

The Use of Models in Finance Ministries – An Overview

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1/ This report was written while the author was on leave from the International Monetary Fund. The views expressed herein are those of the author and do not necessarily reflect those of the International Monetary Fund or the Norwegian Ministry of Finance.

Background

- Advisory Panel on Macroeconomic Models (MMU) request for survey of macroeconomic models in finance ministries
- Builds on previous work by Dyvi et al. (2015) and National Institute of Economic Research (2015)
- Comparison of models across some key technical, institutional, and practical themes important for the use of models in finance ministries
- How have these key themes influenced choice of model?

Background (cont.)

- Analysis based on:
 - publicly-available documentation
 - presentations to the MMU
 - Response to questionnaire sent to institutions developing/using models
 - Conversations and comments from key stakeholders in Ministry of Finance, Statistics Norway, and Norges Bank
- Disclaimer:
 - Documentation in some cases does not reflect latest version of model
 - Documentation and response to questionnaires vary in detail (and in some cases is lacking)
 - Likely that some factual errors and mischaracterizations remain

Outline

- Model Overview
- Key Themes:
 - Theoretical Foundations
 - Empirical Foundations
 - Comprehensiveness
 - Fiscal Policy
 - Model Use
 - Institutional Framework
 - Model Use
- Conclusions

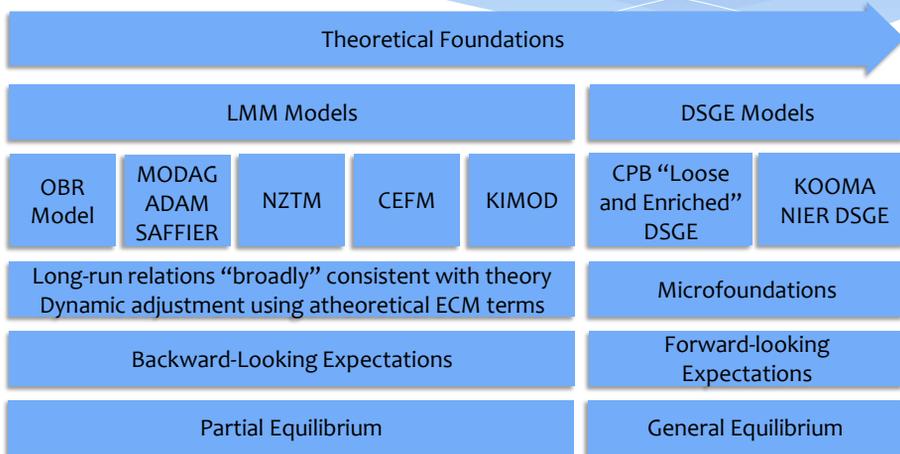
Model Overview

Main Model Characteristics

Country	Developing Institution	Name	First version	Type	Size 1/	Industries 2/	Frequency	Endogenous monetary policy	Endogenous fiscal policy 3/	Model-consistent expectations 4/	Documentation
Norway	Statistics Norway	MODAG	1980s	LMM	2692/150	15/3	Annual	Yes	No	No	Boug and Dyrvi (2008)
Sweden	National Institute of Economic Research	KIMOD	2004	LMM	40/5	1/1	Quarterly	Yes	Yes	Yes	Bergvall et al. (2007)
Denmark	Statistics Denmark	ADAM	1972	LMM	2500/90	11/1	Quarterly	No	No	No	Danmarks Statistik (2012)
Finland	Ministry of Finance	KOOMA	2011/12	DSGE	23/0	1/1	Quarterly	Yes	Yes	Yes	Obstbaum and Pietiläinen (2013)
The Netherlands	Central Planning Bureau	SAFFIER	2004	LMM	3000/25	1/1	Quarterly/Annual	No	No	No	Kranendonk and Verbruggen (2007)
United Kingdom	Office of Budget Responsibility	...	1970s	LMM	500/30	2/1	Quarterly	No	No	No	Office of Budget Responsibility (2013)
Canada	Ministry of Finance	CEFM	1986	LMM	560/128	1/3	Quarterly	Yes	No	No	Robidoux and Wong (1998)
New Zealand	Ministry of Finance	NZTM	2002	LMM	Unclear	1/1	Unclear	Yes	No	No	Ryan and Szeto (2009)

1/ Number of endogenous variables/estimated equations. For the UK both endogenous and exogenous variables are included as the exogenous variables (the exact number of which is unclear) are included in the code with their own equation.
 2/ Private/public sector.
 3/ SAFFIER includes a set of dummies that allows it to be used either in "balanced budget mode" (endogenous fiscal policy) or with exogenous fiscal policy.
 4/ The term "model-consistent" is used instead of forward-looking as several of the LMM models surveyed in this report including forward-looking expectations that are proxied using current and past values of variables or using survey data.

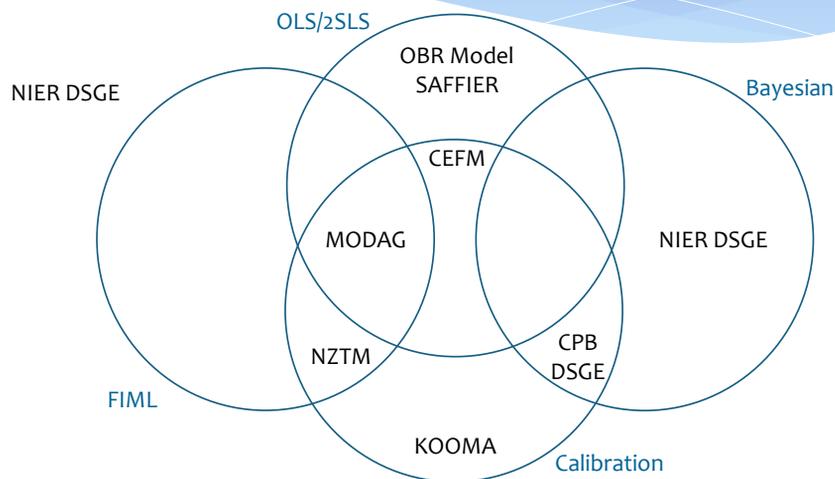
Theoretical Foundations



Theoretical Foundations (cont.)

- Lucas critique
 - Highlighted by Finnish Ministry of Finance and the CPB as reason for moving to DSGE framework
 - **Is it relevant in practice?**
- Forward-looking Expectations
 - Highlighted by CPB as weakness of SAFFIER
 - **Are expectations based on surveys and market data more realistic than rational expectations?**
- General equilibrium
 - Captures interaction of different markets and agents in the model
 - **Complexity rises exponentially with size and precludes large models with the “level of detail required by our customers” (CPB)**
 - **Resulting lack of flexibility is a drawback (Statistics Denmark, CPB)**
- Structural shocks
 - Highlighted by Swedish Ministry of Finance, NIER, and the CPB as reason for moving to DSGE framework
 - **Do we know what the shocks mean? Paul Romer’s “imaginary forces”**
- Forecasting
 - **Trade-off between theoretical consistency and forecast accuracy (CPB)**
 - **DSGE models time-consuming to use for forecasting (NIER)**

Empirical Foundations



Empirical Foundations (cont.)

System Estimation

- Respects all cross-restrictions in model

Bayesian Estimation

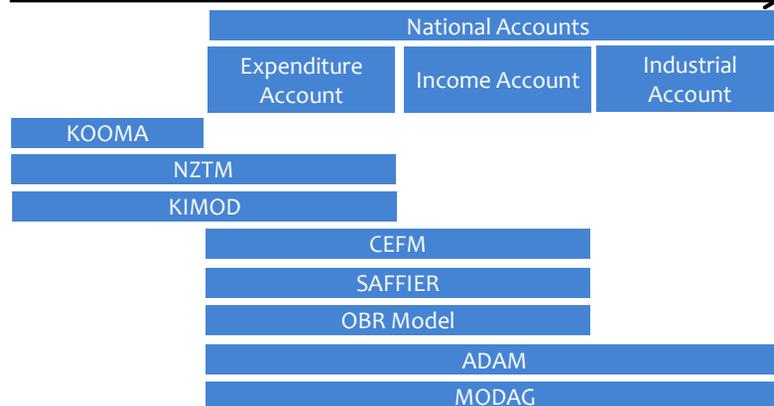
- Models often have multimodal/flat likelihood functions; data often uninformative about many parameters (Chari et al.)
- Requires tight prior distributions that can drive results and undermine empirical foundations (Blanchard)

Equation-by-Equation Estimation

- Computationally easier
- Protects against misspecification in other parts of model (Eitrheim et al.)
- Danger of misspecified model greater than danger of simultaneity bias (Eitrheim et al.)
- Statistical implications of combining sub-systems unclear (Johansen); Dynamics of individually estimated equations can be at odds with system (Blanchard)
- “Tweak” estimation till system performs satisfactorily (Statistics Denmark)

Comprehensiveness

Greater Dissagregation →



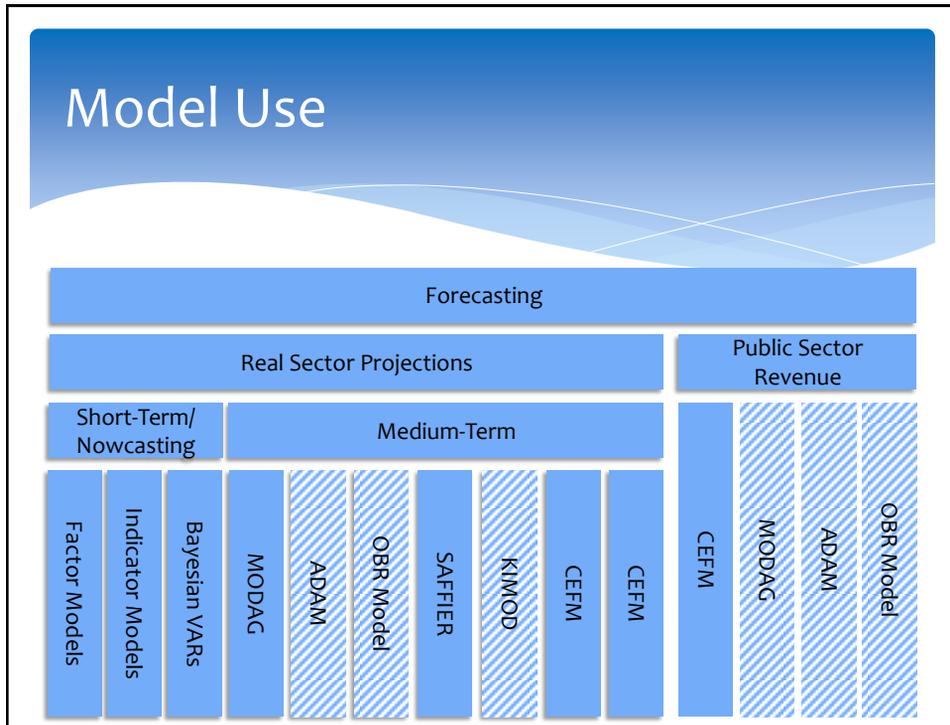
Comprehensiveness (cont.)

- Disaggregation makes it possible to identify how aggregate or industry-specific shocks are transmitted through the economy (Dyvi et al.)
- Disaggregation necessary for full description of how economic conditions determine government income and expenditure (Dyvi et al.; OBR)
- Industry level projections less accurate and hard to interpret; but impact projections in future years so can't be ignored (Dyvi et al.; Canadian Department of Finance)
- Greater disaggregation reduces transparency (CPB)
- High degree of disaggregation unnecessary as (KIMOD) forecast not used as direct input into public financial calculations (NIER); industry-level breakdown unnecessary as budget does not involve decision about which industry to tax or spend in (Canadian Department of Finance)

Fiscal Policy

Model	Government Spending			Disaggregated Government Revenues	Marginal Tax Rates	Government Employment	Government Financing	Endogenous Fiscal Policy ^{1/}
	Consumption	Investment	Transfers					
MODAG	✓	✓	✓	✓	✓	✓		
KIMOD	✓	✓	✓			✓	✓	✓
ADAM	✓	✓	✓	✓	✓	✓		
KOOMA	✓		✓				✓	✓
SAFFIER	✓	✓	✓			✓		
OBR Model	✓	✓	✓	✓		✓		
CEFM	✓	✓	✓	✓	✓			
NZTM	✓	✓	✓			✓		

^{1/} SAFFIER includes a set of dummies that allows it to be used either in "balanced budget mode" (endogenous fiscal policy) or with exogenous fiscal policy.



Model Use

- Policy Scenario Analysis
 - All models except OBR Model
 - DSGE (and KIMOD) models particularly well suited given microfoundations (Lucas critique)
 - Challenge of implementing permanent policy/structural reform shocks in DSGE models (NIER, CPB)
- Drivers of historical data/forecast
 - Weakness of LMM models that can't be used for full historical/forecast decomposition (CPB, NIER)
 - Compare outcome and model forecast (OBR; NIER)
 - In LMM models analyze individual equations (Dyvi et al., CPB, OBR)
 - "Turn off" certain parts of model (e.g. monetary policy) to identify drivers
- Uncertainty
 - OBR, SAFFIER, and MODAG all used to give sense of uncertainty based on past forecast errors

Institutional Framework

	Development	Maintenance	Operation
MODAG	Statistics Norway		Ministry of Finance
KIMOD	NIER		Ministry of Finance
ADAM	Statistics Denmark		Ministry of Finance
SAFFIER	CPB		
OBR Model	OBR/HM Treasury		OBR
CEFM	Department of Finance		
NZTM	New Zealand Treasury		
KOOMA	Ministry of Finance		

Institutional Framework

- In-house development/maintenance/operation
 - Increases human capital (Finnish Ministry of Finance, Canadian Department of Finance, Swedish Ministry of Finance)
 - Makes it easier to preserve/transfer knowledge (Finnish Ministry of Finance, Canadian Department of Finance)
 - More likely that model matches requirements of the Ministry of Finance?
 - **Harder to shield resources for modelling?**
- Outsource development/maintenance/operation
 - Usually for institutional reasons (CPB, OBR)
- Outsource development and maintenance
 - Useful to outsource to statistical agency if model close to national accounts (Dyvi)
 - Makes modelers in Ministry of Finance part of an external community (Dyvi)
 - Reflects lack of capacity in ministries of finance (NIER)
 - Facilitates recruitment (NIER)
 - **Can pose communication challenges (Dyvi)**

Resource Costs and Knowledge Management

“the fact that an existing model has existed for a long time may be reason enough to ensure that it is still used – simply because it takes time and resources to develop a new one” (NIER)

- Cost to develop LMM models unclear
 - KIMOD 2 years (policy analysis); 5 years (forecasting)
 - Other larger LMM models likely more
- Cost to develop DSGE models around 2-4 years with resources ranging from 3 FTEs (Norges Bank) to 7 FTEs (Bank of England – includes full suite of models)
- Maintenance costs vary depending on how often redeveloped/re-estimated
 - MODAG/Kvarts 5FTEs in Statistics Norway
 - CEFM 2/3 employees at Department of Finance
 - KOOMA 2 employees at Finnish Ministry of Finance

Resource Costs and Knowledge Management

- Model complexity and resulting overreliance on key individuals major risk for model survival (Swedish Ministry of Finance, CPB, NIER)
- Can be mitigated with strict documentation routines (OBR), clear and transparent programming (Dyvi), and user-friendly software (OBR)
- Limited resources argues for choosing model that makes it easier to draw on external “community” (NIER)
- Choosing model type actively used in academia facilitates recruitment and reduces risk of overreliance on key individuals (NIER)

Some concluding thoughts...

Does the lack of microfoundations in LMM models argue for moving to a more micro-founded model?

- *Yes. Not because of the Lucas critique, but because of the general equilibrium aspect and ability to tell story about evolution of economy based on structural shocks*

Is it necessary to have a large disaggregated model?

- *No. Disaggregation increases complexity and overreliance on key individuals, and is difficult to integrate into work processes*
- *Evidence suggests disaggregation does not improve forecast accuracy, but increase complexity of producing projections*
- *Note important that model is sufficiently disaggregated to capture main elements of economy and impact of policies, and be able to answer questions of interest to policy makers*

Some concluding thoughts... (cont.)

Is there a case for moving to smaller model that can be estimated using full-information methods?

- *Yes. Dynamics of equations estimated individually can be very much at odds with that of the entire system*
- *Reliance on overly tight priors likely to decline gradually as literature develops*

Is it necessary to have a model with a detailed description of the public sector?

- *To a certain extent. Important that models include main fiscal policy instruments/captures main transmission channels*
- *Line item projections of public revenue and expenditure better handled in separate satellite models*

Some concluding thoughts... (cont.)

Is it important to have a single model for forecasting and policy analysis?

- *Not necessarily. Using two separate model may reduce complexity; empirical models may be more accurate, at least at shorter time horizons*
- *Possible compromise to initially develop small structural model for policy analysis, with decision on forecasting to be made later*

Who should be tasked with developing a new model?

- *It depends. For LMM models continued reliance on Statistics Norway makes sense*
- *If DSGE only choice may be for Ministry of Finance to develop in house with support from Norges Bank and international institutions*

Backup slides

