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**An Empirical Analysis of Bundling and
Tying: Over-The-Counter Pain Relief and
Cold Medicines**

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AN EMPIRICAL ANALYSIS OF BUNDLING AND TYING:
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ABSTRACT

We apply and extend the cost-based approach to bundling and tying under competition developed in Evans and Salinger (2004a) to over-the-counter pain relievers and cold medicines. We document that consumers pay much less for tablets with multiple ingredients than they would to buy tablets with each ingredient separately. We then decompose the sources of these savings into marginal cost savings and a component that reflects fixed costs of product offerings. The analysis both documents substantial economies of bundling and illustrates the sort of cost analysis that is necessary for understanding tying.

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An Empirical Analysis of Bundling and Tying: Over-the-Counter Pain Relief and Cold Medicines

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I. Introduction

At virtually any pharmacy, grocery store, or convenience store, one can purchase “cold tablets” that contain more than one active ingredient. The main components of these medicines are pain relievers, decongestants, antihistamines, and cough suppressants. Tablets (or other dosage forms) containing just one of the ingredients are also available. The tablets that contain more than one active ingredient are therefore examples of bundled products.¹ In this paper, we establish that the bundle discount is substantial and use a cost-based framework to estimate the cost savings from bundled products.

Our theoretical framework is based on the cost-based, unified theory of bundling and tying developed in Evans and Salinger (2004a). Under that theory, a bundle discount can be the result of two distinct cost effects. One is marginal cost savings (that could arise from, for example, conserving on the number of packages and tablets produced). The other is a reduction in the contribution to fixed costs of each product offering (such as the cost of a shelf slot or the system cost of an additional stock keeping unit (sku)). As we will explain,² whether the private savings consumers get from the bundle reflect social savings as well depends on the relative contribution of each. Thus, to estimate cost savings from bundling, we must empirically identify these two effects.

¹ A bundled product is one that combines more than one product that could be sold separately.

To do so, we exploit regularities in the pricing of different package sizes. The price per tablet for any given medication tends to be a decreasing function of package size.³ Suppose, for example, that a particular medicine—acetaminophen, is available in packages of 50, 100, and 200 tablets, with the price per tablet a decreasing function of tablet size. There seems no reason to rule out the possibility that some customers would ideally like to purchase 150 tablets. Such a customer could either buy one package of 100 tablets and one of 50 tablets, thus sacrificing potential economies of package size, or one package of 200 tablets that contains 50 more tablets than he wants. We estimate how high fixed costs would have to be to make it unprofitable to offer package sizes that we do not observe. As a basis for these estimates, we extend the model in Evans and Salinger (2004a) to package size effects.

We estimate that, in this case, the marginal cost savings from bundled products exceed the fixed costs of the product offerings, so bundling lowers costs. For example, we estimate that the price of a package of 48 tablets that combines two active ingredients is \$3.60 less⁴ than the sum of the prices of the same ingredients sold in separate packages of 48 tablets each. We decompose this \$3.60 into a marginal cost savings of \$2.40 and an average fixed cost of \$1.20. The net cost effect is the difference between the two, or \$1.20. The gain would be substantially larger for tablets that contain three active ingredients. Moreover, these cost effects do not capture the value of the convenience consumers get from bundled products.

² See Section III.

³ While this assertion should come as no surprise, we document the regularity in Section II.

⁴ The percentage difference would vary with the active ingredients but would generally be between 30 percent and 50 percent.

We can also use our framework to estimate the cost savings from having the separate products available rather than having consumers who want just one component buy the bundled product. This type of calculation is important for addressing the policy issues associated with the antitrust laws concerning tying. Tying occurs when a bundled product is offered and at least one of the separate products is not. Since tying can be an antitrust violation, the law encourages companies, at least those with market power, to offer the products that it bundles separately as well. For a consumer who wants just one component of a bundle, buying the separate component rather than the bundle saves the marginal cost of the components he does not want. However, the separate component is itself a distinct product that generates a fixed cost of offering it. Selling the separate component only saves costs if the fixed cost is less than marginal costs avoided by not providing a customer with the part of a bundle he does not want. While in most of the cases we consider, our estimates are that the separate products save costs, there is one case in which we estimate that it does not. Of course, this result does not imply that the separate product should not be offered in this case. In the example we consider, consumers who want, for example, just pain relief, would strictly prefer not to have to take a decongestant at the same time. Just as a complete welfare analysis of bundling and tying would have to account for the convenience value of the bundle for consumers who want all the components, so would it also have to account for the possibility that some consumers would pay not to have a component of a bundle.

The remainder of the paper is organized as follows. Section II describes the data and establishes some broad empirical regularities in it. In Section III, we first present our arguments for why the bundle discount should not be interpreted as pure price

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discrimination. We then lay out our cost-based approach to understanding the bundle discount and derive the formulas to calculate the (possibly negative) cost savings from the bundle and from the separate products. In Section IV, we extend the cost-based theory to package-size effects and derive the formula to calculate the average fixed cost of a good. We then estimate the average fixed costs and use them to in turn estimate the effect of bundling and components sales on costs. Our concluding section, Section V, discusses implications for the economics literature and for policy.

II. The Pricing of Pain Relief, Cold, Sinus, and Allergy Medicines

The primary data collected for this paper were the prices of all cold⁵ and pain relief medications sold at the Walgreens⁶ at 757 N. Michigan Ave in Chicago on April 3, 2003. For each package, we observe the brand, the price, the dosage form,⁷ the quantity of each active ingredient per unit, and the number of units. We have supplemented the data with some prices offered at www.cvs.com⁸ and have generally checked prices on the web and at other outlets to confirm that the regularities we document are not specific to this particular location and time.

A. Empirical Regularities

We will ultimately use a price regression to describe the bundle discount. To guide the specification of that regression, it will be useful to explore less formally some strong regularities that are present in the data. We will also use these stylized facts to argue for a cost-based explanation for the bundle discount.

⁵ We use the term “cold” to include medications labeled as sinus, allergy, and cough as well.

⁶ Walgreens is a large pharmacy chain in the United States.

⁷ Dosage forms include tablets, caplets, liquid, “gel tabs,” etc.

⁸ The web site www.cvs.com is a vehicle for ordering pharmaceuticals (and other products) to be delivered by mail. The web site is operated by CVS, which also operates a large chain of retail pharmacies.

1. Bundle Discounts and Brand Name Premia

Johnson & Johnson's Tylenol is the dominant brand of the pain reliever acetaminophen and Pfizer's Sudafed is the dominant brand of the decongestant pseudoephedrine hydrochloride. Each Extra Strength Tylenol contains 500 mg of acetaminophen and each Maximum Strength Sudafed contains 30 mg of pseudoephedrine hydrochloride. Johnson & Johnson does not offer a Tylenol-brand pseudoephedrine hydrochloride nor does Pfizer offer a Sudafed-brand acetaminophen. However, both a Tylenol Sinus Caplet and a Sudafed Sinus and Headache Caplet contain 30 mg of pseudoephedrine hydrochloride and 500 mg of acetaminophen.⁹ Table 1 lists the prices we observed for 24-tablet packages of these products and for their store-brand equivalents.¹⁰ Table 1 illustrates two general phenomena in the pricing of this class of product. First, branded products command a substantial premium—from just over 30 percent to 50 percent—over the price of the CVS product. Second, within both the branded and non-branded segments, the price of the combination product is much lower than the sum of the prices of the stand-alone products. The incremental cost to a consumer of the pseudoephedrine hydrochloride in the Tylenol Sinus Caplet over purchasing just Extra Strength Tylenol is \$2.00, which is only 44 percent of the price of buying a package of 24 Sudafed tablets. The incremental price of the acetaminophen in the Sudafed Sinus and Headache Caplets is \$1.40, which is 35 percent of the price of buying a package of 24 Extra Strength Tylenol tablets. The comparisons are even more

⁹ Novartis also offers a product that contains 500 mg of acetaminophen and 30 mg of pseudoephedrine hydrochloride, Tavist Allergy/Sinus/Headache.

¹⁰ These data are taken from www.cvs.com rather than our Walgreen's data set. To isolate the bundle discount, we need to hold package size constant. To do so, we need all six of the products in Table 1 (just acetaminophen, just pseudoephedrine, and the combination tablet in branded and generic form) available in

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striking with the CVS products. The incremental price of the acetaminophen in the combination product over pseudoephedrine hydrochloride tablets is only \$0.50 or 17 percent of the price of buying acetaminophen tablets separately.¹¹

There are also products that combine pseudoephedrine hydrochloride and ibuprofen. Here, the comparisons are not quite as clean because we observed package sizes of 20 rather than 24 for the combination product. Still, as we will document in section II.A.3 below (and as is well known), the price per pill is generally a decreasing function of package size. Thus, comparing the price per pill of the bundled product with the sum of the prices per pill of the component products sold in somewhat larger packages understates the gains from bundling. We observed a price of \$6.29 for a package of 20 Advil “Cold & Sinus” tablets, which is less than \$0.32/tablet. To buy Advil and Maximum Strength Sudafed separately in 24-tablet packages, the sum of the prices per pill would be more than \$0.49/tablet.¹² On a per-pill basis, the price of the bundled product was 64 percent of the price of the components. For the store-brand versions, the per pill price of the bundled product was less than \$0.21, which was 21 percent less than \$0.27, the sum of the per-pill prices of the two separate products.¹³

The strong stylized fact that emerges from this set of comparisons is that the prices consumers pay for combinations of medicines—both branded and store-brand—are

a common package size. Our Walgreen’s data set did not generate such a comparison, but the data we obtained from the CVS’s web site did.

¹¹ In our Walgreen’s data set, the comparable prices were \$6.99 for 24 Tylenol Sinus tablets, \$4.99 for 24 Extra Tylenol tablets, and \$6.79 for 24 Sudafed. Thus, the price of the branded combination product was only \$0.20 higher than the stand alone Sudafed product. For the Walgreen’s brands, the prices were \$2.99 for 24 tablets of extra strength acetaminophen and \$3.49 for 24 maximum strength pseudoephedrine hydrochloride tablets. While we did not observe a Walgreen’s version that combined just these two active ingredients, we did observe a package of 24 tablets with these two ingredients and 25 milligrams of the antihistamine, Diphenhydramine HCl. The price was \$3.99.

¹² The price we observed for 24 Advil was \$4.99. As reported in note 11, we observed a price of \$6.79 at Walgreen’s for a package of 24 Sudafed.

¹³ The Walgreens products are WalProfem tablets (ibuprofen), WalPhed (pseudoephedrine hydrochloride) and WalProfem Cold & Sinus. The prices we observed were \$4.29 for 20 WalProfem Cold & Sinus Tablets, \$2.99 for 24 WalProfem tablets, and \$3.49 for 24 WalPhed tablets.

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substantially less than the prices they would pay to buy the same active ingredients as separate medicines. Of course, consumers who want all the components of the combination medicines likely get convenience as well as the lower price.

2. Pricing of Different Dosages

The phenomenon of lower prices for combining the same active ingredient into fewer pills and distinct packages that we observed with combination drugs applies to different doses of the same medicine.

a) Pain Relievers

Tylenol comes in three dosage forms for adults:¹⁴ Regular Strength (325 mg/tablet), Extra Strength (500 mg/tablet), and Arthritis Strength (650 mg/tablet). In a sense, each Arthritis Strength tablet is a bundle of two Regular Strength tablets. As a result, buying two packages of, say, 100 Regular Strength Tylenol rather than one package of 100 Extra Strength Tylenol is analagous to buying Tylenol and Sudafed separately rather than in "sinus tablet" form.

Table 2 presents prices we observed that reveal the economies of combining products as well as the general pricing structure for Tylenol. First, note that in the two cases in which the number of tablets is held constant (50 and 100), the incremental price of the higher levels of extra ingredients is small. At the 50-tablet size, the arthritis strength contains 30 percent more active ingredient for an incremental price of only \$0.20, or 2.8 percent. At the 100-tablet size, the Arthritis Strength price is 10 percent higher than the Extra Strength price. In turn, Extra Strength contains approximately 50 percent more active ingredient than

¹⁴ It also comes in junior and children's doses.

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regular strength for an incremental price of \$0.60 or 6.4 percent. The comparison that most corresponds to the bundling comparison in the previous section is between purchasing one package of 100 Arthritis Strength tablets and two packages of 100 Regular Strength Tablets. The amount of active ingredient is the same, but buying two packages of Regular Strength entails two packages rather than one and twice as many tablets. As the table indicates, the price of the one Arthritis Strength package is \$10.99 while the price of two Regular Strength packages is \$18.78.¹⁵

Table 3 shows similar data for Walgreens' acetaminophen. Here, the evidence is more mixed. The clean comparison that is comparable to the cold medicines is the 100-tablet size. The total price of two packages of Regular Strength acetaminophen is \$9.98, which is about 25 percent more than the \$7.99 price of a single package of Arthritis Strength. However, it is not universally true that the per milligram price of the arthritis strength is lower than the per milligram price of the others.¹⁶

b) Decongestants

Pseudoephedrine hydrochloride comes in three dosage forms. “Maximum Strength” contains 30 mg per tablet. The “12-hour version” contains 120 mg per tablet and the “24-hour version” contains 240 mg per tablet. Table 4 lists the prices that we observed for different package sizes and dosage forms of Sudafed, Contac (another brand of pseudoephedrine hydrochloride) and Walgreens pseudoephedrine hydrochloride. Table

¹⁵ Note further that a package of 60 Extra Strength Tylenol has about the same active ingredient as 100 Regular Strength and costs \$1.50 less.

¹⁶ All but one of the prices in Table 3 are \$0.01 less than an even dollar, with the other being \$0.01 less than an integral multiple of \$0.50. This feature of the pricing could be part of the explanation for why the price of Arthritis Strength does not show evidence of bundling efficiencies. For example, a price of \$3.49 for the package of 24 might not be sufficient to cover the incremental cost. Also, as we will discuss further below, if demand for this package size of Arthritis Strength is sufficiently low, then a higher margin might be needed to cover the fixed cost of the shelf space.

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4 provides one clean comparison that is analogous to the bundling analysis above. The price of one package of ten 24-hour Sudafed tablets is \$9.99, whereas the sum of the prices of two packages of ten 12-hour Sudafed tablets is \$12.98. Note further that the price of five 24-hour Sudafed tablets is somewhat less than the price of ten 12-hour tablets and that the price of ten 24-hour Sudafed tablets is somewhat less than the price of twenty 12-hour tablets. The differences are not large. However, the obvious source of cost savings from the 24-hour version concerns placing the medicine into tablets. Since the absolute difference in the number of tablets is small, one would not expect large cost differences.¹⁷

3. Package Size Effects

The third empirical regularity we document concerns package size, which is another form of bundling. A package of 200 tablets is a bundle of two packages of 100 tablets. In addition to providing evidence of another source of gains from bundling, evidence on the prices of different package sizes will yield insights into the fixed costs of product offerings.

Pain relief medications provide better evidence about package size effects than do decongestants or antihistamines because they come in a broader range of packages. Figure 1 presents the data on extra strength acetaminophen and Figure 2 presents the data on ibuprofen. Each graph contains two series, one for branded versions and one for the Walgreens' product. All four of the series are concave and would appear to have a positive intercept.

¹⁷ Note that one odd feature of the table is that the price of 96 Walgreens Maximum Strength tablets is more than double the price of a package with half the number of tablets. That price is the exception, however. In general, the price per tablet is lower for larger package sizes.

B. Regression Results

With the above results in hand, we now seek to estimate a single regression equation to characterize the gains consumers realize from purchasing bundled products. The data set we collected had 305 observations. However, these included a variety of dosage forms, such as tablets, liquids, and liqui-gels. To avoid any misspecification from how we treat dosage forms, we restricted attention to tablets or delivery forms typically priced the same as tablets.¹⁸ This eliminated a large fraction of the medicines with cough suppressants. Also, the variety of active ingredients to treat coughs is substantially greater than the variety of decongestants, antihistamines, and pain relievers; and we were concerned that we would be unable to get reliable estimates of how each cough suppressant is priced. As a result, we excluded cough medicines. More precisely, we restricted attention to tablets in which the active ingredients were limited to the pain relievers acetaminophen and ibuprofen, the decongestant pseudoephedrine hydrochloride, and the antihistamines chlorpheniramine maleate and diphenhydramine HCl.¹⁹ This left us with 112 observations.

In order to capture brand effects and the non-linearities in package size documented above, we chose the following specification:

$$(1) P_i = b_0 + b_1 B_i + b_2 T_i + b_3 T_i^2 + b_4 T_i B_i + b_5 T_i^2 B_i + \sum_{j=1}^N c_j Z_{ij}$$

where:

¹⁸ This filter excluded any medicines in liquid or packet form as well as “liquigels,” which typically sell for a premium. It includes caplets.

¹⁹ Thus, we excluded medicines with cough suppressants. The products we observed contained a much greater variety of cough suppressants than of the other types of ingredients, and we were concerned that we did not have sufficient data to estimate with much accuracy the price effects of each cough suppressant.

P_i is the price of package i

T_i is the number of tablets in package i

B_i is a brand name dummy for package i

Z_{ij} is the amount of ingredient j in package i

The presence of a brand premium raises issues for the effect of bundling in this case. To see the general issue, consider Table 1. For the branded products, the bundle discount is computed as the price of Tylenol Sinus (or Sudafed Sinus Headache) with the sum of the prices of Tylenol Extra Strength and Sudafed Maximum Strength. Both of the prices of the component products include a brand premium.²⁰ Unless the price of the bundled product includes a double brand premium, then part of the bundle discount reflects a brand premium effect.²¹

Our specification allows the brand premium to be a quadratic function of the number of tablets. While this functional form allows for some flexibility in estimating how companies impose a brand premium, it does not allow the brand premium to be a function of the number of active ingredients. Neither does it allow for the brand premium to depend on the volume of active ingredient per tablet.²² We ran regressions in which the brand premium could depend on the number of active ingredients. They provided no

²⁰ The fact that Tylenol is a Johnson & Johnson brand while Sudafed is a Pfizer brand is of interest, but a similar issue would arise if the same company owned both.

²¹ As we will see, the brand effect accounts for a substantial piece of the bundle discount in this case. Exactly how to interpret this effect would require a better understanding of the source of brand premia than one can currently get from the economics literature. The branding effect could easily be the subject of an entire other paper. In this paper, we merely document the effect and leave its explanation as a potential avenue for future research.

²² If, for example, one compares the three different strengths of Tylenol described above, it would be of interest to estimate whether the brand premium depends on the number of tablets or on the amount of acetaminophen.

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evidence that bundled, branded products command a higher (absolute) premium than do unbundled ones.²³

Our estimated equation is:

$$\begin{aligned} R_i = & 2.31 + 0.029T_i - 3.3 \times 10^{-5} T_i^2 + 0.63 B_i + 0.054 T_i B_i - 1.23 \times 10^{-4} T_i^2 B_i \\ & (7.25)^* \quad (1.89) \quad (4.12)^* \quad (1.47) \quad (5.15)^* \quad (2.85)^* \\ (2) \quad & + 0.014 IB_i + 0.012 AC_i + 0.065 PH_i + 0.035 CM_i + 0.042 DI_i \\ & (0.95) \quad (0.85) \quad (5.13)^* \quad (1.90) \quad (2.90)^* \end{aligned}$$

$$s=1.24, R^2 = 0.91, F=132.31^*, N=112$$

(Note: Values in parenthesis are absolute values of asymptotic t-statistics based on heteroskedasticity-consistent standard errors. * denotes significance at 1 percent (two-tailed) level.)

Where:

IB_i = ibuprofen in package i in units of 200 mgs
 AC_i = acetaminophen in package i in units of 500 mgs
 PH_i = pseudoephedrine hydrochloride in package i in units of 30 mgs
 CM_i = chlorpheniramine maleate in package i in units of 2 mgs
 DI_i = diphenhydramine in package i in units of 25 mgs

The coefficients on the active ingredients are all positive. The coefficients on the amount of acetaminophen and on ibuprofen are small and imprecisely determined. That they are small makes sense. The price of both bulk acetaminophen and bulk ibuprofen is approximately \$8/kg,²⁴ which would contribute \$0.004 per 500 mg acetaminophen tablet and \$0.0016 per 200 mg ibuprofen tablet.

²³ We believe that the branding effect of bundling is potentially of great interest in understanding branding, but we do not pursue it in more detail here because we suspect that it is not a common effect of bundling.

²⁴ See <http://www.the-innovation-group.com/ChemProfiles/Acetaminophen.htm> and www.tulika.com/exportprices.htm

These regressions reveal three primary sources of gains to consumers from buying bundled products. The first is the intercept term of \$2.31, which is highly statistically significant. The purchaser of the bundled product pays one fixed component in the price term. Purchasers of the two separate products would pay two. The second component is associated with the number of tablets. It is $0.029 T_i - 3.3 \times 10^{-5} T_i^2$. Again, purchasers of the bundled product pay this component once. Purchasers of two separate products would pay it twice. This component of the savings comes to \$0.67 for 24-tablet packages and \$1.29 for 48-tablet packages. Thus, the cost-based savings absent of brand effects is \$2.98 for 24 tablet packages and \$3.60 for 48 tablet packages. The third component applies only to purchasers of branded products. It is given by $0.63 + 0.54 T_i - 0.00012 T_i^2$. It amounts to \$1.84 and \$2.92 for 24-tablet and 48-tablet packages, respectively.²⁵

III. Understanding the Bundle Discount

Having documented a substantial bundle discount for cold medicines and pain relievers, we now turn to the question of how to interpret it. In broad terms, the price savings either reflect cost savings or they do not; and if they do not, they constitute price discrimination. As a practical matter, we cannot hope to measure costs precisely enough to ascertain that the bundle discount exactly reflects cost differences; and, even if we could, it would be surprising if they did. Our objective here is not to make an either/or determination or even to estimate what fraction of the bundle discount is cost-based. Rather, it is to make a judgment as to which competing theoretical framework is most useful for understanding the phenomenon we have observed.

²⁵ These estimates are for the savings from buying a bundled medicine with two active ingredients as compared with buying the components separately. The effect would be twice as large for products with 3

A. Price Discrimination

The models of bundling as a vehicle for price discrimination are typically based on the assumptions that the seller is a monopolist and that demand can be characterized as a statistical distribution of reservation values.²⁶ Given this assumption, bundling can serve two purposes. First, particularly if reservation values are negatively correlated but even if they are not “too” positively correlated, the variation in the sum of the reservation values for the underlying components is lower than the variation in the reservation values for the individual components.²⁷ This “flattening out” of the demand curve can make it possible for a monopolist to extract a greater fraction of the potential surplus than it could with simple pricing.²⁸ Second, mixed bundling gives the monopolist an additional degree of pricing freedom to try to segment markets.²⁹

These models posit a seller with market power over all the potential components of the bundle. That assumption does not match the broad facts of the case.³⁰ First of all, the bundle discount applies to store brands as well as to branded products. Yet, store brands do not have any appreciable market power in the sale of pharmaceuticals. Second, while branding is an important feature of this industry, no single company controls all the brands involved. Even if Johnson & Johnson, which owns the brand Tylenol, has market power in the sale of acetaminophen, it does not have market power in the sale of

active ingredients as compared with buying all three separately.

²⁶ This treatment of demand presumes that the cross-price elasticities of demand for the underlying components are 0, which is a strong assumption.

²⁷ For an exposition of the precise sense in which this rather loose description is true, see Salinger (1995).

²⁸ The seminal paper in this area is Stigler’s (1968) article on block booking. For more general treatments that reveal the general statistical properties underlying Stigler’s insight, see Schamlensee (1984), Salinger (1995), and Bakos and Brynjolffson (1999).

²⁹ Adams and Yellen (1976) extended Stigler’s analysis to show that mixed bundling can be a better price discrimination strategy than pure bundling. McAfee, McMillan, and Winston (1989) show that the point is quite general.

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decongestant. By the same token, Pfizer, the company that produces Sudafed, does not have market power in acetaminophen.

An alternative perspective is to posit that the purchasers of bundled products constitute a distinct group of customers. Again, to use the example underlying Table 1, some people want acetaminophen, some want pseudoephedrine hydrochloride, and some want both.³¹ If the group that wants both has more elastic demand, then the monopoly price to them would entail a lower mark-up.³²

There are three reasons, though, why price discrimination is implausible as a complete explanation for the bundle discount.

First, the nature of the products themselves should lead us to expect that bundling saves costs. The bundled product entails one package rather than two (or more), the production of fewer tablets, and the processing of one transaction rather than two. Since the price of the bulk ingredients represents a small fraction of the total price of these products, we should expect these obvious sources of cost savings to represent a substantial fraction of costs.

Second, as noted above, the bundle discount is not just a feature of branded prices. It is present in generic and store-brand pricing as well. Since we should expect those prices to be more nearly cost-based, the bundle discount for those products likely reflects cost savings.

³⁰ Cable television is one example in which the model might apply. See Crawford (2004) for an estimate of the effect of bundling in cable television based on the price discrimination framework.

³¹ This demand structure could be captured by the approach of modeling demand as a statistical distribution of reservation values. However, it could arise in other contexts as well. For example, the people who want both products might view them as complements.

³² Our cost-based model uses a demand framework that is similar in that we assume different classes of customers. The difference between the price discrimination approach and ours concerns the relative roles of cost and demand elasticities in determining prices.

Third, if there are no cost savings from bundling, then the mark-ups on the unbundled products have to be very large. Consider the pricing of the CVS medicines in Table 1. Since the price of the combined product is presumably not less than marginal cost, then \$3.99 is an upper bound on the marginal cost of the bundled product. If there were no marginal cost savings, then the sum of the marginal costs of the two component products would have to be \$3.99 as well. The sum of the prices for the two products is \$6.48. If we assume that the elasticities of demand for the two separate products are equal then the elasticity implied by the well-known optimal pricing formula³³ is -2.6 .³⁴ To the extent that CVS is forced by competition to price below the monopoly price, it is quite possible that its price falls in an inelastic region of the demand curve. However, the result that the elasticity of demand for CVS' sinus headache medicine is in general (as opposed to at a particular point) as low as -2.6 seems implausible.³⁵ For example, it implies that an increase in the price of the store-brand acetaminophen in Table 1 (\$2.99) to the branded price (\$3.99) would only cut sales of the branded product in half. Without any discount for the store-brand product, we suspect sales would be negligible.

An analysis of the branded pricing makes it even more implausible that the prices of the combination products do not reflect any marginal cost savings. In Table 1, the price premia for the branded products relative to the CVS product range from 32 percent

³³ The formula is $\eta = -P/(P - MC)$, where η is the elasticity of demand, P is price, and MC is marginal cost. In this case, the calculation is $-6.48/(6.48-3.99) = -2.6$.

³⁴ This analysis assumes, of course, that the relevant elasticity of demand is the one for the product itself. More likely, retailers compete on margins that might vary somewhat across product classes but which are constant within product classes. (The use of "sale" items would, of course be the source of variations in margins, but does not invalidate our broader point.)

³⁵ It is not clear that the elasticity of demand for Walgreen's acetaminophen is relevant for determining the price of its brand of acetaminophen. Rather, that price might be set in the context of a more general pricing strategy designed to get customers to shop at Walgreen's in general.

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to 50 percent.³⁶ This premium likely reflects advantages of branding rather than marginal cost differences.³⁷ Thus, let us take the \$3.99 price of CVS brand as an upper bound on the marginal cost of Tylenol Sinus Caplets and Sudafed Sinus Headache caplets. If there are no marginal cost savings from combining the products, then the sum of the marginal costs of Tylenol and Sudafed are \$3.99. The sum of the prices of the separate products is \$8.58. Again, assuming that the elasticities of demand are the same for the two products, the implied elasticity is -1.87 . In light of the existence of competing products like ibuprofen and aspirin and of generic and store-brand acetaminophen, this estimate of the elasticity of demand for Tylenol seems low. The same point seems even stronger for Sudafed, for which there are competing branded versions.

B. The Cost-Based Approach

While it might seem obvious that cost savings provide part of the explanation for the bundle discount, the cost explanation and its welfare implications are more subtle than one might initially expect. In Evans and Salinger (2004a), we present a cost-based model that serves as a unified framework for understanding bundling and tying under competition. The essential features of the framework are:

1. There are two products, A and B, that can be sold separately or bundled;
2. Some customers want A, some want B, and some want both;
3. The marginal cost of the bundle might be lower than the sum of the marginal costs of the components;
4. There is a fixed cost of each product offering;
5. Markets are perfectly contestable, which implies that prices equal average cost; and

³⁶ It is interesting that the premium for the combined product is substantially higher than the premia for the separate products.

³⁷ *Advertising Age* estimates that measured media spending (which is less than total advertising) for Tylenol brand products was \$82.8 million in 2003. Source: <http://www.adage.com/page.cms?pageId=1027>, accessed March 23, 2004.

6. The prices for the goods offered in the market are sustainable.

The first three of these seem readily applicable to this case. The different medications can be (and are) sold both separately and in combination. To use the example in Table 1, some people have a headache and want just acetaminophen. Some people have a cold and want just a decongestant. Some have a sinus headache and want both. Because of savings in packaging, making tablets, and transactions expense, the marginal cost of the bundled product is less than the sum of the marginal costs of the unbundled items.

Assumption 3 implies that, without some constraint on the products offered, there is an advantage to having the bundle available in addition to the separate components. The bundle makes it possible to satisfy the demand of people who want both components at a lower cost and, therefore, price. In practice, another efficiency of bundling is that it provides convenience. If so, consumers who want both components would be willing to pay a convenience premium to buy them in bundled form. It would be trivial to extend the model to allow for a convenience premium. We do not do so here for two reasons. First, we want to keep the model simple, and marginal cost savings are sufficient to make those who want both components prefer to buy them in bundled form. Second, under competition, the convenience value would not be reflected in prices. Measuring it would require more precise estimates of demand than we attempt here.

The fourth assumption is necessary to capture the possibility of tying. Tying, as an economic matter, occurs when the two products are sold in bundled form and at least one of the products is not available separately. As such, it represents a limitation on the products that are offered. To make sense of this limitation when there are some customers

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who would like the component that is not offered, there needs to be some product-specific scale economy. The simplest way to model these scale economies is to assume a fixed cost of each product offering.

Tying is a prevalent practice under competition. Indeed, our objective in formulating the model was to understand tying under competition. Given that scale economies are necessary to understand tying, however, one cannot assume perfect competition. The contestability assumption is a way of incorporating competition into a model when scale economies are present. Like any model, it should be viewed as an approximation. The key implication of a contestability model is that prices are determined primarily by costs with the underlying elasticity of demand playing at most a secondary role. This perspective is in distinct contrast to price discrimination models. In evaluating whether contestability is a reasonable approximation, we need to consider whether the threat of entry is the primary constraint on the extent to which prices can exceed costs. Given the substantial number of large companies that would seem to have the capability to produce and market any one of these products, that assumption strikes us as being reasonable.

In this case, tying does not occur.³⁸ In the Evans-Salinger model, however, mixed bundling is a possible outcome, so the absence of tying is not a reason to reject the model. Moreover, fixed costs of product offerings are likely present in this case even if

³⁸ This comment requires some qualification. To take one example, Johnson & Johnson sells acetaminophen alone and acetaminophen in combination with pseudoephedrine HCl. It does not sell pseudoephedrine HCl alone. While this is technically tying from the standpoint of the company, the market outcome does not entail tying. One can purchase pseudoephedrine HCl. Moreover, because Johnson & Johnson does sell Tylenol without any additional active ingredients, its tying is not the sort that could raise antitrust concerns.

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they are not sufficient to result in tying.³⁹ Each additional stock keeping unit (sku) imposes a cost on a retailer as it must order the product, maintain inventories, and so on. In addition, each distinct product sold by a retailer must occupy a shelf slot. The cost of these slots is an example of what accountants refer to as “semi-fixed” or “step” costs. They are not fixed with respect to all levels of output, but they are incurred in discrete units (or “steps”). Whether or not such costs should be deemed primarily fixed or primarily marginal depends on the size of the steps relative to total demand. We do not have the information one would need to determine whether shelf space should be considered a fixed or marginal expense, but it is at least plausible that it is more nearly fixed.⁴⁰

In the simplest version⁴¹ of the model, let X_1 be the number of people who want just good 1, X_2 be the people who want just good 2, and X_B be the number of people who want both. Let F be the fixed cost of a product offering, c_1 and c_2 be the marginal cost of goods 1 and 2, respectively, and c_B be the marginal cost of the bundle with $c_B \leq c_1 + c_2$. Letting p_1 , p_2 , and p_B be the prices of goods 1 and 2 and of the bundle, then the contestable prices are:

$$(3) \quad p_i = c_i + \frac{F}{X_i} \quad i \in \{1, 2, B\}$$

³⁹ The model assumes that consumers who want just one component are willing to buy it as part of the bundle. In economics terminology, we assume free disposal. That plainly does not apply to this case. Many people with just a headache would no doubt prefer just a pain reliever to a pain reliever-decongestant combination.

⁴⁰ One relevant piece of information is the number of shelf slots devoted to an item. In grocery stores, it is common to observe multiple slots devoted to two-liter bottles of Coca-Cola, and the number of slots increases when Coca-Cola is a sale item. In that case, the shelf space should be treated as a marginal cost. When just one shelf slot is devoted to an item, there is a stronger case for treating shelf space as a fixed cost.

⁴¹ In this version, demand by each group is treated as being perfectly inelastic within the range of prices that might prevail. See the appendix to Evans and Salinger (2004a) for an extension to price-sensitive demand.

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and the discount for the bundle (DB) is given by:

$$(4) \quad DB \equiv p_1 + p_2 - p_B = c_1 + c_2 - c_B + \frac{F}{X_1} + \frac{F}{X_2} - \frac{F}{X_B}$$

As equation (4) makes clear, there are two possible sources of the bundle discount. One is marginal cost savings, $c_1 + c_2 - c_B$. The other concerns fixed costs. A customer who buys the two components separately contributes to two fixed costs; the purchaser of the bundled product only contributes to one.

Without knowing X_1 , X_2 , and X_B , we cannot be sure that the bundle discount is attributable at all to fixed costs. As a practical matter, however, it likely is. To cover its costs, a retailer must “mark up” the prices of the items it sells. Unless the retail mark-up on the bundled item is at least the sum of its mark-ups on the components—and there is no reason to suppose that it is—then part of the customer savings reflects retail mark-ups.

A key result in Evans and Salinger (2004a) is that mixed bundling can occur even if it is not the set of offerings that minimizes total costs. Under mixed bundling, there has to be a bundle discount,⁴² but the private savings from the bundle discount do not necessarily represent social savings. If we let SB be the cost savings from offering the bundle⁴³ (stated on a per-customer basis to aid comparability with the bundle discount), then:

$$(5) \quad SB = c_1 + c_2 - c_B - \frac{F}{X_B} = DB - \frac{F}{X_1} - \frac{F}{X_2} \quad \text{📄}$$

The first three terms of (5), which reflect marginal costs, are identical to (4). With the marginal costs, private savings reflect social savings. The last term of (5) is also the last term of (4). There is a social fixed cost of offering the bundle that must be subtracted

⁴² Otherwise, consumers who want both components would not buy the bundle.

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from the marginal cost savings. In a contestable market, purchasers of the bundle bear this cost as well. The difference between (4) and (5) comes from the two terms in (4) that reflect the average fixed costs of the two component goods. If those who want both components were to buy them separately, the prices they would pay would reflect these fixed costs. When they buy the bundle instead, they get a private benefit from not contributing to those fixed costs, but there is no corresponding social benefit because the fixed costs of the components are not reduced.

The last part of equation (5) provides a simple approach to inferring the cost savings from the bundle (under mixed bundling) from the bundle discount. It says that the cost savings (per consumer of the bundle) are the bundle discount minus the average fixed cost portion of the prices of the two separate goods.

The following pair of examples illustrates the point:

Example 1: $c_1 = c_2 = 2$, $c_B = 2.9$, $F = 0$, $X_1 = X_2 = X_B = 100$

Example 2: $c_1 = c_2 = 1$, $c_B = 1.9$, $F = 100$, $X_1 = X_2 = X_B = 100$

In both cases, the unique sustainable outcome is mixed bundling with $p_1 = p_2 = 2$ and $p_B = 2.9$.⁴⁴ The bundle discount is substantial. In example 1, the bundle discount entirely reflects social savings. The total cost of meeting demand with mixed bundling is 690. The cost of meeting demand with components selling would be 800, or 110 more. In example 2, the total cost of meeting demand with mixed bundling is also 690, just as in example 1. In contrast to example 1, however, the total cost of meeting demand with components selling

⁴³ SB represents the savings from offering the bundle given that goods 1 and 2 are also offered.

⁴⁴ This point should be obvious for example 1. For example 2, the prices under pure components selling would be \$1.50 (calculated as $1 + 100/200$) for each item. Customers who buy both pay a total of 3. This outcome is not sustainable because it is susceptible to entry with the bundle at a price of 2.9. Similarly, pure bundling is not sustainable. The price under pure bundling would be $1.9 + 100/300 \approx 3.23$. That price is not sustainable because an entrant could break even selling either component at a price of 3.

would be only 600.⁴⁵ Unless the bundled product provides convenience for the customers who want both items, the mixed bundling would be inefficient despite the substantial bundle discount.

A similar point applies to the individual components. Under mixed bundling, the price of each component has to be less than the price of the bundle,⁴⁶ but that does not imply that offering the separate good lowers costs. If we let DC_i and SC_i be the discount and cost savings (per customer of good i) of offering good i (given that the bundle is offered), we have:

$$(6) \quad DC_i \equiv p_i - p_B = c_B - c_i + \frac{F}{X_B} - \frac{F}{X_i}$$

$$(7) \quad SC_i = c_B - c_i - \frac{F}{X_i} = DC_i - \frac{F}{X_B}$$

Equation (7) says that to infer the cost savings from having a component available separately, one must subtract the average fixed cost component of the price of the bundled good from the component discount.

Referring back to our pricing regression, the bundle discount has three components: the intercept, the coefficients on the tablet variables, and the coefficients on the brand-name variables. As noted above, we focus on the first two. The estimated equation distinguishes between price components that are fixed and variable with respect

⁴⁵ In example 2, there are some marginal cost savings from bundling. If there were no marginal cost savings from bundling, then mixed bundling would still be sustainable (and inefficient), but it would not be the unique sustainable outcome. Components selling would be sustainable as well. Mixed bundling can be the unique sustainable outcome with no marginal cost savings from bundling if X_B is greater than the geometric mean of X_1 and X_2 . For a more complete explanation, see Evans and Salinger (2004a).

⁴⁶ Another simplifying assumption of our model is that consumers who want just one of the goods get no utility or disutility from the other good. As a result, they view the bundle as a perfect substitute for the good they want. That assumption does not apply to our application, since, for example, many consumers who want just a pain reliever would prefer not to have to take a decongestant as well. Just as it would be easy to

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to package size. Within our model, however, the key distinction is whether or not the costs are fixed or marginal with respect to a customer. The cost of placing active ingredients into tablets and, to some extent, the cost of the package itself, are examples of costs that are marginal with respect to both package size and to the customer. To the extent that package costs rise less than proportionately with the number of tablets, however, then part of packaging cost would be reflected in our intercept term. Even though this component is fixed with respect to package size, it is variable with respect to the customer.⁴⁷ Another example of this kind of cost is the cost of the time it takes a clerk to process a transaction. Finally, some costs are fixed both with respect to the customer and to the size of the package. The costs of having an additional sku and, to a large extent, the cost of shelf space are examples.⁴⁸

IV. Decomposing Fixed and Marginal Cost Effects with Package Size Pricing Regularities

We now show how to use the package size regularities documented in Section II to decompose the bundle and component discounts into marginal cost and fixed cost components. This decomposition will then allow us to measure the (possibly negative) cost savings (per customer) from each product.

incorporate a convenience value for the bundle in the model, we could also assume that consumers who want just one component are willing to pay a premium not to have it bundled with the other.

⁴⁷ Our argument that the packaging cost is reflected at least partially in the intercept term does not require that the packaging cost equation literally has a positive intercept. If we observed packaging costs directly, our estimates of the marginal cost savings from bundling would be based on the cost of a package of a given size, such as 24 tablets or 48 tablets. Taken, literally, the intercept reflects the cost of a 0-tablet package, which is irrelevant for computing the gains from bundling. Given our choice of a quadratic functional form, however, the cost of a package of a particular size would be reflected in part in the intercept.

1. Theory

The key to understanding the size of the the product-specific fixed costs is to observe products that could conceivably exist but do not.⁴⁹ In the cases we have considered, product tying does not occur. Among the products sold in bundled form that we have considered, all the component medicines are available separately. Rather than looking to products that do not exist, we look to package sizes that are not offered. The price-package size relationships presented in Figures 1 and 2 provide evidence of economies of package size. As a consequence, customers who want a large quantity are better off buying one large package than several smaller ones. However, not all possible package sizes are offered. For example, the Walgreens in question sold Extra Strength Tylenol in packages of 24, 100, 150, 200, and 225. It did not, however, sell packages of 175. There does not seem to be any reason to suppose that there were no customers who would most prefer to buy 175. Such a customer must choose between buying a package of 200 and wasting 25 of them or buying a package of 150 and supplementing the package of 150 with, say, another package of 24.⁵⁰ Given the economies of package size, neither of these solutions would give the customer as good a price as he would get if a package of 175 were available on the market.

To estimate the cost factor that prevents the package of 175 from being introduced, we need to introduce some theory that extends the contestability analysis from our previous paper. The general approach is to view the set of products offered and their prices as a

⁴⁸ It is possible that some costs might be variable with respect to package size but fixed with respect to the customer. This could happen if, for example, larger packages require more shelf space. Our procedure for estimating the component of price that covers fixed costs ignores this possibility.

⁴⁹ Other papers that use or suggest an analogous approach to estimating fixed costs are Bresnahan and Reiss (1987), Pakes and McGuire (1994), Ericson and Pakes (1995), Fershtman and Pakes (2000), Miravete (2004), and Pakes, Ostrovsky and Berry (2004).

⁵⁰ This choice would, of course, leave the consumer one pill short of his desired quantity.

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sustainable market outcome, which means that entry with another product, (which in this case is a different package size), is not profitable. Let Q_i , Y_i , and P_i be the package size, number of purchasers, and price of package i for $i = 1$ or 2 with $Q_1 < Q_2$. Let $C(\cdot)$ be the marginal cost of selling a package of a particular size to an extra customer. Then, the contestability result that price equals average cost implies:

$$(8) \quad P(Q_i) = \frac{F}{Y_i} + C(Q_i)$$

Let \bar{Q} be the average of Q_1 and Q_2 , and assume that if \bar{Q} were offered at a lower price, half the people who buy Q_2 would buy \bar{Q} instead. The price at which it could be offered would be:

$$(9) \quad P(\bar{Q}) = \frac{2F}{Y_2} + C(\bar{Q})$$

We now need to make the simplifying assumptions that Q_1 and Q_2 are close enough to each other that a linear approximation of the marginal cost function is reasonable and that $Y_1 = Y_2$. With these additional assumptions, it is straightforward to show that the condition that makes it impossible to offer the package size half way between Q_1 and Q_2 is:⁵¹

$$(10) \quad \frac{F}{Y_2} > \frac{P_2 - P_1}{2}$$

2. Results

The left-hand side of (10) is the component of the price that goes to covering the fixed cost. Each successive pair of package sizes yields an estimate. Figure 3 shows a

⁵¹ This condition only insures that the existing offering is sustainable with respect to entry half way between two package sizes that are offered. More generally, one might impose the condition that the

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histogram of our estimates of the lower bounds of the fixed costs taken from the data underlying Figures 1 and 2. The mean value is \$1.33, the median is \$1.20, and the modal range is \$1.00 to \$1.50. Taking the median as our estimate, we estimate that \$1.20 of each package price represents a contribution to fixed costs.

In Section II, we estimated a cost-based savings⁵² of \$2.98 and \$3.60 for 24-count and 48-count packages of tablets with two active ingredients. Given our estimate of \$1.20 as the part that reflects a contribution to fixed costs, the implied marginal cost savings are \$1.78 and \$2.40. Using equation (5), we estimate that the cost savings per customer from the bundled products are \$0.58 and \$1.20, respectively.

Both the private and net savings would be larger for tablets that combine three active ingredients. The private savings are twice as large, so they are \$5.96, which reflects \$3.56 in marginal cost savings and \$2.40 in average fixed cost. From the marginal cost savings of \$3.56, which represents a social benefit, we must subtract the \$1.20 average fixed cost of the additional offering. The net cost savings are \$2.36.

The gains from bundling would also be larger for larger packages. For example, for packages of 48 tablets, our regression equation implies private gains of \$3.60 and \$7.20 for tablets that combine two ingredients and three ingredients, respectively. The net effect on costs would then be savings of \$1.20 and \$3.60 for the bundled products.⁵³

We can also use equation (8) to estimate whether there are cost savings from offering the stand-alone products. Consider again the example in Table 1. The regression results indicate that for people who want just acetaminophen, the marginal cost of buying

offering be sustainable with respect to all possible intermediate package sizes. In doing so, however, one would probably not make our simplifying assumptions about marginal cost and demand.

⁵² By cost-based savings, we mean those not related to branding effects.

⁵³ The calculations are $\$3.60 - 2 \cdot \$1.20 = \$1.20$ and $\$7.20 - 3 \cdot \$1.20 = \$3.60$.

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acetaminophen bundled with pseudoephedrine hydrochloride would be $\$0.065 \cdot 24 = \1.56 . As this exceeds our estimate of the average fixed cost of \$1.20, we estimate the cost savings from having the stand-alone acetaminophen product to be \$0.36. For consumers who want just pseudoephedrine hydrochloride, the regression results imply that the marginal cost of buying it bundled with acetaminophen would be $\$0.012 \cdot 24 = \0.29 . As this incremental cost is less than the average fixed cost, it would lower costs not to offer the 24-tablet package of just pseudoephedrine hydrochloride. In other words, tying would lower costs.⁵⁴

We acknowledge that these estimates are very rough.⁵⁵ Our primary purpose in putting them forward is to emphasize the necessity of distinguishing between the marginal cost and fixed cost components of the bundle discount. In an antitrust case, the cost data needed to estimate these effects directly might be available. If so, one would not have to rely on the indirect means we use here. Armed with cost data, though, it would be important to be clear on what should count as a benefit of bundling and what should count as a cost.

V. Conclusions – Implications for Economics and for Policy

This paper is part of a research project in which we sought to 1) gather evidence about bundling and tying and 2) understand the bundling and tying that occurs under competition. The economics literature stresses the use of bundling as a pricing practice to

⁵⁴ Assuming that the groups that want just pseudoephedrine HCl and that want the bundled product are of equal size, tying would also be sustainable. By pricing the bundled product to attract the group that wants just the decongestant, the average fixed costs could be reduced from \$1.20 to \$0.60. This \$0.60 price reduction would more than offset the \$0.29 marginal cost associated with the extra active ingredient.

⁵⁵ It may well be that the fixed cost component is a function of package size. Within the model, this could occur if demand for the larger packages was smaller or if the fixed cost of the product offering were higher (perhaps because bigger packages take up more linear shelf space). If so, then our estimates might overstate

exploit market power and tying as a device to extend or preserve market power. While it is common to acknowledge that bundling can result in efficiencies, the formal models tend to rule out the possibility that bundles better meet the needs of (some) consumers than would components selling separately. Based on a reading of the economics literature on bundling, one might suspect that Johnson & Johnson sells Tylenol Sinus to segment different markets for branded acetaminophen. We think it far more likely that the product exists because it better serves the needs of some customers (because it is both cheaper to produce and more convenient) than buying the same active ingredients as separate products. It is an example of bundling that is compelled by competition rather than one that is designed to best exploit deviations from competition. We also think it likely that this type of bundling is far more common than the sort explained by existing economic models. On one level, our intent is to lay an analytical framework that captures the essence of most of the bundling and tying that occurs.

On another level though, we hope that our analysis and analysis that follows from it will affect public policy. As we discuss in more detail in Evans and Salinger (2004b), tying law in both the United States and Europe lacks a solid economic foundation. The challenge in formulating an economically sensible tying doctrine is to distinguish the substantial number of ties that are beneficial from the handful that are not. As it currently stands, the economics literature does not provide much guidance on how to do so because it has focused exclusively on how tying can be used to foreclose competition.⁵⁶ Without an explanation and documentation of beneficial ties, it is hard to know how to distinguish the anticompetitive cases of tying from beneficial cases. To understand beneficial tying,

the fixed costs and thereby understate the cost savings from bundled products, which come in relatively small sizes.

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we first need to understand why firms bundle and then we need to understand why, when they bundle, they do not necessarily offer all the components.

While the case we have discussed does not entail tying, our analysis is relevant for evaluating the proper approach to analyzing tying for antitrust purposes. The *per se* treatment of tying in the United States is so striking that there is a temptation to argue that the needed change is to shift to a rule of reason.⁵⁷ Certainly, that change would be an improvement, but a mere shift to a rule of reason would not be sufficient. By itself, a rule of reason could treat claims that a tie is efficient and claims that a tie is anticompetitive as being equally plausible *ex ante*. Without a clear articulation about how to distinguish between the two, however, courts will inevitably err; they will sometimes conclude that beneficial ties are harmful (“false conviction”) and at others conclude that harmful ties are beneficial (“false acquittal”). Decision theory suggests that when the risk of such errors is present, the relative frequency of harmful and beneficial ties is a relevant consideration.⁵⁸ Since objective estimates of these relevant frequencies are not likely to be available, one must therefore rely on subjective estimates.⁵⁹ Because tying is so prevalent under competition (in which case it is presumptively beneficial) and because there have been few if any documented cases of anticompetitive tying, we believe that the vast majority of cases of tying are beneficial. If so, legal standards must be set to create a low risk of a false conviction.

One way to do so is to require that plaintiffs demonstrate that a tie is harmful. Such a legal standard would require an empirically feasible approach to doing so. The

⁵⁶ See Whinston (1990) and Carlton and Waldman (2002)

⁵⁷ See Ahlborn, Evans and Padilla (2003).

⁵⁸ See Hylton and Salinger (2001). Relative error costs are another consideration. See Beckner and Salop (1999).

broad framework we present here could be the basis for such a demonstration. The framework does need to be extended (to, for example, incorporate the value customers are willing to pay for convenience), but we are confident that empirical implementation will be far more practical with our model than with many of the models of anticompetitive tying that have found their way into academic journals.

We must, though, add a word of caution. Our analysis makes clear that marginal cost savings from bundling and fixed costs of product offerings are two key components of a tying analysis. In the retail example we have studied, at least part of the fixed costs of a product offering—the part attributable to shelf space—might be relatively easy to estimate. In Evans and Salinger (2004b), however, we discuss the trend on the part of United States automobile manufacturers to sell optional equipment only in tied form. The fixed costs in that case arise from the cost created by product complexity. As this cost is rooted in organizational costs, which are much harder to understand and document than the cost of shelf space, costs of this type might be hard to measure. Yet, from the behavior we observe, we must infer that they are significant.

Thus, economists still have work to do before they can offer policymakers the analysis that they should want to guide tying policy. By offering some evidence and presenting a framework that should be useful for evaluating other cases, though, we hope that we have advanced our understanding of bundling and tying in a useful way.

⁵⁹ See the exchange between Grimes (2002) and Hylton and Salinger (2002).

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TABLES

Table 1. 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

Note: 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 30 mg of pseudoephedrine hydrochloride and 500 mg of acetaminophen.
 Source: Downloaded from CVS Web site, <http://www.cvs.com>, Feb. 11, 2004.

Table 2. Prices for Different Tylenol Dosages

Number	Regular Strength (325 mg)	Extra Strength (500 mg)	Arthritis Strength (650 mg)
50		\$7.19	\$7.39
60		\$7.89	
100	\$9.39	\$9.99	\$10.99
150		\$14.29	

Source: Prices observed at Walgreens at 757 N. Michigan Ave in Chicago on April 3, 2003.

Table 3. Prices for Different Walgreens Acetaminophen Dosages and Package Sizes

Number	Regular Strength (325 mg)	Extra Strength (500 mg)	Arthritis Strength (650 mg)
24		\$2.99	\$3.99
50			\$5.49
60		\$3.99	
100	\$4.99	\$5.99	\$7.99
175		\$7.99	
250		\$8.99	\$13.99
500		\$11.99	

Source: Prices observed at Walgreens at 757 N. Michigan Ave in Chicago on April 3, 2003.

Table 4. Prices for Different Brands, Dosages and Package Sizes of Pseudoephedrine Hydrochloride

Number of Tablets	30 mg/tablet		Contac	120 mg/tablet		240 mg/tablet
	Sudafed	Walgreens		Sudafed	Walgreens	Sudafed
5						\$5.99
10			\$6.79	\$6.49	\$3.99	\$9.99
20			\$9.49	\$10.49	\$6.49	
24	\$6.79	\$3.49				
48	\$9.49	\$5.99				
96		\$14.99				

Source: Prices observed at Walgreens at 757 N. Michigan Ave in Chicago on April 3, 2003.

FIGURES

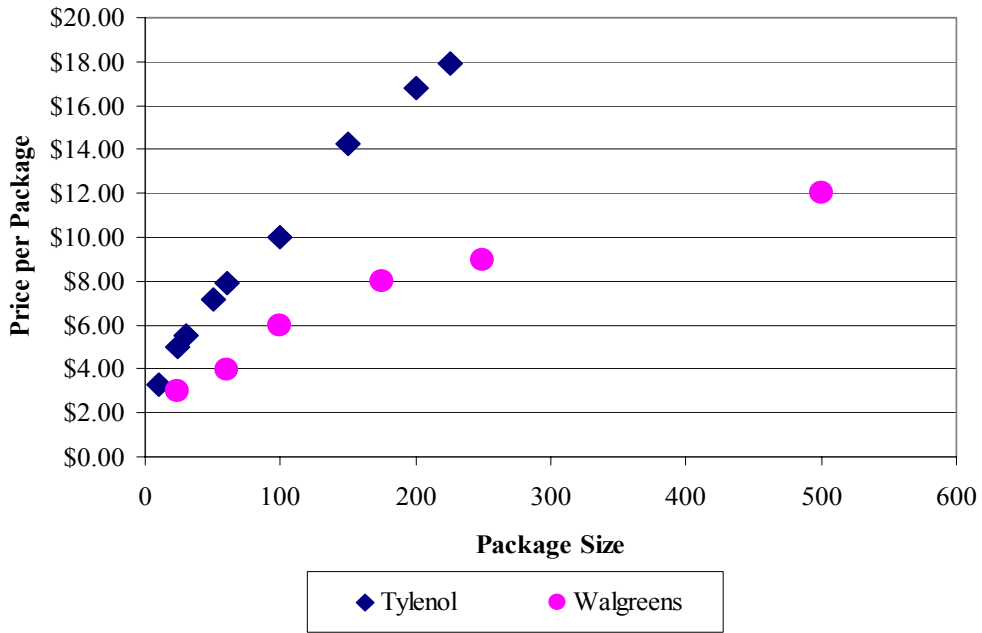


Figure 1. Extra Strength Acetaminophen Prices

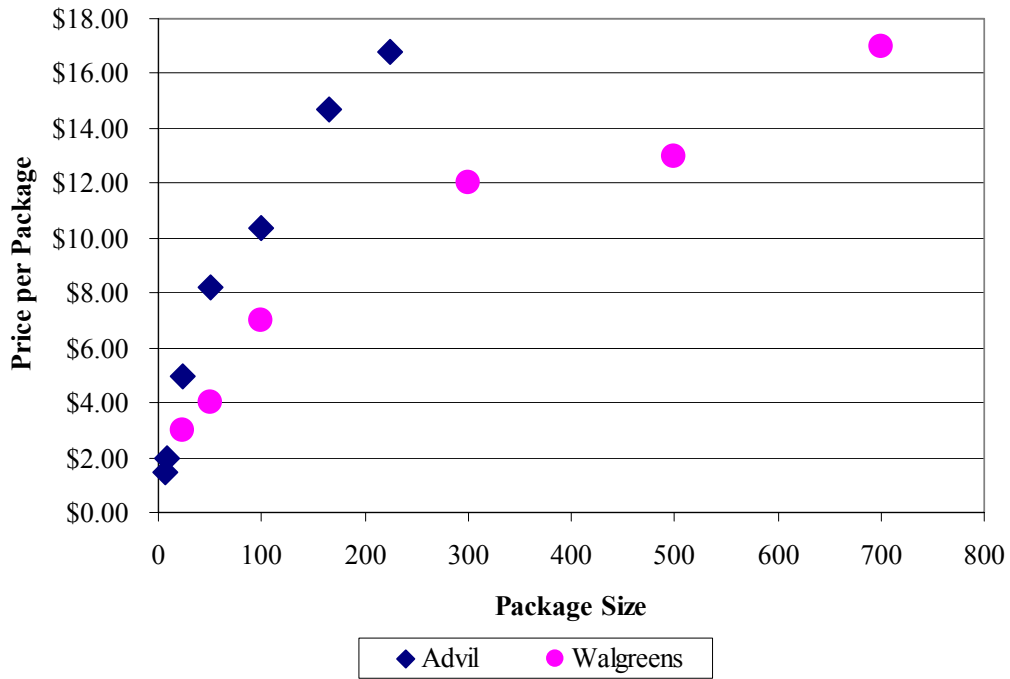


Figure 2. Ibuprofen Prices

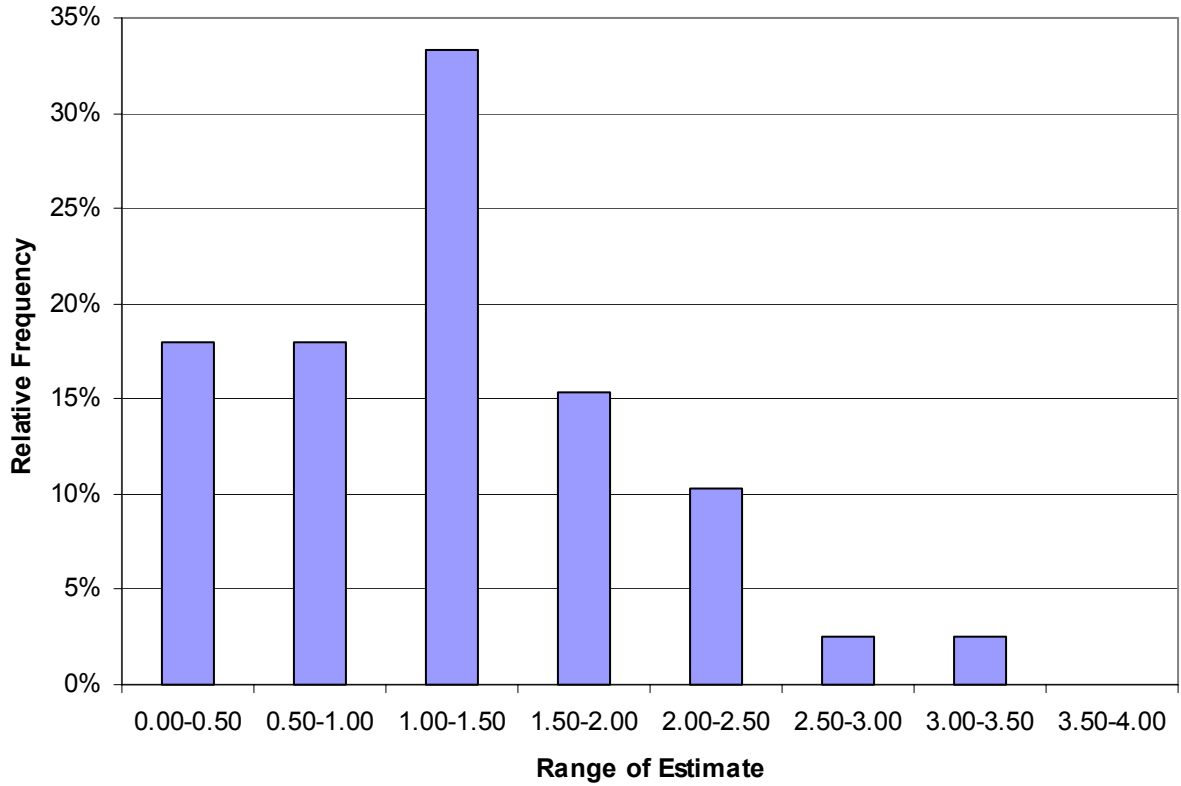


Figure 3. Estimated Lower Bounds of Offering Average Fixed Costs