MMB Replication Package
Making the MMB the standard for DSGE algorithm testing

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Motivation

Testing new algorithms

- Need for a standardized platform in macroeconomic modeling
- How to ensure robustness and reliability across different models?

Enhance consistency and comparability in macroeconomic research

- MMB as the ideal platform due to its extensive model database
- Thus far used to compare outcomes, e.g. policies, across models

Advance the field through improved algorithm performance and accuracy

- extend the MMB to provide a model database for testing

Goal:

Make the MMB the standard for model robust algorithm testing

Outline

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Current State

Currently, MMB replication is a zip download

- Incomplete, not standardized
  - Contains all the replications of the last 20 years with different Dynare version
  - Some replications do not work with newer Matlab/Dynare versions
  - Not including self-replicated models by the MMB team
  - Not generic using the Macroeconomic Model Data Base (MMB)

A comparison of solution methods using a large set of model

- Requires a lot of manual work sifting through the zip

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Highlights

- The analysis requires Matlab and Dynare
- Users can run the exercise through all models in the **updated** replication folders
- We provide an option to run the exercise only with worked models

New Repository

- The new repository contains two main folders
  - A replication folder with updated models from the MMB
  - The other folder that can run comparison exercise
- There is one main file that the users only need to press to run
- They can choose between running with all models in the replication folder or only models that work with the comparison exercise

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1. Environment Setting

Required Software

- Install MATLAB (Optimization Toolbox package, the Statistics Toolbox package and the R2019a or newer versions are required).
- Install Dynare version 5.1

2. The Comparison Exercises

Model

- The MMB categorizes the models into five groups:
  Calibrated - Models calibrated to match a closed economy.
  Estimated US and **Estimated Euro Area** - Models estimated on the US and the Euro area data.
  Other - Models calibrated or estimated on data of multiple countries or countries outside the US or the Euro area
  Adaptive Learning - Models in which agents form expectations through adaptive learning.

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Running Comparison Exercise

- Go to the main directory
- **run_Example_AMG_errors.m** will run the comparison exercise.
- The file will run the comparison exercise through all models in the replication first as the default set-up. Some models will not work with the error calculation methods.
- After that, all the reports will be stored in **Results/Result_allmodels.xlsx** and **Results/AMG_Results_worked.mat**
- The program will then loop through only those models that worked and save the results in **AMG_Results.mat**

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Measuring the numerical stability of solution methods

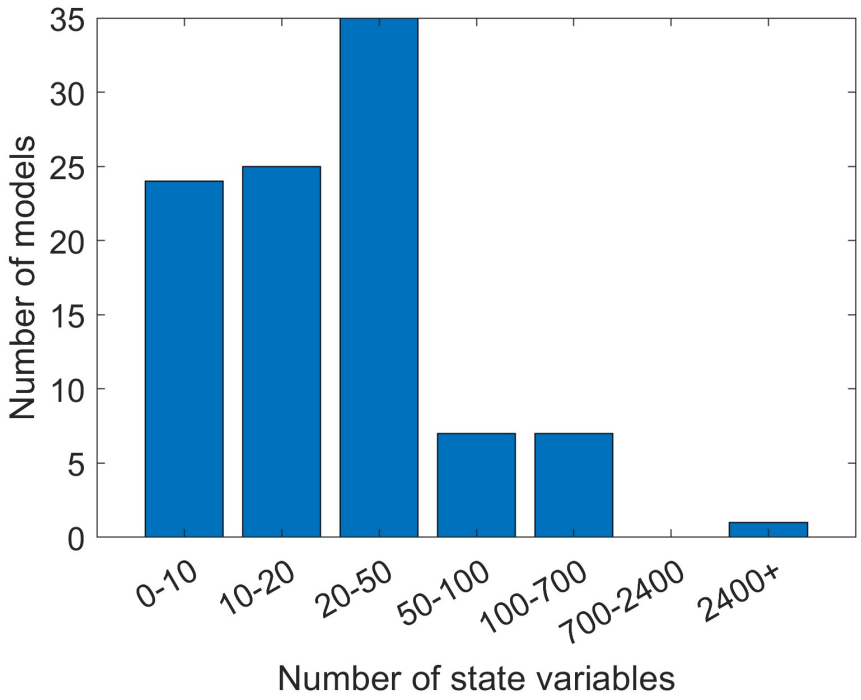
- Meyer-Gohde (2023a)
- Derives, implements and tests condition number and backward stability measures for solution of DSGE models

Implementing and assessing linear DSGE solution methods from applied math lit for matrix quadratics

- Meyer-Gohde and Saecker (2024) - Newton based methods
- Huber et al. (2023) - Structure preserving doubling methods
- Meyer-Gohde (2023b) - Bernoulli iteration based methods

MMB Comparisons - Presented at ESEM, CEF, IAAE, CFE, SNDE

- Macroeconomic Model Data Base (MMB) (Wieland et al., 2012)
- compare solution methods for 99 models
  - **accuracy**
- Non-model specific approach
- A useful way to assess new solution (and estimation) techniques
- Look for toolbox extension of the MMB from the IMFS soon!



MMB Comparison: Forward Errors of Linear DSGE

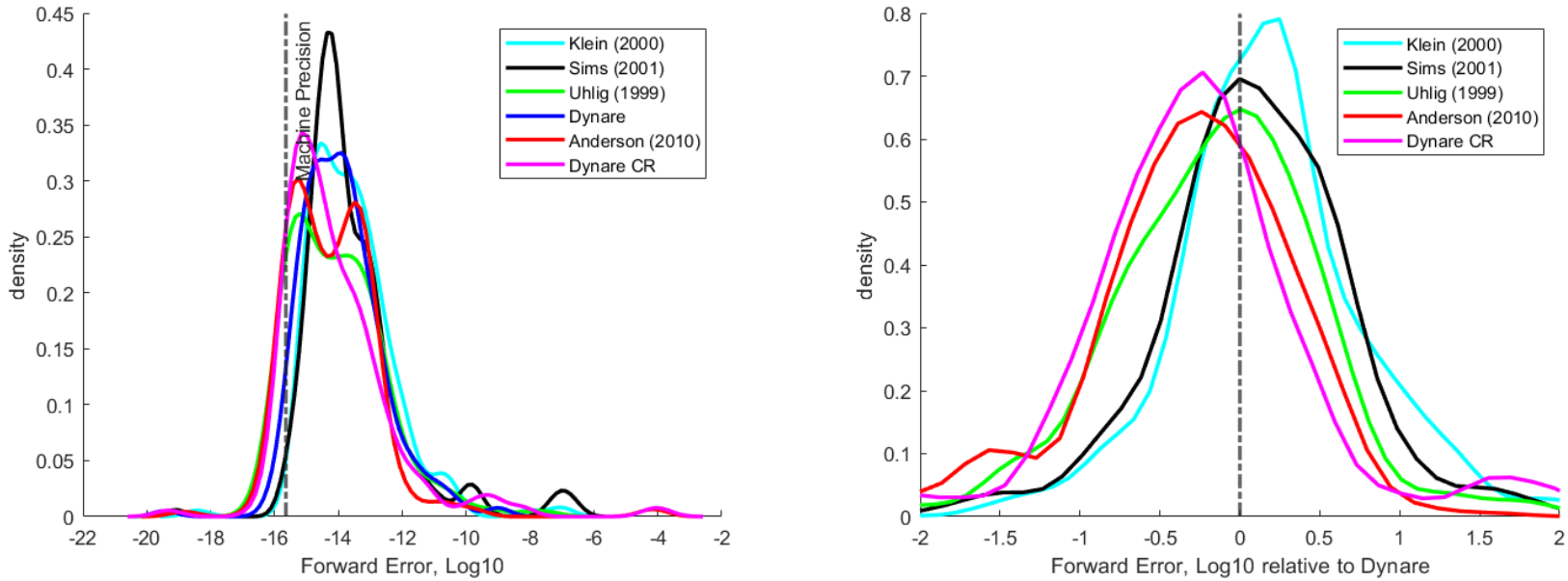


Figure: Forward Errors in MMB, Density Estimates

- Forward errors are in general within a couple orders of magnitude of machine precision
- Evidence that AIM and Cyclic Reduction in general more
- Solab and Gensys less accurate than Dynare

MMB Comparison: Speed & Convergence of Newton Based Methods

Method	Convergence	Run Time			Iterations
		Median	Min	Max	
Dynare (QZ)	99	1	1	1	1
Baseline Newton Method	99	0.34	0.032	29	1
Modified Newton Method	99	0.34	0.031	25	1
with Šamanskii Technique	99	0.49	0.055	70	1
with Line Searches	99	0.34	0.033	30	1
with Occ. Line Searches	99	0.33	0.032	63	1
with Occ. LS & ŠT	99	0.54	0.058	71	1

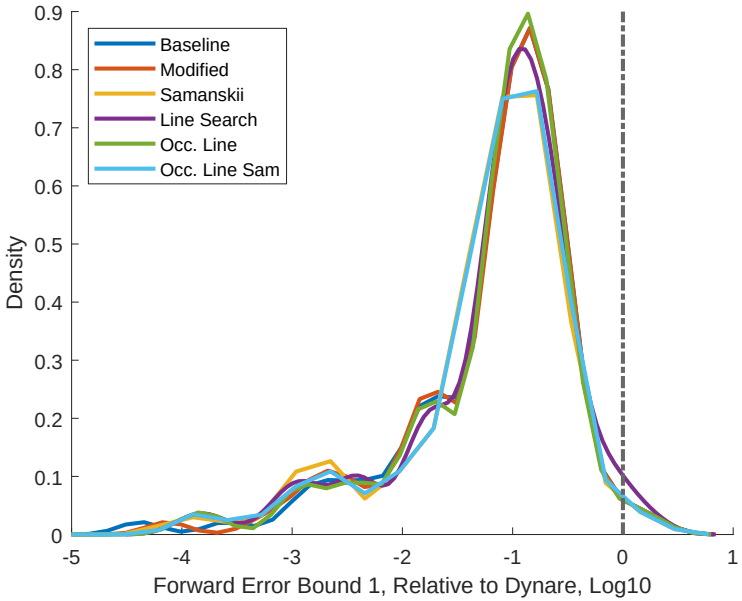
Initial guess: QZ-based solution. Run time relative to Dynare.

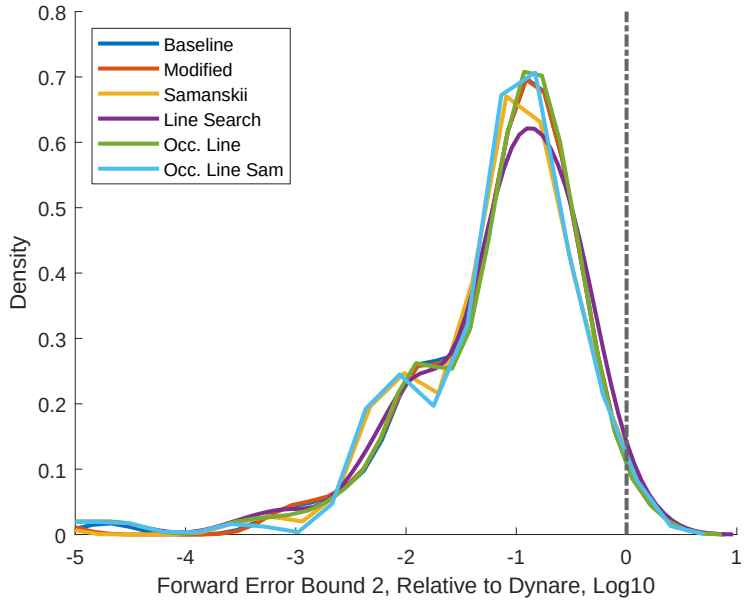
Initial guess: Dynare's solution

⇒ convergence rate significantly improved

⇒ one order of magnitude quicker

MMB Comparison: Accuracy of Newton Based Methods

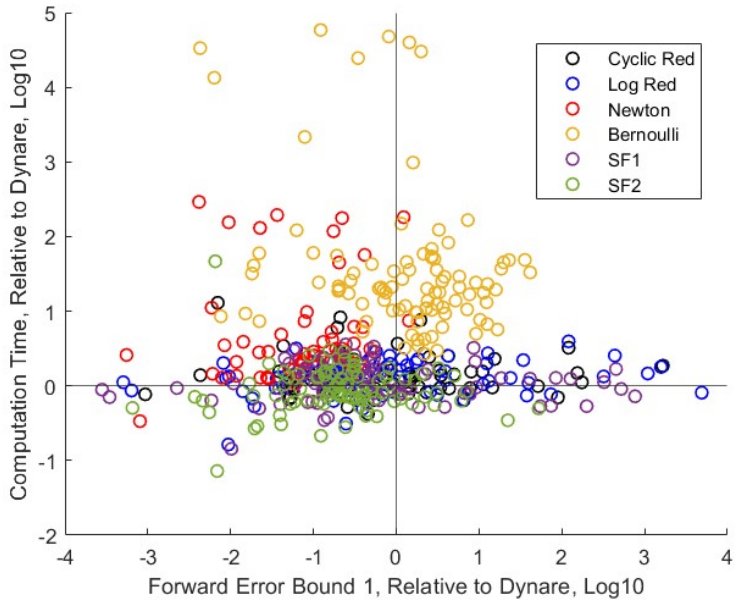


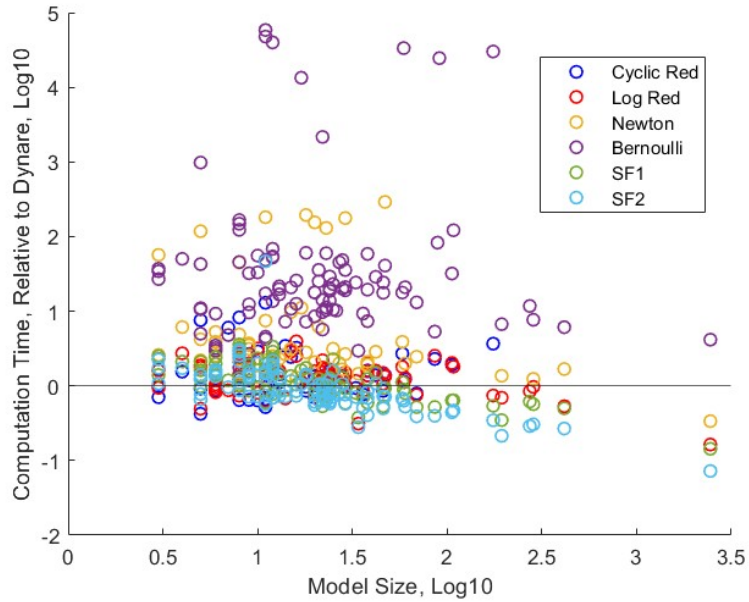


Initial guess: Dynare's solution

$\Rightarrow$ **all** methods more accurate than Dynare(QZ)

MMB Comparison: Accuracy of Doubling Methods





Initial guess: Dynare's solution

⇒ similar in term of speed

⇒ more accurate (especially SF2)

⇒ **both** doubling algorithms become faster for larger models relative to Dynare(QZ)

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Conclusion

Generally new methods to solve, estimate, etc models are

- designed, tested, and implemented for a specific application

Are the results applicable to different models?

- How can we evaluate new models in a model robust way?

Goal:

With the MMB: the standard for model robust answers

Thank you for your attention!

References I

Huber, J., A. Meyer-Gohde, and J. Saecker (2023): "Solving linear DSGE models with structure-preserving doubling methods," IMFS Working Paper Series 195, Goethe University Frankfurt, Institute for Monetary and Financial Stability (IMFS).

Meyer-Gohde, A. (2023a): "Numerical Stability Analysis of Linear DSGE Models: Backward Errors, Forward Errors and Condition Numbers," IMFS Working Paper Series 193, Goethe University Frankfurt, Institute for Monetary and Financial Stability (IMFS).

——— (2023b): "Solving Linear DSGE Models with Bernoulli Methods," IMFS Working Paper Series 182, Goethe University Frankfurt, Institute for Monetary and Financial Stability (IMFS).

Meyer-Gohde, A. and J. Saecker (2024): "Solving linear DSGE models with Newton methods," Economic Modelling, 133, 106670.

Wieland, V., T. Cwik, G. J. Müller, S. Schmidt, and M. Wolters (2012): "A new comparative approach to macroeconomic modeling and policy analysis," Journal of Economic Behavior & Organization, 83, 523–541.