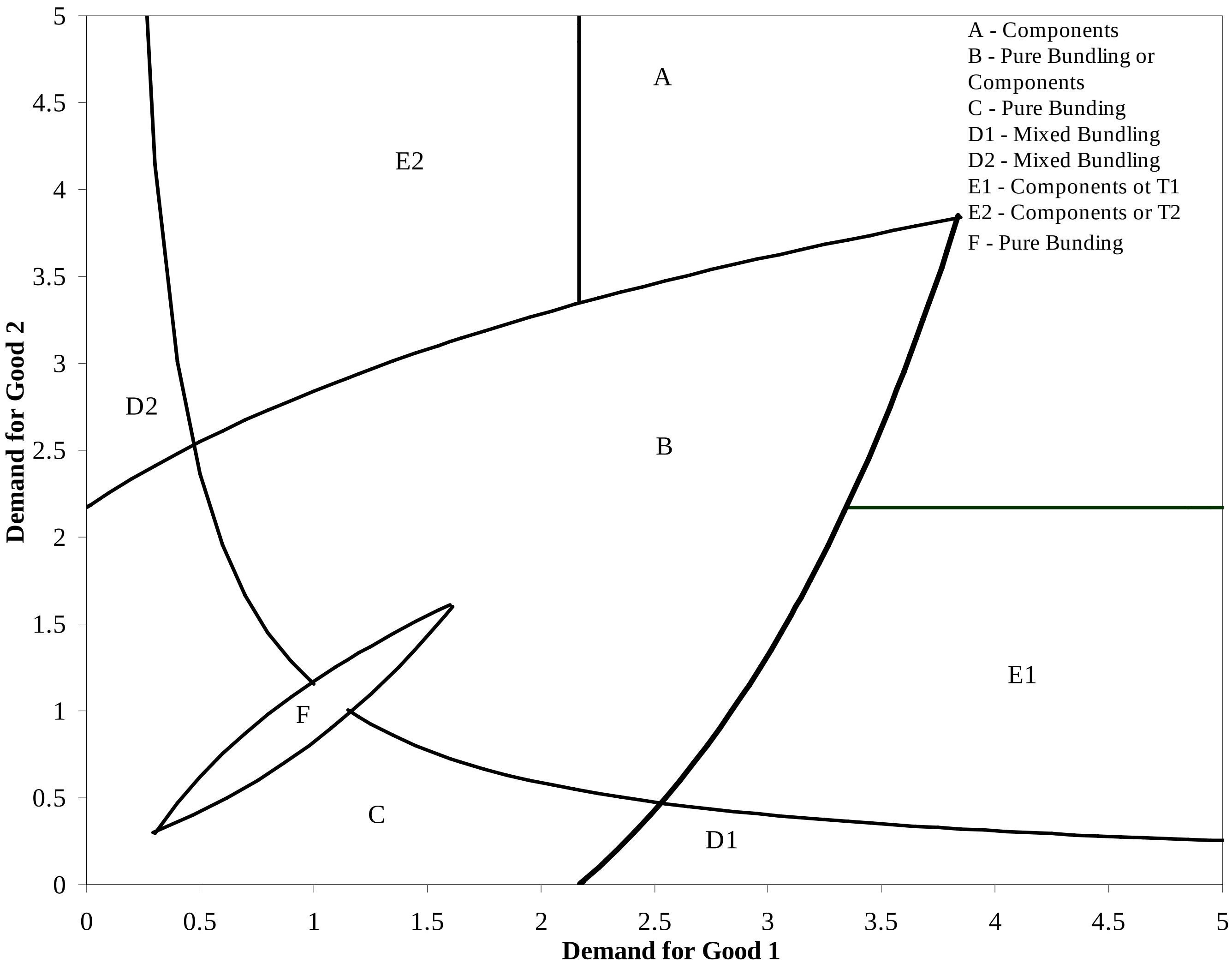
Note: c_1=c_2=1, c_B=1.8, and F=1.

Figure 3a. Stand-Alone Conditions: High Fixed Costs.



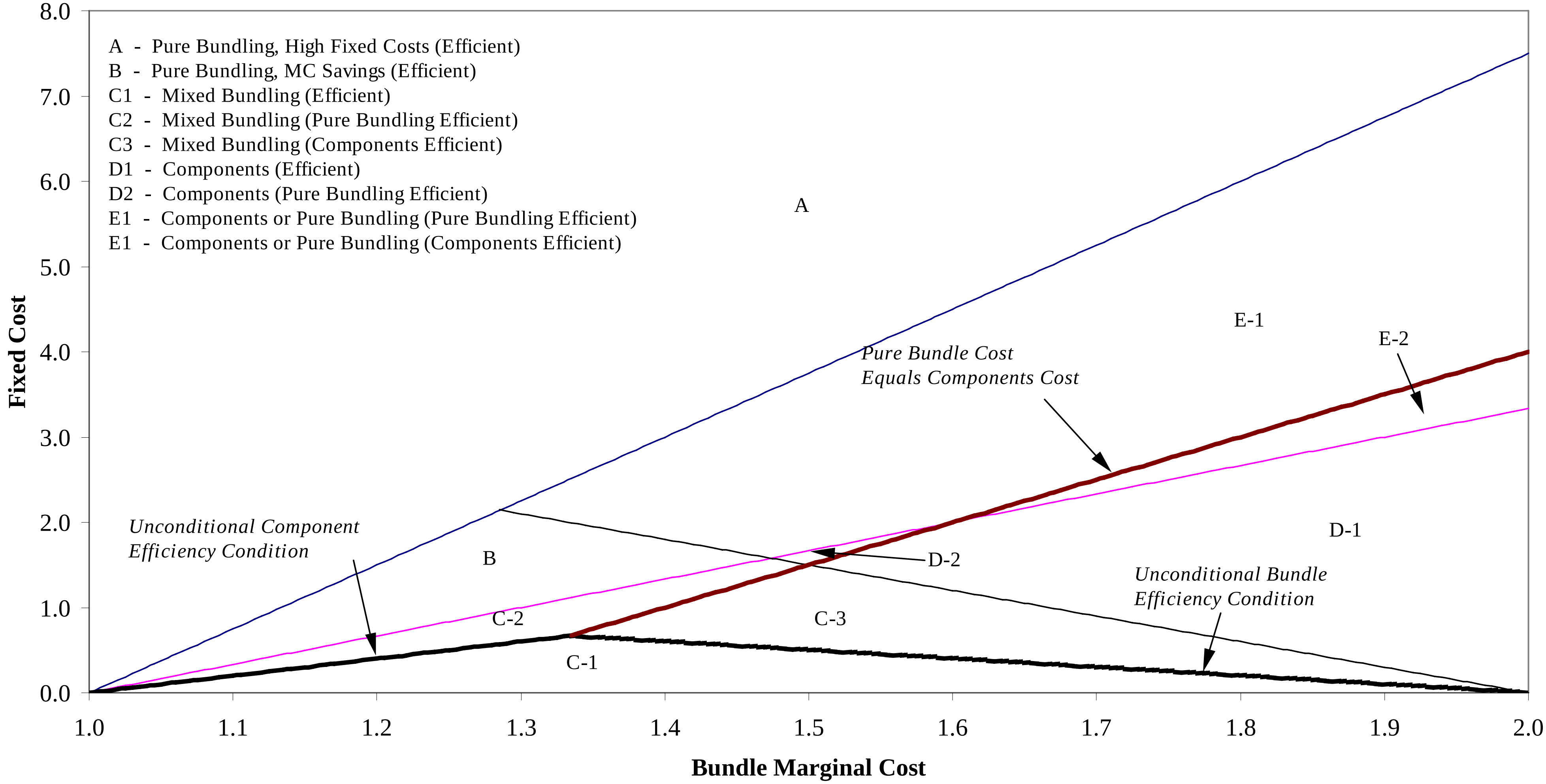
Note: c_1=c_2=1, c_B=1.8, and F=5.5.

Figure 3b. Sustainable Outcomes: High Fixed Costs.



Note: c_1=c_2=1, c_B=1.8, and F=5.5.

Figure 4. Comparing Sustainable and Efficient Outcomes.



Note: $X_1=X_2=2$, $X_B=1$, and $c_1=c_2=1$.

Table A1.

s	$E_{1,s}$	$E_{2,s}$	$E_{b,s}$
M	$P_{1,M}$	$P_{2,M}$	$P_{b,M}$
C	$P_{1,C}$	$P_{2,C}$	$P_{1,C} + P_{2,C} + v$
B	$P_{b,M} + d$	$P_{b,M} + d$	$P_{b,M}$
T1	$P_{1,T1}$	$P_{b,T1} + d$	$P_{b,T1}$
T2	$P_{b,T2} + d$	$P_{2,T2}$	$P_{b,T2}$

Table A2. Generalization of Sustainability Conditions.

Condition	*Condition in Text*	*Generalized Version*
Strong Good i Stand-Alone	(1)	$P_{i,M} < P_{b,B} + d \;\; i \in \{1,2\}$
Weak Good i Stand-Alone	(2)	$P_{i,M} < P_{b,Tj} + d \;\; i,j \in [1,2\} \; j \neq I$
Bundle Stand-Alone	(3)	$P_{b,M} < P_{1,C} + P_{2,C} + v$
Pure Bundle Sufficiency	(4)	$P_{b,B} + d < P_{i,C} \quad i = 1$ and 2

[1] See Evans and Salinger (2004).
[2] The seminal paper is Whinston (1990). See Choi and Stefanidis (2001) and Carlton and Waldman (2003) for extensions. Also, the literature on the compatability of system components can be understood as models of tying, as the choice not to make components compatible can be interpreted as tying. See Matutes and Regibeau (1992).
[3] An exception is Salinger (1994).
[4] There is some variation in how the terms bundling and tying are used. As we use the terms, bundling refers to the joint sale of two goods that could be sold separately. Tying means that a good that could be sold separately is not. Two distinct types of tying exist. One is when two (or more) goods are sold as bundle and one of the individual components is not sold separately. The other can arise in cases such as cameras and film, copiers and toner, and so on. In these cases, one of the goods is durable and the other is consumable. The demand for the latter varies with the use of the durable. In such cases, tying can be an indirect means of implementing usage-based pricing for the durable. Our model relates to the first type of tying, not the second.
[5] In the economics literature, mixed bundling means that the bundle and all individual components are available with the price of the bundle typically being less than the sum of the components pricing. Mixed bundling is not tying (although a sufficiently large discount might create a "virtual tie.") Pure bundling means that the bundle is available but none of the components are. It is a form of tying, as are cases when the bundle and only some of the individual components are available.
[6] These costs are an essential feature of the strategic tying models such as Whinston (1990).
[7] Product variety is also affected by market structure. The variety of products offered by a profit-seeking monopolist may be different and less socially efficient than under perfect competitions (White (1977), Mussa and Rosen (1978)).
[8] Pure bundling even when no one wants all the components can also arise in the model by Bakos and Brynjolfsson (1999),which is an extention of the demand-based models of bundling. In that model, however, firms either choose pure bundling or pure components selling. Mixed bundling is not an option. Absent some constraint on the distinct set of product offerings, it is not clear why a firm would impose on any consumer a component he values at less than marginal cost.
[9] There is a third type of tying that can occur, which we label "extreme marginal cost savings from bundling." This arises when the marginal cost of the bundle is less than the marginal cost of a component. It would seem to be rare for such economies to arise from production costs. However, system sales can reduce (expected) marginal costs if they eliminate the cost of business and legal proceedings to determine blame for failure of a system that consists of components produced by different companies.
[10] Members of group B either buy the bundle or both components. Members of group 1 (2) buy either good 1 (2) or the bundle.
[11] Both d and v could be negative. A negative d would mean that members of group 1 and 2 do actually get some value from the "unwanted" component, while a negative v means that members of group B prefer to buy the components separately.
[12] As a result, this paper should be viewed as part of the literature on product variety. The central issue addressed by that literature is whether, given heterogeneous customer preferences and product-specific scale economies, the set of product offerings is optimal. The models in that literature generally assume some form of monopolistic competition. (See Eaton and Lipsey (1989) for a review.) We have chosen the contestability framework rather than monopolistic competition because the latter models have two features that make them difficult to apply to the bundling and tying issues we address here. First, those models rest on demand structures that are difficult to adapt to a case in which there are two goods that can be sold either separately or in combination. (One alternative is a location model like the one introduced by Hotelling (1929) and subsequently used by, for example, Schmalensee (1978) and Salop (1979)). A second alternative is a model that captures a taste for variety such as in Dixit and Stiglitz (1977). A third is the model of vertical product differentiation due to Shaked and Sutton (1983). None of these fit the problem we are addressing.) Second, those models assume that there are an infinite number of possible products; and it is the entry and exit of firms producing those products that act as the constraint on profits. In the problem

we are analyzing, there are only three possible products: the two separate goods and the bundle. Limiting attention to those three goods brings the bundling and tying issues into sharp relief.

[13] Recall that we have assumed that each customer group values the good(s) they want enough so that they will obtain them in some form. Without that assumption it would be possible for just one or none of the components to be offered.

[14] This description of sustainability is an adaptation of the formal definition given by Baumol, Panzar, and Willig (1982), pp. 192-3.

[15] For example, under mixed bundling, we analyze whether it would be possible to lower the price of the bundle to attract groups 1 and 2. Also, we analyze whether it would be possible to offer the components at low enough prices to attract group B.

[16] That is, it is the sum of the marginal cost of the bundle, 3, and the average fixed cost, which is the fixed cost of 1 divided by the number of customers who buy the bundle, which is 3.

[17] A nuance in this result is that if the bundle stand-alone condition and the strong stand-alone condition for one of the separate goods holds, then only the weak stand-alone condition for the other good is needed for mixed bundling to be the only sustainable configuration.

[18] The bundle stand-alone condition ensures that the bundle is part of a sustainable configuration. Given that the bundle is offered, the failure of the strong stand-alone conditions for the components implies that they are not offered.

[19] The possibility of multiple sustainable outcomes is not an unusual feature of sustainability models. See Baumol, Panzar, and Willig (1982), pg. 195 for a graph with many sustainable price vectors.

[20] In this case, there is no marginal cost associated with providing consumers with an unwanted component (provided disposal is free).

[21] Note that when $c_B = 1$, any positive fixed cost results in pure bundling because there is no marginal cost to providing a customer with an unwanted component.

[22] When $X_B = X_1 = X_2$, components selling is not sustainable because the bundle stand-alone condition holds. Given these parameter values, consumers who want both goods end up paying half the fixed cost of both components, which equals paying the entire fixed cost for just the bundle. As a result, any marginal cost savings from the bundle ensures that the bundle can be offered.

[23] With these assumptions, marginal cost savings and the level of fixed costs relative to the number of people who want both components are constant. Fixed costs relative to total demand are not constant, however, as the total population is larger for points farther from the origin.

[24] Note that the weak good 1 stand-alone condition lies to the left of the strong one, so that there are some values for which the former holds and the latter does not.

[25] Two additional features of region F worth noting are that it does not touch the origin and that it is centered around the 45^0 line. To be in region F, both groups 1 and 2 must prefer to buy the bundle under pure bundling than just the one component they want under components selling. The explanation for both features is that for groups 1 and 2, the preference between pure bundling over components selling arises because the savings from spreading the fixed cost over a larger customer base outweighs the additional marginal cost from buying the bundle rather than just one component. This happens for group 1 only when there are some people in group 2 and vice versa and therefore does not happen at the margin. Indeed, with sufficient imbalance between groups 1 and 2, the larger group prefers component selling because adding the smaller group does not lower the average fixed cost enough to compensate for the additional marginal cost.

[26] The literature linking bundling to price discrimination started with Stigler's (1968) classic article on block booking. That article provided an explanation for pure bundling, but only because it excluded mixed bundling by assumption. The extension by Adams and Yellen (1976) used simple examples to demonstrate the advantage of mixed bundling, foreshadowing the more general finding of McAfee, McMillan, and Whinston (1989).

[27] The optimal pricing under mixed bundling can, however, entail charging a premium for the bundle, which might not be practical.

[28] CVS is a large drug store chain. The web site www.cvs.com is its "on-line pharmacy."

[29] Extra Strength Tylenol tablets contain 500 mg of acetaminophen. In contrast, "Regular Strength" acetaminophen tablets contain 325 mg while "Arthritis Strength" tablets contain 650 mg.

[30] Maximimum Strength Pseudoephedrine HCl tablets contain 30 mg of active ingredient.

[31] See “Chemical Profiles – Acetaminophen” at http://www.the-innovation-group.com/welcome.htm (last accessed December 16, 2004).
[32] By “highly competitive,” we do not necessarily mean a complete absence of market power. Whatever market power might be present is sufficiently limited that a monopoly model is unlikely to yield a useful approximation.
[33] Frank and Salkever (1997) consider a sample of 45 drugs that lost patent protection during 1983-1987 and find that five generic producers on average entered the market of a brand name medicine in the first post-patent year. Grabowski and Vernon (1992) show that generic prices tend to decrease toward their marginal cost as generic entry continues.
[34] In 2001 the FTC approved a merger of AmeriSource Health Corporation and Bergen Brunswig Corporation, which at that time were the third and the fourth-ranked firms. The FTC concluded that the proposed merger did not “appear likely substantially to lessen competition or tend to create a monopoly in the relevant market”, Statement of the Federal Trade Commission, AmeriSource Health Corporation/Bergen Brunswig Corporation, File No. 011-0122.
[35] McKesson has market share of 34.1 % of U.S. annual sales, Cardinal Health – 29.9%, and AmeriSource Bergen – 24.8%. (Source: GICS Sub-Industry Revenue Share (09/04/2004), Standard & Poor’s)
[36] In 1997, for every dollar of prescription drugs sold, 76 cents went to the manufacturer, 20 cents to the dispenser, and only 4 cents to the wholesale distributor (U.S. District Court for the District of Columbia, 1998, FTC vs Cardinal Health, Inc and Bergen Brusnwig Corp., Civil Action No. 98-595)
[37] The average net profit margin for the wholesale industry is 1.3%, data downloaded from Yahoo! Finance http://biz.yahoo.com/ic/756.html on 11/29/05
[38] We do not observe the wholesale prices at which CVS purchases the medicines. We observe, however, the prices of wholesalers which provide private labeling services (customized packaging) of generic drugs to retailers as reported in the Red Book© of pharmacology. These prices are a good proxy for the wholesale prices of the generic drugs we consider.
[39] Source: Red Book©, Thomson Healthcare, 2005 edition.
[40] Without further analysis, of course, all we can say is that they reflect private costs savings. If fixed costs of product offerings are present, as they likely are to some extent, a cost-based bundle discount does not necessarily reflect social savings. See Evans and Salinger (2006) for a further discussion.
[41] Moreover, the fact that some price discrimination is present does not necessarily mean that the existing models of bundling as price discrimination would help us explain the variations in margins. Those models are complicated and it is not obvious that they provide a useful framework for analyzing data.
[42] In assuming that group B views the products as perfect complements, we are deviating from the demand assumptions of the price discrimination strand of the bundling literature. In that literature, the demands for the two components are viewed as being economically independent. (That is, the cross-price elasticities are assumed to be 0.) In this regard, the model more nearly resembles the system compatibility literature. See, for example, Matutes and Regibeau (1992).