The Impact of Research Design on Consumer Price Recall Accuracy: An Integrative Review

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For almost half a century, researchers have examined consumer knowledge of prices, often with disturbing and conflicting results. Although the general findings suggest that consumer knowledge of prices is poorer than assumed in neoclassical economic theory, significant variations among results exist. The authors synthesize findings from prior studies to determine the impact of research design choices on price recall accuracy measures. A meta-analysis indicates that a significant amount of variation in the accuracy of consumers' price recall is related to research design characteristics such as the presence of financial rewards, respondents' task size, and the price elicitation approach. Implications for price awareness research are discussed.

Ever since the early investigation of Gabor and Granger (1961), researchers have examined consumers' general knowledge of prices, often with disturbing results. For example, it has been estimated that less than half of all consumers can accurately recall prices for goods purchased on a regular basis (e.g., Dickson and Sawyer 1990; Krishna, Currim, and Shoemaker 1991), and that for many product categories, consumer price estimates may deviate significantly from actual prices ("How Much Do Consumers Know" 1964; "Poor Price-Quiz Scores" 1977). Such observations challenge the notion of a consumer who is fully knowledgeable about prices—a fundamental assumption made in neoclassical economic thinking (Marshall 1890). Moreover, poor consumer knowledge of prices points to potential consumer vulnerabilities in the marketplace.

The ability of consumers to learn and recall price information has therefore been a topic of concern for several decades. To assess the accuracy of this information, researchers have used a variety of memory tests. These tests have examined the accuracy of consumers' recalled prices (e.g., "What Shoppers Know" 1974), their ability to rank items in terms of their expensiveness (e.g., Brown 1971; Mazumdar and Monroe 1990), and their ability to recognize price labels (e.g., Dickson and Sawyer 1990). Although the latter two measures—rankings and recognition—may be more reasonable tests of consumers' memory for price information, as many consumers may not explicitly attempt to memorize prices, most research on price awareness has relied on price recall measurement (Monroe and Lee 1999; Monroe, Powell, and Choudhury 1986). These studies examine consumers' ability to recall prices correctly by gauging the deviation between the recalled price and the actual price.

In an earlier article in this journal, Monroe and Lee (1999) review the existing body of research on consumer processing of price information and contend that "the more we learn, the more we realize we do not yet understand" how consumers attend to, process, and use price information (p. 207). Researchers disagree on the extent of shortcomings in consumer price knowledge. For example, the estimate of the percentage of consumers who can exactly recall specific product prices ranges from below 5 percent (e.g., "How Much Do Consumers Know" 1964; Krishna et al. 1991) to more than 50 percent (e.g., Harrell,

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Hutt, and Allen 1976; Helgeson and Beatty 1987; Le Boutillier, Le Boutillier, and Neslin 1994). Studies also disagree in their assessment of the role of consumer demographics on price recall accuracy.

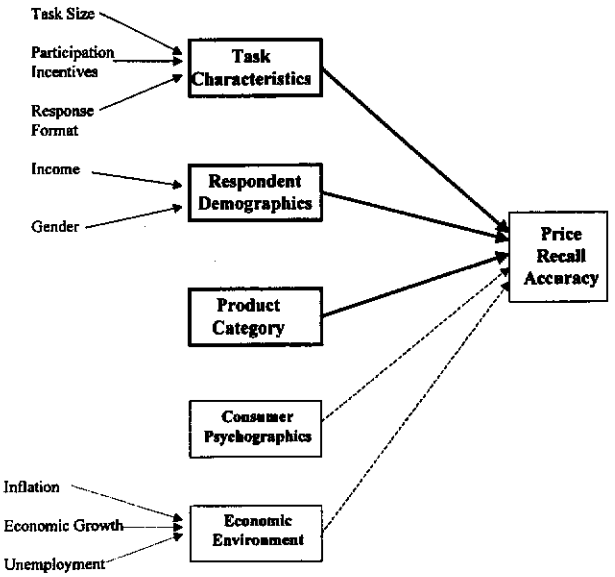
The purpose of this meta-analysis is to address one of Monroe and Lee's (1999) concerns by synthesizing findings from prior research on consumer price recall accuracy. Overall, researchers in this area have applied different research designs in studying consumer price recall. For example, studies vary in their choice of product categories, financial incentives given to respondents to participate, and the price elicitation approach. Such research design variations may lead to differing assessments of consumers' awareness of prices. Using a meta-analytic approach, the impact of research design variations on price recall accuracy measures is examined. Findings suggest a significant impact of fundamental design factors such as task size, the product category, respondent demographics, and the financial incentives given to respondents for their participation.

RESEARCH DESIGN DETERMINANTS OF PRICE RECALL ACCURACY

Figure 1 outlines the numerous factors that may influence consumer price recall accuracy. Price recall accuracy may vary as a function of research design choices relating to the product category used, respondent demographics, and price elicitation task characteristics. The product category used as the basis of the study may influence price recall accuracy, as consumers' product familiarity may significantly vary across categories. In addition, since demographics are often a determinant of price sensitivity and product category familiarity, respondent demographics such as gender and income may influence price recall accuracy. Moreover, an array of task-related factors such as task size, financial incentives given to respondents for participation, and the ability of respondents to not express a price estimate may influence price recall accuracy measures.

Of course, in addition to these research design factors, a series of factors unrelated to research design may influence price recall accuracy exhibited by consumers. For example, the economic environment at the time of data collection, as reflected by factors such as inflation, unemployment, and economic growth rates could influence consumer desire to learn price information and the subsequent accuracy of their price recalls. Moreover, psychographic consumer characteristics such as price vigilantism can further influence price recall accuracy. The objective of this meta-analysis however, is to explore the relationship between research design variables and price recall accuracy, as indicated by the solid arrows in Figure 1.

FIGURE 1
Determinants of Price Recall Accuracy



Product Category

Price recall studies have used products ranging from bathroom tissue and soft drinks to bicycles, jeans, and various consumer services. Since product categories vary in terms of key characteristics such as their purchase frequency, consumer involvement, the amount of price advertising in the media, and price variability, the accuracy of consumers' memory for prices may also vary across categories. According to Helson's (1964) adaptation-level theory, exposure to price information may help create price expectations based on which subsequent exposures to prices are evaluated. Moreover, repeated exposure to prices due to frequent purchases, price advertising, or high involvement levels is likely to increase the likelihood of processing price information (Jacoby and Olson 1977). This assertion has been empirically confirmed in contexts using both experimental (e.g., Monroe 1973) and field data (e.g., Winer 1986), and suggests more accurate knowledge of prices for frequently purchased products.

Converging evidence for the effects of past price exposures on price memory can also be found in the multiple-store theory of memory (Lindsay and Norman 1972; Shiffrin and Atkinson 1969), which suggests that attended exposure to price information through repeated shopping experiences would increase the likelihood of elaboration and rehearsal of price information. This may help improve the accuracy of price information stored in long-term

memory (Sawyer 1974). Therefore, consumer price recall accuracy may be better for certain product categories than others.

Hypothesis 1: Price recall accuracy will vary across product categories.

Interestingly, while significant cross-category variations in price recall accuracy can be theoretically expected, existing price recall studies are inconclusive on the role of the product category on the accuracy of consumers' memory for prices. While some studies have documented significant effects for the product category (e.g., Estelami 1998; "How Much Do Consumers Know" 1964), others have not found any clear effects (e.g., Conover 1986; Wakefield and Inman 1993). Therefore, one objective of this meta-analysis will be to examine the role of the product category on price recall accuracy across existing studies.

Price Elicitation Task Factors

The accuracy of consumers' recalled prices may also vary as a function of the elicitation approach used by the researchers. Studies vary in the amount of incentives given to participants to provide accurate responses, the size of the price elicitation task, and the response format.

Incentives to Participate

To date, no price awareness study has linked the quality of price responses to monetary compensation for the respondent. Such incentives are common in the psychology literature where respondents may, for example, receive monetary compensation based on the accuracy of their responses in numerical processing tasks (e.g., Carroll, Turner, and Prasad 1986; Dansereau and Gregg 1966). Three levels of participation incentives can be identified in price recall studies:

1. *None:* No incentives whatsoever are given to the respondent. Respondents are neither compensated for their participation in the study nor for the accuracy of the estimates they provide.
2. *Community or student groups:* A somewhat stronger incentive may be provided by recruiting participants from community groups or student classrooms, where respondents may have an interest in participation (e.g., group funding, class participation grade). It could be expected that these groups would be more motivated than those not receiving any incentives to provide accurate responses.
3. *Fixed monetary rewards:* The strongest incentive used to date has been in the form of fixed rewards such as coupons for future purchases, which the participants can redeem at a local store.

Increasing respondents' incentives and holding them accountable for their responses increases task involvement and significantly intensifies information processing (Celsi and Olson 1988; Tetlock 1983). Assuming respondents have accurate price information, the following is expected:

Hypothesis 2: Price recall accuracy will be positively related to participation incentives given to respondents.

Task Size

The difficulty of the tasks respondents are asked to complete also varies from one price recall study to the next. Respondents may be asked to recall prices for only a single product, or they may be asked to provide prices for multiple products. A large number of product price requests from each individual respondent may result in poorer price estimates. Since repeated measures designs may lead to respondent fatigue, the resulting price estimates may deteriorate in accuracy as the task size increases (Sudman and Blair 1998). Use of larger repeated measures designs is also likely to result in artificial tasks, in which the respondents may be conditioned to the study (Sawyer 1975), and can further promote a simplification strategy in respondents, forcing them to use heuristics in their responses (Bettman 1979; Newell and Simon 1972). Therefore, as the number of products for which the average respondent is asked to provide prices increases, it is likely that price recall accuracy deteriorates.

Hypothesis 3: Price recall accuracy will be negatively related to task size.

Response Format

In many studies, respondents are forced to provide price estimates, regardless of their ability to recall specific information from memory. For consumers who have not memorized prices and have no retrievable information available in long-term memory, forcing a response is likely to result in inaccurate price estimates (Mazumdar and Monroe 1992; Monroe and Lee 1999; Monroe et al. 1986). Such consumers may engage in price construction rather than price recall—in which they heuristically construct numerical price values based on other information in memory and knowledge of related products (Gardiner and Java 1993). Allowing a "don't know" response option will improve price recall accuracy measures, as respondents who have inaccurate memory of prices have the option of choosing not to participate.

Respondent Characteristics

Price recall accuracy may also correlate with demographics. Variables such as gender and income are often considered to be related to product familiarity and purchase behavior and are therefore frequently used as a basis for market segmentation (e.g., Calantone and Sawyer

1978; Weinstein 1994). For example, consumers of a particular gender may account for a large percentage of purchases in certain categories and may therefore be more knowledgeable about prices. In studies of shopping behavior for grocery products, the perceptions of the critical role played by female shoppers on such household purchases led many early researchers (e.g., Gabor and Granger 1961; "What Shoppers Know" 1974) to focus on this segment as a sampling frame. Similarly, household income may play a role in consumers' knowledge of product prices. Households with lower income levels may be more sensitive to prices and hence may learn price information more than higher income households (Gabor and Granger 1961; Wakefield and Inman 1993). Since higher income individuals have a higher marginal wage rate, they may also see fewer benefits in price shopping.

Hypothesis 5: Price recall accuracy will be negatively related to income.

Hypothesis 6: Price recall accuracy will differ between men and women.

It is important to note that past studies have been mixed in their findings on income and gender effects. For example, while Dickson and Sawyer (1990) identify certain demographic effects on price recall accuracy, Wakefield and Inman (1993) and Estelami (1998) found no effects for gender. Therefore, the above two hypotheses will be treated from an exploratory perspective in this study.

A META-ANALYSIS OF PRICE RECALL STUDIES

To examine the effects of the above factors on price recall accuracy, a meta-analysis was conducted. Meta-analyses have been successfully used in synthesizing study results in pricing research (e.g., Biswas, Wilson, and Licata 1993; Compeau and Grewal 1998; Rao and Monroe 1989) and in other fields of study (e.g., Brown and Peterson 1993; Peterson, Albaum, and Beltramini 1985; Sultan, Farley, and Lehmann 1990; Wilson and Sherrell 1993). To identify relevant papers, the approach proposed by Rosenthal (1991:36-46) was used. This approach relies on multiple sources for independently identifying relevant research studies. Papers cited in three pricing texts (Dolan and Simon 1996; Monroe 1990; Nagle and Holden 1995) and those cited in earlier review articles were identified. The bibliography sections of these papers were further used to identify other articles that may relate to the topic. Parallel to this, four bibliographic searches using various computerized indexes were conducted. These were the *American Bibliographic Index* (for business publications between 1970 and 1999), *PsycInfo* (for psychology publications from 1960 to 1999), *EconLit* (for the economics literature from 1960 to 1999), and *Dissertation Abstracts International* (for doctoral dissertations defended between 1961 and 1999).

Moreover, an issue-by-issue examination of five leading marketing journals between the years 1974 and 1999 was conducted. These were the *Journal of the Academy of Marketing Science*, the *Journal of Consumer Research*, the *Journal of Marketing*, the *Journal of Marketing Research*, and the *Journal of Retailing*. To minimize a "file drawer" bias (Rosenthal 1991), which may result from the exclusion of unpublished studies, the approach proposed by Cooper (1984) was followed, whereby the advice of three experienced pricing experts was sought to identify manuscripts that may not have been published. In addition, for every paper identified through the various approaches, an ancestral search of references was conducted to identify other relevant papers that cited the paper. This procedure for identifying research results for inclusion in the meta-analysis is consistent with those of Rao and Monroe (1989), Biswas et al. (1993), and Compeau and Grewal (1998). Identified papers were then inspected for the presence of reported price recall accuracy measures. Papers that did not explicitly report price recall accuracy or those that had used price memory tests based on ranking or recognition tasks were not included in the meta-analysis. As a result, a total of 22 papers were identified and are listed in Appendix A. Since many papers examine multiple product categories and some examine price recall under different conditions, most yielded multiple studies as observations in our meta-analysis. A total of 279 studies were obtained from the identified papers.

Independent Variables

The coding scheme used for the design characteristics was as follows:

1. *The product category:* Products were grouped into three general categories:
   a. Frequently purchased consumer goods (e.g., bread, milk, soft drinks);
   b. Consumer durables (e.g., refrigerators, home electronics, automobiles), in which case a dummy variable *DUR* was set to 1 (otherwise it was set to 0); and
   c. Services (e.g, dry cleaning, physicians, photo developing), in which case a dummy variable *SERV* was set to 1.
2. *Participation incentives:* We found no study that financially rewarded respondents for the accuracy of their responses. However, three mutually exclusive levels of participation incentives were identified:
   a. None;
   b. Task completed as part of a classroom or community group, in which case a dummy variable *GROUP* was set to 1; and

c. Fixed monetary incentives (e.g., coupons), in which case a dummy variable *MONEY* was set to 1.

3. *Task size:* is the number of products for which each respondent in the study is asked to provide prices.
4. *Response format:* was coded using a dummy variable *NORESP*, which was 1 if respondents are allowed to provide a "don't know" response.
5. *Gender:* was coded as the percentage of respondents who are female. In studies where this information is not provided, this was set equal to the average for all studies where this figure has been reported.
6. *Income:* was coded as the average income of respondents in the study. Income figures were translated to 1999 dollars based on the consumer price index. In some studies, authors provided information on the occupation or the social class of respondents instead of income, in which case dollar translations using income distribution tables from the *Census Bureau* (1998, 1992, 1982, 1979, 1974, 1966) were used. In cases where neither socioeconomic nor income information are reported, the average of all studies in which income has been reported was used.

Dependent Variable

Measures used to report consumer price recall accuracy typically focus on the deviation between the price elicited from the respondent and the actual price. The measure that is most frequently used has been the percentage deviation used by Dickson and Sawyer (1990), Mazumdar and Monroe (1992), Wakefield and Inman (1993), Zeithaml (1982), and others, defined as follows:

$$Percent\ Deviation = \frac{|actual\ price - recalled\ price|}{actual\ price}. \quad (1)$$

To express the overall level of price recall accuracy in a given study, often the percentage deviations are averaged across all respondents in the study, and the percent average deviation (PAD) is reported. This measure is inversely related to price recall accuracy, as higher PAD levels indicate lower accuracy in recalled prices. In studies where PAD is not explicitly reported, authors often report a distributional measure such as the percentage of respondents for whom price estimates are within a given percentage of the actual price (e.g., 25% of respondents had price estimates within 5% of the actual price). From this, PAD can be derived by fitting the distributional measures to an exponential distribution. PAD is estimated by

$$PAD = \frac{-x}{\log(1-A)}, \quad (2)$$

where A is the percentage of respondents who provide price estimates within x percent of the actual price. Derivations for the PAD estimate and a demonstration of its appropriateness are outlined in Appendix B.

RESULTS

Frequency of Research Design Choices

Table 1 reports the frequency of the various research design choices, as well as the associated PAD values. As evident by the table, considerable variation in PAD levels and research design choices can be noticed. Average PAD levels range from less than .05 to close to .2. Of the 279 studies identified, about 18 relate to services, 11 to consumer durables, and the remaining examined price recall for frequently purchased consumer goods. About 30 percent of the studies provide some incentive for respondents to participate, and most require 6 to 10 price estimates from each respondent. The average task size is 9.8 price recalls per subject, and about 23 percent of the studies allow respondents to express a "don't know" response to price recall tasks. Most studies have a high percentage of female respondents, and the average income in 1999 dollars is $43,948.

While the average PAD across all observations was .142, a significant amount of variation exists. The distribution of the PAD measures was similar to an exponential distribution, consistent with observations made in earlier studies regarding PAD distribution at the individual study level (Gabor and Granger 1961; McGoldrick, Betts, and Wilson 1999; McGoldrick and Marks 1987). The PAD distribution was as follows: 78 percent of the observations were between PAD levels of 0 and .2, 18 percent were between .2 and .4, 3 percent were between .4 and .6, and only 1 percent exceeded .6. To determine the sources of these variations, mean PAD values were estimated for each level of each design characteristic and are also shown in Table 1. Statistical tests using t-tests and ANOVAs were applied on both PAD and the logarithm of PAD to assess the significance of the observed differences on a variable-by-variable basis. The log transformation in the statistical tests was conducted since the distribution of PAD deviates from normality and the log transformation helps improve the reliability of t-test and ANOVA results, which may be vulnerable to deviations from normality in the dependent variable (Hair, Anderson, Tatham, and Black 1998; Lehmann, Gupta, and Steckel 1998). Both analyses, shown in Table 1, produce essentially identical results.

Table 1 also reports average PAD levels across the three product category groups. The lowest level of price recall accuracy (highest average PAD level) is for durable consumer goods, and the highest level of accuracy (lowest average PAD level) is for services. However, these variations do not reach statistical significance at conventional levels ($p > .05$). Furthermore, Bonferroni contrast tests also indicate that only consumer durables exhibit PAD levels higher than the other two product category groupings, and no significant differences between services and frequently purchased consumer goods are evident ($p > .05$). While variations in both purchase frequency and promotion frequency exist across product category groups at statistically significant levels ($p < .001$), there is no evidence of significant variation in price recall accuracy across these product category groups. As a result, no support for Hypothesis 1, suggesting cross-category variations in price recall accuracy, was found, although this may be due to the small number of nonfrequently purchased products available for analysis.

To further explore the possible effect of purchase frequency and promotion frequency on PAD, promotion and purchase frequency data from the *Marketing Fact Book* (1995) were correlated with PAD. The resulting correlations were –.05 and .01, for purchase frequency and promotion frequency, respectively, neither of which is statistically significant ($p > .4$). Median-split analyses of the sample exhibited no statistically significant differences in average PAD levels resulting from purchase frequency ($p > .3$) or promotion frequency ($p > .4$). It is important to note that since no reliable source for purchase frequency and promotion frequency data for the 1960s through 1980s could be identified, possible temporal variations in these two variables for studies conducted in those years could not be accounted for in the above analysis, and the purchase frequency and promotion frequency results should be considered as exploratory. The above observations are consistent with earlier works, many of which have not found statistically significant and explainable cross-category variations in price recall accuracy (e.g., Conover 1986; "What Shoppers Know" 1974; Wakefield and Inman 1993).

However, significant effects emerge from most of the remaining design characteristics. For example, PAD levels are lower by about .1 when respondents are provided monetary incentives for participation (Hypothesis 2). Table 1 also shows that smaller tasks have lower PAD levels. In between-subject designs where respondents are only asked to provide a single price estimate, the highest level of price recall accuracy can be seen. However, as the task size increases, so does the magnitude of PAD, reflecting lower price recall accuracy levels. The correlation between task size and PAD is positive ($r = .40$) and significant ($p <$ .01). Consistent with Hypothesis 3, eliciting prices for a larger number of products results in poorer average price recall accuracy. As suggested by Hypothesis 4, a significant relationship between price recall accuracy and response format can also be noted. Price elicitation tasks that allow respondents to provide a "don't know" response result in a reduction of about .08 in PAD levels ($p < .01$). The results also suggest a significant relationship between income and average price recall accuracy ($p < .01$). The correlation between income and PAD is .29 ($p < .01$), which suggests that higher income will be associated with higher PAD levels (i.e., lower price recall accuracy), as indicated by Hypothesis 5. In addition, the gender composition of the sample influences price recall accuracy, as higher percentages of female respondents seem to result in slightly lower PAD levels ($p < .01$), thereby supporting Hypothesis 6.

TABLE 1
Individual Effects of Design Characteristics on Price Recall Accuracy (PAD)

Design Characteristic	*Number of Studies*	*Average PAD*	*Significance Level*[a]
Product category			
Frequently purchased goods	250	.140	$p_{(PAD)} = .13$
Services	18	.126	$p_{Log(PAD)} = .06$
Consumer durables	11	.229	
Participation incentives			
None	199	.159	$p_{(PAD)} < .01$
Group	43	.133	$p_{Log(PAD)} < .01$
Fixed monetary compensation	37	.063	
Task size			
1 price estimate	14	.049	$p_{(PAD)} < .01$
2-5 price estimates	28	.059	$p_{Log(PAD)} < .01$
6-9 price estimates	121	.127	
10 or more price estimates	116	.190	
Response format			
"Don't know" allowed	64	.159	$p_{(PAD)} < .01$
"Don't know" not allowed	215	.084	$p_{Log(PAD)} < .01$
Percentage of respondents who are female			
0-24	0	NA	$p_{(PAD)} < .05$
25-49	8	.073	$p_{Log(PAD)} < .01$
50-74	38	.183	
75-100	234	.137	
Average income of respondents			
$0-$19,999	11	.057	$p_{(PAD)} < .01$
$20,000-$29,999	9	.060	$p_{Log(PAD)} < 0.01$
$30,000-$39,999	7	.011	
$40,000-$49,999	227	.150	
$50,000 or more	26	.174	

NOTE: NA = not applicable. PAD = percent average deviation.
a. Statistical significance assessed through *t*-tests and ANOVAs. $p_{(PAD)}$ refers to the p value when PAD is used as the dependent variable, and $p_{Log(PAD)}$ refers to the p value when log (PAD) is used as the dependent variable.

TABLE 2
Correlation Matrix

	PAD	*DUR*	*SERV*	*MI*	*GI*	*SIZE*	*NO RESP*	*PF*	*INC*
Percent average deviation (PAD)	1.00	.16	−.04	−.27	.03	.40	−.28	−.05	.29
Consumer durable (DUR)		1.00	−.05	−.08	.07	.15	−.11	−.31	−.29
Service (SERV)			1.00	−.10	.21	−.10	.48	−.60	−.01
Monetary incentive (MI)				1.00	−.17	−.27	.01	−.09	−.15
Group incentive (GI)					1.00	−.26	−.04	.05	−.14
Task size (SIZE)						1.00	−.31	.10	.11
"Don't know" response allowed (NORESP)							1.00	−.26	−.19
Percentage female (PF)								1.00	.21
Income (INC)									1.00

Examining the Combined Effects of Research Design Variables on PAD

To examine the combined effect of the design characteristics, we use regression analysis. As in most meta-analyses, correlations among the design variables may make the simple (one variable at a time) results misleading due to omitted variable bias. Table 2 reports the correlation matrix, indicating no strong correlations among any pair of independent variables. The design characteristics were subjected to principal components analysis, and the results suggest very weak multicollinearity. This is evident by a condition number (ratio of largest eigenvalue to smallest eigenvalue) of 12.37 and a minimum eigenvalue of 0.17, both of which are very favorable by conventional regression standards for multicollinearity (Belsley, Kuh, and Walsh 1980; Ofir and Khuri 1986) and are consistent with earlier meta-analyses in pricing research (e.g., Rao and Monroe 1989).

The design characteristics were then used in a regression analysis, the results of which are shown in Table 3. As before, two sets of analyses are reported, one with PAD as the dependent variable, and the other with the natural logarithm of PAD as the dependent variable. As in the prior analyses, the second regression using the log of PAD was conducted to account for potential effects on the regression estimates resulting from deviations from normality in the PAD measure. Both regressions are statistically significant, $R_{PAD}^2 = .28$; $R_{Log(PAD)}^2 = .46$, and exhibit essentially identical effects of the independent variables. Moreover, the results are consistent with the individual variable results of Table 1. The product category has no significant impact on price recall accuracy, as evidenced by a lack of significance in the product category dummy variables. However, as before, participation incentives in the form of monetary rewards (MONEY) significantly reduce PAD. Consistent with the earlier results, conducting studies in groups (GROUP) has no significant effect on PAD. Task size has a positive and statistically significant impact on PAD, as observed in the earlier results. Similarly, allowing respondents not to provide price estimates (NORESP) decreases PAD. The percentage of women in the sample is negatively related to PAD, while income has a positive effect.

To examine specific interactions among the independent variables, additional analyses were conducted. For example, one could argue that since consumers of a particular gender may account for a large proportion of purchases in certain categories, an interaction between these two variables may have incremental effects on PAD. To test this possibility, product category-by-gender interactions were added to the regression analyses mentioned earlier. All were found not statistically significant ($p > 0.1$). This result is consistent with the work of Estelami (1998) exploring the price estimate accuracy of participants on the popular TV game show *The Price Is Right*. Estelami's results show that with a sample of more than 600 participants, no product category-by-gender interactions could be detected in the accuracy of price estimates provided for all the 29 product categories studied.

Although it is common practice in meta-analyses to use multiple observations from a single manuscript (Farley and Lehmann 1986; Rosenthal 1978), further analyses were also conducted to examine the independence of the various observations. Sourcing multiple observations from a single manuscript may result in correlated errors across these observations. The use of multiple observations from a single manuscript is consistent with previous meta-analyses in pricing (e.g., Biswas et al. 1993; Compeau and Grewal 1998; Rao and Monroe 1989) and other areas of marketing (e.g., Assmus, Farley, and Lehmann 1984; Farley and Lehmann 1986). To examine whether this had an impact on the observed results, a regression analysis with the original eight variables in Table 3 as well as additional dummy variables corresponding to the 22 manuscripts used in the meta-analysis was conducted. The addition of these dummy variables resulted in no significant increase in model fit, $F_{21, 249} = 1.48$, $p > .05$. The observed variations in the PADs are therefore driven by variations in the research design

TABLE 3
Regression Results for the Combined Effects of Design Characteristics

Variable	*PAD as the Dependent Variable*[a]	*Log(PAD) as the Dependent Variable*[b]
Intercept	.078	−3.131**
	(.059)	(.436)
Product category		
Consumer durable	.039	.387
	(.036)	(.264)
Service	−.044	.002
	(.039)	(.292)
Participation incentives		
Money	−.055**	−.617**
	(.19)	(.141)
Group	.022	−.046
	(.019)	(.147)
Task size	.006**	.035**
	(.001)	(.009)
"Don't know" response allowed	−.038*	−.785**
	(.018)	(.134)
Percentage female	−.150**	−1.429**
	(.055)	(.419)
Income	.034**	.437**
	(.009)	(.067)

NOTE: PAD = percent average deviation. Numbers in parentheses are standard errors.
a. $F_{8, 270} = 13.32$, $p < .001$, $R^2 = .283$
b. $F_{8, 270} = 14.64$, $p < .001$, $R^2 = .459$
* Coefficient significant at the $p < .01$ level. ** Coefficient significant at the $p < .05$ level.

variables and are unaffected by the manuscript from which the observation was sourced.

Forecasting PAD in Future Studies

Meta-analysis can be used to provide benchmarks and baselines for further analysis, including those situations that have not yet been studied. Since no significant interactions among the design variables were detected in the meta-analysis, and since additive models have been shown to approximate interactive models quite well (Dawes and Corrigan 1974; Taylor 1997), an additive model was used to predict the effects of the various design variable levels on PAD. Table 4 reports the expected outcomes for various combinations of the design variables related to price elicitation.

The predictions reported in Table 4 suggest, for example, that in studies where monetary participation incentives are not present, respondents are forced to give estimates, and task sizes are large, average PAD levels around .18 can be expected. Similarly, if respondents are given monetary incentives for participation, are not forced to provide price recall responses, and are given five or fewer prices to recall, average PAD levels should be around .01. These PAD estimates can be used to gauge whether or not future results deviate from expectations, and, if so, one could conduct further analyses to probe the sources of these deviations and to identify additional covariates.

TABLE 4
Prediction of Percent Average Deviation (PAD) Under Various Research Designs

Participation Incentive	*"No Response" Allowed*	*Task Size*	*Expected PAD*
None	No	20 prices	.176
None	No	10 prices	.116
None	No	5 prices	.095
None	Yes	20 prices	.058
None	Yes	10 prices	.038
None	Yes	5 prices	.031
Monetary	No	20 prices	.071
Monetary	No	10 prices	.047
Monetary	No	5 prices	.038
Monetary	Yes	20 prices	.023
Monetary	Yes	10 prices	.015
Monetary	Yes	5 prices	.013

DISCUSSION

Impact of Research Design on Price Recall Accuracy

Results indicate that price recall accuracy is influenced by research design choices, both relating to how price estimates are elicited from respondents and the demographics of respondents recruited in the study. Specifically, the lack of monetary incentives used for motivating respondents, a large respondent task size, and an enforced response format all have negative effects on price recall accuracy. In general, studies in which respondents are compensated for participation are more accurate than those where they are not. Similarly, while the majority of existing works have used tasks in which respondents are required to provide price estimates on multiple products, and many studies do not provide respondents the option of not expressing a price, our results show a direct relationship between these data elicitation approaches and price recall accuracy.

An interesting result of this meta-analysis has been the lack of a statistically significant effect for the product category groupings. This observation is consistent with Wakefield and Inman (1993:231) who note that despite decades of pricing research, cross-category variations on consumer price knowledge measures remain unclear. The

lack of significant cross-category variations in price recall accuracy may be due to the fact that a large number of factors may influence consumers' motivation for learning price information and their subsequent recall and use of this information within a given category. The presence of external reference prices at the time of purchase—such as the prices of competing products—may reduce the impact and relevance of internally memorized price information (Rajendran and Tellis 1994; Urbany and Dickson 1991). In addition, the frequency and depth of promotions for various brands, as well as consumers' prior price perceptions, may create incremental uncertainty in consumers' memory for prices within a category (Alba, Broniarczyk, Shimp, and Urbany 1994). The effects of these factors may be further amplified in retail shopping environments in which consumers face a large number of choices, and limited time and involvement can be committed to information processing (Alba and Marmorstein 1987). Moreover, variations in the level of consumers' shopping experience, as well as within-category variations in price-level fluctuations may further influence consumer reliance on price memory (Urbany and Dickson 1991; Yadav and Seiders 1998). Since these factors may significantly influence price recall accuracy both within and between product categories, an examination of their potential effects may provide additional insights into the determinants of consumer price knowledge and should provide a fruitful area for future investigation. It is important to also note that lack of statistical significance may be driven by sample size or the choice of products covered in existing studies, so the absence of category-based variations in price recall accuracy observed here does not necessarily mean that such an effect does not exist and may therefore provide an interesting area for future research.

The meta-analysis results also indicate asymmetric use of various design characteristics. Overall, the elicitation approach in price recall studies is more likely to use no participation incentives for respondents, to deploy large task sizes, and response formats that do not allow respondents to not express prices if they do not feel confident in doing so. Moreover, most studies have used frequently purchased consumer goods as the basis of analysis and have used samples overrepresented by female respondents. As Farley, Lehmann, and Mann (1998) suggest, one can identify studies that would best expand the scope of existing knowledge. Their approach for choosing the "next best study" is to identify the smallest eigenvector of the Z'Z matrix, where Z is the matrix of research design characteristics. For our meta-analysis, the smallest eigenvector for Z'Z identifies the next best study in price recall research as one that provides respondents with participation incentives in the form of financial rewards, uses tasks that require few price estimates per respondent, and gives respondents the option of not providing a price estimate.

Limitations and Future Research

Several limitations of this research need to be acknowledged. Our meta-analysis focused on explicit price recall measures, in particular those collected using direct elicitation of prices from consumers. However, it has been suggested that price recall tasks may not reflect consumers' actual knowledge of prices. Research on human memory has distinguished between two types of memory: explicit and implicit (Hamann 1990; Roediger and McDermott 1993). Explicit memory involves the conscious retrieval of factual information from long-term memory and can be tested through recall accuracy measures. However, implicit memory involves the unconscious storage of information, which is subsequently used in decision tasks, without conscious retrieval of specific facts. Monroe and colleagues (Monroe and Lee 1999; Monroe et al. 1986) argue that since consumer decisions rarely require explicit recall of prices from memory, consumers are much more likely to rely on implicit, rather than explicit, memory. Therefore, compared to price recall measurement, recognition and ranking tasks may be much more reasonable tests of consumers' knowledge of prices. Nevertheless, price recall measures have formed the basis for most of our current understanding of consumer price knowledge, and our task in this article has been to examine factors that affect these explicit recall accuracy measures.

The above discussion suggests that price recall studies may in general be providing a pessimistic view of consumers' ability to process price information. The meta-analysis results show that on average, consumers' explicit price estimates are within 15 percent of the actual prices. This level of error may not be sufficiently large to create notable failures in the quality of consumer decisions. As Helson's (1964) adaptation level theory suggests, consumers may be much more alert to price changes than to the absolute level of prices. This alertness is known to influence subsequent purchase decisions (Winer 1986) and may serve as a mechanism for reducing error in consumer decisions. Moreover, compromises in decision quality need to be examined within a cost-benefit framework. From a cost-benefit perspective, the benefits of having exact prices stored in long-term memory may not outweigh the considerable effort associated with memorizing and processing multidimensional price information at the point of purchase (Estelami 1997, 1995; Monroe and Lee 1999). Consumer effort may be significantly reduced, without much compromise on decision quality, by reliance on simplifying heuristics, use of implicit memory, and external

reference prices at the point of purchase. Analytical and empirical studies have shown that reliance on such mechanisms in decision-making often does not result in a significant compromise in decision quality (e.g., Johnson and Payne 1985; Russo and Dosher 1983). Lack of reliance on explicit price recall may therefore be a rational response for improving the cost-benefit ratio in consumer decisions, and a study of such a phenomenon may provide a fruitful area for future research. Furthermore, a cost-benefit study of alternative memory tests such as ranking and recognition tasks in consumer price knowledge studies may shed light on the mechanisms by which consumers are most likely to store and process price information.

Another limitation of this article has been driven by the variation in methodologies used in previous works. Certain studies (e.g., Brown 1971; Mazumdar and Monroe 1990) could not be used since the dependent measures obtained relate to ranking or recognition tasks. Data reported in these works could not be transformed onto a common scale, thereby reducing the scope of the meta-analysis. Moreover, similar to most other meta-analyses, the basis of our examination has been published research, and a publication bias may occur since nonpublished articles are likely to be excluded from analysis. Although an extensive effort was made to uncover unpublished manuscripts through seeking advice from recognized experts in this area, none were identified. However, as in all meta-analyses, the potential exclusion of unpublished studies could bias the obtained estimates. Using the approach devised by Rosenthal (1991:101-109), one can estimate the number of unpublished studies that would have to exist in order for null results to be observed in the meta-analysis. It was estimated that given the existing 279 published studies, a total of 2,309 nonpublished studies with null PAD results would have to exist to render the existing results nonsignificant at the $p < .05$ level. It is unlikely that such a large number of unpublished studies exist. In addition, as in all meta-analytic work, the choice of the independent variables included in the analysis may affect the results. For example, in our meta-analysis, the student status of respondents in the study was not included. However, this study characteristic significantly relates to whether or not respondents were recruited from community groups or class rooms (GROUP), as well as income level, and was excluded from the analyses to prevent high levels of multicollinearity. Moreover, separate analyses of studies using student versus nonstudent samples produced similar results, and no statistically significant differences between the two groups in their average PAD levels was found ($t_{277} = 1.39, p = .17$).

Despite the limitations, this work provides substantive results and suggestions that need to be considered and addressed by future researchers studying consumer price knowledge through recall measures. For example, the results show that respondent incentives, price elicitation response format, and task size have significant effects on price recall accuracy. Therefore, researchers who desire to reduce measurement error in their studies will benefit from providing their respondents with monetary incentives for participation, the smallest possible task size, and the option to provide a "don't know" response. Moreover, careful attention to respondent recruitment and demographics is needed, as these variables were also found to influence price recall accuracy. Whether other variables are important determinants of price recall is a topic for future research.

APPENDIX A
Papers Used in the Meta-Analysis

Authors	Publication	Average PAD[a]	Number of Studies	Sample Size(s) per Study	Average Purchase Frequency
Conover (1986)	*Advances in Consumer Research*	.060	9	14-22	.109
Chernatony and Knox (1992)	*Marketing Intelligence and Planning*	.119	6	80-86	.134
Dickson and Sawyer (1990)	*Journal of Marketing*	.028	1	201	.049
Dietrich ("Poor Price-Quiz Scores" 1977)	*Progressive Grocer*	.159	12	500	.067
Gabor and Granger (1961)	*Applied Statistics*	.010	7	49-145	.058
Goldman (1977)	*Journal of Marketing*	.155	3	400	.010
Harrell, Hutt, and Allen (1976)	*Michigan State University Report*	.112	9	1044-1452	.050
Helgeson and Beatty (1987)	*Journal of Consumer Research*	.019	8	139-176	.016
Heller ("What Shoppers Know" 1974)	*Progressive Grocer*	.221	44	560	.051
Krishna, Currim, and Shoemaker (1991)	*Journal of Marketing*	.051	20	220-400	.113
Lawson, Gnoth, and Paulin (1995)	*Journal of Travel Research*	.168	10	206	.010
Le Boutillier, Le Boutillier, and Neslin (1994)	*Marketing Letters*	.010	2	92-143	.129
Mazumdar and Monroe (1992)	*Journal of Retailing*	.188	24	15	.097
McGoldrick, Betts, and Wilson (1999)	*Service Industries Journal*	.114	4	175	.049
McGoldrick and Marks (1987)	*European Journal of Marketing*	.089	10	10-93	.031
"How Much Do Consumers Know" (1964)	*Progressive Grocer*	.129	59	2000	.052
Schindler and Wiman (1989)	*Journal of Business Research*	.158	3	50	.001
Stephens and Moore (1977)	*Journal of Advertising Research*	.229	18	132-180	.097
Turley and Cabannis (1995)	*Journal of Professional Services Marketing*	.073	8	57	.014
Wakefield and Inman (1993)	*Journal of Retailing*	.029	4	72	.074
Zbytniewski ("Shoppers Cry" 1980)	*Progressive Grocer*	.218	16	400	.078
Zeithaml (1982)	*Journal of Consumer Research*	.046	2	80	.050

a. PAD = percent average deviation.

APPENDIX B
Derivation of the Percent Average Deviation (PAD) for Studies Reporting Distribution Measures of Price Recall

To quantify the degree of price recall accuracy in a consumer's response, most studies examine the extent by which the price elicited from the consumer deviates from the actual price. The percentage deviation between the recalled price and the actual price is a common measure:

$$Percent\ Deviation = \frac{|actual\ price - recalled\ price|}{actual\ price}. \quad (B1)$$

This measure has been used extensively by previous researchers (e.g., Dickson and Sawyer 1990; Mazumdar and Monroe 1992; Wakefield and Inman 1993; Zeithaml 1982). To express the overall level of price recall accuracy in a study, the average deviation across all respondents, referred to as percent average deviation (PAD) is often reported. This is simply the average of the percentage deviations in the price recall of all respondents in a study and has an inverse relationship with consumer price recall accuracy, as higher PAD levels indicate lower levels of price recall accuracy.

In studies where authors do not explicitly report a value for PAD, distributional deviation measures indicating the percentage of respondents for whom price estimates are within a given percentage of the actual price (e.g., 25% of respondents had price estimates within 5% of the actual price) are instead reported. Since previous research reporting on the distribution of consumers' price recall errors indicates that this distribution closely follows an exponential form (Gabor and Granger 1961; McGoldrick and Marks 1987), the PAD can be estimated by fitting the distributional measures to an exponential distribution. Fitting an exponential distribution to the data implies that

$$e^{-\lambda x} = 1 - A, \quad (B2)$$

where A is the percentage of respondents reported to have price estimates within x percent of the actual price, and λ is the parameter for the cumulative exponential distribution function. In other words, given that A% of respondents' price estimates are within x% of the actual price, the assumption of an exponential distribution of the xs, would lead to the above equation. Rearranging this equation would result in the following:

$$\lambda = \frac{\log(1-A)}{-x}. \quad (B3)$$

PAD is the mean of all respondents' deviation measures x, which are assumed to be exponentially distributed with parameter λ. PAD, which is the average of the x's, is therefore by definition equivalent to the mean of this exponential distribution, or $1/\lambda$:

$$PAD = \frac{-x}{\log(1-A)}. \quad \text{(B4)}$$

To test the ability of this transformation to predict PAD values, in 53 studies where both the PAD and distributional measures were reported, the transformation was calculated, and the correlation between the two measures was computed. The correlation between the estimated and actual PAD was found to be strong and significant ($r = .68$, $p < .01$). If multiple distribution measures are reported in a study, the average computed PAD for all the measures was used.

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