Patterns of Rightmost Digits Used in Advertised Prices: Implications for Nine-Ending Effects

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Analysis of the rightmost digits of selling prices in a sample of retail price advertisements confirmed past findings indicating the overrepresentation of the digits 0, 5, and 9. The high cognitive accessibility of round numbers can account for the overrepresentation of 0- and 5-ending prices and suggests the existence of two effects that could account for the overrepresentation of 9-ending prices: (1) a tendency of consumers to perceive a 9-ending price as a round-number price with a small amount given back and (2) a tendency of consumers to underestimate a 9-ending price by encoding it as the first round number evoked during incomplete left-to-right processing. Analysis of the patterns of rightmost digits observed in the sample provides supportive evidence particularly for the second of these two 9-ending effects.

A number of studies have documented the common observation that certain digits are more likely than others to appear as the rightmost digit, or ''ending,'' of an advertised price. In particular, the digits 0, 5, and 9 have been found to occur as the rightmost digit of a price much more often than chance would predict (Kreul 1982; Rudolph 1954; Twedt 1965).

Whereas the overrepresentation of the digits 0 and 5 seems natural and tends to be taken for granted, the overrepresentation of the digit 9 has led observers to offer explanations. It is sometimes suggested (e.g., McCarthy and Perreault 1993, p. 547) that the overrepresentation of the digit 9 is merely the persistence of a retailing practice that originated in attempts by early retailers to reduce dishonesty among clerks. Because most customers paid in even-dollar amounts, a 9-ending price would oblige clerks to use the cash register to make change and thus reduce their opportunity to pocket the payment (Hower 1943, p. 52). However, many current observers (e.g., Nagle and Holden 1994, pp. 300–302) consider that the overrepresentation of 9 endings results from price impressions created in the mind of the consumer.

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The goal of this article is to more carefully examine the pattern of price-ending usage as an approach to gaining insights as to how such impression effects may occur. In particular, we investigate the possibility that the overrepresentation of the digit 9 may result from the same cognitive processes that lead to the overrepresentation of the digits 0 and 5. If these cognitive processes cause 9-ending prices to produce consumer effects that are beneficial to the seller, then the price setter's tendency to continue practices associated with high sales and profits would lead to retail price-ending practices that maximize these effects. Further, such shaping of managerial behavior by market forces is likely to occur whether or not retail price setters are explicitly aware of these consumer effects.

We begin by considering a psychological factor that can account for the overrepresentation of 0- and 5-ending prices and then describe two effects of 9 endings on consumers that are suggested by this factor. We present several hypotheses concerning how the presence of these two consumer effects would be expected to affect the distribution of rightmost digits in advertised prices. We then test these hypotheses by examining the pattern of price endings used in a large sample of retail price advertisements.

THE HIGH COGNITIVE ACCESSIBILITY OF ROUND NUMBERS

The overrepresentation of 0 and 5 endings in advertised prices appears to be an aspect of a more general phenome-

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non regarding the use of numbers in human communication. For example, Dehaene and Mehler (1992) surveyed a wide variety of printed materials in seven different languages and tallied the number words that occurred. They found that numbers ending in the values 0 and 5 were consistently overrepresented. Dehaene and Mehler attributed this overrepresentation at least partially to the high cognitive accessibility of certain numbers, which are commonly referred to as ''round'' numbers.

Cognitive Accessibility

The ease with which a mental unit is retrieved from memory has been termed its ''availability'' (Tversky and Kahneman 1973) or its ''accessibility'' (e.g., Fazio et al. 1982; Higgins, Rholes, and Jones 1977). The concept of accessibility is important because if a mental representation comes to mind more easily, then the representation is likely to be used in thought more frequently. In the context of numbers, the tendency to think in terms of readily accessible numbers can be directly related to the limitations of the human information-processing system (Dehaene and Mehler 1992). Our cognitive apparatus appears to have a limited number of ''slots'' for apprehending numerosity (Miller 1956). When small numbers are involved, say four or fewer, we can recognize the quantity easily and directly. But when dealing with larger numerosities, to avoid the effort of counting, we tend to be less precise and estimate the quantity by using the closest easily accessible number (Kaufman et al. 1949).

Studies that require respondents to generate numbers clearly point to 0- and 5-ending numbers as having greater cognitive accessibility. In a variety of explicit numerical estimation tasks, people show a marked tendency to produce 0- and 5-ending numbers (Hornik, Cherian, and Zakay 1994; Hultsman, Hultsman, and Black 1989; Huttenlocher, Hedges, and Bradburn 1990; Tarrant and Manfredo 1993). In the context of pricing, Schindler and Wiman (1989) found that consumers tend to produce 0-ending numbers when recalling prices. Although both 0- and 5-ending numbers are found to be overrepresented in numerical estimation responses, it appears that 5-ending numbers are overrepresented to a lesser degree than 0-ending numbers (Baird, Lewis, and Romer 1970; Kaufman et al. 1949; Kubovy 1974). This suggests that 5-ending numbers may have less cognitive accessibility than 0-ending numbers.

This high accessibility of 0- and 5-ending numbers most likely derives from the special status of multiples of 10 and midpoints between multiples of 10 in a decimal number system (the use of which in turn is probably related to a reliance on our 10 fingers for counting). There is evidence that even young children are aware of the special status of 0- and 5-ending numbers (Fuson, Richards, and Briars 1982; Siegler and Robinson 1982; Yoshida and Kuriyama 1986), thus suggesting that our tendency to favor these numbers in cognitive processing may be very deeply ingrained.

The Benefit of Using Highly Accessible Numbers in Pricing

By setting prices at numbers that have relatively high cognitive accessibility, the price setter communicates with consumers in the terms in which consumers think. The result is prices that are more easily perceived, remembered, and compared. This is particularly important because of the information-processing demands created by the high degree of price variability in many consumer product categories (e.g., Grewal and Marmorstein 1994) and the evidence that consumers use round numbers as a means of dealing with such complex information environments (Coupey 1994). Thus, the use of round numbers in advertised prices benefits the retailer by simplifying the communication and increasing the chances that consumers will perceive and recall those prices that the retailer considers worthy of being advertised.

TWO POTENTIAL EFFECTS OF 9 ENDINGS

The high cognitive accessibility of round numbers that helps account for the overrepresentation of 0- and 5-ending prices also suggests two possible consumer effects that could help account for the overrepresentation of 9-ending prices.

Perceived-Gain Effect

If round numbers are indeed highly accessible in memory, then they may tend to serve as reference points in the consumer's price evaluations. Such use of round numbers as reference points might lead the consumer to perceive the 9-ending price as indicating that the retailer is giving a small amount back to the consumer (e.g., Friedman 1967; Kreul 1982). For example, a consumer might interpret a price such as $29 as involving a $1 discount from $30.

In the terms of prospect theory (Kahneman and Tversky 1979), the high accessibility of the 0-ending round-number price may cause a 9-ending price to be framed as a round-number amount along with a small gain. Because of prospect theory's negatively accelerated function for the value of gains, the perception of a small gain would be expected to improve the evaluation of a price to a degree disproportionate to the perceived gain's small size (Thaler 1985). This enhancement of the evaluation of a 9-ending price will be termed the ''perceived-gain effect.'' The existence of such a perceived-gain effect would help account for the price setter's tendency to favor 9 endings.

If a round number serves as the reference point for the perception of a price that falls just below a round number, such as a 9-ending price, then it should also serve as the reference point for the perception of a price that falls just above a round number. This would result in the just-above price being encoded as a round number plus a small additional amount. Further, because prospect theory's value function is negatively accelerated for losses as well as for gains, the perception of a small additional amount would impair the evaluation of the just-above price to a degree disproportionate to the size of perceived additional loss. This would be expected to lead price setters to avoid such just-above prices.

Because of the previously mentioned evidence that 0-ending numbers are more accessible than 5-ending numbers and thus more likely to serve as reference points, it is the number most immediately above the 0 ending—the 1 ending—where this avoidance should be most apparent. Thus, if the perceived-gain effect has played a role in leading to the overrepresentation of 9-ending prices, we would also expect to observe an underrepresentation of 1-ending prices. This then is our first hypothesis.

H1a: Among advertised prices, 1-ending prices are underrepresented, both with respect to chance and with respect to the nine other digits.

Note that as the number of digits in a price (i.e., price *length*) increases, there is a decrease in the relative size of the one-unit difference between a 9- or 1-ending price and the adjoining 0-ending price.[1] For example, the one-unit difference between the two-digit price of $40 and $41 is 2.5 percent of $40. However, the one-unit difference between the three-digit price of $440 and $441 is only 0.23 percent of $440. Although consumers may not always use the proportional size of price changes in valuing these changes (Heath, Chatterjee, and France 1995), there is considerable evidence that consumers often do so (Kahneman and Tversky 1984; Monroe 1973; Monroe and Petroshius 1981). Thus, one would expect the effect of the perceived gains and losses to be smaller as the number of digits in the price increases.

This likelihood of a smaller perceived-gain effect as price length increases should lead price setters to be less likely to favor use of the 9 ending and also less likely to avoid use of the 1 ending in longer prices. Thus, if the perceived-gain effect has played a role in the overrepresentation of 9-ending prices, we would expect the following effect of price length:

H1b: As the length of an advertised price increases, the amount of both the overrepresentation of 9 endings and the underrepresentation of 1 endings will decrease.

Underestimation Effect

If consumers favor the use of round numbers in their cognitive processing of price information, then we can consider how they may translate an advertised price into a round-number mental representation. Given the evidence that people process multidigit numbers from left to right (Hinrichs, Berie, and Mosell 1982; Poltrock and Schwartz 1984), there are two strategies for this encoding: rounding and truncation.

The first encoding strategy, rounding, starts with attending sequentially to each digit of the price. Then, if the number is not already a round number, the perceiver applies a rounding rule to arrive at a round number. A commonly used rounding rule is, if a number's rightmost digit is 4 or less, round down to the next lower 0-ending amount; if the number's rightmost digit is 5 or greater, round up to the next higher 0-ending amount. This would lead a price such as $799 to be encoded as $800. The second encoding strategy, truncation, involves cutting off left-to-right processing of a price's digits before all of the digits are recognized and using the most accessible number (most likely a 0-ending round number) that is evoked by the digits that have been processed. This might result in a price such as $799 being encoded as $790 (if the price's leftmost two digits are processed) or $700 (if only the price's single leftmost digit is processed).

Of the two encoding strategies, truncation clearly requires less effort: fewer digits need to be processed, and no rounding rule needs to be recalled and then applied (Brenner and Brenner 1982). With truncation, the perceiver could process only one or two digits and then simply use the first round number of appropriate length that is evoked. With rounding, the perceiver must process all of the digits, retrieve the rounding rule, decide how many ''significant digits'' to round to, and then apply the rounding rule by changing one or more of the digits already perceived. In addition, there is empirical evidence supporting the consumer's use of the truncation strategy. In a study of price recall, Schindler and Wiman (1989) found evidence that consumers sometimes process only a price's leftmost digit. In their analysis of supermarket scanner data for canned tuna and yogurt, Stiving and Winer (1997) were able to increase the accuracy of sales predictions by using a price model that assumed consumers' use of a left-to-right truncation strategy.

If consumers, at least sometimes, use the truncation strategy, then it would create a benefit to the seller who is using 9 endings. The rounding strategy always causes both a 9-ending price and the adjacent 0-ending price to be encoded into the same perceived price. But the truncation strategy often causes the 9-ending price to be encoded into a perceived price that could be considerably lower than the 0-ending price. This consequence of the truncation strategy—leading the consumer to underestimate a 9-ending price relative to the 0-ending price one unit higher—will be termed the ''underestimation effect.'' This underestimation effect predicts that sellers will often drop a 0-ending price by one unit (i.e., one dollar or one cent) to form a 9-ending price.

Further, assuming that consumers who truncate will at least sometimes process only a price's first or second digits, the existence of the underestimation effect also predicts that the move to a 9 ending would be more desirable for some types of 0-ending prices than for others.

[1]This is so because with any constant set of units (e.g., cents only, dollars and cents, or dollars only) the size of a one-unit increase will not change with increasing price length, but the size of the price will. Assuming constant units, a price of length $N + 1$ digits will always be larger than a price of N digits.

TABLE 1

EFFECTS OF TRUNCATION STRATEGY ON CONSEQUENCES OF ONE-PENNY DIFFERENCE FOR VARIOUS TYPES OF PRICES

	Type of price								
	High potential underestimation			Moderate potential underestimation			Low potential underestimation		
Price-type examples	0-ending form		9-ending form	0-ending form		9-ending form	0-ending form		9-ending form
Actual prices	50.00		49.99	48.00		47.99	48.60		48.59
Likely perceived prices under differing amounts of left-to-right processing:									
Three digits processed	50.00		49.90	48.00		47.90	48.60		48.50
0/9 difference		.10			.10			.10	
Two digits processed	50.00		49.00	48.00		47.00	48.00		48.00
0/9 difference		1.00			1.00			0	
One digit processed	50.00		40.00	40.00		40.00	40.00		40.00
0/9 difference		10.00			0			0	
Maximum potential underestimation:									
$ amount		10.00			1.00			.10	
Percent of actual price		20.0			2.1			.2	

To carry out a test of this prediction, we define three price types on the basis of the price digit that decreases when a 0-ending price is lowered by one unit to create a 9-ending price. These price types are illustrated by the three pairs of four-digit prices in the first row of Table 1.

High Potential Underestimation. A high-potential underestimation (PU) price is one, such as $50.00, where the one-unit decrease to form the 9-ending price, $49.99, causes the leftmost digit (the 5) to decrease. For this type of price, the truncation strategy would produce underestimation if either the leftmost one, two, or three digits are processed, and the PU resulting from the use of the 9 ending could be large relative to the 0-ending price (in the Table 1 example, as high as 20 percent).

Moderate Potential Underestimation. A moderate-PU price is one, such as $48.00, where the one-unit decrease to form the 9-ending price, $47.99, causes the second (from the leftmost) digit (the 8) to decrease. For this type of price, the truncation strategy would produce underestimation if the leftmost two or three digits are processed but not if only the single leftmost digit is processed. The relative PU for this price type could not be as large as for the high-PU price type (in the Table 1 example, only as high as 2.1 percent).

Low Potential Underestimation. A low-PU price is one, such as $48.60, where the one-unit decrease to form the 9-ending price, $48.59, causes the third (from the leftmost) digit (the 6) to decrease. For this type of price, the truncation strategy would produce underestimation if the leftmost three digits are processed but not if only the leftmost one or two digits are processed. Thus, the relative PU for this price type could only be small (in the Table 1 example, only as high as 0.2 percent).

These differences in the extent of an effect that is beneficial to the seller would then predict that the likelihood of price advertisers using a 9 ending would be greater for price types where the relative potential underestimation is higher. Thus, we hypothesize as follows:

H2: There is more use of 9 endings among high-PU prices than among moderate-PU prices and more use of 9 endings among moderate-PU prices than among low-PU prices.

METHOD

Sampling

The sampling procedure was designed to produce a representative sample of managerial price-ending decisions in a context that would yield data comparable to that of past price-ending surveys. We therefore chose to sample price advertisements from newspapers, the sampling domain used in previous surveys (Kreul 1982; Rudolph 1954; Twedt 1965).

The surveyed newspapers were selected from the population of Sunday newspapers with a circulation of 40,000 or more that are published in major U.S. metropolitan areas. One newspaper was selected from each of 43 states (see the Appendix for a list of newspapers included in the sample). For each newspaper, the issue used was the one published on Sunday, September 9, 1990. The newspapers were obtained from the microfilm archives of the Center for Research Libraries. The sample was limited to run-of-press advertisements and did not include price advertisements in flyers or inserts because the microfilm records did not consistently include those parts of the Sunday papers.

We sampled advertisements from each newspaper by first randomly determining whether odd- or even-numbered pages would be selected. On each selected page, we picked every advertisement that was as large as two news columns in width and 4 inches in height and that contained at least one selling price. Advertisements that contained only reference prices (e.g., ''Compare at $75.00'') or savings amounts (e.g., ''Save $50'') were not included. In all, 1,415 advertisements were sampled from 43 Sunday newspapers.

The selected advertisements varied widely in the number of selling prices they contained. For example, advertisements for furs or jewelry typically contained only one or two prices, but tire advertisements often contained as many as 300 prices. Because a manager's price-ending practices would be expressed in all of the prices in an advertisement, these disparities would lead an analysis of all of the prices displayed in the advertisements to be biased toward the price-ending practices of managers in a few particular product categories. Moreover, a survey of the first 931 of the 1,415 advertisements in the sample indicated that such a bias would be quite strong. Of the 13,230 selling prices in those 931 advertisements, a full 40 percent were in advertisements for automobile tires.

To avoid biasing the analyses toward the practices of managers whose product categories tend to use advertisements displaying large numbers of prices, we used only one price from each advertisement in the sample. When an advertisement contained more than one selling price, one was selected randomly by use of a numbered grid overlaid on the microfilm reader screen. The price within or closest to a randomly chosen square was then selected and coded. In this sampling procedure, the characteristics of the selected price in a multiprice advertisement are used to characterize the entire advertisement.

Coding

The selected selling price was coded exactly as it appeared in the advertisement; we recorded each of the price's numerals that was printed. For example, a price appearing as ''$39.00'' would be considered a four-digit price with 0 as the rightmost digit. If that same quantity had been expressed in the advertisement as ''$39,'' then we would have considered it a two-digit price with 9 as its rightmost digit. When we encountered, for example, in a real estate advertisement, a price expressed as ''from the $170s,'' we considered it a three-digit price with 0 as the rightmost digit.

RESULTS

The 1,415 sampled selling prices ranged from $.34 to $3,900,000. Six were one-digit prices, 142 were two-digit prices, 397 were three-digit prices, 541 were four-digit prices, 222 were five-digit prices, 95 were six-digit prices, and 12 were seven-digit prices. Fourteen of the advertised prices represented cents only, 586 represented dollars and cents, 792 represented dollars, and 23 represented thousands of dollars.

As can be seen in Figure 1, the rightmost digits of advertised selling prices were not evenly distributed among the 10 possibilities ($\chi^2(9) = 1662.4$, $p < .001$). Three digits, 0, 5, and 9, were greatly overrepresented; 27.2 percent ended in the digit 0, 18.5 percent ended in the digit 5, and 30.7 percent of the prices ended in the digit 9. Thus, more than three-quarters of the advertised selling prices ended in one of these three digits. The digits 1, 2, 3, 4, and 6 were particularly underrepresented in the distribution, all five digits together accounting for only 7.6 percent of the selling price endings.

Hypotheses 1a and 1b: Evidence Regarding Perceived-Gain Effect

If the use of 9 endings by price setters derives from the consumer's perception of a small gain from a 9-ending price, then a 1-ending price should lead consumers to perceive a small loss. Thus, our Hypothesis 1a is that 1 endings would be underrepresented among advertised prices because price setters respond to consumer perceptions by avoiding the use of the digit 1 as the rightmost digit of a price.

The results do provide evidence that 1 endings are underrepresented (see Fig. 1 and Table 2). If the six one-digit prices are excluded from the sample, only 12 of the 1,409 prices of two or more digits showed a 1 in the rightmost digit. This observed proportion (.009) is substantially less than the .10 proportion expected by chance ($\chi^2(1) = 131.0$, $p < .001$). Further, there were fewer 1 endings than 2 endings ($\chi^2(1) = 4.00$, $p < .05$) and less use of the digit 1 than of any other digit (all p's $< .025$) with the exception of the digit 3, whose incidence did not differ significantly from that of 1 ($\chi^2(1) < 1$). We did consider whether incidence of the digit 3 was lessened by a superstition-caused avoidance of the use of the two-digit price ending 13. However, the low use of 3 turned out not to be due to an avoidance of 13; three of the 11 3-endings were prices that ended in the digit pair 13.

Thus, the data offer some support for Hypothesis 1a. The digit 1 is certainly underrepresented with respect to chance. The digit 1 also appears to be underrepresented with respect to other digits. However, our inability to explain why there are as few 3 endings as 1 endings weakens this second finding.

If perceived gains drive the overrepresentation of 9 endings and perceived losses drive the underrepresentation of 1 endings, then this pattern should become less pronounced as the ending digit becomes a smaller percentage of the overall price. Thus, our Hypothesis 1b is that 9 endings would become less frequent in longer prices and 1 endings would become more frequent.

As can be seen from Table 2, the results are mixed with regard to this prediction. The use of the 9 ending does tend

FIGURE 1

DISTRIBUTION OF RIGHTMOST DIGITS OF THE 1,415 ADVERTISED SELLING PRICES

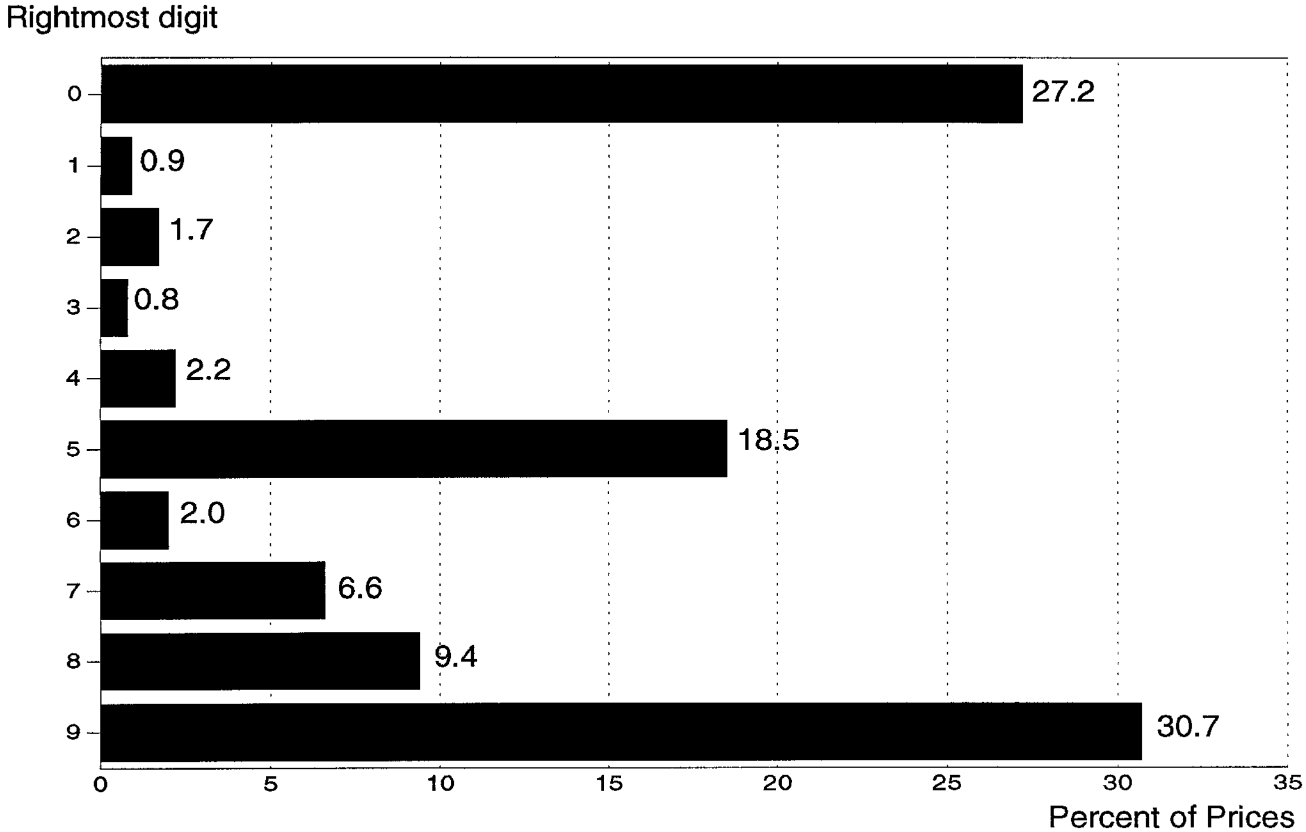

TABLE 2

PERCENTAGE OCCURRENCE OF EACH RIGHTMOST DIGIT BY LENGTH OF SELLING PRICE

		Price length (in digits)						
Rightmost digit	No. of prices	1 (6)	2 (142)	3 (397)	4 (541)	5 (222)	6 (95)	7 (12)
0	385		14	14	23	39	97	92
1	13	17		1	1	1		
2	24		8	2	1	1		
3	11		1	1	1	1		
4	31		6	3	2	1	1	
5	262	17	20	18	22	18	1	8
6	28	33	2	3	1	2		
7	93	17	3	7	7	9		
8	133	17	12	10	10	11		
9	435		33	42	34	18	1	
Total	1,415	100	100	100	100	100	100	100

NOTE.—Numbers of sampled prices at each length are indicated in parentheses. Because of rounding, some of the columns do not total exactly 100 percent.

to decrease. After an increase from two- to three-digit prices, the percentage of 9 endings decreases monotonically as price length increases beyond three digits ($\chi^2(4) = 87.9, p < .001$). However, there is no apparent increasing trend for the 1 endings. In fact, there is no statistically significant difference in the occurrence of 1 endings across the price lengths two through seven ($\chi^2(5) = 3.66, p > .5$). Thus, Hypothesis 1b is only partially supported by the data.

Further, it appears from Table 2 that the decrease in the use of the 9 ending as price length increases is paralleled by an increase in the use of the 0 ending ($\chi^2(5) = 327.2$, $p < .001$). This increase in the use of 0 endings is so marked that almost all prices longer than five digits end in the digit 0. Although the existence of a perceived-gain effect would predict the decrease in the use of 9 endings as price length increases, it would not necessarily predict this striking increase in the use of 0 endings.

Hypothesis 2: Evidence Regarding the Underestimation Effect

The underestimation effect predicts that the use of the 9 ending is related to the magnitude of the perceptual underestimation that this use could potentially cause in consumers using a truncation strategy to perceptually process the price. Price advertisers should show a greater likelihood of using a 9 ending in price types where the relative potential underestimation is higher. Thus, the existence of the underestimation effect predicts that high-PU prices will be used in their 9-ending form more often than moderate-PU prices, which in turn will be used in their 9-ending form more often than low-PU prices.

We tested this prediction by considering the 820 prices in our sample that ended in the digits 0 or 9. We classified the 0-ending prices into PU categories by determining which digit decreases when one unit is subtracted so as to form a 9-ending price. Correspondingly, we classified the 9-ending prices into PU categories by determining which digit increases when one unit is added so as to form a 0-ending price. Seven hundred and twenty-four of these 820 prices fell into one of the three PU categories referred to in Hypothesis 2.[2] Table 3 shows the percentage of the 0- and 9-ending prices in each PU and price-length category that appeared as 9-ending prices.

As can be seen from the first column of Table 2, the percentage of 9 endings for high-PU prices is higher than that for moderate-PU prices ($\chi^2(1) = 9.28$, $p < .005$). The percentage of 9 endings for moderate-PU prices is higher than that for low-PU prices ($\chi^2(1) = 85.1$, $p < .001$).

As noted above in our discussion of Hypothesis 1b, the use of 9 endings tends to decrease as price length increases. It can be seen from Table 3 that the three PU categories do differ in their price length distributions. To control for an effect of price length on the percentage of 9 endings, we repeated each price-type comparison by entering price length along with an indicator variable for price type into a logistic regression equation with presence of the 9 ending as the dependent variable. Even with price length in the equation, the percentage of 9 endings for high-PU prices was higher than that for moderate-PU prices (odds ratio = 1.58, $p < .03$), and the percentage of 9 endings for moderate-PU prices was higher than that for low-PU prices (odds ratio = 4.90, $p < .001$). This indicates that the differences in the percentage of 9 endings between the high-, moderate-, and low-PU categories are not due to the decreasing use of 9 endings at higher prices.

Thus, the data offer strong support for Hypothesis 2. The usage of 9 endings is higher for high-PU prices than for moderate-PU prices, and higher for moderate-PU prices than for low-PU prices. Further, these differences are not due to differences among the three PU categories in price length.

DISCUSSION

The data from this study of advertised prices indicates that the uneven distribution of rightmost digits of selling prices, found in previous studies, continues to exist. There is a marked overrepresentation of the digits 0, 5, and 9. The overrepresentation of 0 and 5 endings can be accounted for by the high cognitive accessibility of 0- and 5-ending numbers. The use of these round-number endings makes price information easier for consumers to perceive, compare, and remember. This effort explanation is consistent with our finding that as prices become longer and potentially more complex, the number of rightmost 0's increases. It is interesting that an association between larger values and increased use of round numbers has also been found when respondents are asked to give numerical answers to survey questions (Hornik et al. 1994).

The evidence concerning the perceived-gain explanation of the overrepresentation of 9 endings is mixed and does not allow a confident conclusion regarding the existence of this effect. On the one hand, the findings of the underrepresentation of 1 endings and the decrease in 9 endings as the length of the advertised price increases are consistent with a perceived-gain effect. On the other hand, the findings of as few 3 endings as 1 endings and the lack of an increase in 1 endings as price length increases are inconsistent with the predictions of a perceived-gain effect.

Nor do the data concerning 5-ending round numbers—numbers which might also serve as reference points—serve to help clarify the results. Although we did find more endings just below 5-ending round numbers than just above 0-ending round numbers (i.e., more 4 endings than 1 endings), we did not find a reliable tendency for there to be more endings just below than just above 5-ending round numbers (i.e., more 4 endings than 6 endings).

Certainly one factor in the inconclusiveness of the results regarding the perceived-gain effect is the low incidence of the seven digits that were not overrepresented. In particular, the extremely low incidence of the digits 1, 2, 3, 4, and 6 may have resulted in a sample size that is too small to reliably detect patterns that may exist regarding these endings. In addition, although we did not find evidence of superstitious avoidance of the two-digit ending 13, comparisons among low-incidence digits may be

[2]The remaining 96 prices were those where the one-unit decrease or increase changes the fourth or fifth (from the leftmost) digits (i.e., they are *very* low-PU prices). A separate data analysis where these prices were included in the low-PU category produced the same results as those reported here.

TABLE 3

9-ENDING PRICES AS A PERCENTAGE OF 0- AND 9-ENDING PRICES OF EACH PRICE TYPE AND PRICE LENGTH

Price type	Overall price lengths	Price length (in digits) 2	3	4	5	6 and 7
High potential underestimation: Lowering from 0 to 9 ending decreases first (leftmost) digit	78	70 (67)	89 (90)	82 (61)	80 (10)	0 (8)
Moderate potential underestimation: Lowering from 0 to 9 ending decreases second (from left) digit	67		66 (130)	71 (143)	67 (33)	0 (8)
Low potential underestimation: Lowering from 0 to 9 ending decreases third (from left) digit	23			31 (100)	16 (50)	5 (24)

NOTE.—Numbers in parentheses are the total number of 0- and 9-ending prices for each price-type and price-length combination.

particularly vulnerable to such possible image effects (see Schindler 1991).

The evidence concerning the underestimation explanation of the overrepresentation of 9 endings is consistently supportive. The use of 9 endings is greater in high-PU prices than in moderate-PU prices and greater in moderate-PU prices than in low-PU prices. That these differences between price types persist even when price length is controlled indicates that these differences are not caused by the decreasing use of 9 endings in higher prices. Rather, this pattern of 9-ending use is what would be expected in response to a consumer tendency to truncate partially perceived prices when encoding them into easier-to-use round numbers. Thus, through this underestimation effect, the high cognitive accessibility of round numbers that results in the overrepresentation of 0- and 5-ending prices may also lead to the overrepresentation of 9-ending prices.

Implications for Consumer Price-Evaluation Processes

These results give us the picture of a consumer who tends to use round numbers in processing price information. Although the data do not enable us to conclude that consumers use round numbers as reference points when evaluating non-round-number prices, the data are consistent with a consumer tendency to translate prices into round numbers if round-number prices are not provided by the retailer. It appears that consumers at least sometimes accomplish this translation by scanning a price from left to right and, before all of the price's digits are processed, using the most accessible round number (which is likely to be a 0-ending number) evoked by the digits that have been processed. This strategy could lead the price that the consumer evaluates to be considerably lower than the actual displayed price.

It could be asked why consumers would ever use such an inaccurate strategy for this translation process. One possibility is that consumer time constraints and an information-rich shopping environment may sometimes result in severe limits to the amount of cognitive capacity that is available for the processing of any single input to a decision. Another possibility is that consumers may conserve effort by relaxing their accuracy standards early in a decision process under the assumption that price will be given more careful consideration later in the decision process. However, consumers may not fully appreciate the degree to which early quick choices, such as those relating to whether or not to further consider a brand or retail outlet, may have a major effect on the final outcome of the decision process (Schindler 1995; Wilkie and Dickson 1991).

Limitations

Although the analyses presented in this article are based on a large and systematic sample of price advertisements, it should be noted that the population of advertisements sampled was limited to a particular form of print advertising. The observed patterns of price endings may have been different if advertisements from Sunday inserts, weekday newspapers, flyers, magazines, direct mail, or radio and television had also been considered. However, the present study provides evidence about price-ending practice in at least one fairly broad range of price advertising.

It also should be noted that our analyses were limited to price endings that were defined by the price's single rightmost digit. This focus simplified our analyses considerably and enabled us to increase our understanding of how the choice of a price's rightmost digit can reflect the nature of the consumer's perceptual and cognitive processes. We strongly suspect that these results can be applied to situations where price endings are defined as the rightmost two or three digits, but it is necessary that this be confirmed in future research.

The finding of correspondences between managerial price-ending behavior and the expectations that follow from likely consumer information-processing strategies supports the existence of these information-processing strategies and their importance in price perception. However, we cannot rule out the possibility that some of these correspondences are due to managerial beliefs that persist in the absence of actual effects on consumer response. The existence of such unfounded beliefs would be an interesting phenomenon in itself, because it would reveal an aspect of the price setter's model of the consumer. It is clear that future research questioning managers about their beliefs concerning 9-ending effects would be an interesting complement to the behavioral data reported here.

Conclusions and Implications

Our study, the first attempt to provide a theoretical explanation for observed patterns of advertised price endings, supports the existence of at least one mechanism by which 9-ending prices may affect the consumer. It thus adds to recent evidence that price-ending variables can indeed affect sales (Schindler and Kibarian 1996; Stiving and Winer 1997). In addition, the correspondences between the observed price-ending patterns and those that would be expected given the high cognitive accessibility of round numbers along with the consumer's tendency to minimize effort suggest the importance of these psychological factors for understanding how price endings can affect consumer response.

It is interesting that the overrepresentation of the digit 9 in advertised prices can, to some extent, be accounted for by the same psychological factors that account for common occurrence of the other two overrepresented digits, 0 and 5. It suggests that further research on the common use of 9 endings in prices may be an effective means to gain insight into basic principles of consumer information processing. There may be much to learn from exploring how a small difference in a marketing stimulus could create a benefit to the marketer through its interaction with the consumer's natural cognitive tendencies and limitations.

APPENDIX

Newspapers Included in the Sample

Albuquerque Journal, Albuquerque, NM
Arizona Republic, Phoenix, AZ
Arkansas Gazette, Little Rock, AR
Atlanta Constitution, Atlanta, GA
Baltimore Sun-Times, Baltimore, MD
Birmingham News, Birmingham, AL
Boston Sunday Globe, Boston, MA
Casper Star Tribune, Casper, WY
Charlotte Observer, Charlotte, NC
Chicago Tribune, Chicago, IL
Clarion Ledger, Jackson, MS
Commercial Appeal, Memphis, TN
Connecticut, Hartford, CT
Courier Journal, Louisville, KY
Dallas Morning News, Dallas, TX
Denver Post, Denver, CO
Des Moines Sunday Register, Des Moines, IA
Forum, Fargo, ND
Great Falls Tribune, Great Falls, MT
Honolulu Star Bulletin, Honolulu, HI
Idaho Statesman, Boise, ID
Indianapolis Star, Indianapolis, IN
Kansas City Star, Kansas City, MO
Las Vegas Review Journal, Las Vegas, NV
Los Angeles Times, Los Angeles, CA
Maine News, Bangor, ME
Miami Herald, Miami, FL
Milwaukee Journal, Milwaukee, WI
New Hampshire Sunday News, Manchester, NH
New York Times, New York, NY
Oregonian, Portland, OR
Philadelphia Inquirer, Philadelphia, PA
Plain Dealer, Cleveland, OH
Richmond Times-Dispatch, Richmond, VA
Salt Lake Tribune, Salt Lake City, UT
Star Tribune, Minneapolis, MN
State, Columbia, SC
Sunday Gazette-Mail, Wheeling, WV
Sunday Oklahoman, Oklahoma City, OK
Times, Trenton, NJ
Times-Picayune, New Orleans, LA
Washington Post, Washington, DC
Wichita Eagle, Wichita, KS

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