



HOW TO IMPROVE THE USE OF MODELS FOR MONETARY POLICY?

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Macroeconomic Modelling at Central Banks

- Central Banks use models to support their functions:
 - forecasting
 - policy analysis
 - risk management
 - communication
- Determinants of Modelling Framework:
 - mandate of central bank
 - available instruments
 - effective use of central bank resources
- Key Modelling Approaches:
 - Core model vs Suite of Models
 - which models?
- Evaluation crucial for understanding whether macroeconomic models:
 - constitute best practice;
 - are appropriate to answer relevant policy questions
 - can be improved and how
- Latest Norges Bank review of macroeconomic modelling in 2019:
 - *external* committee;
 - benchmark: best practices in other central banks/institution and in relation to *recent academic developments*



Suggested Improvements of Models Used for Policy Preparation

**Model
Based
Economic
Narrative**

Model
Based
Projections

Model
Based
Risk
Analysis

Model
Based
Monetary
Policy
Evaluation

Enhanced
Medium
Term
Reference
Scenario



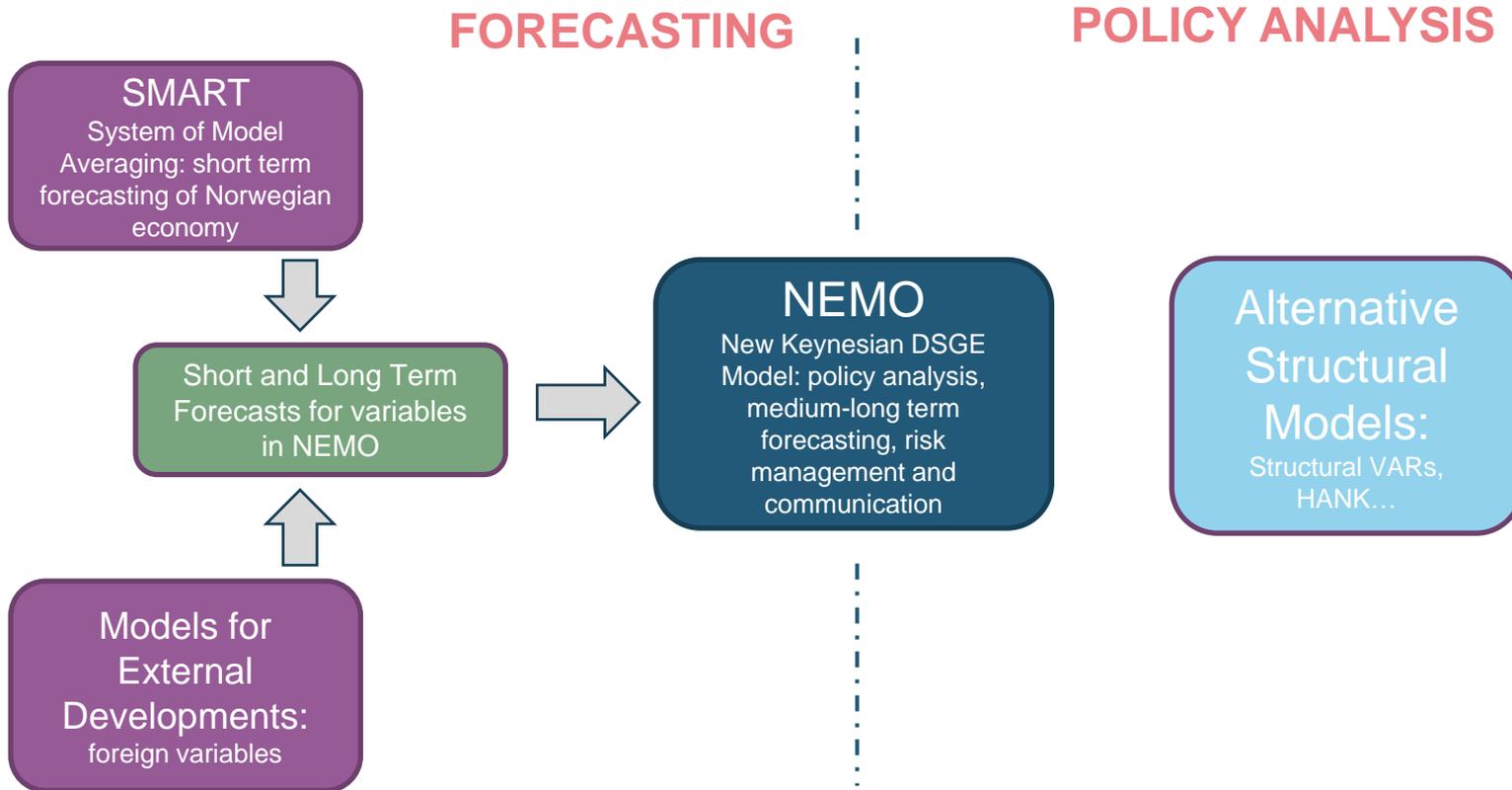
Model Based Economic Narratives

Current Practice	<i>Satellite structural</i> models are used to provide an economic narrative behind the projection base
Challenges	<ul style="list-style-type: none">• limited ability to interpret innovations in projection models in terms of structural macroeconomic shocks• disconnect between the main projection models and the ones used to interpret it
Recommendations	<ul style="list-style-type: none">• Extend use of existing satellite models (sectoral developments)• Improve structural interpretation of semi-structural projection models (factor model on residuals)• Model comparison exercise for structural errors
Discussion	<ul style="list-style-type: none">• Importance of obtaining economic interpretation of macroeconomic dynamics and run counterfactuals:<ul style="list-style-type: none">• basis for calibrating policy measures and appropriate communication• a fully-fledged economic narrative for baseline projections is instrumental to improving relevance, transparency and accountability for policymakers• Challenges stem from suite of models approach:<ul style="list-style-type: none">• <u>pros</u>: robustness and flexibility• <u>cons</u>: inconsistencies across satellite structural models and projection models and possible inconsistency across projection rounds; difficulty in internal and external communication• A different approach: core model for projection purposes and policy analysis



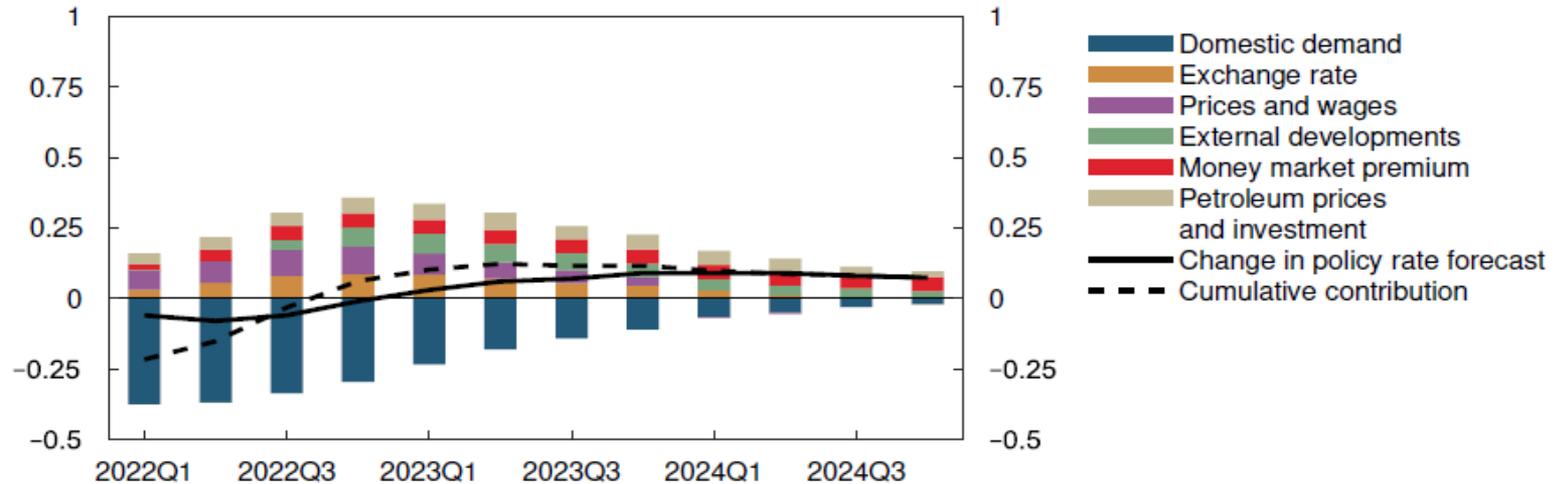
Macroeconomic Modelling at Norges Bank

The Core Model Approach



Decomposition of changes in the Policy Rate Path

Chart 4.7 Higher price and wage inflation pulls up the rate path
Cumulative contribution. Percentage points



Source: Norges Bank

- Structural interpretation of the projection baseline conducted using NEMO as published in the 2021-04 MPR;
- Advantages:
 - easy to communicate internally and externally;
 - consistent narrative across time



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Model Based Projections

Current Practice

Judgement-free model-based projections are not explicitly reported in the forecast process

Challenges

- Judgement pervasive of projections: experts intervene in a range of features, mainly bringing external sources of information to the main projection model
- Modelling features could also be seen as judgement

Recommendations

- reviewing strictly model-based projections as part of a more general model validation and maintenance protocol.
- harmonize strictly model-based projections across the Eurosystem and use them as effective diagnosis tools for constructing the baseline

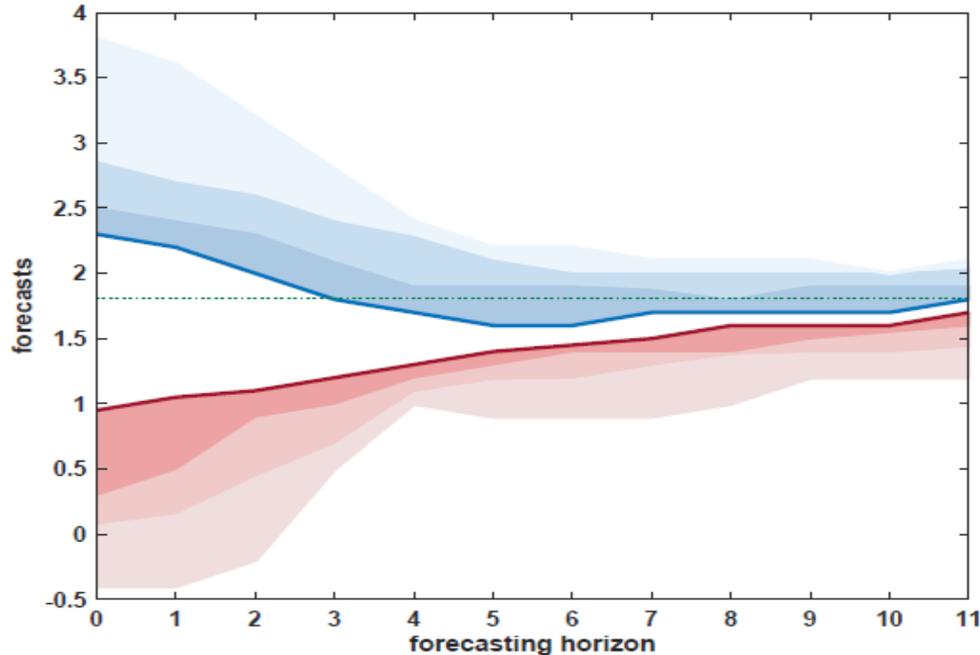
Discussion

- Important to distinguish built-in feature/performance (persistence, forecast accuracy) of the model from expert processing of assumptions, incoming data, short-term forecasting information and long-term anchors
- Judgement-free forecasts can serve as cross-checks of forecasts
- Store judgement free forecasts to evaluate forecast accuracy and understand value added of judgement (need a long time series and make sure information set is the same across time!)
- Additional exercise: review of contribution of external assumptions in driving ECB projection errors



Model Embedded Persistence vs Judgement

- Regardless of the starting value, ECB projections tend to revert to target after 3/4 quarters: judgement or persistence embedded in the models?



Judgement Free Forecasts as Crosscheck

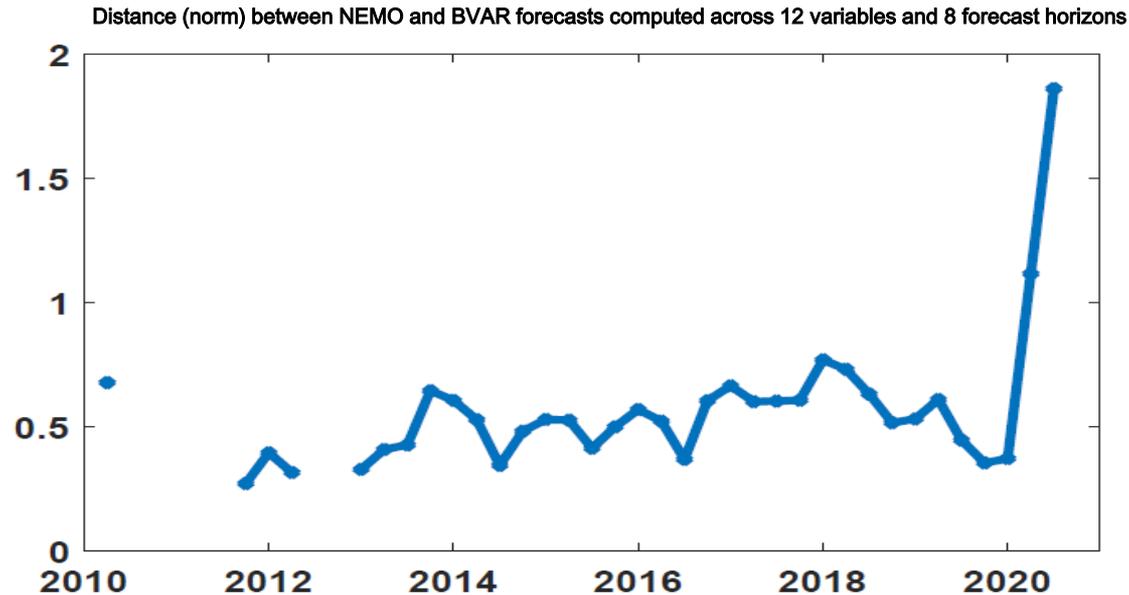
The SMART platform

- Newly developed comprehensive model system that brings together all empirical models:
 - AR, VARs, factor models, *time-varying coefficients*, *stochastic volatility*, *mixed frequency*
 - Use of *high frequency data (up to daily)*, *new data sources*, *granular data*
- Significant upgrade from previous platform SAM; more flexible platform
- Models are trimmed and combined into one estimate for *each* variable in NEMO and for the *whole* projection horizon
- Empirical properties (accuracy) determine the weights of the different models
- Medium/Long-term goal: live judgement free nowcast and forecast of output and inflation on Norges Bank website



Importance of Cross-Check

- Alternative, judgement free time series models useful for cross-check:
 - Evaluation of relative forecast accuracy
 - Tracking the distance between models over time



Source: staff computations from historical projections



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Model Based Risk Analysis

Current Practice

Staff provides subjective probability distributions around the baseline

Challenges

- risk assessment around the (B)MPE baseline is not derived from a statistical model
- communication of uncertainty around the baseline difficult and “ad hoc”

Recommendations

- develop, select and evaluate a set of time-series models delivering full predictive densities (expand existing models and/or consider new ones)
- model combinations

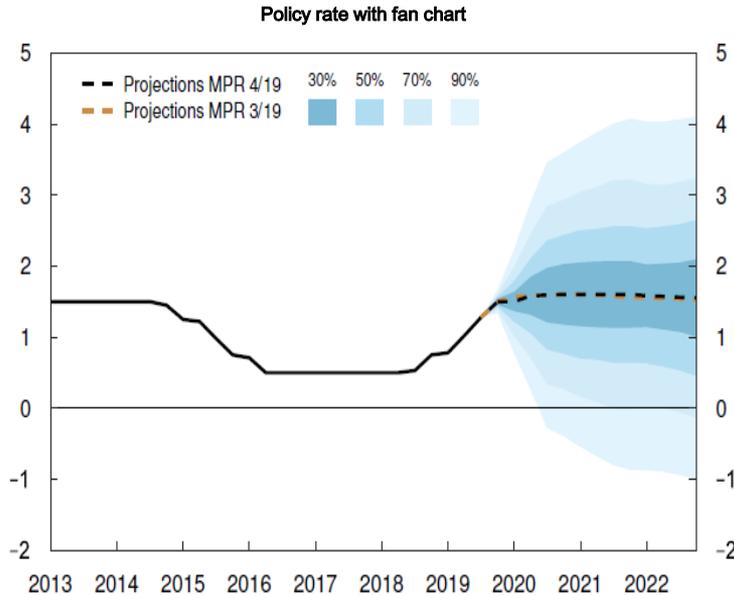
Discussion

- Performance of density forecast accuracy should be performed (for model combinations requires training sample for weights)
- Density forecasts might not be centered around the point forecast of models used to produce the point forecast;
- Some models might not be equipped to produce density forecasts in the presence of large shocks: NB published fan charts based on density forecasts from NEMO, but published only point forecasts during the pandemic



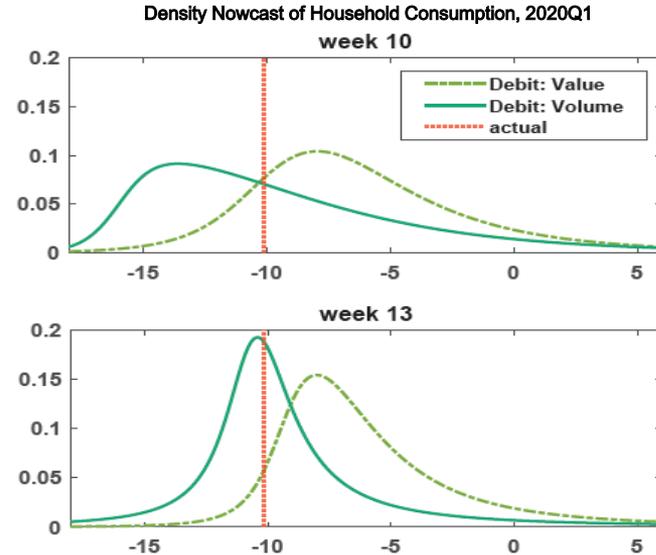
Uncertainty Around Baseline Scenario

- Norges Bank publishes fan charts based on density forecasts from NEMO



Source: NB MPR 2019Q4

- Exploring alternative ways to produce density forecasts, critical during the pandemic (e.g. quantile/MIDAS quantile models) to account for skewness



Source: Aastveit et al (2020)



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Model Based Policy Evaluation

Current Practice

impact of monetary policy decisions is quantified through a suite of models: a set of satellite models from the Eurosystem, a BVAR model, NAWM II and ECB-BASE

Challenges

- model-based monetary policy evaluation can vary across different policy processes, simulation designs and types of model
- disconnect between projection models and models used for policy analysis

Recommendations

- review and improvement of existing structural and semi-structural models to better understand the impact of policy actions
- identify the key channels that play a quantitative role in discrepancies between these assessments and trying to understand the sources of these differences

Discussion

- importance of revising existing models to eliminate unappealing features (e.g. forward guidance puzzle) or include important ones (financial frictions)
- BUT still, need of new models to address new questions: e.g. how to incorporate climate change into business cycle analysis and forecasting, how to address inequality (how has COVID affected consumption distribution e.g. liquidity constrained vs unconstrained households?)
- Norges Bank experience: one core model (NEMO) gradually enhanced through time, but complementary set of models for answering other policy questions (e.g. HANK models)



Models for Policy Analysis

HANK Model: Heterogeneous Households with Housing

- *MPR 3/21: Uncertainty surrounding the effects of higher interest rates warrants a gradual rise in the policy rate.*
- Some of this uncertainty relates to how household will respond to tighter monetary policy
- Modelling heterogeneity directly predicts a stronger impact on consumption from interest rate changes than NEMO
- Key mechanisms:
 - Cash flow Channel: Liquidity constrained households are more sensitive to interest rate changes.
 - Amplification via housing market: Big consumption impact on households from adjusting the timing of their housing transaction.
- As we bring the policy rate back to normal, that may hold back consumption growth more than we have assumed so far.
- Exercise: compare aggregate consumption response from NEMO and HANK model
- To understand the aggregate impulse response better, look at
 - responses of subgroups (possible only with heterogeneous agents)
 - responses to different rate/house-price changes



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Enhanced Medium-Term Reference Scenarios

Current Practice	MTRS conditioned on potential output growth estimates by NCB experts, changes in government consumption and the euro area's external environment (IMF projections)
Challenges	MTRS largely reflects the mean-reversion properties of the model used to build it No revisions at the end of the reference scenario
Recommendations	<ul style="list-style-type: none">• fully-fledged model-based medium-term extension of the euro area baseline• more comprehensive set of “trends” (labor, macro-pru reforms, climate change etc)• move to a set of medium-term scenarios• sensitivity analysis
Discussion	<ul style="list-style-type: none">• Set of medium term scenario: how will trends be estimated? consistency across variables and models• more challenging goal: explicitly incorporate long term trends in models, variables enter in levels rather than gaps• further issue: trend itself might be subject to breaks: shifts in one or more parameter values in structural models specified in gaps• gaps enter in NEMO but Norges Bank has started to include structural break points through new solution technique:<ul style="list-style-type: none">• shift in long run exchange rate following oil price swing• new inflation target• Suite of satellite models used for other questions, e.g. potential output and output gap



Break points in NEMO

- March 2018: Norges Bank's inflation target was lowered from 2.5 to 2 percent.
 - this induced a corresponding change in the steady-state inflation rate in NEMO that would otherwise be hard to implement without the new procedure
- MPR 1/19: we “now apply the assumption that the depreciation of the equilibrium exchange rate after the oil price fall was slightly more pronounced than assumed earlier.”
 - permanent decline in the real oil price in NEMO was introduced
 - weaker steady-state real exchange rate and a lower real wage.
- In both of these cases, introducing the break points led to shifts in the steady state of the model. However, in the former case, the steady states of real variables remained unchanged.
- Technique can be applied when there is a change in some underlying preference or policy (inflation target, macroprudential regulation)
 - relates to steady-state parameters which cause permanent changes in the model



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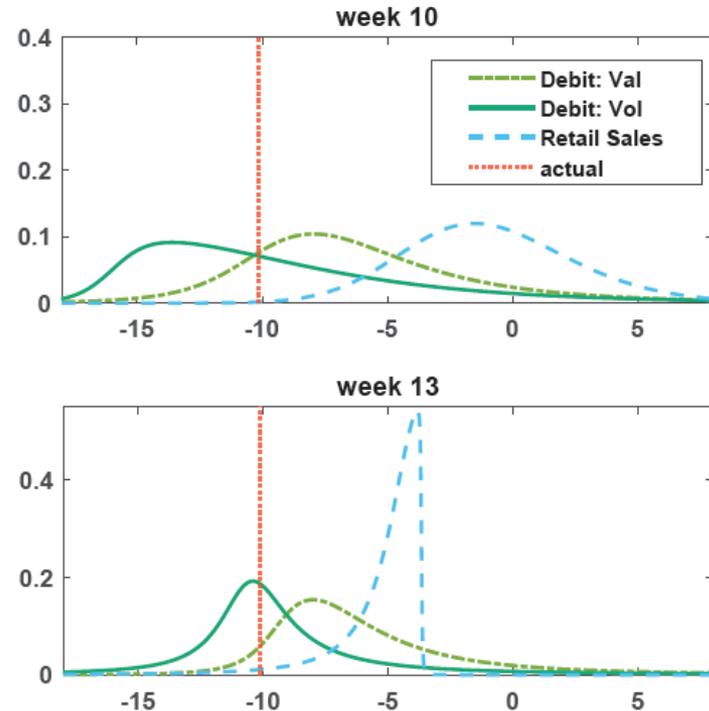
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Data Based Analysis and Scenario



Incorporate New Types of Data

- New, high frequency and granular types of data becoming available: need to explore their usefulness in forecasting and policy analysis wrt existing data
 - debit card data more useful than retail sales to nowcast consumption when pandemic hit
 - linking debit card and credit card data with administrative data to inform HANK model
 - textual data are used to construct a financial condition index, analyze the components of uncertainty and to forecast house prices



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Model Based Economic Narratives:
Core vs suite of models

Model Based Projections:
Judgement free forecasts as cross-check

Model Based Risk Analysis:
Density forecasts from new models

Model Based Monetary Policy Evaluation:
New models to address new questions

Enhanced Medium Term Reference Scenario:
Include long term trends and structural breaks

Data Based Analysis and Scenario:
Include high frequency and new data into projections and policy analysis



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THANK YOU!