Marketing Science

Invited Commentary—Comment on Structural Modeling in Marketing: Review and Assessment

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Comment on Structural Modeling in Marketing: Review and Assessment

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Chintagunta, Erdem, Rossi, and Wedel (CERW) discuss examples of structural research to motivate its value in the empirical marketing literature. They provide a balanced assessment in which they emphasize both advantages and disadvantages. Recognizing the importance of predictive validity in marketing, they describe that structure can reduce flexibility in estimation and potentially reduce fit, yet be more reliable when we are predicting the effects of strategies not observed in the existing data. This is an important contribution of structural research in marketing, and their paper will hopefully spread this message. They also suggest that structure can help us test theories and resolve endogeneity, but also restrict the types of decisions we can prescribe in our normative role as marketing researchers. I comment on these latter three issues below. In §1, I explain how a structural model can begin to differentiate between theories, but also note its limitations. In §2, I argue that using structure to resolve endogeneity provides identification from assumptions that are highly subject to misspecification. In §3, I suggest that structure enables, rather than constrains, our abilities to prescribe improved policies.

1. Structural Models and Testing

Structural econometric models are designed to measure the primitives underlying the decision processes of agents. The structural model of how these primitives relate to observed outcomes is a theoretical representation of an empirical setting based on the rational behavior of the agents involved. This structure allows us to attach meaning to parameters we measure, and as Chintagunta, Erdem, Rossi, and Wedel (CERW)

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point out, consider different strategies or equilibria than we observe in the data. However, if the theory defines the primitives we intend to measure, can we actually use the model to test theory? It depends on whether we are testing the model, or testing behaviors conditional on the model being true.

Structural models allow us to test between theories or behaviors nested within the model. The model itself can define the scope of parameters consistent with each theory, and estimation reveals which set of parameters occurs in the data. Tests can be applied to determine whether the parameter values are significantly different from the margin between the theories. This is the sense in which CERW describe how structure allows us to test between theories.

However, CERW's notion of tests does not apply when the model does not nest competing theories and cannot actually test the theory underlying the specified model. The best approach for these purposes may be using the theories to define testable implications that specify competing relationships between observable variables. The goal in these cases will be to identify the joint distribution of the variables. This approach is, however, subject to its own criticisms. Estimating the relationship between observable variables may still require specific functional forms, or too many observations may be required to nonparametrically estimate the relationship (see Reiss and Wolak 2003 for a discussion of these issues). It also may not be possible to define testable implications. In summary, the notion of testing described by CERW provides a step in testing theories, but much of what we would like to test may still be out of reach.

2. Using Structure to Resolve Endogeneity

As many have recognized, endogeneity is an important concern in the estimation of consumer choice

data. While we would ideally like to have experimental data or valid instruments, CERW point out that these are typically hard to come by and leave us searching for other methods to circumvent econometric endogeneity problems.

In §5.1 of their review, CERW describe an approach to circumvent the need for instruments by using the supply-side in estimation to define the relationship between the observables and unobservables in the demand equation. This seems to apply the same logic to resolve endogeneity as early models in the selection literature (Heckman 1976, 1979), where a selection equation determined the relationship between the observables and unobservables in an outcome equation. Estimates in these models are, however, very sensitive to the specification of the distribution of the unobservables and the functional form of the equations. Without an exclusion restriction, the same set of observables defines both the relationship between the observables and the unobservables and the relationship between the observables and the dependent variable (which is obviously also a function of the unobservables). Certain distributions may make these relationships perfectly collinear, and the specification of the equations can lead to multicollinearity (Olsen 1980, Lee 1982). The demand estimation example of CERW also relies on imposed differences in these relationships. This likely puts too much importance on the chosen distributions and the supply-side specifications such as cost specifications or equilibrium assumptions.

3. Do Structural Models Limit Our Ability to Suggest Improved Policies?

CERW argue that the different orientations between economics, which seeks to explain observed behavior, and marketing, which seeks to provide improvements to firms, suggests caution in using structural modeling. In §2 of their review, CERW state that if "too much structure is imposed then, the models may be less useful for certain decision-making purposes" and that the structural approach differs from the normative in that it "seeks to identify the constraints in the optimizing behavior of agents." I do not understand how identifying the constraints faced by agents makes the structural model less useful.

Much of CERW's focus on this issue involves imposing the supply-side in estimation. The common reason for this is to uncover parameters that cannot otherwise be identified. In these cases, the model cannot actually be solved unless the supply-side is imposed in estimation. In other cases, most structural researchers would suggest trying to define the supply-side that rationalizes firms' observed choices ex post to either uncover the institutional factors that limit the optimizing behavior of agents or to understand the reasons why observed policies may be preferable to others. Both of these factors enable the ability of researchers to prescribe improved policies. Another advantage recognized by CERW is that identifying the supply-side that rationalizes the observed policies can help validate the demand model. In light of these issues, it is unclear why imposing structure is limiting.

4. Conclusion

As stated above, CERW's review gives a balanced account of the trade-offs of incorporating structure in estimation. However, I have highlighted areas where I think they may have either overemphasized or underemphasized the usefulness of structure. Hopefully, discussion of these issues will motivate additional research in the areas of endogeneity and testing, or avoid dissuading researchers from using structure in estimation.

References

Heckman, J. 1976. The common structure of statistical models of truncation, sample selection and limited dependent variables and a simple estimator for such models. *Ann. Econom. Soc. Measurement* **5** 475–492.

Heckman, J. 1979. Sample selection bias as a specification error. *Econometrica* **47**(1) 153–161.

Lee, L.-F. 1982. Some approaches to the correction of selectivity bias. *Rev. Econom. Stud.* **49** 355–372.

Little, R. 1985. A note about models for selectivity bias. *Econometrica* **53**(6) 1469–1474.

Olsen, R. J. 1980. A least squares correction for selectivity bias. *Econometrica* **48**(7) 1815–1820.

Reiss, P., F. Wolak. 2003. Structural econometric modeling: Rationales and examples from industrial organization. Stanford Research Paper 1831, Stanford University, Stanford, CA.