Lecture I

What is Quantitative Macroeconomics?

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Quantitative Macroeconomics

Qualitative economics

- Qualitative analysis: existence and uniqueness of equilibrium, social efficiency, dependence of equilibrium outcome from parameters, sign of comparative statics, qualitative explanation of data patterns etc...
  - Too difficult to provide full characterization in rich (and thus interesting) models
  - Too general to have quantitative significance: $corr(x, y) > 0$
- Special cases: analytical examples that are pedagogically useful, but often too stylized to teach us something about the real world
  - We don't know what the interesting case is. E.g., is it $r > g$ or $g > r$?

Quantitative economics

- Quantitative theory: empirical investigation that uses computational techniques to solve and simulate a structural model
- Quantitative theory $>$ qualitative analysis: more comprehensive characterization of equilibrium
  - Through simulation, one can exhaustively study behavior of the model
- Quantitative theory $>$ analytical examples: use computation to solve for more complex and more relevant special cases
  - One picks the right point in the parameter space
- Criticism: black box. It is the author's duty to clarify the determinants of the answer
- Computers are changing economics: don't stay behind the curve.

Pillars of quantitative macro

1. Questions are about measurement, and answers are numbers
2. Key ingredient: structural theory of the aggregate economy (a model)
3. The model is the measurement device to derive the quantitative implications of the theory
4. The model is calibrated along some dimensions of the data and used to explain other dimensions of the data
5. The computer is used to solve for the equilibrium process and run the computational experiment that answers the question

Point 4 very controversial. Others, widely accepted.

The computational experiment (Kydland and Prescott)

- *"In a computational experiment, the researcher starts by posing a well-defined quantitative question. Then the researcher uses both theory and measurement to construct a model economy that is a computer representation of a national economy. A model economy consists of households, firms and often a government. The people in the model economy make economic decisions that correspond to those of their counterparts in the real world. The researcher then calibrates the model economy so that it mimics the world along a carefully specified set of dimensions. Finally, the computer is used to run experiments that answer the question"*
  - Theory only provides restrictions on behavior, not a law of motion for the aggregate state (as in the natural sciences)
  - Computational experiments in economics include the additional step of computing the equilibrium process of the aggregate state. Most of the course will focus on this step.

Step 1: Pose the question

Types of questions:

1. How much can we explain of Y (e.g., output fluctuations) with X (e.g., technology shocks)?

2. What are the welfare/redistributive implications of policy P? Or, what is the optimal policy P (e.g., degree of tax progressivity)

3. How does the answer to question Q (e.g., correlation between hours and wages) changes if we introduce the new feature X (e.g., home production) into the well-known model M (e.g., RBC model) that abstracts from X?

Step 2: Choose the model

1. Start from a well-tested theory. E.g., the neoclassical growth model, the NK model, the Huggett-Aiyagari model.
   - Strength (solid ground) and limit (extent of innovation)
2. Less is better than more: do not add features that are irrelevant for the question you are asking. Never lose sight of the question.
3. Think hard about the trade-off between amount of detail and the feasibility of computing the equilibrium process
4. Think hard about whether you have enough data to discipline your model parameters: do not proliferate free parameters!
   - Existence of free parameters weakens your conclusion

Step 3: Calibrate your measurement instrument

1. Empirical moments used to calibrate the model are different from the ones the model aims to account for.

   - Different frequency: RBC calibrated based on "long-run" facts and evaluated on business cycle facts
   - Different moment of distribution: in Aiyagari model, β set to match average wealth (relative to income) and often one tries to account for wealth inequality (higher moments)
   - Different variables: in Aiyagari model, income process is estimated to replicate income dynamics, but objective is to account for wealth inequality

2. Do not justify parameter choices based on prior studies unless mapping between model and data is the same

3. Match measurement to model. Establishing this correspondence may require to re-organize data.

Step 4: Run the measurement experiment

1. Lay out the computational algorithm, step by step
2. Do not rewrite numerical routines if already available and well tested (but understand how they work, you may need to modify them)
3. Test your code as you go along: e.g. solve for special cases you understand well or replicate findings from previous work
4. Flesh out your main result as clearly as possible: do not underestimate the importance of tables and graphs
5. Sensitivity analysis is crucial when closed form are unavailable
6. If your model is quantitatively unsuccessful, call it a puzzle :-)

Valid criticisms to calibration

1. Calibration is a form of casual empiricism. Sometimes it is, but it should not be.
   - ▶ Use econometric techniques, e.g., MDE
   - ▶ Discuss (even better, prove) parameter identification
2. In the evaluation stage, no formal statistical approach is used
   - ▶ True, the logic is: all models are false, with enough data you always reject them. You can still learn from the model though.
3. Why not using all moments instead of a subset?
   - ▶ By design, parameter values selected are not the ones that provide the best fit to the data you wish to explain
   - ▶ Estimation: what does it take to match the data? Calibration: how much of the data can we explain by restricting the model in a reasonable way?

External model validation (Todd-Wolpin, AER 06)

- Problem: in macro we cannot run natural experiments to identify effects. However, (quasi) randomized experiments can be run on a micro scale.
- Paladins of the experimental approach argue models are stylized and parameterized in arbitrary ways, so cannot give reliable policy lessons
- Todd and Wolpin: use quantitative findings from randomized experiments to validate parameterizations of structural models
- Example: schooling subsidy
- Validated model can be more credibly used for counterfactual or large-scale (e.g, GE) policy analysis
- Complementarity btw structural and experimental approaches