Structural Modeling in Marketing: Some Future Possibilities

Girish Punj *

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* School of Business
University of Connecticut
2100 Hillside Road, Storrs, CT. 06269
Tel: (860)-486-3835; E-mail: Girish.Punj@business.uconn.edu

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The growing interest in using structural modeling to test theories of consumer and firm behavior stems from the increased availability of market data at the individual level (both longitudinal and cross-sectional) for a variety of products. The emergence of online consumer panels where data on behavioral intentions can be collected and the availability of retail transactional data from online stores can only be expected to accelerate the trend. Hence, the recent review article by Chintagunta, Erdem, Rossi, and Wedel (2006) is a timely contribution to the structural modeling, along with other recent contributions by Wittink (2005), Franses (2005a, 2005b), Van Heerde, Dekimpe and Putsis (2005), and Bronnenberg, Rossi and Vilcassim (2005).

Chintagunta et. al. (2006) and the other authors mentioned discuss the state-of-the-art in the development and application of structural models in marketing. They discuss the advantages and disadvantages of using structural modeling to test marketplace theories, and the cautions to be observed in the validation of structural models. The recommendations offered by them suggest the potential for further use of structural models in marketing. The purpose of this commentary is to take some of the recommendations offered by Chintagunta et. al. (2006) and use them to discuss some future possibilities.

First, there is the issue of how much behavioral theory should be included in a structural model. At one extreme, no data is needed to develop a theoretical model (Moorthy 1993). In fact, data may be considered a “distraction” or even irrelevant (Shugan 2002a). Theoretical models that do not rely on data are developed from both behavioral (i.e., substantive) assumptions and those made for analytical tractability (Moorthy 1993). With that distinction in mind, theoretical models could be adequate to provide a preliminary “test” of behavioral theories (Shugan 2002b). Likewise, a theoretical supermodel with economic primitives that are invariant to strategy/policy change could be used to initially evaluate alternative (i.e., competing) strategy/policy regimes that are contained within it (Moorthy 1993). The nested structure of a theoretical model could be used to eliminate some strategy/policy regimes (Moorthy 1993). Eventually, an econometric specification of the supermodel (or the "winning" nested model) would need to be developed. Yet, the use of logical experimentation at the front-end could alleviate some of the estimation and inference difficulties created by starting with a single tightly parameterized structural model. The ideal situation would be where some degree of modularity could be achieved between a theoretical supermodel and tightly parameterized structural models that are nested within it.

Second, there is the matter of how to validate structural model. Chintagunta et. al. (2006) specify the use of modeling criteria such as plausibility, interpretability, fit and predictive validity to evaluate a structural model. Some of these criteria are necessarily subjective. Franses (2005) mentions that structural models pass diagnostic tests have out-of-sample predictive validity and exhibit parameter stability. There is little debate that reduced-form models should meet diagnostic tests, which may be applied in check-list fashion. Reduced-form models can exploit the bias-variance trade-off to achieve excellent predictive performance, hence more demanding predictive tests are needed. But, such a check-list approach to measure model performance may be less useful for structural models (Shugan 2004). Some diagnostic tests may not be applicable, others may not be available, and even when a diagnostic test is failed it may not alter the managerial implications that can be drawn from a model (Wittink 2005). The substantive insights provided by a structural model can only be compared to those from a simpler model or even subjective managerial judgment. A model can satisfy diagnostic tests but still not be useful for strategy/policy simulation (Bronnenberg, Rossi and Vilcassim 2005). Conversely, a structural model can perform poorly on diagnostic tests but still be useful for strategy/policy evaluation (Wittink 2005) if there is confidence that the model primitives are strategy/policy invariant. Furthermore, efforts to improve the predictive performance of a structural model could make it theoretically worse. Thus, regarding reduced-form and structural models as the end-points of a continuum may not be appropriate, without the recognition that modeling criteria change along the continuum and are not incremental.

Third, there is a debate about how to best incorporate forward-looking behavior by consumers into a structural model. Consumers can be expected to form (rational) expectations about the future actions of firms and incorporate them into their own behavior. Franses (2005) presents three scenarios relating to the potential impact of consumer expectations. Consumers may have no information on future policy/strategy (marketing instrument) changes, or they foresee policy/strategy changes, incorporate them into their expectations, but do not change behavior, or consumers foresee policy/strategy changes, incorporate them into their expectations and change behavior. In the latter instance, additional equations are normally added to the model specification to capture the impact of expectations. But, whether the additional specification accurately captures forward-looking behavior if often not tested. Chintagunta et. al. (2006) advocate the use of survey data on expectations to test behavioral assumptions, as do Bronnenberg, Rossi and Vilcassim (2005).

A future possibility is to attempt to directly measure behavioral intentions using online consumer panels and combine it with retail POS data. Some marketing research suppliers already offer such a service (Veraart 2004). While the quality of expectations data gathered from an online consumer panel may not be the best, there is an unmistakable trend toward the development of larger (2.5 to 5.0 million) and more heterogeneous panels. The modeling challenge would be merge passive (historical) data with (stated) intentions or expectations data, similar to the one encountered in the case of scanner data (Winer 1999). Behavioral theories could continue to be relied on when intentions data is nonexistent or sparse and removed as more becomes available (Shugan 2002). Structural models in the I/O literature have adapted well as newer and better forms of data have become available. A similar approach could be successful in marketing.

Fourth, controlled experimentation is more feasible in marketing than in economics (Swait and Andrews 2003; Van Heerde, Dekimpe and Putsis 2005). Retail transaction data generated from online stores offer the opportunity for controlled experimentation relating to incremental changes in marketing instrument variables. With the use of the internet as an additional distribution channel by firms, such data are likely to become more available in the future (Johnson 2001; Lohse, Bellman and Johnson 2000). Anecdotal accounts of online stores using controlled experimentation to test alternative pricing levels have been reported, but not without controversy (Streitfeld 2000). Since forward-looking behavior by consumers is context dependent (i.e., is specific to product categories, time periods, etc.), direct measurement of the effects of a “strong” instrumental variable may be a better option than an additional econometric specification using a “weak” instrument. The endogeneity bias in structural models cannot be overcome if “weak” instrumental variables are used.

Fifth, as Chintagunta et. al. (2006) note, a strength of the structural modeling approach is the ability to predict the effects of a strategy/policy change that is beyond the historical data used in developing the model. In so doing, several challenges have to be overcome, including the Lucas critique. One approach to capturing the effects of a strategy/policy change is to use time-varying response parameters, which have the benefit of fewer (less restrictive) behavioral assumptions (Van Heerde, Dekimpe and Putsis 2005). But, time-varying parameter models still assume that the relationship between policy/strategy and response parameters remains constant.

Hence, they merely shift the problem of assuming constant parameters to assuming a constant relationship between policy/strategy and response parameters (Van Heerde, Dekimpe and Putsis 2005). Further, time invariant parameters could be due to a constant strategy/policy regime. Also, time-varying parameters could be for reasons other than a change in a strategy/policy (Bronnenberg, Rossi and Vilcassim 2005). Hence, using time dependent parameters or other similar surrogate approaches may not always be adequate to predict the effects of a strategy/policy change.

Sixth, how often do firms make discrete (i.e., significant) changes in strategy/policy? Probably not very often. Two often-cited examples in the literature are the Marlboro price drop (Van Heerde, Dekimpe and Putsis 2005) and the Procter and Gamble adoption of an EDL strategy (Ailawadi, Lehmann, and Neslin 2001). Ironically, both these strategy/policy changes relate to the marketing mix element that is viewed as the easiest to change. Which leads to the rhetorical question of how critical is it for a structural model to be able to predict the effects of a change in policy/strategy well beyond the historical data? Such changes when they occur are most likely to influence the behavior of consumers and the competitive interaction among competitors. Hence structural models with a limited focus on modeling marketing-mix changes or testing theories of competition may be an option.

For testing theories of competition, Chintagunta et. al (2006) draw attention to the models of Shaffer and Zhang (1995), Besanko, Dube and Gupta (2003), and Sudhir, Chintagunta and Kadilyali (2005). Likewise, Franses (2005) and Van Heerde, Dekimpe and Putsis (2005) make mention of the efforts of Sun, Neslin and Srinivasan (2003) and Erdem, Imai and Keane (2003) for capturing the effects of a marketing-mix change. These “exemplar models” (and several others not mentioned here) provide good opportunities for extension (and replication) that expand or test the boundary conditions in these models. In other words, these models could be considered as "centers" around which a "model cluster" that share model specifications, behavioral assumptions, and perhaps even the same product categories (e.g., ketchup, photo film) could be developed. Expansion of these clusters can then occur with refinements and extensions that expand a particular "model cluster." Such directed growth of related structural models could be more productive than efforts to build comprehensive structural models with more complexity (e.g., Reiss and Wolak 2004). An advantage of such an evolutionary approach would be the ability to systematically expand boundary conditions and test alternative specifications or assumptions (e.g., the mechanism for expectations formation).

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