Assessing Structure in Monetary Policy Models

Ragnar Nymoen

University of Oslo, Department of Economics

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1 Introduction

Structural models carry positive connotations in economics. Hence proponents of rival theories and modelling strategies compete about priority to label their models as structural.

Development: several countries have adopted inflation targeting, IT, which is both model-based and model-dependent:

- Operational target is the forecasted rate of inflation

- Forecast is a function of the chosen interest rate path in the forecast period.

⇒ close linkage between a given IT-model’s forecast ability and its policy implications.

Debate about “what is good model for a central bank to use” is currently “on” in Norway (details below), Bank of England (Pagan report).
Issues in the debate

• Role of theory and data in specification and evaluation of empirical models.
  — Legitimate to trade fit for theoretical content, structural interpretation?

• Large versus small models

• Relationship between model producers and models users
  — Overlapping interest?
  — If conflict, who should get priority?

  * Interaction desirable, though

• Forecast performance. Ways to improve? Implications for model choice and specification.

Many of these issues can be subsumed under the broader question about the meaning of model structure, its detectability (can we assert structure?) and relevance for IT.
2 Svennson on Norwegian monetary policy models

In a review of monetary policy and institutions in Norway, Svensson et al. (2002) make several remarks on research at Norges Bank [The Norwegian Central Bank]. The group, named Norges Bank Watch (NBW hereafter), specifically advocates "structural models" of the Norwegian economy, to be used for policy simulation and forecasting.

**NBW critique:** A list of problems with the Bank’s incumbent model: i) Flawed methodology, being based on empirical modeling rather than on modern open macroeconomic theory. ii) It does not adhere to the principle of model consistent expectations on current dated variables, and in particular it omits so called forward variables. iii) Being empirically rather than theoretically derived, it is “very sensitive” to regime shifts.

**NBW recommendation:** Develop structural models along the principles of modern open economy macroeconomics.

“eclectic applications of modern open economy macroeconomics where the equations have structural interpretations.” (p. 56).
But—what is (meant by) a structural macroeconomic model anyway?

NBW gives one definition: a structural model is synonymous with a model which is made up of equations that are derived from (or at least consistent with) modern macroeconomic economic theory, i.e., each equation has a structural interpretation.

However, there is a distinction between a model’s structural interpretation and its eventual structural properties.

There is no guarantee that a model with structural interpretation has the desirable structural properties. On the contrary, such models often leave a lot to be asked in terms of explanatory power, they forecast badly, and have unstable parameters.

Hence, models may have non-structural properties, their structural interpretation notwithstanding. This thesis is substantiated in the below.
3 Structural interpretation and structural properties

Structural interpretation means “explicitly derived by the use of economic theory”.

Economic analysis has the advantage of being based on explicit assumptions, which can be assessed both by introspection and formal confrontation with the data. Theoretical results (e.g., regarding policy) are logically derived. Parameters of interest can be defined without ambiguity.

Economic theory evolve over time, so the hallmark of structural interpretation changes its valour over time.

For applied work, there are well-known costs to theoretical simplification, elegance and rigour:
As economic data are non-experimental, theoretical ceteris paribus clauses and simplifying assumptions cannot be trusted to carry over to the empirical analysis. As a result, model residuals do not reflect the assumed properties of the disturbances (making inference difficult), omitted variables induce bias in the estimates of the parameters of interest, and the econometric model becomes unstable with respect to extensions of the data set.

Econometric techniques have been invented in order to rectify some of these problems, but the validity of these correction methods remain dependent on the initial assumption that the model is basically sound, and that e.g., autocorrelated residuals are indeed a sign of autocorrelated disturbance of the true model and not of misspecification. Section 4 provides an example of the problem.

A main thesis in the following is that an empirical model’s eventual structural properties are not implied by structural interpretation.
Heuristically, we take a model to have structural properties if it is robust to shocks, and is able to fence off challenges from rival models. A model with structural properties does not disintegrate that easy!

Structural properties are nevertheless relative, to the history, nature and significance of regime shifts.

Structural properties have several dimensions:

1. Theoretical interpretation.
2. Ability to explain the data.
3. Ability to explain earlier findings, i.e., encompassing the properties of existing modes.
4. Robustness to new evidence in the form of updated/extended data series and new economic analysis suggesting e.g., new explanatory variables.
Economic analysis (#1) is always the main guidance in the formulation of econometric models.

The main distinction seems to be between seeing theory as representing the correct specification, (leaving parameter estimation to the econometrician), and viewing theory as a guideline in the specification of a model which also accommodates institutional features, attempts to accommodate heterogeneity and so on.
Ability to explain the data (Re #2)

NBW re-iterate arguments against what they call “largely empirical models”, e.g., sample dependency, Lucas-critique, unnecessary complexity (in order to fit the data) and chance finding of “significant” variables.

Yet, ability to characterize the data (#2) remains an essential quality of useful econometric models.

The pitfalls of empirically based models can be reduced in practice and avoided in principle. Conversely, acting as if the specification is given by theory alone, is bound to result in the econometric problems noted above and which section 4 below will demonstrate.
**Encompassing and autonomy (#3 and #4)**

There is usually a “modelling record”, and a new model’s capability of encompassing earlier findings is an important aspect of structure (i.e., #3).

Structural models are relatively invariant to changes elsewhere in the economy, i.e., they contain autonomous parameters, see Haavelmo (1944), Johansen (1977), Aldrich (1989), Hendry (1995).

However, autonomy is a relative concept. No model is invariant to every imaginable shock. Unlikely that all parameters of an econometric model are equally invariant. Elements of structure typically will be grafted into equations (or models) that also contain parameters (or equations) with a lower degree of autonomy (argument against big systems of equations?).

In operational terms, therefore, partial structure is what we can hope for.
Partial structure (conditional model)

$y$ and $x$ are jointly determined, but we only manage to model “$y$ given $x$”:

$$
\Delta y_t = \gamma \Delta x_t - \alpha (y_{t-1} - \beta x_{t-1} - \mu) + \varepsilon_t, \quad \varepsilon_t \sim IIN(0, \sigma^2) \quad (1)
$$

- can (logically) have structural change in $\mu$, without shifts in $\gamma$ and $\beta$
- the $x$ process can change without any parameters changes in (1)

Partial structure (cointegration)

Identified cointegration vectors (i.e., between $x_t$ and $y_t$) are invariant to extensions of information set.
Other attributes of structure?

5. Similarity of results between different datasets

6. Precise forecasts

#5 can be spurious! (See below) Non-spurious examples are usually a function of already achieving property #2-#4, and then only for some key parameters of interest (e.g., cointegration coefficients).

#6 is not implied by (partial) structure, neither is structure implied by it. Yet, the two are closely related in practical monetary policy judgements! As discussed at the end of the talk.
4 Non-structural properties despite structural interpretation

There is a big gulf between measurable complexities of the real economy and what a model can hope to incorporate. Hence, starting with the idea that theory is complete (or that we can act as if it is complete) does not solve any of the problems of empirical modelling in economics, and specifically does not guarantee a high degree of structure.

Consider the New Keynesian Phillips Curve, NPC, an equation that NBW would (probably) recognize as a structural equation. In terms of our list of structural characteristics, the NPC scores high on theory consistency (#1).
As an econometric model, the NPC states that inflation, defined as $\Delta p_t \equiv p_t - p_{t-1}$ where $p_t$ is the log of a price level index, is explained by expected inflation one period ahead, $E(\Delta p_{t+1} | I_t)$, and marginal costs $x_t$ (e.g., output gap, the unemployment rate or the wage share in logs), see e.g., Clarida et al. (1999):

$$\Delta p_t = \alpha E(\Delta p_{t+1} | I_t) + \beta x_t + \epsilon_t. \tag{2}$$

The disturbance $\epsilon_t$ is an innovation relative to the information set $I_{t-1}$. 

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The claimed empirical success of the NPC is based on goodness of fit (#2) and similarity of results across different datasets (#5). Thus for three very different economies (and with the wage share of value added in place of $x_t$)

<table>
<thead>
<tr>
<th>Dataset</th>
<th>Empirical equation</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>US 1960:1-1997</td>
<td>$\Delta p_t = 0.92 \Delta p_{t+1} + 0.25 ws_t$</td>
<td>GG99</td>
</tr>
<tr>
<td>EURO 1971:3-1998:4</td>
<td>$\Delta p_t = 0.91 \Delta p_{t+1} + 0.09 ws_t$</td>
<td>GGL01</td>
</tr>
<tr>
<td>Norway 1972:4-2001:1</td>
<td>$\Delta p_t = 1.01 \Delta p_{t+1} + 0.01 ws_t + 0.04 \Delta p_{it}$</td>
<td>BJN02</td>
</tr>
</tbody>
</table>
Figure 1: Actual and fitted values of Euro area equation in GGL01 (i.e., second row above), together with the fit of a random walk.

Good fit? Maybe, but no better than random walk.

Means that autoregressive part of NPC dominates. \( w_{st} \) has no numerical significance (in this model).
In empirical applications, the NPC is often modified by inclusion of $\Delta p_{t-1}$ (incidentally specific-to-general methodology) and is referred to as the hybrid model, see Gali et al. (2001)—hereafter GGL. With actual, rather than expected inflation on the right hand side, the model can written as

$$\Delta p_t = \alpha^f \Delta p_{t+1} + \alpha^b \Delta p_{t-1} + \beta x_t + \varepsilon_{p,t}. \tag{3}$$

$\varepsilon_{p,t}$ is a composite disturbance made up of the expectations error and the structural equation disturbance, $\varepsilon_t$. It is useful to complete the model with an equation for the ‘forcing variable’ $x_t$:

$$x_t = \gamma \Delta p_{t-1} + \lambda x_{t-1} + \varepsilon_{xt}. \tag{4}$$

The qualitative dynamic properties of the system (3)-(4) depend on the three roots, see Bårdsen et al. (2002).

$\alpha^f$ and $\alpha (\equiv \alpha^f + \alpha^b)$ are main parameters of interest. Important that (3), when viewed as a statistical model, give rise to valid (Neyman-Pearson) tests of hypotheses about $\alpha^f$ and $\alpha$. Thus, the statistical adequacy of the model is a main issue.
Estimation of NPCs by GMM is problematic, since one then tacitly assume that for example serial correlation in the (uncorrected) residuals is symptomatic of serial correlation in the true disturbances:

Implies that the specification of the econometric model used for testing hypotheses (regarding $\alpha_f$ and/or $\alpha$) incorporates the alternative hypothesis associated with a misspecification test (i.e., of residual autocorrelation).

This is usually not a good idea in econometrics, since the underlying cause of the residual misspecification may be quite different.

Instead, when departures from the underlying assumptions of the statistical model have been established, there is need for respecification, with the aim of finding a statistical model which does a better job in capturing the systematic variation in the rate of inflation.

A hybrid NPC estimated by 2SLS without any correction, using GGL's data for the Euro area, and their choice of forcing variable $x_t$, namely the wage share denoted $w_{st}$, gives (Bårdsen et al. (2002) has more details):
\[ \Delta p_t = 0.655 \Delta p_{t+1} + 0.280 \Delta p_{t-1} + 0.071 w_{st} \]

\[
\begin{align*}
(4.84) & \quad (2.39) & \quad (0.827) \\
+ 0.1027 & \quad (0.844)
\end{align*}
\]

2SLS, 1972 (2) to 1998 (1) Residual properties: fails Stability: ok

The estimates of the coefficients of the inflation terms are typical of GGL’s results, as well as of estimates on US data.

The model fails on standard model evaluation criteria, so it is inadequate as a statistical model of the rate of inflation, and it does not provide the basis for reliable inference about parameters of interest. It also means that the apparent stability of the equation (suggested by the ok below the equation) is unfounded.

In terms of structural properties the NPC fails on #2 (it does not explain the data) despite the high score on #1 (structural interpretation). A popular fix is either to whiten the residuals (GMM estimation), or to correct the 2SLS
coefficient standard errors, but the validity of this practice assumes that the model is correct.

A better approach is to respecify the model, with the aim of attaining innovation error processes and thus obtaining a firmer basis for hypothesis testing, equation, and to attain a locally encompassing equation, i.e., #3 above.

As an example of respecification, consider moving the lagged output-gap \((emugap_{t-1})\) and the fourth lag of inflation \((\Delta p_{t-4})\) from the list of instruments used for estimation of (5), and include them instead as explanatory variables in the equation. The results (using 2SLS without corrections) are:

\[
\Delta p_t = 0.068 \Delta p_{t+1} + 0.248 wst + 0.4421 \Delta p_{t-1} \\
+ 0.1799 \Delta p_{t-4} + 0.1223 emugap_{t-1} + 0.5366 \\
\]

\(2SLS, \ T = 104 \ (1972 (2) \ to \ 1998 (1))\)

Residual properties: \(\text{ok}\)  Stability: \(\text{ok}\)
Compared to (5), note:

1. the coefficient of $\Delta p_{t+1}$ is reduced by a factor of 10, hence (2) has non-structural properties despite its structural interpretation.

2. the diagnostic tests no longer indicate residual autocorrelation or heteroscedasticity, so we can undertake substantive inference in a reliable way. Clearly, the forward term is insignificant in this model.

Is it a good model (i.e., the wider issue of model evaluation)?

- it is better than the NPC (the easy question)

- it is better than the minimal nesting model, and if that GUM is a valid and relevant statistical model, then (6) is a good model.
But not likely that a GUM thus constructed (i.e. from loosening up the restrictions of the NPC) is the best we can do!

Summary of NPC evaluation

NPC is almost void of explanatory power.

“Similarity of results” is not structure barely reflects a common feature among different countries data sets, namely autocorrelation.

Our thesis is that each country specific NPC will disintegrate once relevant characteristics of each country specific inflation process is included in the model, thus leading to models with higher structural content.
5 Asserting structure in a model of Norwegian inflation

Norwegian inflation modelling has for some time centered around the ICM framework (incomplete competition model), see Bårdsen et al. (2003)

1. Price setting firms
2. Unions have bargaining power
3. Empirical implementation:
   (a) Cointegrating relationships closely related to theory Cointegration implies equilibrium correction
   (b) Integrates earlier theories and models (Scandinavian model, Phillips curve)
4. Implies steady-state rate of unemployment, but not NAIRU unless as a special case, see Bårdsen and Nymoen (2002).
Here, total economy. Using data from 1967(4)-1993(2), Bårdsen et al. (1998) obtain:

\[ w = p + a - 0.1u + \hat{\mu}_w \]  

(7)

\[ p = 0.65(w + t1 - a) + 0.35pi + 0.5t3 + \hat{\mu}_p \]  

(8)

- \( w \) = log wage rate  
- \( u \) = log rate of unemployment  
- \( a \) = log average productivity,  
- \( pi \) = log import price index  
- \( t1 \) and \( t3 \) = payroll and indirect tax rates

Figure 2 shows recursive estimation of the two key elasticities
Figure 2: Identified cointegration vectors. Recursively estimated parameters (elasticity of unemployment in the wage equation and the elasticity of the import price in the price equation) and the $\chi^2(8)$ test of overidentifying restrictions,
A number of contesting inflation models exists, in the form of single equation models.

The dynamic ICM implies two equations, for $\Delta p_t$ and $\Delta w_t$. Hence, to be able to make a comparison of statistical properties, we derive the ICM-reduced form equation for $\Delta p_t$.

Right hand side variables:

- lagged changes of wage rates ($\Delta w$), and productivity ($\Delta a$)
- GDP growth rate ($\Delta y$), energy prices ($\Delta pe$)
- changes in length of working week ($\Delta h$) and regime shift dummies ($pdum$, $wdum$)
- ECMs defined by (7) and (8).
ICM reduced form for $\Delta_{4p_t}$

$$\hat{\Delta_{4p_t}} = 0.05 \Delta_{3w_{t-1}} - 0.07 \Delta_{w_{t-2}} + 1.03 \Delta_{3p_{t-1}} + 0.13 \Delta_{p_{t-2}}$$

$$+ 0.07 \Delta_{2y_{t-1}} + 0.02 \Delta_{pi_t} + 0.04 \Delta_{pe_t}$$

$$- 0.06 ECM_{p,t-1} - 0.019 ECM_{w,t-1} - 0.04 \Delta_{4a_t}$$

$$- 0.09 \Delta_{ht} - 0.01 pdum_{t} - 0.003 wdum_{t} - 0.015$$

$$\hat{\sigma} = 0.35\%$$

Diagnostics

<table>
<thead>
<tr>
<th>Test</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$AR\ 1 - 5$ $F(5, 109)$</td>
<td>$0.680[0.64]$</td>
</tr>
<tr>
<td>$ARCH(1 - 4)F(4, 106)$</td>
<td>$0.27[0.90]$</td>
</tr>
<tr>
<td>Normality $\chi^2(2)$</td>
<td>$4.75[0.093]$</td>
</tr>
<tr>
<td>Hetero $F(27, 86)$</td>
<td>$1.33[0.16]$</td>
</tr>
<tr>
<td>$RESET F(1, 113)$</td>
<td>$0.017[0.90]$</td>
</tr>
</tbody>
</table>
Figure 3: Alternative inflation models: Misspecification tests

<table>
<thead>
<tr>
<th>$\Delta_{4p}$ model</th>
<th>$k$</th>
<th>$\hat{\sigma}<em>{\Delta</em>{4p}}$ %</th>
<th>AR 1-5</th>
<th>ARCH 1-5</th>
<th>Normality</th>
<th>Hetero</th>
<th>RESET p-values</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICM</td>
<td>15</td>
<td>0.35</td>
<td>0.64</td>
<td>0.90</td>
<td>0.09</td>
<td>0.16</td>
<td>0.90</td>
</tr>
<tr>
<td>Md-Inv</td>
<td>11</td>
<td>0.45</td>
<td>0.15</td>
<td>0.28</td>
<td>0.03*</td>
<td>0.00**</td>
<td>0.01**</td>
</tr>
<tr>
<td>Pstar</td>
<td>13</td>
<td>0.35</td>
<td>0.29</td>
<td>0.54</td>
<td>0.39</td>
<td>0.05*</td>
<td>0.44</td>
</tr>
<tr>
<td>PsGap</td>
<td>11</td>
<td>0.46</td>
<td>0.07</td>
<td>0.06</td>
<td>0.09</td>
<td>0.00**</td>
<td>0.02*</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>$\Delta p$ model</th>
<th>$k$</th>
<th>$\hat{\sigma}_{\Delta p}$ %</th>
<th>AR 1-5</th>
<th>ARCH 1-5</th>
<th>Normality</th>
<th>Hetero</th>
<th>RESET p-values</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCIV</td>
<td>8</td>
<td>0.53</td>
<td>0.01**</td>
<td>0.24</td>
<td>0.30</td>
<td>0.05*</td>
<td></td>
</tr>
<tr>
<td>PChIV</td>
<td>9</td>
<td>0.47</td>
<td>0.00**</td>
<td>0.25</td>
<td>0.54</td>
<td>0.23</td>
<td></td>
</tr>
</tbody>
</table>
Figure 4: Omitted variables tests (OVT) for neglected monetary effects on inflation in the reduced form ICM

<table>
<thead>
<tr>
<th>Money growth, Interest rates, excess money and credit</th>
<th>$F_{OVT}(5,109) = 0.2284[0.9494]$</th>
</tr>
</thead>
<tbody>
<tr>
<td>money growth rates</td>
<td>$F_{OVT}(1,113) = 0.0328[0.8565]$</td>
</tr>
<tr>
<td>real interest rate</td>
<td>$F_{OVT}(1,113) = 0.3075[0.5803]$</td>
</tr>
<tr>
<td>spread</td>
<td>$F_{OVT}(1,113) = 0.1302[0.7189]$</td>
</tr>
<tr>
<td>excess money</td>
<td>$F_{OVT}(1,113) = 0.5173[0.4735]$</td>
</tr>
<tr>
<td>excess credit</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>&quot;Gap&quot; variables from the $P$-star model</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>gdp gap</td>
<td>$F_{OVT}(1,113) = 0.4476[0.5049]$</td>
</tr>
<tr>
<td>$\Delta_4$ excess money</td>
<td>$F_{OVT}(1,113) = 1.5663[0.2133]$</td>
</tr>
<tr>
<td>$\Delta_4$ price gap</td>
<td>$F_{OVT}(1,113) = 0.0114[0.9152]$</td>
</tr>
<tr>
<td>excess real m</td>
<td>$F_{OVT}(1,113) = 2.0426[0.1557]$</td>
</tr>
</tbody>
</table>

Exchange rate volatility term from the MdImproved model

| Ex-rate volatility                                   | $F_{OVT}(1,113) = 1.5024[0.2228]$ |
Figure 5: Alternative inflation models: Encompassing tests

<table>
<thead>
<tr>
<th>$\Delta 4p$ model</th>
<th>$k$</th>
<th>$\sigma_{4p}$</th>
<th>$F_{\text{EncGUM}}(j, 63)$</th>
<th>$p$-values for two types of encompassing tests</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\sigma_{4p}$</td>
<td></td>
<td></td>
<td>$F_{\text{Enc},1}$</td>
<td>$F_{\text{Enc},2}$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$j$</td>
<td>p-value</td>
</tr>
<tr>
<td>ICM</td>
<td>15</td>
<td>0.35</td>
<td>51</td>
<td>0.67</td>
</tr>
<tr>
<td>Md-Inv</td>
<td>11</td>
<td>0.45</td>
<td>55</td>
<td>0.00**</td>
</tr>
<tr>
<td>Pstar</td>
<td>13</td>
<td>0.35</td>
<td>51</td>
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</tr>
<tr>
<td>$\Delta p$ model</td>
<td>$k$</td>
<td>$\sigma_{4p}$</td>
<td>$F_{\text{EncGUM}}(j, 63)$</td>
<td>$F_{\text{Enc},1}$</td>
</tr>
<tr>
<td>$F_{\text{Enc}}$</td>
<td></td>
<td></td>
<td>$j$</td>
<td>p-value</td>
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<tr>
<td>PCIV</td>
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<td>9</td>
<td>0.47</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Conclusion from statistical assessment of ICM:

1. Partial structure in ICM wage-price model

2. The reduced form equation for $\Delta p_t$ encompasses most of its rivals, but P-star model represents aspects of inflation that is unaccounted for.
   - However, does not change ICM cointegration findings (partial structure again)
   - But possible disequilibria effects from other markets on rate of inflation

3. Range of structure: Nordic countries, see Nymoen and Rødseth (2003), UK, see Bårdsen et al. (1998)
   - But delineated by “1-20” percent annual inflation institutional set-up?
6. Forecast Properties

In IT regimes, the operational policy target is the forecasted rate of inflation 2 years ahead, using the rate of interest to achieve the target.

Figure 6 illustrates that:

1. Information value of forecast depends on initial conditions (unusual initial conditions most valuable!)

2. Measured forecast uncertainty depends on model parameters.

3. Forecast approaches unconditional mean of inflation.

1.-3. All hinge on structural properties.
Figure 6: An illustration of a conditional inflation forecast. $\pi_t$ corresponds to $\Delta p_t$ (or $\Delta_4 p_t$) above. Fan shows distribution of likely outcomes,
Figure 7: Norwegian rate of inflation 1966(1)-2002(2) and estimated equilibrium rate of inflation 1993(1)-2002(2).
Nevertheless, a structural model (with interest rate $i$)

\[
M1: \pi_t = \delta - \alpha(\pi_{t-1} - \mu) + \beta \Delta i_t + \varepsilon_t
\]

(9)
can produce inferior forecasts relative to a non-structural forecasting mechanism (dVAR):

\[
M2: \Delta \pi_t = \nu_t,
\]

\[
\nu_t = -\alpha \Delta \pi_{t-1} + \beta \Delta^2 i_t + \varepsilon_t - \varepsilon_{t-1}
\]

(10)

\[
E[\pi_{T+1} - \hat{\pi}_{M1,T+1} | \mathcal{I}_T] = \alpha(\mu - \mu^*), \text{ if } \mu \rightarrow \mu^*, \text{ before and after } T
\]

\[
E[\pi_{T+1} - \hat{\pi}_{M2,T+1} | \mathcal{I}_T]] = -\alpha \Delta \pi_T + \beta \Delta^2 i_{T+1}, \text{ if } \mu \rightarrow \mu^*, \text{ before } T
\]

meaning that:

- Non-structural forecasts, $M2$, “error corrects” to structural change occurring before forecast period.
- $M2$ forecasts do not break down, despite regime shift.
- $M1$ produces forecast failure, also when forecasts do not $M2$, break down, unless corrected by intercept correction.
In IT regimes, forecasting and policy purposes are fully integrated, thus M1 must have priority.

- Combine with M2 to identify structural breaks.

- Respecification (overturning) of M1 necessary after a break
  - Progress from forecast failure
Figure 8: Partial structure in practice: Development of long-run coefficients in the Norwegian Consumption function

\[
\begin{array}{cccccc}
\text{log INC} & \text{log W} & \text{real } i & \text{AGE} & \text{Sample} \\
0.7 & 0.7 & 0.56 & 0.27 & \text{ending 1984(4)} \\
0.65 & 0.23 & 1968(1) - 1989(4) \\
0.64 & 0.15 & -0.65 & -0.63 & 1968(3) - 2004(4)
\end{array}
\]
7 Conclusions

Care must be taken if the meaning of structural interpretation is stretched to convey truth or robustness of econometric models.

Specifically, structural properties (explanatory power, constancy and autonomy of parameters, encompassing) cannot be postulated, but are likely to be hard earned features of models that have been developed and tested over time with the aim of maximizing their degree of structural content.

As Lucas and Sargent (1981) note: “[The] question of whether a particular model is structural is an empirical, not theoretical, one”.

The empirical section showed that a model with structural interpretation, the New Keynesian Phillips curve, fails on each measurable structural property.

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Theoretical frameworks that inspire genuine empirical modeling of individual data sets are better travelers than seemingly full fledged specifications (à la NPC)
References


