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Current State of Econometric Modelling

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Current State of Econometric Modelling

This memo is about the status for 'best procedures' for empirical model work.

One step in these procedures is *a correct and informative quality declaration of the model*. It is therefore natural to draw some parallels to chapter 5 in 'Dansk Økonomi, efteråret 2021'

The procedures are essentially the same for all econometric models, but the technique will vary, and may even not exist for all models. Therefore, this memo is non-technical and most examples are taken from the traditional macroeconometric model.

This is actually relevant because the new Makro Model was put in place because Adam - or the FM use of Adam - was not good enough.

Makro models should be solid based on data.

This memo may result in a working paper discussing if Makro is an emperical model.

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1. A template for a Quality Declaration for a model:

Chapter 5 in 'Dansk Økonomi, efteråret 2021' is the first attempt of DØS to produce an evaluation of models in FM. This memo suggests some structure in the evaluations.

A quality declaration should include information on the following items:

1. Which model type is in question.

   Each model type can be used to answer different requests, and it is important that a model is not claimed to be able to produce answers to questions for which it has not been designed.

   a Structural econometric model

   b Descriptive econometric model

   c Theory model with calibration

   d Theory model

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e Numerical example

Below we only discuss a. and b. which are models validated by data, see Econometric Modelling.

To be an *empirically based model* the modelling must have been through all the steps mentioned in that section.

Structural econometric models are futher discussed below.

2. For which population has the model been developed?
3. How was the sample drawn. And if it is not a simple random sample, then the impact this has on the estimation must be described.
4. The stochastic properties of the data sample
5. Detailed explanation of how well the model and the data sample describe the problem or relations in the real world.

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6. Identification of the model, discuss how the existence of effects modelled will show up in data and how to reject the model if these effects do not show up in data.
7. How is uncertainty reported.
   internal/external validity discussion?

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Observed data outcomes are treated as realizations of data generating processes.

Since Haavelmo (1944) the *joint distributions* of all observable variables for the sample period are the most *general statistical model* allowing estimation and inference of the model.

There are five practical problems:

1. The researcher does not know DGP. If a wrong DGP is chosen the statistical model is misspecified. If tests reject the chosen DGP another statistical model is chosen by the researcher. *Empirical research is a process.*

2. Most econometric models are so complicated that estimations and tests can be derived only for *large samples.*

   Numerical simulation on computers, Monte Carlo experiments, can elucidate the properties of the estimators in sample sizes used in economics.

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3. All relevant variables must be included in the model. The joint distribution can be expressed in conditional and marginal distributions to reduce the size of the model. For conditioning to be valid, appropriate exogeneity conditions must be satisfied. Different kinds of exogeneity are required for estimation and conditonal policy analysis.
4. Most macromodels use time-series observations so *dynamic models* must be used.
5. Many variables seem to be non-stationary processes. Equilibrium-correction models are applied to such non-stationary processes.

Economic theory is the starting point, but many aspects of the model like functional form, dynamics, deterministic factors, are data determined.

The *empirical model* is the model resulting from lack of knowledge of the statistical model.

By assuming the empirical model correct, evaluate outcomes to check for misspecifications, we can learn when models are wrong and then

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develop improved models for the next round.

When no evidence remains in conflict with the empirical findings we have a *congruent, encompassing model*, and we can proceed using the model.

Structural equations

The structural equation is an important concept in traditional macro economic models.

We will look at the econometric modelling of structural equations.

The Cowles Commission approach assumes that a complete economic theory supplied a function and variables for a structural equation.

Haavelmo (1944) recognized and explained in the context of this macro model that the *joint distribution* of all observable variables for the sample period is the most general statistical model allowing estimation and inference. The variables explained by the model are named *endogenous* variables; the other variables are named *exogenous variables.*

Haavelmo defined a structural equation as a behavioral equation which would not change functional form, parameters or variables if another structural equation would change.

It is named a *structural* equation because the functional form and the involved variables are *derived* from *economic* theory and the parameters have an economic interpretation,

Structural equations

If it is accepted that it is possible to construct such a model then comparative statistic exercises with ceteris paribus changes are what economists mean by *causal effects*.

Identification

Many different theoretical models may be consistent with the same data. In economics, this is called the problem of identification.

Identification specifies the conditions under which structural parameters can be identified from data.

But a maintained structural model does not prove these causalities, just that they cannot be rejected by data.

It is therefore important to include as many restrictions as possible in the model, to discuss how the model can explain past data and potential, new data values, to discuss how the restrictions can predict values that can be verified by data, and subject the model to extensive empirical verification.

The model may be rejected by data if the parameters are identified. The power is higher the more restrictions.

A model may also be rejected by data by testing the compliancy with the DGP.

The Estimation process

In the Cowles Commission Approach, the macromodel delivered by the economic theory was considered a maintained hypothesis tested against available data, and no method of model selection was proposed.

(Hendry & Johansen, 2015), Hendry and Johansen (2015) argue that it "'seems essential to nest 'theory-driven' and 'data-driven' approaches" to ensure that the maintained SEM model is complete and correct. and "'guiding empirical discovery by the best available theoretical ideas, but always being prepared to have those ideas rejected by sufficiently strong counter- evidence".

A model is complete and correct if there are no omitted variables relevant in the DGP , no included variables are irrelevant, the functional form is correct, and the error term added to the theoretical model is uncorrelated with all included variables and independently and identically distributed.'

Combining 'theory-driven' and 'data-driven' approaches

The structural equation is

$$y_t = \boldsymbol{\beta}' \mathbf{x}_t + \boldsymbol{\varepsilon}_t$$

After inclusion of all possible relevant variables the equation is

$$y_t = \beta' x_t + \gamma' w_t + \varepsilon_t$$

w_t are exogenous or predetermined variables that may be part of the DGP, but a priori theory suggests $\gamma_0 = 0$

$\dot{w}_t$ and x are orthogonalised by regressing w_t on x_t with the residuals

.

The extended structural equation is reformulated to

$$y_t = \beta^{+'} x_t + \gamma \widehat{u}_t + \varepsilon_t^+$$

According to Frisch & Waugh (1933), the estimators $\widehat{\beta}$ in the structural equation and β^+ and the residuals $\varepsilon^+$and $\varepsilon^+$are equal.

Combining 'theory-driven' and 'data-driven' approaches

Before this analysis, you may be able to remove a lot of the w_t variables by testing if w_t does not Granger cause y_t and x_t

Common problems with DSGE like models

Many problems are reported for DSGE like models with regard to the required procedures for econometric modelling.

- ⋆ The models may not be identified.The problem of identification is seldom treated explicitly.
- ⋆ The assumptions of the DGP process are not tested. (Juselius, 2021), Juselius (2021) reports on page 7 that Cointegrated Vector Autoregressive Model (CVAR) checks of the assumptions in a DSGE model reported by P.N. Ireland essentially show that all assumptions of the model lack empirical support.

Juselius also concludes that CVAR results are more supportive of traditional Keynesian models.

- ⋆ Often the parameters are not estimated. The statistical properties for calibrated DSGE models are not established.

Requests for a new macro model

The Ministry of Finance needs a new macro model.
This has been claimed by many groups.

1. Ministry of Finance.

   A new macro model is required to produce

   a middle to long-term forecast, including structural budget accounts

   b policy evaluations

   The new model must be deeply founded in empirical data, however some forecasts will be incorporated from other models.

   A large number of external satelite models are incorporated.

2. The political parties Enhedslisten, Alternative, SF.

   The dynamic effects of new policies are only included for changes in taxes, not for changes in welfare or education, public consumption, and inequality. And the dynamic effects of lowering income taxes are much too large.

Requests for a new macro model

3. Nina Smith, head of 'kommissionen for 2. generation af reformer' wants to use other models to evaluate the effects of their plans which have small effects and tale a long time to come into effect.

Are these effects not included because ADAM is not an objective model but a strongly liberal model, or because these effects cannot be modelled?

Looking at the new macro model it is obvious that it attempts to drag more effects out of data than is possible. But beause the model has not been throug all the steps of Econometric Modelling this is not discovered in the process. Makro can still descibe these effects, but they cannot be supported by data.

The government and parliament must simply learn to use and interpret ADAM and other models correctly.