Macroeconomic Theory: Lecture 2

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Last week

- Historical survey
- Description of the accounting framework
- Growth-consumption-disribution

Today

- A step towards a model of economic growth
- Technological change
- Labor market

Understanding macroeconomics

Descriptive macro is nice but we need more

- Explanatory Models
- *Endogenous* vs *exogenous* variables
- Prediction making

Prediction 2008 Q3

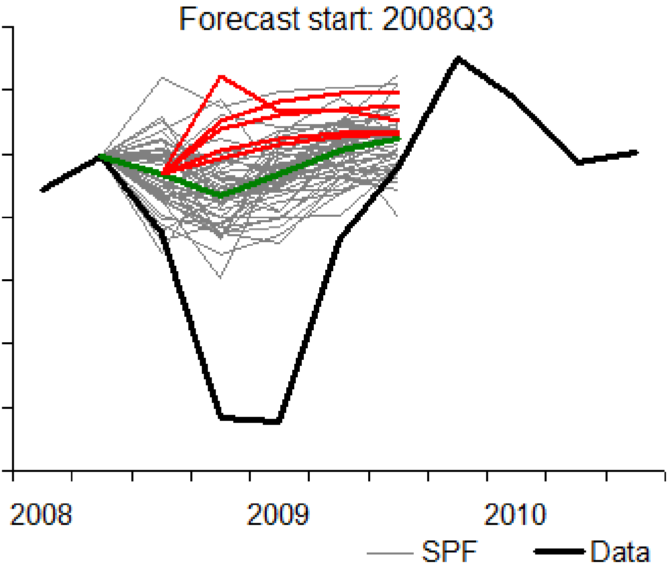

Figure 1: source: Economist's View (2014)

Prediction 2008 Q4

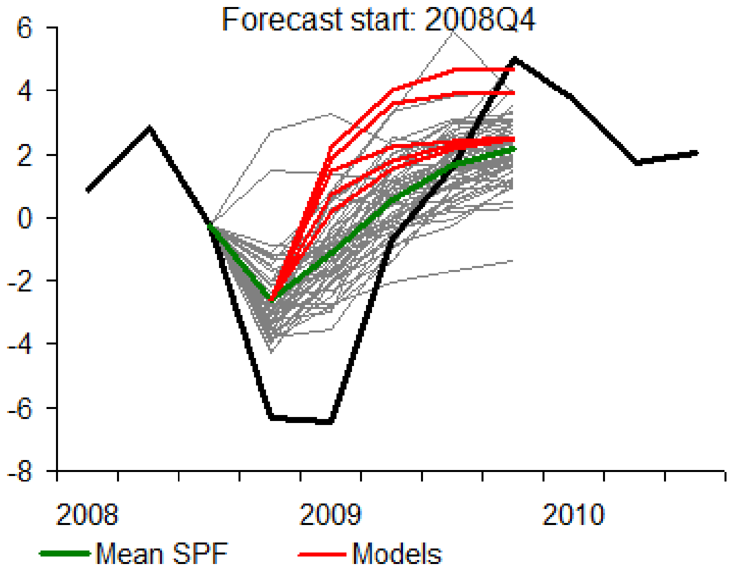

Figure 2: source: Economist's View (2014)

Prediction 2009 Q1

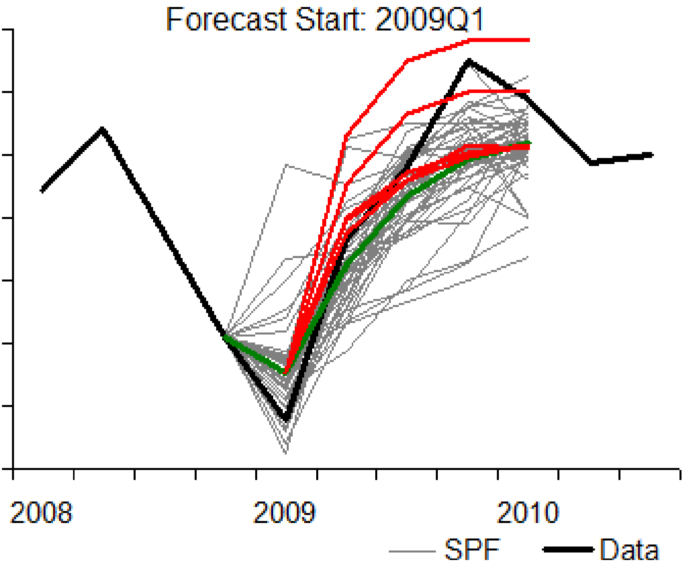

Figure 3: source: Economist's View (2014)

Prediction 2009 Q2

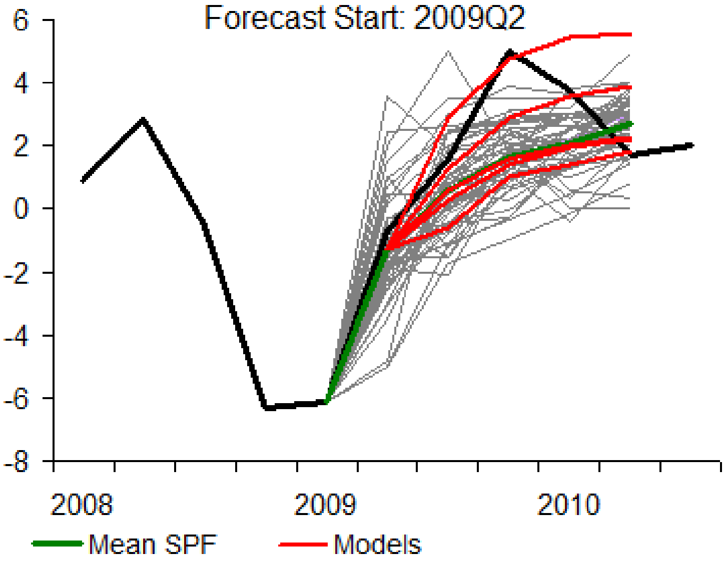

Figure 4: source: Economist's View (2014)

A Model of Production, a few assumptions

- Discrete time
  - Years
  - Simultaneous decisions and output
- Output (X) is produced in a year (end of period) with capital(K) and labour (L) with a technique showing *constant return to scale*
- A *technique of production* is described by three numbers (k, x, δ)
  - k is the capital stock per worker
  - x is the output per worker
  - δ is the depreciation rate ≤ 1
  - Could describe the technique as (ρ, x, δ) or (k, ρ, δ) where $\rho = x/k$ is is the productivity of capital

Roles (simplified) and Distribution

- Entrepreneurs: organise production by hiring $N = X/x$ employees and using $K = X/\rho$ capital stock for a wage
- Workers: Work for a wage w, $W = w \cdot N$
- Capitalists: Own capital and obtain profits
  - Gross profit $Z = X - W = (1 - \frac{w}{x})X = \pi \cdot X$, rate $v = \frac{Z}{K} = \rho(1 - \frac{w}{x}) = \pi \cdot \rho$
  - Net profit $R = X - W - \delta \cdot K = (1 - \frac{w}{x} - \frac{\delta}{\rho})X$, rate $r = \frac{Z}{K} = \frac{v \cdot K - \delta \cdot K}{K} = v - \delta = \pi \cdot \rho - \delta$

Techniques and Production Functions

- Mathematica example of Techniques of production
  - *domination, switch points, efficient frontier*
- Production function: $X = F(K, N)$, with *constant returns to scale* can be seen as a technology (i.e. a collection of techniques of production).
- A pair (k, x) is an *available technique* given the production function $F(K, N)$ if

$$x = \frac{X}{N} = F(\frac{K}{N}, \frac{N}{N}) = Fk, 1 \equiv f(k)$$

  - $f(k)$ is called the *intensive production function*

Continuous production function

- If the production function is a continuous, smooth function,
  - corresponding technology is an infinite continuum of techniques
  - efficiency frontier is also smooth
  - every point on the frontier is a switch point
- The profit-rate maximising technique of production for a given wage will combine labor and capital such that
  - marginal product of labor is equal to wage
  - marginal product of capital is equal to profit rate

$$Z = X - w \cdot N = F(K, N) - w \cdot N$$
$$\frac{dZ}{dN} = \frac{\partial F(K, N)}{\partial N} - w = 0$$
$$w = \frac{\partial F(K, N)}{\partial N}$$

Particular Production Functions

- See Mathematica file
- Leontief (fixed coefficients)

$$X = min(\rho \cdot K, x \cdot N)$$

  - Adding one of the two output without adding the other has no impact
- The Cobb-Douglas

$$X = A \cdot K^{\alpha} N^{1-\alpha}$$

  - Substitutability of labor and capital
  - Computing the marginal product for each factor, we can show that α is equal to the profits share π.

Problems (p.57)

1. Draw the production isoquant (the combinations of capital and labor required to produce one unit of output), the real wage-profit rate schedule, and the intensive production function for the Leontief technology with k = \$100 000/wkr and x = \$50 00/wkr-yr. What is the marginal product of labor in the Leontief technology?
2. What technique of production will profit rate-maximising entrepreneurs choose if they face a Cobb-Douglas production function and a given real wage, $\overline{w}$? What if they face a fixed coefficient production function and the same real wage?

Technical change classification

- Labor-saving: $1 + g_x = \frac{x_{+1}}{x}$
- Capital-saving: $1 + g_\rho = \frac{\rho_{+1}}{\rho}$
- Factor-saving: $g_x = g_\rho$
- In the case of a production function (change to the whole technology)
  - Labor-augmenting or *Harrod-neutral*: $F'(K, N) = F(K, (1+\gamma)N)$
  - Capital-augmenting: $F'(K, N) = F((1+\chi)K, N)$
  - Factor-augmenting or *Hicks-neutral*: $F'(K, N) = (1+\gamma)F(K, N) = F((1+\gamma)K, (1+\gamma)N)$, $(1+\gamma) = (1+\chi)$
- Note that γ and χ are not equal to g_x and g_ρ except in the case of the Leontief production function because there is only one technique in the technology

Adding a second sector

- In a one sector economy:
  - Price of capital goods to consumption goods is one
  - Output per worker is not affected by change in capital price
  - consumption-growth and real wage-profit schedules are identical
- With *two* sectors, all of the above is not true. The Cambridge capital controversy highlighted these results

The Cambridge Capital Controversy

- Solow, Samuelson and co. in M.I.T. Cambridge, Massachusetts vs Robinson and co. in Cambridge University, UK
- Existence of a well behaved aggregate production function summarising the techniques at hand?
  - Various capital goods
  - Wage change implies any price changes
- No guarantee that lower wage rate leads to lower lower value of capital per worker
- Neoclassicals admitted their defeat but argued that the critiques would only rarely apply and continued assuming an aggregate consumption function.

Two-sector economy

- Capital and labor can be combined to produce a consumption good c or an investment good i, using different techniques
- Consumption good is the numeraire, i.e. price p of capital is relative to price of consumption good, arbitrarily fixed to 1.
- capital intensity and labor productivity for both techniques: k_c, k_i, x_c, x_i
- In the case of a *steady state*, wage-profit frontier is

$$x_x = v \cdot p \cdot k_c + w$$
$$p \cdot x_i = v \cdot p \cdot k_i + w$$

- *Re-switching of techniques*

Model of economic growth

$$w = x - v \cdot k$$
$$c = x - (g_k + \delta)k$$

- We need as many equations as there are endogenous variables. If we want to explain the evolution of g_k, v, c, and w, we need two more equations. These two equations would *close* the model.
- Each school of though offers a different answer, usually based on the labor market (labor supply-labor demand equilibrium), and household saving decision (consumption-investment distribution).

Labor demand

- For one technique of production, the labor demanded is given by the amount of capital available: $N^d = \frac{X}{x} = \frac{K}{k}$
- If we assume a smooth continuous aggregate production function, then labor demand will depend on the technique utilised, i.e. on wages: $N^d(w) = \frac{X}{x(w)} = \frac{K}{k(w)}$

Classical Conventional Wage Model

- Smith, Ricardo, Malthus and Marx all had labor supply changing in response to the demand for labor, at given real wage
- Ricardo and Malthus sustained that population would grow if the real wage was above a *subsistence* level and would decrease otherwise $\Rightarrow$ *Demographic equilibrium*
- Marx:
  - Birth rate and death rate schedules are the outcome of specific social relations (existence or not of safety nets, etc.)
  - Labor participation? Famous *reserve armies of labor* in non capitalist sectors such as agriculture
  - But agreed on the horizontal labor supply for a given real wage, labor participation being the equilibrium factor $\Rightarrow$ *Labor theory of value* based on social and historical factors
- Employment is given by the intersection of the labor demand curve (whatever the form of the production function) and the horizontal labor supply curve. $\Rightarrow w = \overline{w}$

Neoclassical Full Employment Model

- Extreme opposite of classical model: labor supply is exogenously given, at any real wage.
  - Labor supply might grow due to exogenous demographics
  - Real wage will be the equilibrium factor
  - $\Rightarrow$ always at full employment
- Assuming one production technique and no change in capital intensity, growth rate of population must be equal to capital accumulation rate otherwise either no profits or real wage $= 0$.
- In the case of a smooth, continuous production function, change in production technique allows for full employment and drives the real wage movements (frictions explain short run unemployment). $\Rightarrow \frac{K}{kw} = \overline{N}$.

Labor market

Still need one more equation to complete the growth model

- Full employment model with one technique forces $g_k = n$ but need to explain real wage-profit rate
- Classical wage model explains income distribution but not growth
- Full employment with smooth, continuous production function differentiate:
  - short run: full employment determines income distribution but not consumption-investment distribution
  - long run: $g_k = n$ holds but leaves real wage and profit rate unexplained

Summary

- Need endogenous variables to conduct predictions or scenario analysis
- Importance of multi-sectorial models but complexity increases
- If trying to explain growth of capital, profit rate, consumption and real wage, need 4 equations
  - Consumption-investment and growth-distribution schedules give two equations
  - Labor market adds one
  - One more equation needed

Net Time

- Consumption and Savings, read GD chapter 5
- Construction of the national accounts, read ESA 2013, chapters 1 - 3