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The authors reflect on their 1990 article, which won the 1995 William F. O'Dell Award, and the past and future trends in studies of diffusion and of empirical generalization.

## Reflections on "A Meta-Analysis of Applications of Diffusion Models"

We appreciate receiving the 1995 O'Dell award and this opportunity to comment on the area of diffusion and empirical generalizations. Our article, *A Meta-Analysis of Application of Diffusion Models*, resulted from the confluence of Sultan's dissertation on meta-analysis of diffusion models and Farley and Lehmann's work on meta-analysis.<sup>1</sup> After the usual review process (i.e., three revisions and disagreements about the merits of the paper), our article was published the same year as Mahajan, Muller, and Bass's (1990) important summary of the work on Bass's (1969) model, which increased interest in this area.

### SUBSEQUENT WORK AND RESEARCH DIRECTIONS

We have identified 22 substantive publications that cited our article from 1990 to 1995.<sup>2</sup> These appeared in all four major marketing journals, *Management Science*, two forecasting journals, the *Journal of Business and Economic Statistics*, and the *Journal of Economic Psychology*. Categories of meta-analysis effects on parameter values were represented as follows. Twelve articles dealt with specification, including using other variables, model structure aggregation, and heterogeneity; five with estimation; and five with the research environment, including new applications and new geographic areas. The important issue of measurement was not addressed in any of the 22 articles.

*Model specification.* Work continues on model specification, which was identified by Farley, Lehmann, and Sawyer (1995) as the largest single source of variability in parameters of marketing models. Specific issues include incorpo-

<sup>1</sup>Wilfried Vanhonacker's subsequent suggestions on estimation helped substantially.

<sup>2</sup>These references plus a more extensive bibliography are available from the authors on request.

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Table 1  
VALUES OF COEFFICIENTS OF INNOVATION AND IMITATION

	Average for All Products in Our Paper	Meta-analysis- Adjusted Prior	Hahn and Colleagues' (1994) Study of Ethical Drugs
Coefficient of Innovation	.03	.02	.01
Coefficient of Imitation	.38	.40	.43

rating other variables, hazard modeling, and dealing with heterogeneity. Work on specification is likely to continue and typically will result in relatively small prediction improvements given the results of Bass, Krishna, and Jain's (1994) study.

*Estimation.* The work on estimation, the second most important source of parameter variability, primarily focuses on replacing the Goldberger-Thiel mixed estimation approach with more-sophisticated procedures (Vanhonacker, Lehmann, and Sultan 1990; Vanhonacker and Price 1992). Again, the likelihood for major improvements is small.

*Research environment.* A major use of meta-analysis is for analyzing and forecasting the diffusion pattern of other products. For example, Hahn and colleagues (1994) estimate the diffusion of 21 ethical drugs with results similar to our meta-analysis results (see Table 1). This correspondence emphasizes the inappropriateness of the null hypothesis of zero for subsequent studies in an area, an important general contribution of meta-analysis in marketing.

Studies to date are skewed heavily toward successful consumer durables in industrialized northern-hemisphere countries in general and the United States in particular (Farley and Lehmann 1994). This suggests the following:

1. Frequently purchased products (e.g., low-fat foods) industrial goods, and services are clearly understudied.
2. Adoption patterns in less industrialized countries may differ substantially.

3. Unsuccessful products need study, because our knowledge of diffusion is limited to successes. Absolute failures greatly outnumber successes, and products that initially appear to be successes may fade over time (e.g., CB radios, Water Piks, soft cookies). What pattern these follow and whether there are early warning signs of trouble are two areas for further research.
4. Supplanted products need study. Little effort has been devoted to understanding what happens to the previous technology when successful new products emerge. Many products endure for generations (e.g., paper checks, records)—at least in specialized niches. Studying the pattern of sales facing these old technologies is interesting and important for such issues as assessing product cannibalization.

#### NEW PRODUCT FORECASTING

One approach to early forecasting bases estimates on ratings on abstract dimensions, such as relative advantage and compatibility. Yet, obtaining reliable ratings a priori is difficult at best. Concepts such as a "rate of time preference" have been proposed to understand consumer response over time to technology-based products (Sultan 1996; Sultan and Winer 1993). Direct questioning for products based on new technology is a viable option, and information acceleration methods show promise. Improved Bayesian estimation methods more sophisticated than ours can help, though probably not dramatically. Forecasting 20 years in advance for something that requires customers to change their behavior patterns is simply not an exact science.

For all the effort expended studying life cycles once they begin, relatively little has been devoted to what precedes them. For example, until recently little attention was paid to the development cycle. Although the rush to "crush cycle time" has led to noticeable shortening, the impact on subsequent adoption rates has not been adequately investigated. The time between the completion of product development and the beginning of the life cycle, as tracked by sources and measured in terms of noticeable sales, is both long (Golder and Tellis 1994) and almost completely ignored. Kohli, Lehmann, and Pae (1995) demonstrate that this time is significantly related to the subsequent adoption pattern. Further work focusing on this incubation time as well as the relation among development time, incubation time, and the adoption pattern has substantial promise.

#### META-ANALYSIS IN MARKETING

Meta-analysis by nature provides an imperfect representation of a field, and later studies may find different average results because, in some cases, the phenomenon changes (Bayus 1992; Kayande and Bhargava 1994). Hence, tracking over time is needed. Although Bayus (1992) questions the conventional wisdom that diffusion rates have been accelerating over time, the coefficient of imitation (which depends on information and information technology) may, in fact, be increasing (Jeuland 1995; Kohli, Lehmann, and Pae 1995). Similarly though Assmus, Farley, and Lehmann (1984) find an average advertising elasticity of approximately .2, both personal communication between authors and practitioners and subsequent studies (Sethuraman and Tellis 1991) suggest that the average is closer to .1—though it is still within the original standard error of the estimate.

The related problems of empty cells and confounding among the large number of independent variables in the "natural design" matrix (Farley, Lehmann, and Sawyer 1995; Vanhoner and Price 1992) continue to plague meta-analyses in marketing. Journals should consider whether new work essentially duplicates a cell in a meta-analytic design representing the field and thus adds little new information to our knowledge. Furthermore, journals should require such basic statistics as means, standard deviation, and scaleless measures of association, such as correlations or partial correlations, so that more studies can be usable in meta-analyses.

#### SUMMARY

Diffusion of really new products is of increasing concern to marketers because of the evident impact of innovation on firm profitability (Capon, Farley, and Hoenig 1995). A meta-analysis of a disparate set of related, but not identical, marketing studies can provide the kind of empirical generalizations that are both valued by practitioners (e.g., Marketing Science Institute, Research Priorities 1994–1996) and an appropriate goal of basic research. We were fortunate to see a link between the two and recommend both areas for further research. We hope that our reflections and the much-appreciated O'Dell award given to our article will help encourage the use of meta-analysis in marketing. At a minimum, the now-discredited null-hypothesis of zero values for diffusion-model parameters should be abandoned in favor of a null hypothesis that is based on existing results.

There is a tendency to treat anything that looks new as having no precedent. Although each new product or service has certain unique characteristics and consumer reactions to them need to be tracked (e.g., Sultan and Winer 1995), we have much to learn from the past. Formal meta-analysis of previous diffusions and in-depth historical studies of previous analogies, (e.g., the telegraph) can provide useful insights into the adoption of revolutionary innovations, such as the Internet.

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