

Pricing & revenue architecture

What is psychological pricing?

Psychological pricing sets a price's ending, often a 9 below a round number. In catalog tests it raised demand, with larger estimates for new items.

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Management summary Psychological pricing is the practice of choosing a price's rightmost digits, its ending, so that the price falls just below a round number, as with \$29.99 rather than \$30.00 or \$49 rather than \$50. This concept guide defines it (Schindler and Kibarian), sets out the two explanations its sources weigh, a left-digit or underestimation account and an association or information account, and reports four field experiments with women's clothing catalogs and five experiments with undergraduate students. It shows the conditions under which the effect shrank or disappeared, why the mechanism is unresolved, and what a B2B or software pricing team can and cannot carry over, as the author's untested reading, with a one-page record for a price-ending decision.

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What is psychological pricing?

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It is the choice of a price's last digits for the effect they are expected to have on buyers. Schindler and Kibarian (1996)² describe the practice in one sentence: "Retail price-setters tend to choose the rightmost digits, or ending, of a price so that the price falls just below a round number", which gives endings such as 49, 95 and 99. They list three names for it, odd pricing, psychological pricing and just-below-the-round-figure pricing, and note that despite academic attention since the 1930s there was "remarkably little knowledge concerning whether or not the practice has any actual effect on sales".

² Schindler, R. M., & Kibarian, T. M. (1996). Increased consumer sales response though [sic] use of 99-ending prices. *Journal of Retailing*, 72(2), 187-199.

The practice is common. Anderson and Simester (2003)¹ open with the observation that "Published studies report that 30% to 65% of all prices end in the digit 9", and in the two women's clothing catalogs they worked with, over 52 per cent of prices in one and 68 per cent in the other ended in \$9. Their abstract adds that "there is little evidence of their effectiveness".

¹ Anderson, E. T., & Simester, D. I. (2003). Effects of \$9 price endings on retail sales: Evidence from field experiments. *Quantitative Marketing and Economics*, 1(1), 93-110.

The sources test two forms of ending. A cent ending changes the last two digits, as in \$29.99 rather than \$30.00, the form Schindler and Kibarian² tested. A dollar ending changes the last whole digit, as in \$39 rather than \$34 or \$40, the form Anderson and Simester tested. Thomas and Morwitz (2005)³ studied the 99-cent form on prices below ten dollars, such as \$2.99 against \$3.00.

³ Thomas, M., & Morwitz, V. (2005). Penny wise and pound foolish: The left-digit effect in price cognition. *Journal of Consumer Research*, 32(1), 54-64.

In this guide, psychological pricing means setting a price's ending, its rightmost digit or digits, for the effect the ending is expected to have on how buyers perceive or respond to the price, rather than for cost or margin; the form the sources study is a 9 or 99 just below a round number. The price ending is those digits. The left-digit effect is one proposed explanation of why an ending might matter, not another name for the practice. An ending is a different decision from a price promotion, which is a temporary price cut, and from a reference price, the price a buyer compares against; it can be applied to either.

Why would one cent change what a buyer does? § 2 of 8

The three sources offer two answers under different names. Schindler and Kibarian² call the first an underestimation mechanism: numbers are processed from left to right, and “a tendency of consumers to minimize information-processing effort may lead them to ignore or pay less attention to a price’s rightmost digits”. In their example, “completely ignoring the three rightmost digits of \$29.99 would be equivalent to ignoring \$9.99 of the price”, while ignoring the zeros of \$30.00 ignores nothing. The second “could be referred to as the association mechanism”: through low-involvement learning, buyers may come to read a 99 ending as a sign of a sale or a low price. They point to a survey of newspaper advertising in which “the 99 price ending occurred more frequently in ads that claimed discounts”.

Anderson and Simester¹ sort the literature the same way: “These explanations fall into two broad categories.” In the first, buyers discount the rightmost digits, by rounding prices down, by reading digits from left to right, or by not encoding the last digits to save effort. In the second, “price endings provide information about relative price levels and/or product quality”: a 9 may tell a buyer that a price is low or discounted, and they report other researchers’ suggestion that a round ending may signal high quality and a 9 low quality.

Thomas and Morwitz (2005)³ give the first answer a cognitive account. Drawing on the analog model of numerical cognition, they argue that a multidigit number is converted into one mental magnitude, and that the conversion begins as the eye reaches the first digit, so the encoded “magnitude of \$2.99 gets anchored on the leftmost digit”. On this account it is the change of the left digit, from 3 to 2, that lowers the perceived price, not the one cent. They call it the left-digit effect.

What happened when catalogs varied the ending? § 3 of 8

Schindler and Kibarian² ran their test with a direct-mail retailer of women’s clothing. Three versions of a 169-item winter clearance catalog differed only in the cents of the selling prices: 00 in one, 99 in the second, one cent lower, and 88 in the third, 12 cents lower, the ending the retailer had usually used in that catalog. “Each catalog was sent to a randomly chosen sample of 30,000 names on the company’s mailing list”, and orders were collected from mid-December to mid-June. Every item showed its selling price with the cents beside a higher former price, and the mean claimed discount was 49.2 per cent.

By their account, “the 99-ending version of the catalog produced 8.0 percent more sales volume than the 00-ending catalog”, \$78,317 against \$72,529. It drew 968 purchasers against 921, a difference “in the predicted direction” that was not statistically significant, and its purchasers spent more per head, a difference that was significant by a one-tailed t-test on the log-transformed amounts and by a median test. The 88-ending catalog sold about as much as the 00-ending one, and the data gave “only very limited support” for an 88-ending effect. The authors conclude that “these results indicate that the use of 99 endings can increase the amount that purchasers spend”, and add: “We cannot say from these data whether or not 99 endings can also increase the likelihood that a customer will make a purchase”.

The 8.0 per cent sits on a skewed distribution. Ten purchasers each bought more than \$466, and “seven of these ten large purchasers occurred in the 00-ending condition”. With those ten removed, the 99-ending catalog sold 12.8 per cent more than the 00-ending catalog, and the 88-ending catalog moved from 1.1 per cent below it to 3.9 per cent above; the pattern held with up to 60 of the largest purchasers removed (Table 2, p. 193). These percentages describe sales; the tests were run on the number of purchasers and on purchase amounts. The authors also argue that a plain price response is unlikely to explain the result: a one-cent cut is 0.03 per cent of the catalog’s \$31 average price, and if the market responded to any such cut with an 8 per cent sales increase, “it would suggest the highly implausible price elasticity of -267”. The amount of underestimation needed to account for the effect, they add, “would be rather modest”: if two-thirds of purchasers ignored the two rightmost digits, the same 8.0 per cent would correspond to a price elasticity of -3.8, which they call “quite within the range” of those typically observed. The [price elasticity guide](#) sets out how that ratio is defined. After the test, the retailer adopted 99 endings for its later clearance catalogs.

Anderson and Simester (2003)¹ ran three experiments with two national mail-order catalogs, owned by the same corporation, that sell moderately priced women’s clothing at an average price of about \$50. “In each study we simultaneously varied the use of \$9 price endings on identical items in different catalog versions mailed to randomly selected customer samples.” Study 1 mailed 20,000 customers per version and changed the prices of 27 items by \$1, 43 changes across two treatment versions; Study 2 mailed 31,250 per version and lowered 120 prices by \$3 to \$5; Study 3 mailed 90,000 per version and changed 218 prices across two treatment versions. They modelled the units ordered of each item in each version with a Poisson regression that

holds the item, the catalog version and the price constant, so the \$9 ending is estimated net of the price change it came with.

Their summary: “First, use of a \$9 price ending increased demand in all three experiments.” The estimated increase was about 35 per cent in Study 1, 15 per cent in Study 2 and 7 per cent in Study 3, where the estimate was significant only with the price variable in the model. A pilot with four dresses had sold 66 units at the \$9-ending prices against 46 at prices \$5 lower and 45 at prices \$5 higher. In Studies 1 and 2 the price coefficient itself was not significant. The authors read Study 2 as “further evidence that customers are more sensitive to the \$9 ending cues than to actual price differences”, but they had warned after Study 1 that “the variance available to identify a price coefficient is small”, and in Study 3, with more price variation and larger samples, price had a negative and significant effect.

When is \$2.99 read as less than \$3.00?

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Only under some conditions, in the five experiments of Thomas and Morwitz (2005)³, all run with undergraduate students who judged prices, numbers or quality ratings. In Study 1a, 52 students compared pens against a pen at \$4.00: a pen at \$2.99 was rated less expensive than one at \$3.00 (means of 2.07 and 2.76 on a five-point scale of agreement that the price was high), while \$3.59 and \$3.60 were rated alike (2.61 and 2.65). Study 1b, with 63 students marking each price on an uncalibrated 110 mm line, found the same: \$2.99 was placed at 35.6 mm against 55.8 mm for \$3.00, and there was no significant difference for \$2.79 against \$2.80 or for \$3.19 against \$3.20. Hence the first finding in their abstract: the effect occurs only when the leftmost digits of the two prices differ.

The comparison price matters too. In Study 2, 154 students judged a pen at \$3.99 or \$4.00 beside a second pen, the comparison standard in the authors’ term, at \$2, \$3, \$5 or \$6. With the second price \$1 away, the 9-ending price was perceived as lower (2.50 against 3.39); with it \$2 away, the difference was not significant (2.96 against 3.09). The authors explain the pattern with the distance effect of numerical cognition: magnitudes that lie close together are harder to tell apart, so the closer the two prices, the harder the encoding and the more weight the left digit gets. Their abstract states it as a rule: the closer the two prices being compared, the more likely the left-digit effect. Studies 3 and 4 found the same pattern in response times when plain numbers were compared with 5.50, and in judgements of product quality ratings, where the perceived distance set by the range of ratings, not the numerical distance, moderated the effect. The authors take this to

mean that “there seems to be a domain invariant cognitive phenomenon” behind the popularity of 9 endings, while not “ruling out image effects”. Their summary is that 9-ending prices “may sometimes but not always be perceived” to be lower than a price one cent higher. These are judgements of magnitude, not purchases.

Is it the left digit or what the 9 signals?

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The sources lean different ways. Anderson and Simester¹ tested the first class of explanation, in which buyers underweight the right-hand digits, in Study 3 by splitting each price into tens of dollars and dollars. If buyers discount the right-hand digit, the dollars should weigh less than the tens. They did not. The two coefficients were -0.0631 and -0.0651 ; both differed significantly from zero, “but the difference between them is not significant”, and the coefficients of a \$9 ending without a Sale cue and of a Sale cue without a \$9 ending “remained positive and significant”. The authors call this “a relatively weak test”, because the \$9 variables absorb part of what the dollar digit explains. Two further results fit their information reading better than the first class. The estimated effect was larger on new items, and “The explanation requires that customers lack information about relative price levels”. And “customers did not respond to \$9.50 endings in the same way that they respond to \$9 endings”, which the authors find hard to reconcile with an account built on ignoring right-hand digits, since a buyer who ignored the cents would read \$49.50 as \$49. They conclude that “The findings appear to offer greater support for an information explanation”, and leave the digit itself unexplained: “The data and explanations are silent on how customers form beliefs that \$9 endings convey favorable information that increases demand for an item.”

Thomas and Morwitz³ read their results the other way, as perception rather than inference, but keep image effects open. Schindler and Kibarian² could not decide between the two: that the 99 ending moved purchase amounts more than the number of purchasers “is suggestive of the underestimation mechanism”, yet “the results are also consistent with an association mechanism”, and “the present data shed very little light on the mechanism(s) involved”.

On this guide’s reading, the question is open. The laboratory evidence shows a left-digit effect on perceived magnitude under narrow conditions; the field evidence shows effects on demand that one team reads as information about price levels, on a test it calls weak. Anderson and Simester’s¹ catalog designs set a limit of their own. In Study 1, 23 of the 43 price changes replaced a \$9 ending with an \$8

ending one dollar lower, which leaves the tens digit as it was (p. 97; Table 1, p. 98); in Study 2, 75 of the 99 items whose \$9 ending came or went kept their tens digit, and their \$9 version was the dearer one by \$3 to \$5 (pp. 99 to 100). The paper does not split its estimates by whether the tens digit changed, so the field evidence does not show that the effect on orders depends on the left digit. The two accounts predict that a 9 helps in different places: the left-digit account where the left digit changes and the compared price is close; the information account where buyers know little about price levels and no stronger cue already tells them a price is low.

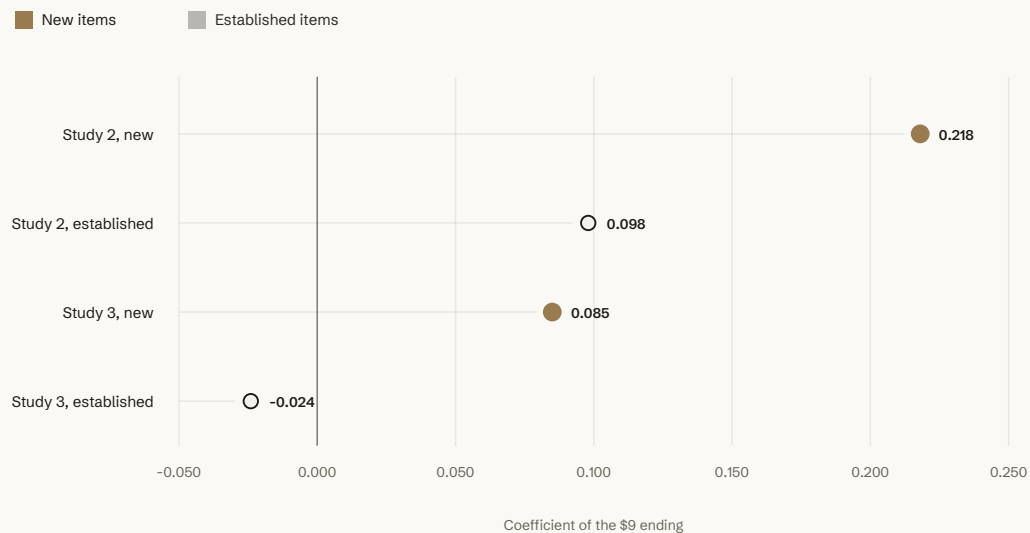
Under which conditions does the effect fade?

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In the sources, the effect shrank or disappeared under five conditions. When the ending left the left digit unchanged, and when the compared price was \$2 rather than \$1 away, the 9-ending price was not perceived as lower (Thomas and Morwitz³). When the item had been offered in earlier seasons, the estimated demand effect was smaller: in Study 2 of Anderson and Simester¹, “A \$9 ending yielded an estimated increase of 1.8 units or 22% for new items compared to 10% for established items”, and Study 3 repeated the pattern (Figure 1).

Figure 1 The estimated effect of a \$9 ending on new and established items

In both studies the estimate for new items was larger and significant, and the estimate for established items smaller and not significant.



New items had generally been introduced in the most recent season; established items had been offered in earlier seasons. Both tables mark the new-item estimates as significant (Table 7 with a single asterisk that its note leaves undefined) and the established-item estimates as not. Footwear, the third category, is not drawn: -0.397 in Study 2 and 0.077 in Study 3, neither significant. The paper reports no test of the difference between new and established items; on the standard errors the two tables print, approximate 95 per cent intervals for new and established items overlap in both studies.

Source Anderson and Simester (2003), Table 4, p. 101 (Study 2, Model 4) and Table 7, p. 104 (Study 3, Model 4, items without a Sale cue): coefficient of the \$9-ending variable in a Poisson regression of units ordered, with item, catalog version and log price held constant. Standard errors: Study 2, new items 0.059 and established items 0.069; Study 3, new items 0.035 and established items 0.112. The authors read a coefficient as the approximate proportional change in demand (p. 98).

When a stronger cue was already present, the ending added less, though only tentatively. In Study 3, a Sale cue, a price shown as a regular price followed by the word sale and a lower price, had a larger estimated effect on demand than a \$9 ending, and adding a \$9 ending to a new item that already carried the Sale cue was estimated to raise demand by 3.9 per cent, against 8.5 per cent for a new item without it. The authors caution that the joint effect “is estimated using relatively few items” and that “This comparison is perhaps best interpreted as a tentative finding worthy of further investigation.”

When 50 cents were added to a \$9 ending, or the cents ended in 88 rather than 99, the effect was weaker or absent. In Study 3, a catalog manager added \$9.50 endings, reasoning that they would bring 50 cents more per item, and “The evidence suggests that, if anything, \$9.50 endings lead to reduced demand in Study 3”; the paper reports no estimate for them. In Schindler and Kibarian’s² test, the 88 ending found only very limited support. The effect also depended on what was measured: there, the 99 ending moved the amount each purchaser spent, while the difference in the number of purchasers was not significant.

Anderson and Simester¹ report two explanations for why retailers do not put a 9 on every price, both offered as theory and not tested in their data. One borrows from their work on sale signs: “If a retailer overuses a cue, it becomes less effective as customers are less likely to believe the item is indeed low priced.” The other is that “retailers have reputations”, which a 9 ending on a relatively high-priced item may damage. The [essay on price elasticity](#) makes the general point for price response: the number depends on the setting it was measured in.

What can a B2B or SaaS pricing team carry over?

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None of the three sources studied business buyers, contracts, subscriptions or negotiated prices, so this section is the author’s reasoning and has not been tested. Four points carry over as questions to ask before an ending is changed. First, an ending can work through the left digit only if it changes the left digit: 49 against 50 does, 45 against 46 does not. Second, it matters which price the buyer compares it with, such as another tier, a competitor’s price or last year’s invoice, and how close that price is. Third, a buyer who already knows the price, such as a renewal buyer with last year’s invoice or a purchasing team with benchmarks, resembles the established items in Anderson and Simester’s¹ catalogs more than the new ones, so on their information reading the ending should matter less to that buyer. Fourth, a quote that already states a discount resembles the Sale cue, after which the ending added less in Anderson and Simester’s one, tentative comparison.

What does not carry over is the size of the effects. The estimates of 7 to 35 per cent and the 8.0 per cent came from women’s clothing catalogs with average prices of about \$31 to \$50, mailed to tens of thousands of consumers per version. Contract values have more digits, and Thomas and Morwitz³ studied only prices with one digit before the decimal point; whether a 9 ending matters when it changes the dollar

digit of a longer price, with or without the tens digit, as in \$19.99 against \$20.00, they leave to future research. Schindler and Kibarian² mailed 30,000 catalogs per version and still could not show a difference in the number of purchasers; a team that signs a few hundred new accounts a quarter would be unlikely to detect effects of these sizes in its own data. The unit a price is charged per, a seat, a volume of use or an outcome, is the subject of the value metric guide; an ending is a choice about the digits of the amount charged per unit and does not change what the price is attached to.

Figure 2 A price-ending decision record

Write down the price, the left digit, the compared price, the buyer's price knowledge, any other cue and the read-out before an ending is changed.

Price	Left digit	Compared with	Price knowledge	Other cue	Read-out
Which price and which ending?	Does the ending change it?	Which price sits beside it?	New buyers, or buyers who know it?	Is a discount already stated?	Buyers and amount per buyer?

Change only the ending, in randomly split groups with an unchanged control, and read buyers and amount per buyer separately.

One row per price. An ending that leaves the left digit unchanged gives the left-digit account nothing to work on; a buyer who already knows the price gives the information account little.

Source Author's decision worksheet. The left-digit and comparison fields follow Thomas and Morwitz (2005), pp. 54 to 59; the price-knowledge and other-cue fields follow Anderson and Simester (2003), pp. 101, 104 to 105 and 107; the read-out field follows Schindler and Kibarian (1996), pp. 192 to 196; the footer's random split with an unchanged control follows the designs of Anderson and Simester (2003), p. 95, and Schindler and Kibarian (1996), p. 191. Applying the fields to B2B and software pricing is this guide's own step. The fields are reader inputs; no company data is supplied.

An illustration, with no company data: a software firm considers listing its middle tier at 49 instead of 50 per user per month, between an entry tier at 30 and a top tier at 90. The record notes that 49 changes the left digit; that buyers read the tier against the entry tier, 19 or 20 away, a

distance the sources cannot place as near or far; that most of the tier's revenue comes from renewals, whose buyers know last year's price, so the information reading predicts a smaller effect there than among new accounts; and that the annual plan already states a discount. It reads new accounts and seats per new account separately, over a period at least as long as the firm's usual buying cycle. If the firm signs too few new accounts for a randomized comparison to detect effects of the sizes reported here, the record says so, and the decision rests on judgement rather than on a measured effect. These are the author's examples and have not been tested.

What do the three studies leave open?

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Mostly how far they travel. Anderson and Simester¹ worked with two catalogs owned by one corporation, both selling private-label women's clothing; they argue that "Measuring purchasing behavior of real customers offers greater external validity than laboratory experiments", but the catalog managers limited which prices could change and by how much. Schindler and Kibarian² tested one clearance catalog in which every price carried a claimed discount, and they write that "one cannot conclude from this study that such an effect will always occur". Thomas and Morwitz³ measured judgements, not purchases, made by undergraduate students about pens, numbers and quality ratings, and their studies used only numbers ending in 99, with one digit before the decimal point. None of the three measured profit, and each field experiment measured the response to a single catalog.

On this guide's reading, two things carry over with some confidence: a 9 ending can change what real buyers order in a randomized test, and the size of that change varies with the setting; in two of the catalog experiments the estimates were larger for new items than for established ones, though the paper reports no test of the difference. Two further conditions, that the ending changes the left digit and that the compared price is close, come from judgements in the laboratory and were not shown for orders. Which mechanism is at work, how large any effect is when business buyers sign contracts, and whether an ending keeps its effect when every price on a list carries it, the sources do not say.

 End of essay

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