

On the Perceived Value of Money: The Reference Dependence of Currency Numerosity Effects

KLAUS WERTENBROCH
DILIP SOMAN
AMITAVA CHATTOPADHYAY*

Money illusion research shows that the nominal (face) value of money affects consumer perceptions of its real value. Recent mixed findings on consumer valuations in different currencies suggest that the underlying anchoring and adjustment processes are complex. We develop a framework to identify boundary conditions that specify the direction of anchoring effects on valuations in different currencies. Consumers anchor on the numerosity of the nominal difference between prices and salient referents (e.g., budgets) when evaluating transactions. Support for our framework comes from a series of experiments that evoke different reference standards. We discuss implications and opportunities for future research.

Market transactions require people to assign a monetary value to the goods or services to be exchanged. Shafir, Diamond, and Tversky (1997) showed experimentally that people rely on the nominal rather than real value of money when making such decisions. In particular, the face value of an amount of money affected participants' preferences to a greater extent than the purchasing power of that amount (accounting for interest and inflation). This focus on nominal rather than real value when evaluating transactions was described in the economics literature almost 80 years ago by Fisher (1928), who termed it "money illusion." Money illusion not only biases individual decisions but may also have profound economic consequences in the aggregate (Fehr and Tyran 2001).

*Klaus Wertenbroch is associate professor of marketing at INSEAD Europe Campus, Fontainebleau, France (klaus.wertenbroch@insead.edu). Dilip Soman is the Corus Chair in Communication Strategy and professor of marketing at the Rotman School of Management, University of Toronto, Canada (dilip.soman@rotman.utoronto.ca). Amitava Chattopadhyay is the L'Oréal Chaired Professor of Marketing, Innovation, and Creativity and professor of marketing at INSEAD Asia Campus, Singapore (amitava.chattopadhyay@insead.edu). Thanks to Henrik Sattler at the University of Hamburg for his help with collecting data in Germany; to Maggie Chan, Kareen Kinzli, Vivian Lam, and Veron Yip for their research assistance; and to the editor, associate editor, and reviewers for their helpful and constructive comments on earlier versions of this article. Authorship is equal, and authorship order is reverse alphabetical.

Dawn Iacobucci served as editor and Mary Frances Luce served as associate editor for this article.

Electronically published March 21, 2007

There have been a number of recent illustrations of money illusion in the context of evaluating different currencies. For example, Raghurir and Srivastava (2002) examined how consumers value products in foreign currencies. They showed that when the nominal value of the foreign currency is a multiple of the home currency (e.g., for a U.S. consumer considering a purchase in Singapore dollars; US\$1 = S\$1.70), consumers are likely to spend less in real terms when buying in the foreign than in the home currency. Conversely, when the nominal value of the foreign currency is a fraction of the home currency (e.g., for a U.S. consumer considering a purchase in euros; US\$1 = €0.80), they are likely to spend more. Applying Tversky and Kahneman's (1974) well-established anchoring and adjustment process, Raghurir and Srivastava (2002) argued that consumers anchor on the nominal, or face, value of the foreign currency and adjust it for the exchange rate to determine its real value. Because the exchange rate conversion is cognitively taxing, the adjustment is inadequate and causes a face value effect, that is, a biased evaluation in favor of the nominal rather than the real value of the price posted in the foreign currency.

However, concurrent work in the context of the introduction of the euro in 2002 has yielded mixed findings that suggest that anchoring and adjustment effects on price evaluations in different currencies are more complex than implied by a simple effect of the face value of the foreign currency. For example, Desmet (2002) and Gamble et al. (2002) found that euro conversion effects on price evaluations did not occur systematically in all affected countries as the face value effect may have predicted. Moreover, large-

scale European consumer surveys show that changing the nominal value of money by replacing national currencies with euros has led to puzzlingly excessive perceptions of consumer price inflation, suggesting a reluctance to spend when the nominal value of the (new) foreign currency is a fraction of the (old) home currency (European Central Bank 2003). Some have argued that consumers may anchor on familiar prices in their home, or base, currency rather than on the face value of the foreign currency to make price judgments in a foreign currency (Jonas et al. 2002; Marques and Dehaene 2004). For instance, Jonas et al. (2002) found anchoring effects of the base currency (German marks) on price estimates in less numerous euros.

In this article, we further examine the impact of the nominal value of money on the perception of real value in individual consumer decisions. In particular, we extend previous research in several important ways. We propose a conceptualization that not only considers the nominal prices faced by consumers but also takes salient reference values into account, such as the budget consumers have available to make a purchase or the price of competing purchase options. By including budget constraints and reference standards, our conceptualization links nominal valuations to standard economic as well as psychophysical theory. We propose and test two alternative computational mechanisms by which consumers might evaluate prices in different currencies relative to such reference standards. Specifically, do consumers use the difference between reference values and prices to derive their evaluations or the ratio of the two?

Following previous research (Jonas et al. 2002; Mussweiler and Englich 2003; Raghurir and Srivastava 2002; Shafir et al. 1997), we also build on Tversky and Kahneman's (1974) anchoring and adjustment mechanism to explain evaluations of transactions in foreign currencies. However, consistent with standard economic theory, we introduce reference values into the evaluation of transactions, allowing us to systematically moderate previously observed face value effects when budgets (or other reference values) and prices are both uniformly rescaled in a new currency. Specifically, we predict underspending when the new (target) currency is less numerous than the original (base) currency (i.e., a fraction of the original currency; e.g., for a U.S. consumer, US\$1 = €0.80), and we predict overspending when the new (target) currency is more numerous than the original (base) currency (i.e., a multiple of the original currency; e.g., for a U.S. consumer, US\$1 = S\$1.70). These latter predictions are the opposite of the results predicted and observed by Raghurir and Srivastava (2002).

We next present our conceptual framework and then test it in two studies. Study 1 compares the two alternative processes that could underlie the predicted effects and shows that consumers use the difference rather than the ratio of budget and price to make their decisions. The study reverses Raghurir and Srivastava's (2002) findings by rescaling both budgets and prices to a new currency. Study 2 extends our results to other salient reference values in the context of price comparisons between store and name brands priced in

different currencies. It shows boundary conditions of the reference dependence of currency numerosity effects by introducing multiple reference values. We conclude by discussing implications of our findings and directions for future research.

CONCEPTUAL FRAMEWORK

To examine boundary conditions of the face value effect, we follow standard economic and psychophysical theory by assuming that consumers evaluate a transaction by comparing its price to a relevant reference value, for example, to a budget constraint. However, we propose a two-stage, biased evaluation process. In the first step, consumers approximate the number of currency units they will have left over in their budget after the transaction. In the second step, they evaluate these units according to their numerosity. Combining these two steps allows us to reverse previous findings on the face value effect, thus providing a more comprehensive account of how consumers evaluate transactions in different currencies. We do not suggest an alternative psychological mechanism but rather cast the role of anchoring and adjustment processes in evaluating prices in foreign currencies (Raghurir and Srivastava 2002; see also Jonas et al. 2002) in a broader framework with boundary conditions that cause these processes to reverse their impact on evaluations (i.e., in the presence of reference values).

Comparison Processes in Value Assessments and Consumer Choice

Research in psychophysics, perception, and decision making shows that subjective evaluations of nominal quantities (such as prices) depend on salient reference standards (Helson 1964; Stevens 1975; Tversky and Kahneman 1991). Research in marketing has found that consumers evaluate a given price vis-à-vis a budget or compare it to the price of a competing good or some other reference price, depending on the salience of the different possible reference standards (Briesch et al. 1997; Winer 1988). We will return to this issue in study 2. Standard economic analysis more specifically prescribes that consumers make purchase decisions subject to a budget constraint (Deaton and Muellbauer 1980). They buy those items from a choice set of goods that maximize their utility, given the prices of other goods and given the prices they can afford to pay. Similarly, theories of mental budgeting suggest that consumers evaluate prices in the context of, or with reference to, a budget (Heath and Soll 1996; Thaler 1985). The relevant budget can be either predetermined (Heath and Soll 1996) or constructed on the spot, depending on the salience of alternative budget constraints (Soman and Cheema 2002). How, then, do consumers compare prices to a reference standard, such as their budget? We propose, and test against each other, two alternative accounts of that comparison process. Below, we use the term "real value" to refer to the value of an amount expressed in a base currency and "nominal value" to refer

to the numerical face value of the amount either in the base currency or in a target currency.

Ratio Assessments. Consumers may derive an approximation of the ratio of budget and price(s). This allows them to determine how many units of a good they could purchase with their budget, yielding an assessment of how far their budget will go, the normatively correct approach (Deaton and Muellbauer 1980). For example, suppose you have \$10 cash and want to buy an apple that costs \$1; your budget would allow you to buy 10 apples, independent of the nominal value of the currency. This assessment is consistent with Stevens's (1957) power law in psychophysics, according to which equal objective stimulus ratios (e.g., budgets to prices) lead to equal subjective ratios of evaluations. The power law illustrates the operation of ratio judgments as a fundamental principle in the subjective assessment of physical stimulus intensities (Raghubir and Greenleaf 2006). However, it has been suggested that the perception of numerical values (such as money) is different from the domains usually studied in psychophysics, in that it does not involve physical stimulation of receptors (Brendl 2000; Wright 2001). So perceptual functions other than the power law may apply.

Difference Assessments. We propose an alternative account of how consumers compare prices to a budget. Consumers may take the difference between their budget and the price, showing how much money they will have left over in their budget after the purchase. The idea that people use not only ratio judgments but also difference judgments when comparing the intensity of several stimuli was first proposed by Stevens and Davis (1938) and has a rich history in experimental psychology (e.g., Fantino and Goldshmidt 2000) and psychophysics (e.g., Rose and Birnbaum 1975). For example, Birnbaum (1990) proposed and reviewed a range of evidence that, for most continua, stimuli are compared by subtraction. More recent research on monetary valuations has suggested that consumers assess price differences not only on a relative basis (i.e., evaluating the ratio) but also on an absolute basis (Darke and Freedman 1993; Wright 2001). For example, Wright (2001) showed that consumer judgments of a price comparison can be modeled as a weighted average of the price ratio and the price difference. If consumers evaluate prices by relying on judgments of the difference between the budget and the price, how do they assess the size of that difference, short of calculating it, which is cognitively taxing? Based on findings that people are especially sensitive to numerosity as a cue for judging quantity (Pelham, Sumarta, and Myaskovsky 1994), we propose that consumers use the numerosity of the difference (i.e., the number of nominal units into which the difference is divided) as a cue to its size. Specifically, they anchor on the numerosity of the difference and insufficiently adjust it for the exchange rate, leading to a biased assessment of the real value of a transaction.

Predictions

Raghubir and Srivastava (2002) applied anchoring and adjustment to judgments of the face value of transactions in target currencies with known exchange rates, without controlling for any reference values by which a transaction can be evaluated. Specifically, they showed in the absence of such explicit reference values that the face value of a target transaction in a foreign currency anchors the estimation of its real value in one's own currency. But the face value effect does not allow for a straightforward prediction if consumers evaluate prices under a given budget (that exceeds prices).

Ratio Assessments. If the price and the budget are both considered in the same currency, then ratio assessments are normatively appropriate as they preserve real value, independently of the currency or scale. The face value effect would not be able to predict a difference in the assessment of transactions in the base (with real price p and real budget b) and in the target currency (with nominal price p^* and nominal budget b^*) because $b^*/p^* = b/p$, no matter what the exchange rate is.

Difference Assessments. In contrast, difference assessments imply that evaluations of the real cost of different prices will vary with the numerosity of the nominal difference between these prices and the budget. We predict a reversal of the face value effect, with assessments of real value biased in the opposite direction, when prices and the budget are quoted in the same currency. If the target currency is more (less) numerous than the base currency, a target price will appear less (more) expensive vis-à-vis the target currency budget because the difference $b^* - p^*$ between budget and price is more (less) numerous than $b - p$. For instance, a target price of S\$1.70 will appear as less expensive when evaluated against a target budget of S\$17.00 than \$1 against \$10 because $17 - 1.7 = 15.3$ units remain in the budget after the purchase instead of $10 - 1 = 9$. In contrast, €0.80 will appear as more expensive vis-à-vis a target budget of €8.00 because only $8 - 0.8 = 7.2$ units remain.

Such overspending (underspending) in the more (less) numerous currency would not only constitute a reversal of Raghubir and Srivastava's (2002) face value effect that has not been demonstrated before, but, more importantly, such a reversal of the face value effect when prices and budgets are quoted in the same currency would allow us to differentiate between the ratio- and the difference-assessment accounts. It would provide evidence that consumers evaluate transactions based on the numerosity of the difference between nominal budgets (or some other nominal reference value) and nominal prices, suggesting that ratio assessments play at best a secondary role. We now turn to testing these predictions.

TABLE 1
TYPICAL PRICES IN HONG KONG AND TRISTANIA

	Target currency low numerosity (T\$)	Base currency (HK\$)	Target currency high numerosity (T\$)
Dinner at a fancy restaurant	12	215	3,870
A beer and food at a bar	6	110	1,980
Movie ticket	3	54	972
Ticket to a sport event or rock concert	10	180	3,240
A pair of branded casual pants	30	540	9,720
T-shirt suitable for daily wear	8	145	2,610

STUDY 1: CURRENCY NUMEROSITY EFFECTS UNDER A BUDGET CONSTRAINT

The purpose of this study is to examine the effect of a budget constraint as a reference value on currency numerosity effects and to test whether consumers process nominal price and budget information based on ratio or difference assessments. As the above analysis has shown, we need to vary the numerosity of the price and of the reference standard simultaneously to tease apart the role of these two assessment mechanisms. If both the price and the reference standard are given in the same target currency, then the ratio of reference standard to price remains constant, independently of the currency, while the nominal difference is greater (smaller) in the more (less) numerous currency than in the base currency. So a currency numerosity effect on evaluating transactions in a target currency when the transactions are subject to an (explicit) budget constraint in the same target currency would arise from difference rather than ratio assessments.

In study 1, we elicit participants' stated willingness to pay (WTP) for different spending categories as a measure of perceived purchasing power, both in our participants' home (base) currency as well as in a hypothetical target currency. In doing so, we always present transactions and budgets in the same currency but manipulate its numerosity. The ratio-assessment account predicts no difference in real WTP between the base and target currency conditions as a function of the numerosity of the target currency. In contrast, the difference-assessment account predicts that consumers will be prepared to spend more in a currency that is more numerous than their home currency (so that nominal differences between transaction prices and the budget are expanded) than in a currency that is less numerous than their home currency (so that these nominal differences are compressed).

Method

Participants were 35 undergraduates from Hong Kong University of Science and Technology. They participated for course credit. The dependent variable was participants' stated willingness to spend per month in each of several

discretionary spending categories. There were two spending conditions, one describing a scenario concerning Hong Kong and another concerning a hypothetical country called Tristania. All participants took part in two sessions that were conducted 2 weeks apart. The first session presented the Hong Kong scenario; the second, the Tristania scenario. Each session comprised a number of unrelated tasks, in which one task involved the present experiment. The design was a $2 \times 2 \times 3$ mixed factorial, with the factors country (Hong Kong base currency vs. Tristania target currency, within subjects), target currency numerosity (high vs. low, between subjects), and spending categories (within subjects).

In the first session, participants were asked to imagine that they had recently graduated and started a new job. Their monthly posttax salary was HK\$9,000. They were told that their essential expenses (rent, groceries, lunch, transportation, and utility and phone bills) were on average HK\$4,860 a month. They were also told to imagine that they would like to save money to buy various household durable goods. They were asked: "After spending HK\$4,860 each month on these essentials, you have no other essential expenses. But you would probably want to budget some money for nonessential expenses like eating out (e.g., dinner, visiting a bar with friends), shopping (e.g., clothes, accessories), or entertainment (e.g., movie tickets, music concerts). Keeping in mind your income and expenses, how much do you think you would budget for each of these types of expenses per month?" In the second session, participants read a similar scenario with the modification that their job required them to move to the foreign country of Tristania. Participants were either in a low numerosity condition where T\$1 = HK\$18, the salary was T\$500, and expenses were T\$270 or in a high numerosity condition where T\$1 = HK\$1/18, the salary was T\$162,000, and essential expenses were T\$87,480. We provided participants with these exchange rates and elicited their WTP in T\$ in this second session.

For each scenario, participants also saw information on typical prices in Hong Kong or Tristania to help them with their budgeting decisions by giving them a feel for the general price level. The information was ostensibly taken from a survey conducted by a tourist guide (see table 1).

Results and Discussion

We had predicted that participants assess their purchasing power by assessing the nominal difference between their overall budget (i.e., their disposable income) and how much of this overall budget they allocate to a specific spending category. Under such a difference assessment, a low numerosity currency yields less perceived purchasing power than a high numerosity currency because the difference between the overall budget and category-specific spending (i.e., what is left over in the overall budget after spending in the category) is nominally smaller. We had varied the numerosity of the target currency (T\$) relative to the base currency (HK\$) and had elicited nominal category-specific WTP as a measure of perceived purchasing power.

A country \times currency numerosity \times category repeated-measures ANOVA revealed the predicted interaction effect of country and currency numerosity, as expected under the difference account ($F(1, 33) = 187.88, p < .0001$). Mean WTPs are shown in table 2, with all amounts expressed in HK\$ or HK\$ equivalents. All 17 participants in the low numerosity condition showed the predicted positive difference in WTP between the base (HK\$ in session 1) and the target currencies (T\$ in session 2) for the entertainment category and for the sum of their spending across these three categories, and 16 out of 17 participants showed it for food and for shopping. All 18 participants in the high numerosity condition showed the predicted negative difference in WTP between the base (HK\$ in session 1) and the target currencies (T\$ in session 2) for the entertainment category and for total spending, 17 out of 18 showed it for food, and 16 out of 18 for shopping.

Specifically, for each of the three spending categories, participants in the low numerosity condition showed a lower mean (real) WTP in the target than in the base currency ($t = 3.57, p < .001$ for food; $t = 4.40, p < .001$ for shopping; and $t = 4.01, p < .001$ for entertainment). Participants in the high numerosity condition showed the reverse pattern. Except for shopping, they stated a significantly higher mean (real) WTP in the target currency (T\$ in session 2) than in the base currency (HK\$ in session 1, with $t = -3.23, p < .002$ for food; $t = -.84, p < .22$ for shopping; and $t = -3.45, p < .001$ for entertainment). Similarly, total-basket WTP (in HK\$ equivalents) was lower in the target than in the base currency when the target currency was less numerous ($t = 9.93, p < .001$). In contrast, total-basket WTP (in HK\$ equivalents) was higher in the target than in the base currency when the target currency was more numerous ($t = -5.75, p < .001$ for total spending).

These results demonstrate that when both budgets and transactions are uniformly rescaled in a new currency, there is underspending when the new currency is less numerous than the original currency, and there is overspending when the new currency is more numerous than the original currency. To test the robustness of this finding across dependent variables and participant populations, we ran several additional studies. First, we asked a sample of 115 U.S. undergraduates from the University of Colorado at Boulder for

TABLE 2

WILLINGNESS TO SPEND IN DIFFERENT CATEGORIES
IN STUDY 1

	Session 1, Hong Kong (HK\$)	Session 2, Tristania (in HK\$ equivalents)
Low numerosity ($n = 17$):		
Food	532.35 ^a	372.71 ^a
Shopping	832.35 ^a	538.94 ^a
Entertainment	414.71 ^a	290.12 ^a
Total	1,779.41 ^a	1,201.77 ^a
High numerosity ($n = 18$):		
Food	547.78 ^b	677.67 ^b
Shopping	811.11	854.92
Entertainment	422.22 ^a	540.12 ^a
Total	1,781.11 ^a	2,072.71 ^a

^aRow-wise means differ at $p < .001$.

^bRow-wise means differ at $p < .002$.

their purchase likelihood ratings for a portable music system. Participants received the price of the system along with a monthly budget in the same target currency. We manipulated the numerosity of the currency (low, control [target = US\$ base numerosity], and high), explicitly providing participants with the exchange rate. Purchase likelihood ratings increased significantly with currency numerosity, providing additional evidence for the difference-assessment account. Second, we also ran a series of gambling experiments with real monetary payoffs (with a total of 105 undergraduates from Hong Kong University of Science and Technology) that tested the difference-assessment account under incentive-compatible conditions. These experiments manipulated the numerosity of the currency in which participants gambled and in which we gave them a nominal budget to gamble with. They again showed that participants' real willingness to bet increases with the numerosity of the difference between their nominal budgets and the nominal expected value of the gamble, even though the real expected value was held constant across the different numerosity conditions. Taken together, our findings show that consumers take budget constraints into account in a manner predicted by the difference-assessment account—they assess the nominal difference between budgets and transaction values and then anchor on the numerosity of that difference to derive their WTP or evaluate a purchasing decision.

The ratio-assessment account does not predict our findings because the ratio of budget to transaction values was held constant across the three numerosity conditions, independently of currency numerosity. Similarly, a simple anchoring and adjustment model where consumers anchor on the face value of the target currency cannot explain this finding either because it would apply to both spending and budget, which would neutralize each other. By expressing both transactions and budgets in (the nominal values of) the target currency, we reverse Raghubir and Srivastava's

(2002) effects, where participants were not given any explicit budget information.

Note, though, that it is possible to interpret their results in terms of our framework. Their participants may have implicitly applied their own budget constraints in U.S. dollars in assessing their WTP in a foreign currency. To check this, we ran a follow-up study that imposed a budget constraint b in the base currency (US\$) and asked 60 U.S. undergraduates from the University of Colorado at Boulder for their WTP for various vacation expense categories in a fictitious foreign currency whose numerosity we varied. In this situation, where transaction values and the budget are in different currencies, both ratio and difference assessments predict biased judgments of real value similar to Raghurir and Srivastava's (2002) effects (if consumers make a nominal comparison). Specifically, if $b/p^* > b/p$ or if $b - p^* > b - p$ (i.e., p^* in the target currency is less numerous than p in the base currency), there will be overspending. If $b/p^* < b/p$ or if $b - p^* < b - p$ (i.e., p^* in the target currency is more numerous than p in the base currency) there will be underspending. While such nominal comparisons of prices and budgets are meaningless in real terms, participants may actually have engaged in comparisons in different currencies because we found overspending (underspending) in less (more) numerous currencies. This suggests that Raghurir and Srivastava's (2002) anchoring mechanism can be cast in a broader framework in which reference effects moderate the impact of anchoring on spending via difference assessments. These last results also argue against an alternative explanation of our reversal of the face value effect. When provided with a budget, consumers might anchor on the nominal value of that budget when evaluating transactions in foreign currencies. But this would not have predicted the biased evaluations in our follow-up study since the nominal budget was the same (i.e., quoted in US\$) across all numerosity conditions.

STUDY 2: PRICES AND BUDGETS AS COMPETING REFERENTS

Study 1 showed overspending (underspending) in more (less) numerous currencies in line with difference assessments—consumers subjectively evaluate their purchasing power by assessing the numerosity of the nominal difference between their disposable income and nominal transaction values. Does this effect of the numerosity of the difference apply only to comparisons of prices and budgets, or does it more generally affect economic evaluations that are subject to multiple reference standards, such as budgets as well as comparisons of one price to another?

To examine this question, study 2 induces price comparisons between name brands and private labels, a standard consumer choice problem in marketing. We predict that consumers perceive the same real price difference between a name brand and a private label as being smaller, the less numerous the currency is in which the prices for the two brands are quoted. That is, the (usually more expensive)

name brand will appear as less expensive relative to the private label. As a result, the choice share of name brands should be higher in less numerous currencies. We predict, however, that the effect of currency numerosity on such price comparisons will be tempered, or moderated, by the overall budget consumers have available to make their purchases. The larger the budget, against which consumers evaluate the prices of both the name brand and the private label, the smaller the impact will be of the numerosity of the price differential between name brands and private labels on name brand choice shares. That is because a larger budget will let any given price differential appear increasingly negligible when seen against the difference between the budget and the prices of either brand.

We frame the problem in the context of repeated choices across categories between name brands and comparable private labels when both are priced either in a less numerous currency or in a more numerous currency.

Method

Sixty-three undergraduate students from the University of Hamburg participated as part of an in-class exercise. They were asked to imagine that they had to make grocery purchases while on vacation in Spain. In a 2×2 between-subjects design, we manipulated whether participants saw prices in euros, a less numerous currency, or in Spanish pesetas (Pta 166.30 = €1), a more numerous currency (CUR). The data were collected in December 2001, a month before the introduction of the euro as the common currency in Germany and Spain. So neither currency was familiar to our participants as usual legal tender. We also varied whether participants had a budget (BUD) of the equivalent of €100 or €300, that is, Pta 17,000 or Pta 50,000. Participants read, and were asked to imagine, the following scenario:

You have just arrived in the Spanish Pyrenees for a short vacation. You are renting a vacation apartment so that you will have to buy some groceries. You'll make these grocery purchases from your food budget, the equivalent of €100 (Pta 17,000) [€300 (Pta 50,000)] in cash, that you exchanged when you arrived. You need to buy one item in each of 20 product categories. The brands that are available at the local grocery store, Continente, where you will buy, are listed below. The store carries both well-known brands as well as its own store-brand products under the Continente name.

This was followed by a list of 20 well-known brand name products and 20 store brand products under the Continente name (a Spanish retail chain) that were matched for key product features such as package size and flavor, which had been selected from retail advertising materials for greater realism. The 20 categories encompassed typical grocery products, from orange juice to ketchup to film. The name brands were all well known in Germany and Spain, including brands like Tropicana, Heinz, and Kodak. In each cat-

egory, the name brand was priced at 15% above the private label price.

Participants chose between the name brand and the private label in each of the 20 product categories. They also provided ratings of familiarity with each of the name brands on a five-point scale (1 = completely unfamiliar; 5 = completely familiar). The dependent variable was the choice share of the name brands across all 20 categories.

Results and Discussion

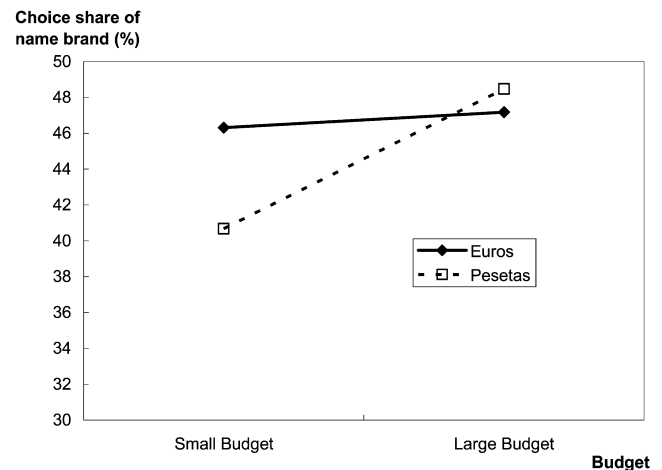
A 2×2 logistic regression analysis ($LL = -643.85$; $\chi^2(23) = 406.14$, $p < .0001$) with familiarity ratings and product category dummies as covariates revealed the following effects. As predicted, the mean choice share of name brands was higher ($M = 46.73\%$) when prices were in the less numerous currency euros than when prices were in the more numerous currency pesetas ($M = 44.54\%$; $\beta_{CUR} = .44$; $\chi^2(1) = 5.29$, $p < .03$). The mean choice share of name brands was also higher when participants had a larger budget available ($M = 47.80\%$) than when they had a smaller budget available ($M = 43.66\%$; $\beta_{BUD} = .53$; $\chi^2(1) = 7.05$, $p < .01$). Also as predicted, these main effects were qualified by an interaction effect of currency and budget ($\beta_{CUR \times BUD} = -.60$; $\chi^2(1) = 4.73$, $p < .03$) such that the choice share of name brands was higher with prices in euros than in pesetas only when the budget was small but not when it was large (see fig. 1). Finally, the choice share of name brands increased with their familiarity ($\beta_{FAM} = .57$; $\chi^2(1) = 60.78$, $p < .0001$).

These results suggest that multiple referents can affect consumer evaluations of transactions in different currencies. Our participants' responses show that they perceived the more expensive name brands as carrying a smaller price premium relative to the corresponding private labels when both were priced in less numerous euros than when both were priced in more numerous pesetas. This is predicted by the difference-assessment account, according to which consumers compare prices of name brands and private labels based on the numerosity of the nominal price difference between these two. However, this assessment is moderated by whether consumers have a relatively small or a relatively large budget available. Increasing the real budget diminishes consumers' reliance on anchoring on the numerosity of the nominal price difference between the two brands and refocuses them on the numerosity of the difference between their budget and the brands' prices.

Specifically, the difference-assessment account suggests that increasing the budget from Pta 17,000 to Pta 50,000 boosts the numerosity of the balance left over after the purchase of either brand much more than increasing the budget from €100 to €300. So choosing the name brand over the private label does not dent the budget as noticeably in pesetas as in euros. Hence, consumers with a large budget feel disproportionately wealthier than consumers with a small budget when budgets are presented in pesetas than when budgets are presented in euros and are thus more likely to choose the more expensive name brand.

FIGURE 1

CHOICE SHARES (%) OF NAME BRANDS IN STUDY 2



These findings shed further light on the operation of difference assessments. They suggest that the impact of any given reference value, such as the price of a competing brand that consumers consider as part of their consideration set, can recede relative to other more salient reference values, such as their available budget. More generally, these results suggest that currency numerosity effects depend on the reference values that are evoked in a given currency evaluation context, consistent with the difference-assessment account. While study 1 focused on showing that consumers' budgets influence their evaluations of transactions and their WTP, study 2 shows that multiple reference standards can be influential, depending on their relative salience in the decision-making environment.

GENERAL DISCUSSION

Summary

We have presented a theory and evidence of currency numerosity effects on the perceived value of transactions. In line with standard consumer choice theory, we have proposed that consumers evaluate transactions vis-à-vis salient reference standards, such as a budget or the price of a competing product. However, consumers deviate from standard theory by anchoring on the numerosity of the nominal difference between that reference standard and the price of the transaction in order to estimate the real value of that transaction. Study 1 and several follow-up studies showed that the face value effect found in previous research reverses when both transaction values and budgets are varied in nominal terms. We demonstrated that consumers evaluate transactions in line with the numerosity of the nominal difference between budgets and spending levels (an approximate measure of their purchasing power), extending previous theo-

ricing on money illusion. Study 2 applied our theory to comparisons of prices of competing products in addition to comparisons of prices and budgets, demonstrating that the perceived price premium of name brands over store brands shrinks, the less numerous the nominal difference is between the two types of brands, boosting name brand market shares. This effect was moderated by the size of the available budget, suggesting not only that multiple referents may apply to any given transaction but also that the relative salience of these referents affects the extent to which consumers use each difference (between two prices or between prices and budgets) to assess the value of a given transaction.

Limitations, Theoretical Implications, and Future Research

The present research is concerned with demonstrating and explaining numerosity effects on the perceived value of transactions under controlled experimental conditions at the individual consumer level. To some degree, our experimental focus limits what we can say about the external validity of our findings. It would be useful for future research to examine market-level (scanner) data on consumer purchases across different countries for evidence of the numerosity effects described here. One potential difficulty with this approach, however, is that the salient reference standards, against which consumers evaluate prices in real life, vary across individual consumers and across purchase situations so that they are difficult to control in market-level data in the same way we controlled them in study 2. Nonetheless, there may be systematic differences between countries in WTP as a function of currency numerosity, all else equal. For example, following up on the main effect of currencies in study 2, it would be particularly interesting to detect possible changes in name brand and private label market shares across countries in the euro zone as a function of changes in currency numerosity when euro notes and coins were introduced in 2002. Other implications of our findings include what follows.

Money Illusion. The economics literature has focused on delineating possible macroeconomic implications of money illusion. The scant experimental research on money illusion has focused on its existence and implications (Fehr and Tyran 2001). Less attention has been paid to the psychological mechanisms that cause money illusion. Shafir et al. (1997) suggested that money illusion arises because people find it easier to think in nominal rather than real terms. Our findings shed more light on the psychological processes by which money illusion operates in general. They add to the fledgling literature by providing evidence that consumer evaluations of transactions are driven by the numerosity of the nominal difference between prices and reference standards that are salient in the evaluation context. Our findings qualify conclusions from existing research about the role of anchoring on the face value of nominal prices in evaluating products in foreign currencies. Our reversal of the simple face value effect of currency numerosity on price percep-

tions when reference standards are salient suggests that money illusion can be explained within the framework of standard consumer choice theory (Deaton and Muellbauer 1980). Consumers evaluate transactions against their budget, but they assess their purchasing power by anchoring on the numerosity of the nominal difference between prices and budgetary or other reference standards, that is, on the number of units into which that difference is divided.

Currency and Inflation. An interesting question that arises from these results concerns the effect of currency denominations and of currency changes on WTP. Specifically, are shifts in WTP of the sort we have observed temporary so that consumers learn to readjust their perceptions of the real value of the target currency over time, or does a numerosity effect on currency valuations lead to a more permanent shift in WTP? If consumers learn to adjust their valuations of a new currency over time (Mussweiler and Englich 2003), then any price changes in the wake of the introduction of the new currency that were due to short-term effects on WTP will eventually be scaled back as real WTP will drop (or rise) again. However, a permanent shift in WTP may lead to a permanent increase (or decrease) in price levels as consumers may be prepared to pay permanently higher or lower prices. Existing research assumes that money illusion effects persist; that is, just like an optical illusion, our cognitive apparatus does not learn to (fully) correct for the illusion (Shafir et al. 1997). In the context of our findings, numerosity effects could lead either to an increase or to a decrease in consumer WTP and, consequently, in price levels, depending on the type and the salience of the reference standard against which consumers evaluate posted prices. Given the natural variation in the salience of reference standards across points of sale, there may be no aggregate effect but rather only a point-of-sale-specific effect as a function of the marketer's ability to induce, or change, consumers' reference standards. A possible, more systematic exception may be the comparison of name and store brand prices, which provide a natural reference standard for each other. For example, our data on the market share of name brands vis-à-vis store brands suggest increases of relative prices of name brands across the euro zone (except in Ireland, which had a less numerous currency before the introduction of euros) in the long term. These increases would stem not from retailer efforts to use the new currency to conceal price hikes (as has been suggested with respect to some euro zone retail prices since the introduction of euros) but rather from a demand-side-driven, permanent change in consumer WTP, depending on which reference standards are salient to consumers at the point of purchase.

Also note that the biases in perceived inflation, which have been observed following the introduction of the euro (despite a relatively low inflation rate of 2%–3%), are consistent with our framework and findings. The conversion of national currencies to (less numerous) euros has left consumers with less numerous nominal balances $b^* - p^*$ in their wallets, making them feel poorer than before. Our framework may thus provide a psychological explanation for the

continued excess of perceived over officially measured inflation that has puzzled policy makers (e.g., Brachinger 2005; Del Giovane and Sabbatini 2005; European Central Bank 2003).

Other Judgmental Dimensions of Value. Beyond money, there are other measurement scales on which the value of goods is often measured or expressed in business, economics, and marketing. These include promotional points such as frequent flyer miles in exchange for effort and rewards (Nunes and Park 2003). It would be interesting to examine how marketers can influence consumer valuations of rewards relative to effort via the numerosity of the exchange rate of points to effort and rewards (Hsee et al. 2003). Moreover, numerosity effects may affect the perceived value of volume or weight information in package design (see Pelham et al. [1994] for numerosity effects on, e.g., size estimation). Are packages perceived to be larger, and hence to provide more value for the money, if their weight is measured in grams or ounces rather than kilograms or pounds? Finally, finance research shows that share valuations increase after stock splits, and only part of this effect can be attributed to dividend increases that are associated with splits (Nayak and Prabhala 2001). Does the reduced numerosity of the share price after a split make shares seem cheaper to investors, boosting demand and, hence, the real share price?

All these are examples of possible numerosity effects on perceived value that may distort market transactions. To shed light on such distortions, this article has provided some initial evidence that consumers evaluate transactions relative to a reference standard as prescribed by standard choice theory but that their assessments are anchored on the numerosity of the difference between the nominal value of the transaction and the nominal value of the reference standard.

REFERENCES

- Birnbaum, Michael H. (1990), "Scale Convergence and Psychophysical Laws," in *Psychophysical Explorations of Mental Structures*, ed. Hans-Georg Geissler, Toronto: Hogrefe & Huber, 49–57.
- Brachinger, Hans W. (2005), "Der Euro als Teuro? Die wahrgenommene Inflation in Deutschland" [Expensive euros? Perceived inflation in Germany], *Wirtschaft und Statistik*, September, 999–1013.
- Brendl, C. Miguel (2000), "Subjective Experience and the Effect of Sample Size on Likelihood Judgments," in *The Message Within: The Role of Subjective Experience in Social Cognition and Behavior*, ed. Herbert Bless and Joseph P. Forgas, Philadelphia: Psychology Press, 69–87.
- Briesch, Richard A., Lakshman Krishnamurthi, Tridib Mazumdar, and S. P. Raj (1997), "A Comparative Analysis of Reference Price Models," *Journal of Consumer Research*, 24 (September), 202–14.
- Darke, Peter and Jonathan L. Freedman (1993), "Deciding Whether to Seek a Bargain: Effects of both Amount and Percentage Off," *Journal of Applied Psychology*, 78 (December), 960–65.
- Deaton, Angus and John Muellbauer (1980), *Economics and Consumer Behavior*, New York: Cambridge University Press.
- Del Giovane, Paolo and Roberto Sabbatini (2005), "Introduction of the Euro and the Divergence between Officially Measured and Perceived Inflation: The Case of Italy," working paper, Economic Research Department, Bank of Italy, Rome.
- Desmet, Pierre (2002), "A Study of the Potential Effects of the Conversion to Euro," *Journal of Product and Brand Management*, 11 (June), 134–46.
- European Central Bank (2003), "Recent Developments in Euro Area Inflation Perceptions," *Monthly Bulletin*, October, 24–25.
- Fantino, Edmund and Jay N. Goldshmidt (2000), "Differences, Not Ratios, Control Choice in an Experimental Analogue to Foraging," *Psychological Science*, 3 (May), 229–33.
- Fehr, Ernst and Jean-Robert Tyran (2001), "Does Money Illusion Matter?" *American Economic Review*, 91 (December), 1239–63.
- Fisher, Irving (1928), *The Money Illusion*, New York: Adelphi.
- Gamble, Amelie, Tommy Gärling, John Charlton, and Rob Ranyard (2002), "Euro Illusion: Psychological Insights into Price Evaluations with a Unitary Currency," *European Psychologist*, 7 (December), 302–11.
- Heath, Chip and Jack B. Soll (1996), "Mental Budgeting and Consumer Decisions," *Journal of Consumer Research*, 23 (June), 40–52.
- Helson, Harry (1964), *Adaptation Level Theory*, New York: Harper & Row.
- Hsee, Christopher K., Fang Yu, Jiao Zhang, and Yan Zhang (2003), "Medium Maximization," *Journal of Consumer Research*, 30 (June), 1–14.
- Jonas, Eva, Tobias Greitemeyer, Dieter Frey, and Stefan Schulz-Hardt (2002), "Psychological Effects of the Euro-Experimental Research on the Perception of Salaries and Price Estimations," *European Journal of Social Psychology*, 32 (March), 147–69.
- Marques, Frederico J. and Stanilas Dehaene (2004), "Developing Intuition for Prices in Euros: Rescaling or Relearning Prices?" *Journal of Experimental Psychology: Applied*, 10 (September), 148–55.
- Mussweiler, Thomas and Birte Englich (2003), "Adapting to the Euro: Evidence from Bias Reduction," *Journal of Economic Psychology*, 24 (June), 285–92.
- Nayak, Subhankar and Nagpurnanand R. Prabhala (2001), "Disentangling the Dividend Information in Splits: A Decomposition Using Conditional Event-Study Methods," *Review of Financial Studies*, 14 (Winter), 1083–1116.
- Nunes, Joseph C. and C. Whan Park (2003), "Incommensurate Benefits: Not Just More of the Same," *Journal of Marketing Research*, 40 (February), 26–38.
- Pelham, Brett W., Tin Tin Sumarta, and Laura Myaskovsky (1994), "The Easy Path from Many to Much: The Numerosity Heuristic," *Cognitive Psychology*, 26 (April), 103–33.
- Raghubir, Priya and Eric Greenleaf (2006), "Ratios in Proportion: What Should the Shape of the Package Be?" *Journal of Marketing*, 70 (April), 95–107.
- Raghubir, Priya and Joydeep Srivastava (2002), "Effect of Face Value on Product Valuation in Foreign Currencies," *Journal of Consumer Research*, 29 (December), 335–47.
- Rose, Barbara J. and Michael H. Birnbaum (1975), "Judgments of Difference and Ratios of Numerals," *Perception and Psychophysics*, 18 (September), 194–200.
- Shafir, Eldar, Peter Diamond, and Amos Tversky (1997), "Money

- Illusion," *Quarterly Journal of Economics*, 112 (May), 342–74.
- Soman, Dilip and Amar Cheema (2002), "The Effect of Credit on Spending Decisions: The Effect of Credit Limit and Credibility," *Marketing Science*, 21 (Winter), 32–53.
- Stevens, Stanley S. (1957), "On the Psychophysical Law," *Psychological Review*, 64 (May), 153–81.
- (1975), *Psychophysics: Introduction to Its Perceptual, Neural, and Social Prospects*, New York: Wiley.
- Stevens, Stanley S. and H. Davis (1938), *Hearing: Its Psychology and Physiology*, New York: Wiley.
- Thaler, Richard (1985), "Mental Accounting and Consumer Choice," *Marketing Science*, 4 (Summer), 199–214.
- Tversky, Amos and Daniel Kahneman (1974), "Judgment under Uncertainty: Heuristics and Biases," *Science*, 185 (September), 1124–31.
- (1991), "Loss Aversion in Riskless Choice: A Reference-Dependent Model," *Quarterly Journal of Economics*, 107 (November), 1039–61.
- Winer, Russell S. (1988), "Behavioral Perspectives in Pricing: Buyer's Subjective Perceptions of Price Revisited," in *Issues in Pricing: Theory and Research*, ed. Timothy Devinney, Lexington, MA: Lexington, 35–57.
- Wright, John H. (2001), "The Influence of Absolute Differences and Relative Differences on Unidimensional Difference Judgments," unpublished dissertation, Department of Marketing, Graduate School of Business, University of Chicago, Chicago, IL 60637.