AUDIENCE CHARACTERISTICS AND BUNDLING: 
A HEDONIC ANALYSIS OF MAGAZINE 
ADVERTISING RATES 

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Centre for Marketing Working Paper 
No. 99-301 
April 1999 

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AUDIENCE CHARACTERISTICS AND BUNDLING:
A HEDONIC ANALYSIS OF MAGAZINE ADVERTISING RATES

ABSTRACT

Advertisers purchasing advertising space in a magazine usually acquire a bundle of demographically distinct reader segments. Increasingly, however, a publisher of a magazine is able to unbundle its reader base by offering editions with customized advertising content for specific reader segments. Thus, a publisher could offer potential advertisers all readers of the magazine (pure bundling), only individual reader segments (pure components pricing) or a combination of the two (mixed bundling), thereby generating interesting pricing and strategy options.

Using data on advertising rates and reader demographics from syndicated services, we estimate the shadow prices of reader characteristics within a hedonic framework. These shadow prices are used to determine the prices that could potentially be obtained under each bundling strategy. We find that the predicted magnitude of the price and revenue premiums earned by “unbundling” a magazine’s male and female readers are substantial. Also, in terms of the pricing of magazine advertising space, we find that a pure component strategy is generally preferable to pure bundling, which is consistent with much of the recent theoretical work on bundling.

Keywords: advertising, bundling, pricing, hedonic analysis.
Introduction

In the United States, the market for print media is characterized by a symbiotic relationship between publishers and advertisers. The revenue derived from providing advertisers with advertising space usually account for a significant proportion of all the revenue generated by any given publication. In turn, publishers provide advertisers with an audience for commercial communication. The relationship between publishers and advertisers is reflected in the observed market prices of advertising space.\(^1\) We empirically explore this relationship for an important segment of the U.S. print media market, namely the market for leading consumer magazines.

Understanding the determinants of advertising media pricing has recently gained in importance since media distribution is increasingly characterized by the ability to target individual audience segments with specific consumption characteristics. For example, publishers can now sell advertising space segmented by regions of the country, while electronic delivery makes it possible for publishers to target even smaller audience segments. Nowadays, it is even possible to customize advertising content for individual subscribers. As a result, understanding the relationship between media pricing and audience characteristics is an important part of understanding the strategic options available to publishers and broadcasters.

In general, little work has been conducted on tying the price of advertising space to underlying audience characteristics, the focus of the present study.\(^2\) Through a hedonic framework (e.g., Griliches 1971, Rosen 1974), we empirically assess the relationship between the price of advertising space in a magazine and the demographic composition of its readers. Thus, the first objective of this research is to quantify the relationship between the underlying characteristics of a magazine’s audience and the market price of its advertising space. This is important since differential valuation of audience characteristics may give rise to non-linear pricing effects, which can have important strategic implications in an environment where publishers have the ability to “unbundle” advertising space.

\(^1\) We use the industry terms advertising rate and the cost of advertising interchangeably with the price of advertising space throughout the paper.

audience segments. Estimating these non-linear pricing effects and understanding their implications for potential bundling strategies within this environment constitutes the second and principal objective of our research.

The paper is organized as follows. The next section develops the motivation for the empirical analysis and discusses the relevant bundling and non-additive pricing issues. The third section outlines the institutional setting and current advertising and media buying practices. The empirical analysis is described in the fourth section, while the fifth section provides a discussion of the empirical findings in their institutional context.

**Non-Additive Pricing and the Bundling of Audience Segments**

_The bundling of audience segments_

When an advertiser purchases space in a magazine, it buys the opportunity to present its product to the readers of that magazine. Magazines vary considerably in terms of the demographic diversity of their readers. For example, with respect to age, certain publications such as Teen have a demographically concentrated readership, while other publications such as Time have readers that are demographically more diverse. An advertiser that purchases advertising space in a magazine with diverse readers usually acquires not just a single demographic reader segment, but a bundle of demographically distinct segments. It is this notion of bundling - a magazine’s bundling of demographically diverse readers - which we shall refer to throughout the paper.

The sweeping changes of the last few years in the media delivery infrastructure make it is increasingly possible for magazines to “unbundle” audience segments by selling advertising space to advertisers wishing to purchase specific segments of readers (as opposed to the entire set of readers for a given magazine). As a result, publishers will be presented with the opportunity to offer strategic bundling options to media buyers. We will define the selling of individual demographic segments separately as a pure components strategy, and exclusively selling the entire set of readers for a given magazine (the norm in the industry) as a pure bundling strategy. Offering buyers both options simultaneously will constitute a mixed bundling strategy.³ Recent research has demonstrated that under certain circumstances a pure components strategy can be preferable to a pure bundling strategy.

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³ Previous research on bundling touches on many aspects, yet is under-developed. We will not attempt to review the literature here. Some recent examples include work on the type of good offered in the bundle (Matutes and Regibeau 1992, Harlam, et al. 1995), the role of prospect theory and price expectations (Kaicker, Bearden and Manning 1995), and premium pricing and partner selection (Venkatesh and Mahajan 1997).
(Venkatesh and Mahajan 1993, Braden 1993, Salinger 1995, Sinha and Reddy 1997), suggesting that adopting a pure components pricing strategy (or a mixed bundling strategy where appropriate) has the potential to be an important strategic tool in the selling of advertising space.

In order to understand the options available to magazine publishers, we begin by taking the perspective of a specific magazine (denoted \( n \), with \( N \) magazines in the entire market). To keep this illustration simple, we will assume that this magazine currently offers only one option: each potential advertiser is offered the opportunity to reach all of the magazine’s subscribers via the placement of a full-page ad. Based largely on the composition of its readers and the size of its circulation, the magazine is able to charge a price of \( P^n (n = 1, \ldots, N) \) for a full-page insert.\(^4\) The magazine is contemplating “unbundling” its subscriber base, \( i.e., \) offering potential advertisers the option of purchasing individual segments of readers.\(^5\) Note that unbundling in this fashion is tantamount to offering advertisers multiple editions of the same magazine, each edition having the same editorial content and its own unique homogeneous readership, albeit with a much smaller circulation.

More formally, let the readers of magazine \( n \) be described by the customarily used three demographic variables age, income and gender. We break age and income into four distinct categories, and gender into two. Denote the age distribution of the readers of magazine \( n \) by \( A^n \equiv \{A_1^n, A_2^n, A_3^n, A_4^n\} \), where \( A_k^n (k = 1, \ldots, 4) \) denotes the fraction of the readers of magazine \( n \) in age category \( k \), with \( \Sigma_k A_k^n = 1 \). Denote the income distribution of readers in magazine \( n \) by \( I^n \equiv \{I_1^n, I_2^n, I_3^n, I_4^n\} \). Similarly, \( G^n \equiv \{G_1^n, G_2^n\} \) denotes the gender distribution of magazine \( n \). Finally, denote the circulation of magazine \( n \) by \( C^n \). We will assume that in the short-run, the magazine’s readership is fixed and the problem currently being faced is the choice of an appropriate bundling strategy given its current readership base.

Traditionally, a magazine could only offer its entire set of readers to a potential advertiser. Due largely to technological constraints, each publisher was forced to adopt a pure bundling strategy. In characteristics space, we will denote the price of advertising space for magazine \( n \) as

\(^4\) We will assume that, based upon the makeup of its subscriber base as well as demand and supply conditions in the market, each magazine is a price taker, \( i.e., \) that it cannot influence market price by increasing its supply \( (e.g., \) through increasing the available ad pages in each issue), which is essentially true in the current empirical application.

\(^5\) In principle, a magazine could completely unbundle, selling individual subscribers. Since the available syndicated sources break down each magazine’s subscriber base only into distinct demographic segments \( (e.g., \) age, income and gender), we will assume for now that the segmentation is only possible on a per-segment basis. We note that the analysis conducted below could quite easily be extended to the individual subscriber case.
$P^n (A^n, I^n, G^n | C^n)$, which represents the market price of magazine $n$ given the current demographic profile and circulation. We will define this price as the pure bundling price. Under a pure components strategy, an advertiser can individually purchase specific demographic groups. Given this setting, we
can represent the 32-dimensional \((4 \times 4 \times 2)\) array of components prices for firm \(n\) as \(\Omega^n \equiv [P^n(A^n_{(1)}, I^n_{(1)}, G^n_{(1)} \mid C^n_{111}), \ldots, P^n(A^n_{(4)}, I^n_{(4)}, G^n_{(2)} \mid C^n_{442})]\), where \(A^n_{(1)}\), for example, is defined by the distribution \([1, 0, 0, 0]\). Note that the term \(C^n_{442}\), for example, represents the number of individuals in age category 4, income category 4 and gender category 2 for magazine \(n\), with \(\Sigma \{C^n_{111}, \ldots, C^n_{442}\} = C^n\). We note that, for each individual segment, the equilibrium price of advertising space is determined by the respective demand and supply of readers \textit{in that segment} (\(i.e.,\) for segment \(abc\), \(\phi^d(\{A^n_{(a)}, I^n_{(b)}, G^n_{(c)} \mid C^n_{abc}\}) = \phi^s(\{P^n_{(1)}(A^n_{(a)}, I^n_{(b)}, G^n_{(c)} \mid C^n_{abc}\})\), where \(\phi^d\) and \(\phi^s\) denote aggregate market demand and supply functions, and \(*\) denotes equilibrium. Thus, the market price is determined in attribute space, enabling us to express equilibrium price as a function of the individual attributes (Rosen 1974).

In principle, if we had an estimate of the relationship between the price of magazine \(n\) and the demographic composition of its readers (\(i.e.,\), estimates of the shadow prices of these characteristics), we could predict a market price for any hypothetical set of audience characteristics, including the pure components price vector \(\Omega^n\). These shadow prices would provide an estimate of the prices that a magazine could command if it decided to unbundle its readers for potential advertisers. Fortunately, we have such a technique available, namely hedonic analysis, which is discussed below.

Thus, we proceed as follows. First, we estimate the shadow prices of reader characteristics for 101 leading consumer magazines using hedonic analysis. Then, based on these estimated shadow prices, we calculate the equilibrium prices for each audience segment for each of the 101 consumer magazines. This enables us to calculate the potential pricing and revenue implications of switching from a pure bundling strategy to a pure components strategy. Finally, the mixed bundling option is discussed.

**Circulation and non-additive pricing effects**

Before we discuss estimation of the shadow prices, we note that the bundling of reader segments is likely to give rise to non-additive pricing effects. In the current context, non-additive pricing is observed when the advertising rate for a bundle of reader segments is different than the sum of the expected rates for the individual segments. The source of this non-additivity may be derived from at least two separate factors: i) cost considerations and circulation effects, and ii) heterogeneity in advertisers’ reservation prices for the individual segments and related bundling strategies. In order to understand and predict changes in advertising rates due to the bundling or
unbundling of readers, it is important to consider these two factors separately. Consequently, we will separate out these two effects in our analysis below.

With respect to costs, previous work on bundling has focused on the distribution of reservation prices, while assuming a zero marginal and additive cost structure (Stigler 1968, Adams and Yellen 1976, Schmalensee 1982, Braden 1993). However, Salinger (1995) shows that the profitability of different bundling strategies will depend, in part, upon the cost implications of bundling. Here, the bundling of two demographic groups produces a larger total circulation and readership. Since per-copy costs often decline as circulation increases due to scale economies in the production of editorial content, printing, and distribution, it is possible that any observed change in price that results from the bundling of two distinct reader segments could simply be the result of the larger resulting circulation. This suggests that a careful investigation into bundling and related non-additive pricing structures in the current context should appropriately control for the impact of different circulation levels.

Once we control for cost considerations and circulation effects, we can isolate non-additive pricing effects related to advertisers’ reservation price heterogeneity and non-linear demands. Since the syndicated data used in the empirical analysis are published in categorical format, we characterize the demographic composition of a magazine’s readers by the fraction of customers in distinct demographic categories. After controlling for circulation, under homogeneous reservation prices, the advertising rate should be a linear function of the fraction of readers in each category, while heterogeneity in advertisers’ reservation prices can result in deviations from a linear pricing structure. Figure 1 illustrates deviations from a linear pricing structure, resulting in potential bundling penalties and premiums for the variable gender, holding circulation constant.

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6 Under scale economies in circulation, the cost $C(a)$ of generating an audience of type $a$ and size $S(a)$ plus the cost $C(b)$ of producing an audience of type $b$ and size $S(b)$ is greater than the cost $C(a+b)$ of producing an audience with both $a$ and $b$ types and size $S(a) + S(b)$. More formally $C(a) + C(b) > C(a+b)$, which violates the cost additivity assumption inherent in most of the previous work on bundling. Under circulation-related scale economies, we would expect a convex relationship between circulation and advertising rates.

7 Alternatively, advertisers may be homogeneous in their preferences for specific demographic groups, but desire to position their product differently to different segments (e.g., a “value” positioning to lower income groups and a “quality” positioning to higher income groups). This would also imply a non-additive pricing structure. It is not our intent to separate the reasons for non-additive pricing in this regard; rather, we investigate the implications of a non-additive pricing structure.

8 A “bundling premium” exists when the cost per thousand of a bundle of readers (a mix of men and women) is greater than the average cost per thousand for the individual components (e.g., all male readers versus all female readers). A “bundling penalty” exists when the cost per thousand of the bundle is less than that of the individual components.
Figure 1: Deviations from a linear pricing rule - possible relationships between demographic concentration and price.

In summary, it is important that special attention be paid to the shape of the functional relationship between demographic variables and advertising rate. Specifically, a model should allow for departures from a linear pricing specification and control for circulation. Recognizing the importance of this functional relationship, we will let ourselves be guided by semi-parametric techniques to identify the appropriate form of the functional relationships.

Measuring characteristics shadow prices - The use of hedonic analysis

Hedonic analysis, with a long tradition in economics (see, e.g., Griliches 1971, Cowling and Cubbin 1972, Rosen 1974, Berndt 1991, Harchaoui and Hamdad 1997), is based on the premise that a differentiated product can be described by an objectively measured set of characteristics. Since market price is expressed as a function of a product’s characteristics, the availability of objective measures of a product’s characteristics combined with observations on market prices allow a researcher to estimate the implicit or “shadow” price of each characteristic. Thus, for a given product, the market price can be broken down into its individual components, namely the characteristics of the product itself. In our analysis, we apply this framework to the market for
Thus, we proceed in the following manner. First, we express the price of a one-page full colour insert as a function of the demographic characteristics of a magazine’s readers, including the size of its readership. Using data from commonly used syndicated sources, we are able to derive estimates for the shadow prices for each demographic characteristic. From the shadow prices, we can then predict the market prices that a magazine could charge if it were able to unbundle its individual audience segments. From these estimated prices, we examine the implications of each bundling strategy. In doing so, we will compare the pricing and profitability implications of a pure bundling and a pure components strategy, while discussing possible mixed bundling strategies.

**Institutional Detail and Data**

Firms use a variety of variables, such as lifestyle and benefit variables to characterize their respective customer targets. Ultimately though, standard demographic variables such as gender, age, and income dominate. Once a customer target is defined, advertisers choose magazines in which to place the ads using syndicated services that provide relevant information for most major magazines including a standard demographic breakdown of the readership of each magazine. Since the syndicated sources on price used by media buyers essentially provide “list price,” we have also gathered data from *Advertising Age*, a trade publication that compiles annual summaries of each major consumer magazine’s ad revenues and number of ad pages. The specific data chosen for this analysis are circulation and demographic data published midway through 1990.10 The corresponding cost data are the data published in January 1991. Hence, we allow for a lag of six months between

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9 Although supply and demand conditions determine the ultimate market price (as well as all shadow prices), the hedonic framework employed in our analysis is primarily concerned with the outcome of price-setting mechanism in characteristics space, not necessarily with the underlying price setting mechanism. See Erlich and Fisher (1982) for a classic study of the demand for advertising.

10 We use 1990 data since 1990 was one of the last years where the prices paid by advertisers for advertising space were very close to the ones posted by the magazine publishers (this is confirmed by the high correlation between the list data and the transactions price data used in our analysis). Over the last few years, the simple exchange of advertising space for a set amount of money has been replaced by elaborate negotiations of packages that no longer just include advertising space in magazines. These packages include, in addition to the advertising space, promotional activities such as sweepstakes and in-store displays that the publisher undertakes on behalf of the advertiser. Thus, one may surmise that today a magazine’s advertising rates also reflect the value of intangibles on which there are no published data and that are of minor interest for the current analysis. Worse yet, these intangibles could easy confound the hypothesized relationships, potentially undermining our empirical analysis.
the publication of the explanatory variables and the publication of our chosen response variable, allowing sufficient time for the data on readership characteristics to disseminate and to affect the advertising rate. Table 1 summarizes the data used in our analysis.

**Table 1:** Data used in the empirical analysis

<table>
<thead>
<tr>
<th>Cost</th>
<th>The cost figure used in our analysis is the rate for a full-page one-time color insert. Most media planners obtain the rate information from Standard Rate and Data Service (SRDS), a company that, on a monthly schedule, compiles and publishes the advertising rates for several thousand of the largest magazines in the U.S. SRDS was the source of the “list price” used in the final analysis. In addition, we calculated “transaction price” as the ratio of annual advertising revenue and total ad pages as reported by Advertising Age for 1991.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Circulation</td>
<td>Circulation refers to the number of copies produced and distributed for a specific issue of a magazine. There are several different ways of measuring circulation. The most frequently used circulation figures, which are used in the present analysis, are audited by the Audit Bureau of Circulation (ABC) and reported by SRDS. Since these figures represent 12 month averages, they reduce much of the issue to issue variation and are, therefore, well suited for analysis and planning purposes.</td>
</tr>
<tr>
<td>Readership Size and Demographics</td>
<td>In the United States, magazine audience measurement is dominated by two services, Mediamark Research, Inc. (MRI) and Simmons Market Research Bureau (SMRB). Both services use probability samples of adult readers of magazines, but differ in their methods of questioning the respondents. SMRB uses a method called <em>Through the Book</em>, where respondents are taken through stripped-down issues of magazines, asked whether they have read or looked at these particular issues before, and are classified accordingly. MRI uses a method called <em>Recent Reading</em>, where respondents are asked whether they have read particular issues of magazines. Both services provide a breakdown of the measured readership by gender, age, and income. Media departments of most major advertising agencies subscribe to either service, but rarely to both. However, the two methods of measurement do not produce equal results – the <em>Recent Reading</em> method tends to produce larger audience numbers than does the <em>Through the Book</em> method. This discrepancy has stirred an on-going debate regarding the overall validity of the two methods (Appel 1993, Mallet 1993).</td>
</tr>
</tbody>
</table>
Empirical Analysis

Variables specification

We include in our analysis only magazines that, for specified time periods, are covered by all three syndicated data services (SRDS, MRI, and SMRB). This choice leaves us with 101 magazines for 1990. We note that our analysis was performed for both “list” and “transactions” price, producing consistent results.\(^\text{11}\) Only the results from the analysis using the “list price” will be presented below.

The data on cost of advertising space and circulation enter the analysis unchanged as provided by SRDS. The data on the size and the demographic composition of the magazines' readers, on the other hand, need some attention. While both MRI and SMRB provide readership frequency counts for different age, gender, and income categories, there is a slight difference in the firms' respective definition of these categories. We take this as an opportunity to redefine the age and income categories to make them more directly comparable not only across data vendors, but also within the demographic framework discussed earlier. Specifically, we define four age categories and four income categories. For each variable, we define the category boundaries so that approximately one fourth of measured total readership falls into each category.\(^\text{12}\) We then calculate the fraction of readers in these re-defined categories from the data published by MRI and SMRB. The following variables are used in the subsequent analysis (subscripts denoting individual magazines are omitted for ease of presentation):

\[
\begin{align*}
y & : \text{cost for a one-time, full-page, four-color insert} \\
x_c & : \text{circulation} \\
x_r & : \text{total number of readers} \\
x_{a2} & : \text{fraction of readers between 29 and 39 years of age} \\
x_{a3} & : \text{fraction of readers between 40 and 53 years of age}
\end{align*}
\]

\(^{11}\) This is not at all surprising given the correlation between the two prices (\(\rho = .975\)). We prefer using the “list price” since the “transaction price” is likely to contain some degree of noise (i.e., price elements not directly related to magazine characteristics including volume discounts). Nonetheless, the use of the “transactions price” provides a convenient external validity check for our results.

\(^{12}\) Not surprisingly, the data furnished by MRI and SMRB are highly correlated. After some preliminary analysis, we combined the MRI and SMRB data and considered weighted averages of the size of readership and the fraction of readers in the different demographic categories. The weighting factors, .7 for MRI data and .3 for SMRB data, were found by including these factors as parameters in the regressions described below and estimating by the least squares method. The heavier weight for the MRI data corresponds nicely to MRI's stronger position in the market for syndicated data. It turns out that the weighting factors are of minor importance here as the substantive conclusions do not change with the choice of weighting factors.
$x_{a4}$ ..... fraction of readers over 53 years of age
$x_{i2}$ ..... fraction of readers with annual household incomes between $21,500 and $36,500
$x_{i3}$ ..... fraction of readers with annual household incomes between $36,500 and $56,000
$x_{i4}$ ..... fraction of readers with annual household incomes over $56,000
$x_w$ ..... fraction of female readers

Related variables of importance are:

$y^*$ ..... log (cost for a one-time, full-page, four-color insert)
$x_c^*$ ..... log (circulation)
$x_{rc}^*$ ..... log (readers per copy in circulation) = log (circulation/total number of readers )

The variables $x_{a1}$ (fraction of readers under 29 years of age) and $x_{i1}$ (fraction of readers with annual household incomes under $21,500$) are not included since $x_{a1}, x_{a2}, x_{a3}, x_{a4}$ and $x_{i1}, x_{i2}, x_{i3}, x_{i4}$ add up to 1, respectively. In our statistical analyses, we will use the logarithmic transformations $y^*, x_c^*, x_{rc}^*$. These customary ad hoc transformations symmetrize the residual distribution and stabilize its variance. Furthermore, they considerably reduce kurtosis and correlation in the explanatory variables, thus simplifying the estimation and statistical interpretation of the analytical models.

A semi-parametric analysis of the shape of the functional relationship

As pointed out earlier, the shape of the relationship between price and underlying demographic characteristics is of particular importance for assessing the presence of any non-linear pricing effects. As a result, we first use semi-parametric estimators to guide the functional form specification. In this manner, the data can directly suggest the shape of the functional relationship in question. This analysis results in the formulation of a parsimonious parametric response model.

The tools used in this analysis are semi-parametric regression methods that make minimal assumptions regarding the functional form of the relationship. As a practical matter, we do need to make a few specific assumptions about the functional relationship in question, because the number of data points relative to the number of explanatory variables is small. In particular, we will assume that the relationship is linear in some smooth and estimable transformations of the explanatory and the response variables. This assumption results in a flexible model that can be accurately estimated and that is easy to interpret. In the mathematical formulation, let $D$ be the set of indices of the demographic variables, that is, let $D = \{a2, a3, a4, i2, i3, i4, w\}$. Furthermore denote by $\phi, \psi_c, \psi_{rc}$.
ψ_d (d ∈ D), smooth (and \textit{a priori} unknown) univariate functions, and by ε a random variable with 0 expectation. We considered the model:

\begin{equation}
\phi(y^*) = \psi_c(x_c^*) + \psi_{rc}(x_{rc}^*) + \sum_d \psi_d(x_d) + \epsilon.
\end{equation}

The formal part of the analysis consists of two steps, namely estimating the functions \(\phi, \psi_c, \psi_{rc}, \psi_d\), and constructing uncertainty bounds for these estimates. For the estimation of the unknown functions we use ACE (Breiman and Friedman 1985) and for the construction of the uncertainty bounds we use the Bootstrap (Efron and Tibshirani 1993). For the data, the model provides an excellent fit with a multiple \(R^2\) of .97.

Based on careful inspection of the estimates, we conclude that there seems to be little evidence that these functions, with the possible exception of \(\psi_w\), are anything other than linear. This motivates the parametric model of the following section. Before we turn to such a model, we would like to emphasize that the functional specification is the result of a detailed and careful semi-parametric analysis.

\textit{Parametric estimation of final model}

While non-parametric regression methods offer considerable flexibility in analyzing the shape of the relationship between variables, parametric regression methods have advantages of their own. These include providing a parsimonious summary of the underlying relationship, generating statistically efficient estimates, and providing the means of extrapolating predictions beyond the range of the data used in the analysis. With this in mind, we first propose the following (full) model:

\begin{equation}
y^* = \alpha_0 + \alpha_c x_c^* + \alpha_{rc} x_{rc}^* + \alpha_w x_w + \alpha_{w2} x_w^2 + \alpha_{d2} x_{d2} + \alpha_{d3} x_{d3} + \alpha_{d4} x_{d4} + \alpha_{i2} x_{i2} + \alpha_{i3} x_{i3} + \alpha_{i4} x_{i4} + \epsilon.
\end{equation}

The \(x\) variables and the \(y\) variable are defined as before, the \(\alpha\) are unknown parameters that need to be estimated, and \(\epsilon\) is a random variable with expectation 0 and variance \(\sigma^2\). The \(\epsilon\) across magazines are assumed to be independently and identically distributed. The results from the non-

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13 The Bootstrap method is implemented as follows: a simple random sample with replacement, the Bootstrap sample, is taken from the set of 101 magazines. Given a particular Bootstrap sample of 101 magazines, we estimate afresh the functions \(\phi, \psi_c, \psi_{rc}, \psi_d\) using ACE and denote these estimates by \(\phi^b, \psi_c^b, \psi_{rc}^b, \psi_d^b\). Repeating this process a thousand times generates one thousand \(\phi^b, \psi_c^b, \psi_{rc}^b, \psi_d^b\) with corresponding empirical distributions which are used to construct confidence bounds.
parametric analysis support a model that is linear in all the explanatory variables other than $x_w$. To account for the possibility that $y^*$ is curvilinear in $x_w$, we have included the term $x_w^2$.

We use ordinary least squares (OLS) methods to estimate the parameters of this model. It turns out that the variables $x_{a3}, x_{a4}, x_{i2},$ and $x_{i3}$ have no discernible impact on the response variable; an F-test (at a significance level of .01) confirms that there is no evidence that $\alpha_{a3}, \alpha_{a4}, \alpha_{i2}, \alpha_{i3}$ either individually or collectively differs from 0.\(^{14}\) We therefore re-estimate the model without including these variables. These results are displayed in Table 2.\(^{15}\)

< Table 2 about here >

Interpretation of results

We first concentrate on providing a substantive interpretation of the results. Unless noted otherwise, we base our interpretation on 95% confidence intervals and tests of hypotheses; references to significant results imply a test of hypotheses at a significance level of .05.

Circulation and Readership: We start by noting that $\alpha_c$ and $\alpha_{rc}$ are significantly less than 1. The relationship between circulation and cost per insert, all other variables held fixed, is convex with diminishing returns. Increasing circulation by 100% increases the cost per insert by only 79% and, as a result, the cost-per-thousand decreases as circulation increases. Similarly, $\alpha_{rc}$ is significantly greater than 0, but it is also significantly less than $\alpha_c$. Hence, both total readership and circulation affect cost per insert, but they do so non-symmetrically – doubling the readership by doubling circulation (and keeping the number of readers per copy constant) increases cost per insert by 79%, but doubling the readership by doubling the number of readers per copy (and keeping circulation constant) increases cost per insert by only 33%.

Demographic Characteristics and Diversity: The coefficients corresponding to the fraction of readers between 29 and 39 years of age and the fraction of readers with household incomes over $56,000 are highly significant, presumably reflecting the premium that advertisers place on readers in these

\(^{14}\) In addition, we included a series of interaction terms, allowing for the possibility that income and age interact in the determination of price. However, an F-test (at a significance level of .01) provided no evidence that these interaction terms either collectively or individually differed from 0 within the context of the model employed. Consequently, we present the most parsimonious specification here.

\(^{15}\) We examined the residuals produced under OLS using a Box-Pierce Q statistic (see Greene 1997, pp. 548-555) and could not reject the null hypothesis of homoscedastic errors at $p = 0.05$ or better.
respective categories. Although we find no evidence of a non-linear relationship between the response variable and age and income, respectively, the parametric model provides confirmation that there is indeed a non-linear relationship between the gender variable and cost per insert. In our model, this relationship is captured by a second order polynomial. It is worthwhile to explore for what value of $x_w$ this polynomial attains its minimum. We use the Bootstrap method (Efron and Tibshirani 1993) to construct a 95% confidence interval for this minimal $x_w$. This confidence interval is found to be (0.45, 0.85). Since the minimum is between the endpoints, the minimum of any monotonically increasing transformation will be between the endpoints as well. Hence, everything else being equal, the cost per insert in a magazine with mixed readership is lower than the cost per insert in a magazine with an exclusively male or female readership. The relationship between the gender variable and cost per insert is indeed not linear. This provides evidence of a non-additive pricing structure (as presented earlier in Figure 1).

The Impact of “Unbundling”

Bundling versus circulation effects – pricing implications

It is interesting to speculate what implications these findings have for the future pricing of advertising space in media markets. It is becoming increasingly viable to deliver targeted reader segments to individual advertisers. For example, *Time* is able to customize an individual issue in terms of its advertising content for male and female subscribers. With the growth of electronic delivery of magazines, customization of advertising for specific reader segments even individual readers will also grow as it becomes a low cost option. Consequently, it is interesting, and potentially quite important, to speculate about the pricing implications of the process of “unbundling” reader segments. We use our empirical results to investigate this question.

We begin by speculating about the price premium that a publisher could extract if she offered two separate editions of her magazine that were read exclusively by women and by men, respectively. We first address the case where a magazine is able to “unbundle” its current readers and deliver two separate publications each with reader segments homogeneous in gender, but where the combined circulation of the two separate publications equals that of the original publication. Thus, if a magazine's total circulation is $x_c$, we assume that the circulation of the edition for women would be $x_c x_w$ and $x_c (1 - x_w)$ for men. Using these circulation figures, we calculate the predicted advertising rates for the two editions using the regression model summarized in Table 2.
The price premium obtained by “unbundling” male and female readers is measured by the ratio of the sum of the predicted advertising rates for the two editions and the predicted advertising rate of the magazine overall. For the 101 magazines that are used in the analysis, the distribution of ratios are displayed in Figure 2, Ratio C. The total premium for “unbundling” male and female readers varies from 10% (a ratio equal to 1.1 in Figure 2) to almost 50% (a ratio of 1.5).

This calculation of this price premium measures the effect of producing two separate editions, each of smaller circulation and homogeneous gender composition. Thus, the pricing effects shown in Figure 2C result from the combined effect of homogeneous gender and a smaller circulation. In order to assess the relative contribution of gender versus circulation-related cost effects, we now consider a slightly different scenario from the one above. Under this scenario, we measure the circulation effect due to producing two smaller publications. Again assume that a publisher of a magazine with circulation $x_c$ decides to publish two editions with circulations of $x_c x_w$ and $x_c (1 - x_w)$, respectively. Now, however, both editions are assumed to have the same original fraction of female readers, $x_w$. Again we calculate for each magazine the ratio of the sum of the predicted advertising rates for the two editions and the predicted advertising rate for the magazine. These ratios are displayed in Figure 2, Ratio A; the premium representing the higher price solely due to the smaller circulation for the two individual publications varies from 5% to 18%.

The premium due solely to providing editions of homogenous gender composition can be inferred by comparing the circulation effect measured in the second scenario (Ratio A) to the total effect measured in the first scenario (Ratio C). The corresponding ratios provide a measure of the price premium earned due solely to providing advertisers with segments homogeneous in gender, controlling for price effects due to the smaller circulation of the two individual publications. These ratios are displayed in Figure 4, Ratio B; the premium due to producing homogenous editions varies from 5% to 28%. Hence even in the absence of a circulation effect, the pricing benefits of "unbundling" male and female readers can be substantial.

**Bundling versus circulation effects – revenue implications**

Most often, component prices are observed and researchers ask under what conditions might bundling be profitable (e.g., Adams and Yellen 1976, Braden 1993, Salinger 1995). Here, we face
the opposite situation where, due largely to institutional and technological constraints, pure bundling strategy is the norm and we are interested in the impact of shifting to a pure components strategy. For illustration, in the section above, we addressed the pricing implications of unbundling male and female readers; here, we focus on the impact of unbundling the magazine’s existing readership base on total magazine revenue. As such, we are not just concerned about gender (as above), but about the entire demographic makeup of the magazine’s readership base.

We take the perspective of a single magazine (with a given demographic makeup and circulation base) and attempt to assess the change in revenue that would result if the magazine switched from a pure bundling to a pure components strategy. We proceed as follows. Using the MRI, SMRB and U.S. Department of Commerce (1992) data, we first divide each magazine’s circulation into the 32 distinct reader segments (4 age x 4 income x 2 gender categories) introduced earlier. Then, using the parameter estimates from the hedonic analysis (Table 3), we produce estimates of the price that would be obtained for each of the 32 segments (using the earlier notation, we generated estimates of $\Omega^n \forall n = 1, \ldots, N$). These price estimates, combined with the individual segment circulation and the number of ad pages, provide the information necessary to calculate the estimated revenue generated under a pure components strategy for each of the 101 magazines. These revenue predictions are then compared with current revenues generated under a pure bundling strategy.

Table 3 presents the results for the two bundling strategies. Consistent with the pricing results for gender above, a pure component strategy results in a significant increase in overall revenue versus pure bundling on average. For example, the predicted mean revenue increase when shifting to a pure component strategy across the 101 magazines was 21.1%. Some of the revenue increases were dramatic. For example, four magazines (Architectural Digest, Ski, Shape and Yankee) had predicted revenue gains of over 100%. Others were nearly as large – Skiing (88.5% revenue increase), Parents (87.6), and American Baby (80.0) all had predicted revenue gains over 80%. In contrast, eight magazines (Good Housekeeping, Life, Sports Illustrated, Sports Afield, The Family Handyman, Time, U.S. News & World Report, and Working Mother) saw their predicted revenue decrease as the result of a shift to a pure components strategy (although all of the predicted revenue decreases were less than 10% in magnitude).
Not surprisingly, the publications that stood the most to gain by shifting to a pure components strategy were those with a higher proportion of readers in the most desirable categories – publications with a higher percentage of consumers in both the highest income and the 20-29 age category saw substantial increases in predicted total revenue. On the other hand, magazines possessing a broad readership base with few readers in the most desirable categories tended not to gain, or to gain little, from unbundling their readership base. These results highlight the trade-off made in bundling decisions (e.g., Adams and Yellen 1976). Moving to a pure components strategy entails pricing for segments with a lower circulation, but with a more demographically concentrated readership. If there are not enough readers in the desirable categories, the decrease in revenue due to a lower segment circulation is not enough to offset the gains from the more concentrated readership.

More generally, we note that early research on bundling (e.g., Stigler 1968) had suggested that pure bundling dominates pure components pricing in terms of profitability (see Braden 1993 for a discussion). Recent research, however, has suggested that under certain demand (Salinger 1995, Sinha and Reddy 1997) and cost (Braden 1993, Salinger 1995) conditions, a pure components strategy can be more profitable than pure bundling. For example, Salinger (1995) finds that when bundling lowers costs (as is likely in the present case given the circulation results), a pure components strategy tends to be more profitable when demands for the components are negatively related and when marginal component costs are low. Although publishers’ costs are usually proprietary, one may speculate that both conditions are likely to be met in the present case, implying that a pure components strategy would, in general, be more profitable than pure bundling. This is consistent with the magnitude of the revenue effects shown in Table 3 – for most magazines in our sample, it is hard to imagine a scenario where the dramatic growth in revenue would not be profitable.

Alternatively, Venkatesh and Mahajan (1993) suggest that a mixed bundling strategy can be more profitable than either a pure bundling or a pure components strategy provided that the relative prices of the bundle and components are chosen carefully. A hedonic analysis of the type presented here used in conjunction with other recent research can guide individual publishers in such a way as to design an appropriate optimal pricing schedule (see, e.g., Hanson and Martin 1990). For example, combined with valuation approaches (e.g., Venkatesh and Mahajan 1997), the hedonic analysis discussed above can be particularly useful since they relate a magazine’s offering characteristics (in terms of demographics and circulation) to the actual underlying market price determined by
aggregate demand and supply conditions. Thus, information on advertiser valuation, production and distribution costs, and an understanding the relationship between a magazine’s product offering and market price can provide a publisher with the appropriate information that can facilitate the choice of pricing structure in designing a mixed bundling strategy.

Conclusions, Limitations and Future Research

The results presented above provide a commentary on various aspects of the print media business. We find, as expected, that circulation and readership increase market price, albeit with diminishing returns. Publications whose readers are concentrated in the 29 to 39 year old range earn a premium, as do publications with a higher income audience. Further, in general, there are substantial pricing and revenue benefits to be gained by moving from a pure bundling to a pure components strategy. A central objective of this paper has been to quantify these effects.

At face value, we believe that these results tell a compelling story about media pricing behavior. Clearly, there are opportunities for firms to target individual magazines to individual reader segments. This is now possible due to changes in the delivery infrastructure. Our analysis has suggested that there can be significant benefits inherent in a shift to a pure components strategy. Nonetheless, there are a number of issues that warrant further attention. For example, it comes as little surprise that the number of a magazine's readers affects the cost of advertising space. It is, however, not entirely obvious why both circulation and total readership separately affect cost per insert. We suspect that this is due in part to the difference between primary readers (the ones who purchase a magazine) and secondary readers (all other readers). Note that the number of primary readers is equal to circulation, while the number of primary and secondary readers equals total readership.

Not surprisingly, price premiums are paid for advertising space in magazines with a high fraction of young, affluent readers. The premiums paid for magazines with a high fraction of readers in the 29-39 age and the $56,000+ income categories beg the question whether these premiums reflect a shortage of readers in these two demographic categories. We compared the distribution of readers in the MRI data for the income and age variables with aggregate U.S. age and income statistics (1990 data, U.S. Department of Commerce 1992). In fact, MRI records a higher fraction of young and affluent readers than suggested by the population statistics. Thus it does not appear, at least through casual observation of the relevant data, that a shortage of readers in these key...
demographics groups is driving the observed pricing relationships.

Finally, there are a number of limitations of this research. First, and perhaps foremost, we do not attempt to explain the underlying economics driving the shadow prices. While this is standard in most hedonic analyses (e.g., Harchaoui and Hamdad 1997), the process by which the demand and supply of advertising space is created and purchased is certainly germane to changes in pricing over time. Consequently, it would be worthwhile for future research to study the supply and demand issues carefully, addressing how the supply and demand of advertising space change in relation to changes in publisher’s pricing policies. Second, related to this issue, our results are static in the sense that we examine the predicted price response if a single magazine were to deviate from its current pure bundling strategy. It is not entirely clear what will happen if all magazines followed a similar pure components strategy. Third, a detailed investigation into the optimal design of mixed bundling strategies (perhaps utilizing the hedonic results with the methodology suggested by Hanson and Martin 1990) would provide greater insight into the profitability of the mixed bundling option.

Nonetheless, the empirical results reported here are extremely robust. We explain 91% of the variation in the (log of) price of advertising space in cross-section with a relatively parsimonious model. The results remain essentially unchanged when interaction terms are added and when an alternative price measure (Advertising Age transactions price) is used. Accordingly, we hope that the questions addressed in our empirical analysis will provide an impetus for further research on bundling issues in a similar setting.
REFERENCES


Table 2: Regression Results (1990 Data)

<table>
<thead>
<tr>
<th></th>
<th>Coefficient</th>
<th>Standard Error</th>
<th>t- statistic</th>
<th>95% Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-3.83</td>
<td>.344</td>
<td>-------</td>
<td>(-4.51, -3.16)</td>
</tr>
<tr>
<td>log(circulation)</td>
<td>.79</td>
<td>.027</td>
<td>29.26</td>
<td>(.74, .84)</td>
</tr>
<tr>
<td>log(reader per copy)</td>
<td>.33</td>
<td>.064</td>
<td>5.16</td>
<td>(.20, .45)</td>
</tr>
<tr>
<td>fraction in 29-39 age cat.</td>
<td>2.52</td>
<td>.513</td>
<td>4.91</td>
<td>(1.52, 3.53)</td>
</tr>
<tr>
<td>fraction in $56,000+ income cat.</td>
<td>2.34</td>
<td>.243</td>
<td>9.63</td>
<td>(1.86, 2.82)</td>
</tr>
<tr>
<td>fraction women</td>
<td>-1.06</td>
<td>.449</td>
<td>2.36</td>
<td>(-1.94, -.18)</td>
</tr>
<tr>
<td>(fraction women)$^2$</td>
<td>.91</td>
<td>.408</td>
<td>2.23</td>
<td>(.11, 1.71)</td>
</tr>
</tbody>
</table>

Residual Standard Error = .212;  Multiple R$^2$ = .91;  F = 154.2 (p = .0000).
Table 3: Predicted Revenue Generated from (a) a Pure Bundling Strategy and (b) a Pure Components Strategy.*

<table>
<thead>
<tr>
<th>Advertising Revenue from:</th>
<th>(a) Pure Bundling Strategy</th>
<th>(b) Pure Components Strategy (%) Gain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Across 101 Magazines</td>
<td>$63,022</td>
<td>$76,348</td>
</tr>
<tr>
<td></td>
<td>(21.1%)</td>
<td></td>
</tr>
<tr>
<td>Selected Publications</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cosmopolitan</td>
<td>$127,544</td>
<td>$193,153</td>
</tr>
<tr>
<td></td>
<td>(51.4%)</td>
<td></td>
</tr>
<tr>
<td>The New Yorker</td>
<td>$53,934</td>
<td>$81,147</td>
</tr>
<tr>
<td></td>
<td>(50.5%)</td>
<td></td>
</tr>
<tr>
<td>House and Garden</td>
<td>$25,609</td>
<td>$31,038</td>
</tr>
<tr>
<td></td>
<td>(21.2%)</td>
<td></td>
</tr>
<tr>
<td>Ladies Home Journal</td>
<td>$112,449</td>
<td>$119,199</td>
</tr>
<tr>
<td></td>
<td>(6.0%)</td>
<td></td>
</tr>
<tr>
<td>Field and Stream</td>
<td>$36,262</td>
<td>$38,329</td>
</tr>
<tr>
<td></td>
<td>(5.7%)</td>
<td></td>
</tr>
</tbody>
</table>

* - All dollar figures are expressed in thousands of U.S. dollars.
Figure 2: Price Premium Ratios for the 101 magazines (1990) used in the study. Circulation effect only (Ratio A), gender effect only (Ratio B), and the combined effect (Ratio C).