Teaching modern general equilibrium macroeconomics to undergraduates: using the same theory required for advanced research

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Motivation

- Undergrad Macro not based strictly on Micro theory:
- with many ad hoc elements.
- No smooth integration of micro with macro, in general.
- Research Macro articles now built mainly on microeconomic theory
- with only some added ad hoc elements.
- Challenge: how to teach undergrad Macro so
- Revise towards Microfoundations with seemless step to grad Macro.
- Bigger Challenge: Do this at intermediate Macro level,
- not just a third year Advanced macro course.
- Methodological consistency (Obstfeld-Rogoff 96): at lower Level, more consistent
Many excellent macro texts but almost all include Split analysis:

- Macro Dichotomy:
- Neoclassical elements of labor-leisure, growth, business cycles
- Keynesian general equilibrium with no derivation of equilibrium.

Trend: Include increasingly more Microfounded elements

- Main Microfounded approach: Barro; but lacks the full model/math.
- Almost all others are a mix, or hodgepodge of approaches.
- Problem: simple Keynesian model almost never used in research.
- Makes large sections of most texts inconsistent with graduate work.
Approach to Bringing Intermediate Macro in line with Graduate Macro

- Intermediate Macro: a level above the graphs, intuition of intro macro
- Fair game to use Calculus, Algebra, solving of systems of equations
- Solution: Use general equilibrium from beginning to end, as is standard in Research
- Use simplest general equilibrium, of one Representative agent for closed economy
- Two agents for open economy: "heterogeneous agents" at simplest level.
- Methodologically consistent Microfoundations from beginning to end.
Mathematics

- Always use log utility
- Always use Cobb-Douglas production.
- Use Calibration consistent with Research, but simple as possible
- Always can have full analytic solution of equilibria.
- Graph actual mathematic functions of Supply, Demand
- Use Chain Rule and partial derivatives.
Specific Structure: Part 1, Labor, Capital and Goods

A. Labor and Goods Market

- One Derivative: Equil Condition
- Labour-Leisure tradeoff in simple gen equil with one agent
- Capital assumed fixed. Firm Profit goes back to Consumer
- Key condition: Marg Prod Labour = Marg Rt Subst Goods-Leisure
- Decentralize problem into Consumer and Firm: gives wage rate
- Extend to 2 agents, one with higher Marg Prod than other
- Trade between agents at equil wage: utility comparison
- Comparative statics of Marg Product changes.
Graphical Approach

- Graphs are Two dimensional
- Show Gen Equil: with Exact Util Levels and Prod Function
- Show Decentralized Markets: Labour and Goods, Supply and Dem
- Relative Price is wage rate $w$ or $1/w$ for each Market
- Again, Exact Functional Representation of Supply and Dem
- Uses Scientific Word Graphics
- With 2 Agents, 2 Supply and Demand lines in each market
Figure 2.15. Labor Market with a Tax Financed Dole
Figure 3.2. The Goods Market under Free Trade
Figure 3.3. General Equilibrium Goods and Labor Markets Under Free Trade
Part 1, B. Capital Dimension

- One Derivative: Equil Condition
- Investment-Savings and Intertemporal Consumption Smoothing
- Simple 2 period Model with full depreciation and zero initial capital
- Margin: Marg Rt of Intertemp Subst = Marg Prod of Capital
- This gives the dynamic Euler equation of Consumpt Growth
- Standard analysis as with Labor, but now Capital and Goods markets
- Then also decentralized into Consumer and Firm sides
- and then 2 representative agents with trade: Open Econ.
- easy extension to 1000 agents of 2 types.
Figure 4.9. Shift upwards in the Supply and Demand for Capital from a Productivity Increase
Figure 4.12. The Shift Back in Savings When a Tax on Gross Capital Income of 10% is Levied
Figure 4.6. Market for Future Period Consumption
Part 2.A. Bringing together Labour and Capital Markets

- Go from two dimensional to dynamic Equilibrium
- Transition into Recursive Dynamic Framework
- Show Exact Same First Order Conditions
- of Previous Part 1, but now from Recursive model.
- Creates Modern AS-AD from Neoclassical Model
- First time? accomplished totally rigourously
- And totally consistent with standard research framework
Recursive Economics and Undergrad Macro

- Must face up to issue of teaching Recursive Dynamic Equil
- Do this by showing First Order Conditions (FOC)
- same as 2 standard Labour and Capital margins.
- New part: envelope condition, FOC in state variable capital $k_t$:
  - Says that discounted Marg util of Cap $k$ at $t+1$ is Marg Util of current $c_t$
  - That yields back the main Margin for Capital, plus have Labour margin.
- This identical equilibrium makes attractive Recursive Methodology.
- Need this to avoid more complicated Dynamic equilibrium FOC:
  - Gives a simple 2 period framework instead of infinite horizon.
Recursive Model: 3 Derivatives; Capital, Labor, State Var

\[ V (k_t) = \max_{c_t, x_t, l_t, k_{t+1}} : u(c_t, x_t) + \beta V (k_{t+1}), \]

\[
\begin{align*}
    c_t &= A_G l_t^\gamma k_t^{1-\gamma} - k_{t+1} + k_t \left(1 - \delta_k\right) \\
x_t &= 1 - l_t.
\end{align*}
\]

\[
V (k_t) = \max_{l_t, k_{t+1}} : u \left(A_G l_t^\gamma k_t^{1-\gamma} - k_{t+1} + k_t \left(1 - \delta_k\right), 1 - l_t\right) + \beta V (k_{t+1}).
\]

\[
MP_l = \gamma A_G l_t^{\gamma-1} k_t^{1-\gamma} = \frac{u_x(c_t, x_t)}{u_c(c_t, x_t)} = MRS_{c,x}.
\]

\[
u_c(c_t, x_t) = \beta V'(k_{t+1});
\]

\[
V'(k_{t+1}) = u_c(c_{t+1}, x_{t+1}) \left[ (1 - \gamma) A_G l_t^\gamma k_t^{-\gamma} + (1 - \delta_k) \right];
\]

\[
MRS_{c_t, c_{t+1}} = \frac{u_c(c_t, x_t)}{\beta u_c(c_{t+1}, x_{t+1})} = \left[ 1 + (1 - \gamma) A_G l_t^\gamma k_t^{-\gamma} - \delta_k \right] = MP_k;
\]
Get AS-AD within Dynamic Neoclass Growth and RBC Model

- Trick 1: Frame within Balanced Growth Path (BGP) equilibrium
- Trick 2: first assume zero Growth. Makes interest rate $r$ exogenous.
- Then add Consumption demand to Investment demand to get $AD$
- $AS$ comes directly from the firm problem
- $AD$ and $AS$ are functions of prices $w$ and capital $k$, and parameters
- Trick 3: need correct equilibrium $k$ value to get the BGP equil $w$.
- Given correct $k$, and a Calibration, can graph and then do comparative statics
- Focus on Change in TFP Productivity, as in Growth/Real Bus Cycle.
Devote whole (next) chapter to this
Solve model until a single equation in $k_t$.
Then plug in parameters and solve $k_t$.
Comparative statics by changing parameters, find new $k$
Then plug in new $k$ and new parameter to $AS - AD$
Find new equilibrium price $w$, in Agg. goods output or Labor market.
$w$ found graphically and analytically
Add Fixed wage rigidity
AS-AD and Labour Graphs

Inverse Wage $1/w$ vs. Aggregate Output $y$

AS-AD Equilibrium with $A_G$ Increase
Aggregate Labour Market with $A_G$ Increase
2.B. Focus Next on Growth and Business Cycles

- Standard Solow Exog Growth along BGP, with AS – AD
- Then introduce Human Capital and Endogenous Growth
- Transition to RBC: show how a shock process accumulates
- Say how similar to static TFP change.
- Add Market, Non-Market Sectors
- Transition to International RBC
- Part 3. Topics in Uncertainty, Insurance and Asset Prices
- Apply to Government Fiscal Tax and Monetary policy.
- Colours: Historical Development towards Modern Macro
- Policy Applications
Conclusions

Can teach Modern Macro with full Microfoundations: Depends on how you do it. Can be made Simple enough: key of 2 dimensions, one derivative And can be made Internally Consistent And can be Complete in certain ways Revives $AS - AD$ within Modern Theory 100% Microfounded