Review of Income and Wealth
Series 43, Number 4, December 1997

MODELING ON THE BASIS OF MODELS

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A large part of official economic data sets is produced with the help of assumed functional relations between variables. Constructing economic models on the basis of such model-generated data results in a "modeling on the basis of the results of modeling." This common procedure can lead to consequences that seriously endanger the quality of empirical analyses. After discussing some of these dangerous consequences the authors explore the reasons behind this development. To avoid some of the most severe difficulties a "Charter for Compilation and Correct Handling of Economic Data" is proposed.

1. INTRODUCTORY REMARKS

Even a brief look at the leading journals in our discipline shows that since the 1980s an increasing number of articles falls within the category of empirical investigations (Morgan, 1988). This trend still continues.

The conspicuous expansion of the number of empirical articles is especially due to a double advantage of modern personal computers. Firstly, immense quantities of national and international data are easily available; Table 1 of Morgan's article shows that from 1982 to 1986 76 percent of the empirical articles in the *American Economic Review* were based on data published or generated elsewhere (Morgan, 1988, p. 160). Secondly, modern personal computers allow large-scale statistical treatments of these data.

The enormous reduction of production costs of empirical articles is not only the result of the availability of data produced by national and international statistical offices. It depends above all on the assumption that, irrespective of the country in question, these data are reliable, consistent and compatible with other data. Users can therefore test their theoretical models without time-wasting tests for completeness and compatibility of the underlying data.

This division of labour between official suppliers of data and empirical economists is also explicitly postulated by modern macroeconomic textbooks. For instance, national accounts are characterized as pure bookkeeping figures which essentially contain directly observable variables and therefore are strictly separable from model analyses which contain falsifiable hypotheses and thus are of a totally different methodological character.

In the following, we show that this romantic textbook view of official economic *ex post* data is not correct. Even at the lowest level of aggregation a large part of official economic data sets is produced with the help of assumed functional relations between variables. These functional relations have the methodological character of model-hypotheses. Constructing own economic models on the basis of such underlying model-hypotheses results in a "modeling on the basis of the results of modeling" (Richter, 1994, p. 104). In the following paragraphs we will

show that this procedure leads to consequences that seriously endanger the quality of the "new empirical" studies.

To avoid misunderstandings: The existence of official data generated with the help of functional relations between variables must not be confounded with the fact that each economic variable inevitably has a theoretical background. Observation is always observation in the light of theories. In this general sense all *ex post* data are theory-loaded. It is also undisputed that with the exception of single observations each statistical handling of data includes abstractions and data concentrations.

2. Hypotheses-Generated Data at Low Observation Levels

Model-hypotheses used to generate *ex post* data can lead to different degrees of irreversibility of the results. At the lowest statistical levels of observation (i.e. micro data on the unit level) users have no possibility to undo the procedures carried out by statistical offices to generate their data. Users normally neither have a chance to recognize that theoretical hypotheses have been used to generate data nor do they get concrete information with respect to content and severity of those hypotheses.

An example is the calculation of production of firms below a given threshold (for example less than ten employees). The missing production data of these small firms can be computed proportionally to key variables of larger firms or with the help of different production functions. They can be computed at different levels of the underlying classification systems and at different regional levels.

Some of the official data generated with the help of hypotheses in principle could be observed. However, because of high costs or unreliable answers of respondents these data are estimated by assumptions. Given the existing accounting systems of enterprises and firms on the other hand there exist variables which cannot be directly observed. Examples are enterprises with several establishments in different regions with only one common bookkeeping unit (one cannot "observe" data concerning the whole enterprise at regional levels) or the impossibility of obtaining direct information about regional imports (and exports) or factor income flows.

A common solution for the first problem is to divide the totals of the variables in question proportionally to the number of regionally employed persons. However, this plausible procedure contains many theoretical assumptions: the same productivity in all establishments, a similar composition of factor inputs, largely similar cost and price structures in all regions etc. These are purely theoretical assumptions which in most cases contradict empirical evidence (e.g. the assumption of similar compositions of factor inputs).

3. Hypotheses-Generated Data at Higher Aggregated Levels

Assumed functional relations between variables are also used at higher (aggregated) levels for the generation of more complex statistical variables. A prominent example is the construction of quadratic tables of input coefficients within the framework of transformation models of SNA. In order to obtain an

input coefficient matrix it is either assumed that each industry needs the same input structure to produce a specific commodity (commodity technology assumption) or that all commodities of a specific industry are produced with the same input structure (industry technology assumption). Each of the two assumptions allows calculation of a commodity × commodity table or an industry × industry table (United Nations, 1968, p. 49). If commodity technology assumption leads to negative input coefficients then sometimes even manual corrections will be practiced. It is evident that these technology assumptions are genuine hypotheses about the production process of involved industries which have a strongly mechanical character.

As opposed to irreversible hypotheses at the level of observation units, however, these hypotheses are reversible by users if the original data are at their disposal. Basically the availability of original data also allows the user to perform sensitivity analyses. However, practical experience shows that in particular empirical investigations directed toward policy recommendations are so strongly result-oriented that there is no room for debates about quality and type of underlying data.

4. The Extent of the Problem

Although large parts of official national accounting systems are based on observations, data generated with the help of functions between variables (hypotheses) can be found in all parts and at all levels of official statistics: Hypothetical assumptions about the productivity of the public sector in procedures of price deflation, assumptions about economic life-time of assets, projections of results of willingness-to-pay analyses to national levels etc. Therefore the comfortable strategy of benign neglect cannot be maintained.

Our examples also show that the hypotheses used to generate official *ex post* data are of a rather different character. They comprise values generated by partitioning totals with the help of key variables, hypotheses concerning production functions etc.

5. The Consequences of "Modeling on the Basis of Models"

What are the dangerous consequences of using the described model-generated data as the basis of own model analyses?

5.1. The use of hypotheses-generated data can lead to unknown and often untestable sources of errors with a systematic bias.

If *ex post* data themselves contain genuine hypotheses, i.e. assumed functional relations between variables, the users implicitly adopt with these data theoretical relations which may be right or wrong. Hypotheses-generated data are subject to untested (and often untestable) sources of error which, due to their systematic bias, differ fundamentally from the usual sources of error in empirical statistics. Moreover, the hypotheses hidden in the data are not competing with other hypotheses and therefore are difficult to detect.

5.2. In most cases the consequences of these systematic errors cannot be properly estimated.

As a rule, "normal" users have no information about the precise processes of data generation and, more often, are not even aware that the underlying data contain hypotheses. In many cases even cautious users have no chance to evaluate the above mentioned errors in the data or to recognize that the existing data are of a "different nature" than expected. It follows that the results of their own modeling cannot be interpreted adequately.

Furthermore, there is a vast difference between computations of users based upon "well-behaved" economic models (e.g. standard input–output models) and those based upon sensitive economic models (e.g. dynamic models with differential equations). Under unfavourable circumstances the use of sensitive models can result in amplification of errors in the underlying data to several hundred percents (Tappeiner, 1992).

5.3. Carefully observed data lose much of their value when irreversibly intermingled with data generated with the help of functional relations between variables.

Confronted with a mixture of observed and hypotheses-generated data, users should know the quotas of these different types of variables. At least this would provide a chance to evaluate roughly the quality of the overall aggregate. The lack of such information can lead to serious misinterpretations even with respect to higher aggregated variables. As an example for problems with more complex data, if an economist attempts to draw conclusions from changes in the input coefficients of input–output tables of different years he cannot differentiate the degree to which the differences found result from changes in economic reality, from changes in availability of data in the different years, from changes in assumptions of the applied updating procedures or even from changing the updating procedures themselves (Richter, 1994, p. 106).

5.4. Using hypotheses-generated data the economist loses degrees of freedom for his own theorizing.

An unwelcome consequence of data-generating processes is their inherent characteristic of pre-forming the resulting data with respect to their theoretical contents. Thus users lose degrees of freedom for their own theorizing. In extreme cases the (often unknown) hypotheses that were used to generate the data are contrary to the hypotheses that are to be tested with the help of these data. An example of such a situation is a test of technology hypotheses using modern input–output tables. Since these tables already contain restrictive technology assumptions (commodity technology assumption or industry technology assumption, see United Nations, 1968, p. 49) they are definitely inappropriate for empirical tests of technology hypotheses.

6. The Reasons Behind This Development

In principal, the dangers enumerated above are generally recognized. Why have the national and international statistical offices not taken appropriate action?

Why do they even propagate new accounting systems, like the UN System of Integrated Environmental and Economic Accounting SEEA (United Nations, 1993), which contain to a large extent data generated by hypotheses?

A possible reason for this attitude is the rising demand of economists for new and/or better structured data. If observed data are insufficient to meet this demand it is tempting to generate missing data with the help of hypotheses.

A second reason stems from the necessity for internationally comparable data. As national statistics still differ with respect to definitions, methods of data collection, and quality, theoretical reconciliations are inevitable. These reconciliations are mostly done with the help of hypotheses.

However, the most important reason for the existence of model-generated data in national accounting systems are the internal quality criteria of modern statistics, which are comprehensiveness and consistency of the data and mutual compatibility of the various accounting systems. Although at first glance these criteria seem to be reasonable, they are harmful in our context because they enforce reconciliations and completions of the data with the help of theoretical hypotheses and models.

The above argument reveals an interesting sociological phenomenon. Reasonable (though generally unattainable) criteria of quality develop into indispensable statistical standards which one cannot fall short of without "losing face." If observable data do not fulfil these (unattainable) demands then reality has to be shaped accordingly. This view is just as unacceptable as the sometimes heard opinion "Better wrong data than no data."

Thus the decisive reasons for the deficiencies pointed out above can be found in the organization of modern economic science. If the main qualifying criterion for scientific abilities (and posts) is the number of publications, a culture of fast produceable articles develops. In such a scientific climate applied theoretical models and especially the results obtained are placed in the foreground (Holub, 1989). Thorough analyses of the data used and sensitivity analyses of the applied models become contra-survival activities. They considerably lengthen the production time of articles and often lead to more restricted and more modest results.

7. What Can Be Done?

What can be done to stop these dangerous developments? In the short run referees and editors explicitly should extend their evaluation criteria in the direction of quality of underlying data and should especially take into consideration the care with which data are handled.

In the long run it is of course not acceptable to place the responsibility for quality of data entirely on users. Therefore we propose a "Charter for Compilation and Correct Handling of Economic Data" which should be obligatory for national and international statistical offices as well as for empirically working economists.

An important clause of this charter should read: "As far as possible statistical offices should renounce functional relations between variables for the generation of their data". Further clauses for this charter could be formulated as follows: "Observed data are not to be intermingled with data generated by theoretical hypotheses;" "If model assumptions have to be used, the resulting data must be

unequivocally labelled and data-generating processes must be explicitly disclosed." "National accountants cannot prevent users from misuse for the data they have compiled, obviously they could do a lot to reduce the number of excuses put forth by analysts in case of improper use of national account data" (Richter, 1994, p. 109).

The clauses mentioned are merely a few examples of claims that refer to statistical offices. They have to be completed by additional clauses and also by claims that refer to users. Some of the problems of (reversible) aggregate economic variables constructed with the help of transformation models could be avoided or at least lessened if at users request original initial data would be at their disposal. For instance, statistical offices could publish the series of single price observations. By choosing their own weighting scheme or index formula users then could condense this basic information to an index adequate to their specific needs.

No doubt original data nearly always will lack consistency and compatibility. However, by using them implicit preforming by theoretical hypotheses is avoided and users themselves bear the responsibility of choosing the most appropriate transformation with respect to the problem investigated. In addition it would be possible to analyse the qualitative and quantitative consequences of various data transformations and thus obtain an additional criterion for the choice of transformations.

An obligatory "Charter for Compilation and Correct Handling of Economic Data" only has a chance of success if at the same time a new style of empirical working is adopted. The current predominant concentration on models and results has to be abandoned in favor of more modest, but more realistic empirical studies.

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