

# Macroeconomic Modeling: From Keynes and the Classics to DSGE

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# Introduction

*Macroeconomics is not an exact science but an applied one where ideas, theories, and **models are constantly evaluated against the facts**, and often modified or rejected... Macroeconomics is thus the result of a **sustained process of construction**, of an interaction between ideas and events. What macroeconomists believe today is the result of an evolutionary process in which they have eliminated those ideas that failed and kept those that appear to explain reality well.*

Blanchard 1997

*There is wide agreement about the major goals of economic policy: high employment, stable prices, and rapid growth. There is less agreement that these goals are mutually compatible or, among those who regard them as incompatible, about the terms at which they can and should be substituted for one another. There is least agreement about the role that various instruments of policy can and should play in achieving the several goals.*

Friedman 1968

*One view and school of thought, associated with Keynes, Keynesians and new Keynesians, is that the private economy is **subject to co-ordination failures** that can produce excessive levels of unemployment and excessive fluctuations in real activity. The other view, attributed to classical economists, and espoused by monetarists and equilibrium business cycle theorists, is that the private economy **reaches as good an equilibrium as is possible** given government policy.*

Fischer 1988

Involuntary unemployment can exist and, without government assistance, any adjustment toward “full employment” is likely to be slow and to involve cycles and overshoots, either because

- ▶ the economy has multiple equilibria, only one of which involves full employment;
- ▶ there is only one equilibrium, but the economic system is unstable without policy.

To this day, controversies remain active between Keynesians and those who favor a Classical approach. A major source of contention: flexible vs fixed prices and wages.



# Some milestones

- 1936 Keynes publishes *The General Theory*
- 1950s Neoclassical Synthesis: nominal rigidities are only temporary
- 1970s Micro-foundations and the role of expectations
- 1980s New Classical approach: market clearing approach with no appeal to sticky prices

**Empirical tests:** **Are predictions consistent with actual experience?**

Unfortunately, empirical tests are often not definitive.

**Micro foundations:** **Are models consistent with the hypothesis of constrained maximization?**

It is utility and production functions that are independent of government policy; agents' decision rules do not necessarily remain invariant to shifts in policy.

# Two stages to making macro models

1. Derive the structural equations, which define the macro model, by presenting a set of constrained maximization exercises
2. Use the set of structural equations to derive the solution or reduce-form equations and perform the counterfactual exercises.

Since the 1970s, the two stages are considered simultaneously: structural equations make reference to the properties of the overall system (e.g. rational expectations).

# The Classical model

# The textbook Classical model

$$Y = C[(1 - \tau)Y] + I(r) + G \quad (\text{IS})$$

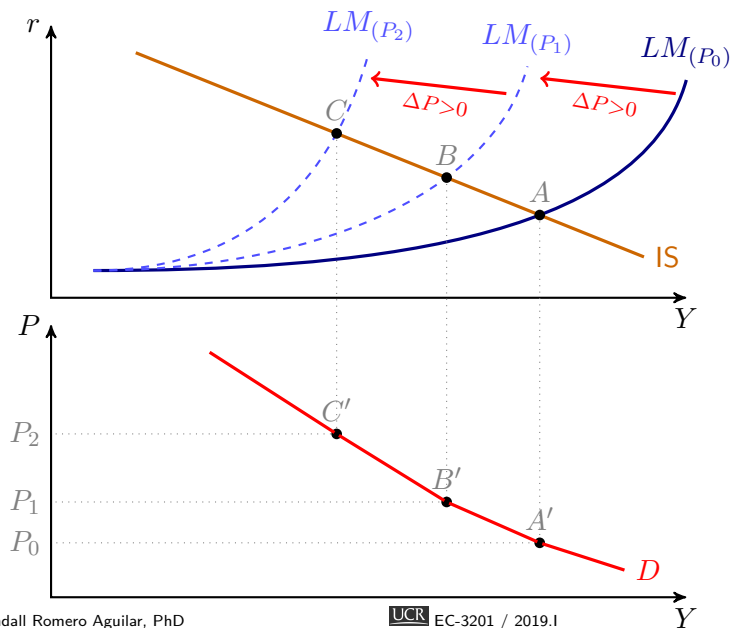
$$L(Y, r) = M/P \quad (\text{LM})$$

$$Y = F(N, K) \quad (\text{production})$$

$$W = PF_N(N, K) \quad (\text{labor demand})$$

$$W(1 - \tau) = PS(N) \quad (\text{labor supply})$$

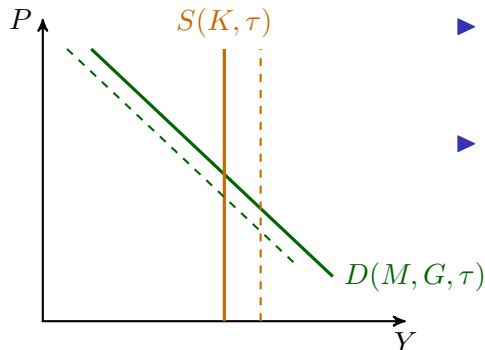
# Derivation of the aggregate demand curve



There are five endogenous variables:  $Y, N, r, P, W$ .

- ▶ The **real variables** ( $N, Y$ ) are determined solely on the basis of aggregate supply relationships (factor market and production function), while...
- ▶ the demand considerations (the IS and LM curves) determined the **nominal variables** ( $r, W, P$ ) residually.

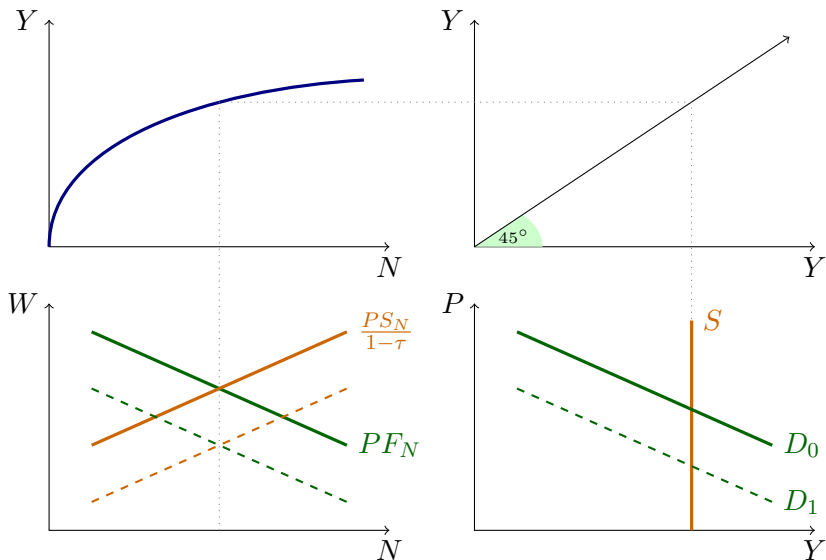
# Aggregate demand and supply curves



- ▶ Classical dichotomy follows from the vertical  $S(K, \tau)$
- ▶ A policy of balanced-budget reduction in the size of government makes sense: higher output and lower prices can follow tax cuts.



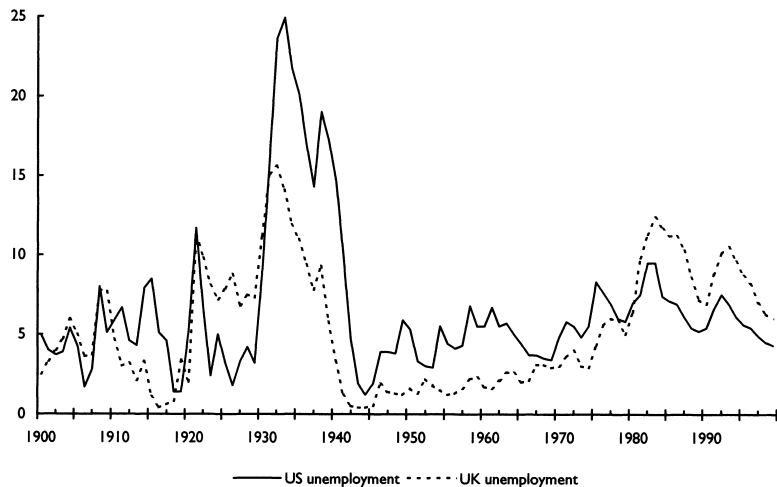
# The Classical Model



# The Keynesian model

# Unemployment during the Great Depression

Chart I. Unemployment



# The Great Depression

| Country        | Depression began | Recovery begins | Industrial production % decline |
|----------------|------------------|-----------------|---------------------------------|
| USA            | 1929q3           | 1933q2          | 46.8                            |
| UK             | 1930q1           | 1931q4          | 16.2                            |
| Germany        | 1928q1           | 1932q3          | 41.8                            |
| France         | 1930q2           | 1932q3          | 31.3                            |
| Italy          | 1929q3           | 1933q1          | 33.0                            |
| Belgium        | 1929q3           | 1932q4          | 30.6                            |
| Netherlands    | 1929q4           | 1933q2          | 37.4                            |
| Denmark        | 1930q4           | 1933q2          | 16.5                            |
| Sweden         | 1930q2           | 1932q3          | 10.3                            |
| Czechoslovakia | 1929q4           | 1932q3          | 40.4                            |
| Poland         | 1929q1           | 1933q2          | 46.6                            |
| Canada         | 1929q2           | 1933q2          | 42.4                            |
| Argentina      | 1929q2           | 1932q1          | 17.0                            |
| Brazil         | 1928q3           | 1931q4          | 7.0                             |
| Japan          | 1930q1           | 1932q3          | 8.5                             |

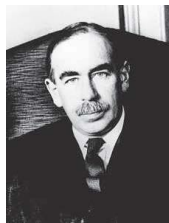
Source: C. Romer (2004)

## Just wait for the storm to pass?

*If, after the American civil war, the American dollar had been stabilised and defined by law at 10 per cent below its present value, it would be safe to assume that [the quantity of money] and [the price level] would now be just 10 per cent greater than they actually are and that the present values of [the velocity of circulation and the reserve ratio] would be entirely unaffected. But this long run is a misleading guide to current affairs. In the long run we are all dead. Economists set themselves too easy, too useless, a task if in tempestuous seasons they can only tell us that when the storm is long past the ocean is flat again.*

Keynes 1923, Tract on Monetary Reform

- ▶ The history of modern macroeconomics starts with the publication of John Maynard Keynes' General Theory of Employment, Interest, and Money in 1936.
- ▶ The General Theory is in fact business cycle theory that emphasizes effective demand (aggregate demand): Effective demand determines output.



John Maynard Keynes

Keynes built the building blocks of modern macroeconomics:

- ▶ The relation of consumption, to income and the multiplier effects
- ▶ Liquidity preference in the demand for money that explains how monetary policy affect interest rates and aggregate demand
- ▶ The importance of expectations in affecting consumption and investment; and shifts in expectations (animal spirits) behind shifts in demand and output

# The textbook Keynesian model

$$Y = C[(1 - \tau)Y] + I(r) + G \quad (\text{IS})$$

$$L(Y, r) = M/P \quad (\text{LM})$$

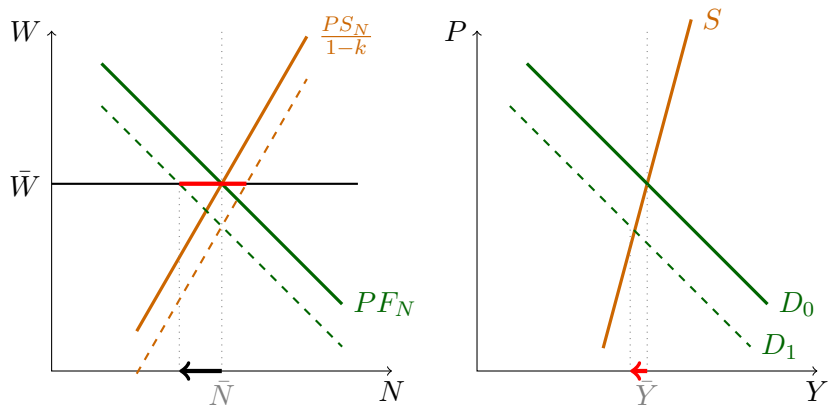
$$Y = F(N^d, K) \quad (\text{production})$$

$$\bar{W} = PF_N(N^d, K) \quad (\text{labor demand})$$

$$\bar{W}(1 - \tau) = PS(N^s) \quad (\text{labor supply})$$



# Fixed money wages and excess labor supply



# Unemployment in the Keynesian model

- ▶ Unemployment occurs in the Keynesian model because of wage rigidity.
- ▶ It can be reduced by any of the following policies
  1. increasing government spending,
  2. increasing the money supply, or
  3. reducing the money wage

# The Neoclassical Synthesis

# The Neoclassical Synthesis

- ▶ By the 1950s, a consensus, called the neoclassical synthesis, had emerged.
- ▶ The IS-LM model, developed earlier by John Hicks and Alvin Hansen, was used to formalize Keynes' ideas.
- ▶ Modigliani and Friedman independently developed the theory of consumption that emphasizes the importance of expectations in determining current consumption decision.



Franco Modigliani



Milton Friedman

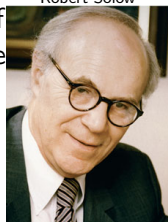
- ▶ Tobin developed the theory of investment, which was further developed by Dale Jorgenson.
- ▶ In light of rapid growth in the 1950s and 1960s, Solow developed the growth model for us to think about the determinants of growth.
- ▶ All these contributions were integrated in larger and larger macroeconomic models, the first of which (16 equations) was developed by Lawrence Klein in the early 1950s for the United States.



John Tobin



Robert Solow

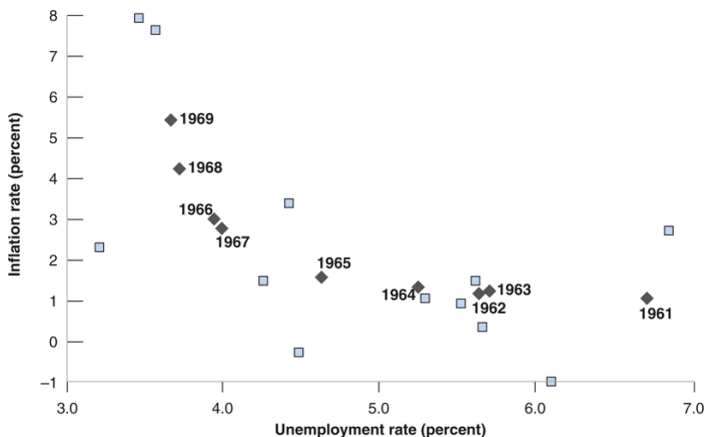


Lawrence Klein

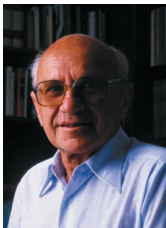
- ▶ The most impressive effort was the construction of the MPS model developed during the 1960s as an expanded version of the IS-LM model, plus a Phillips curve mechanism.
- ▶ In the 1960s, there were heated debates between “Keynesians” and “monetarists”, centering around three issues:
  1. the effectiveness of monetary versus fiscal policy,
  2. the Phillips curve, and
  3. the role of policy.
- ▶ Keynes’ emphasis on fiscal rather than monetary policy was challenged by the opposite view of Friedman.

# The Phillips curve

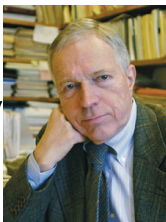
- ▶ Many believed that there existed a stable relationship between unemployment and inflation —the Phillips curve.
- ▶ Policymakers faced what might be a stable 'trade-off'.



- ▶ Friedman and Phelps also challenged the Keynesian view of a reliable trade-off between unemployment and inflation, even in the long run.
- ▶ In contrast to the Keynesians' call for an active role of policy, Friedman argued for the use of simple rules, such as steady money growth.
- ▶ This debate on the role of macroeconomic policy has not been settled.



Milton Friedman

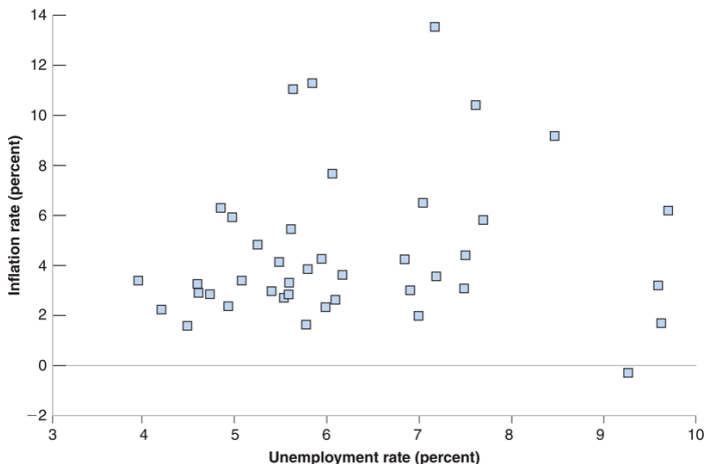


Edmund Phelps



# Good-bye Phillips curve?

- ▶ The Phillips curve: view of economics as engineering; it became the center piece of econometric models.
- ▶ It was, in subsequent years, to prove hopelessly unreliable



# The Rational Expectations Critique

# The Rational Expectations Critique

- ▶ In the early 1970s, Lucas, Sargent and Barro led a strong attack against mainstream macroeconomics.
- ▶ Lucas and Sargent's main argument was based on three implications of rational expectations, all highly damaging to Keynesian macroeconomics:
  - ▶ Existing macroeconomic models could not be used to design policy, known as the Lucas critique.
  - ▶ With rational expectations, only unanticipated changes in money should affect output.
  - ▶ Game theory, rather than optimal control in Keynesian models, was the right tool to design policy.



Robert Lucas



Thomas Sargent



Robert Barro<sup>35</sup>

- ▶ The role of rational expectations has been integrated in different markets:
  - ▶ Hall showed that if consumers are foresighted, then consumption behavior became random walk.
  - ▶ Dornbusch showed that the large swings in exchange rates under flexible exchange rates were fully consistent with rationality rather than the result of speculation by irrational investors
  - ▶ Fischer and Taylor showed that, due to staggering of wage and price decisions, the adjustment of prices and wages in response to changes in unemployment can be slow even under rational expectations.
- ▶ By the end of the 1980s, the rational-expectations critique had led to an overhaul of macroeconomics.



Rudiger Dornbusch



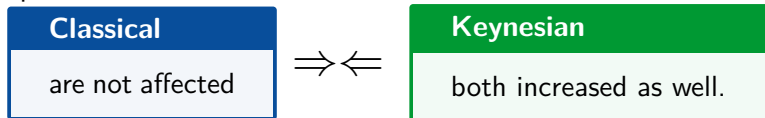
Stanley Fischer



John Taylor

# Keynesians vs Classical: The role of money

When the money supply is increased, employment and real output...



In Lucas (1996)'s words:

*This tension between two incompatible ideas: that changes in money are neutral units changes, and that they induce movements in employment and production in the same direction, has been at the center of monetary theory at least since Hume (1752) wrote.*

# Estimating the effect of money on output

- ▶ To solve this problem, an econometrician estimates this model

$$y_t = \bar{y} + \alpha_0 m_t + \alpha_1 m_{t-1} + c_0 z_t + c_1 z_{t-1} + u_t$$

where  $m$  is money,  $y$  is output,  $z$  a control variable.

- ▶ If  $\alpha_0 = \alpha_1 = 0$ , the Keynesians would be in trouble.
- ▶ If  $\alpha_0 > 0$ , the classicals would be in trouble.

# A monetary policy rule

- ▶ Assume that the central bank wants to stabilize output around  $\bar{y}$ .
- ▶ To this end, it sets money supply:

$$\begin{aligned}m_t^* &= \operatorname{argmin}_{m_t} \mathbb{E} (y_t - \bar{y})^2 \\ &= \operatorname{argmin}_{m_t} \mathbb{E} (\alpha_0 m_t + \alpha_1 m_{t-1} + c_0 z_t + c_1 z_{t-1} + u_t)^2 \\ &= -\frac{\alpha_1}{\alpha_0} m_{t-1} - \frac{c_1}{\alpha_0} z_{t-1}\end{aligned}$$

where we assume that the bank is expecting  $\mathbb{E} z_t = 0$ .

- ▶ The policy rule would be

$$m_t^* = \pi_1 m_{t-1} + \pi_2 z_{t-1} + \nu_t$$

## A different hypothesis about money

Now assume that real output depends only on **unexpected** changes in the money supply  $v_t$ :

$$y_t = \bar{y} + d_0 v_t + d_1 z_t + d_2 z_{t-1} + u_t$$

But the policy rule implies  $v_t = m_t - \pi_1 m_{t-1} - \pi_2 z_{t-1}$ . Then:

$$\begin{aligned} y_t &= \bar{y} + d_0 [m_t - \pi_1 m_{t-1} - \pi_2 z_{t-1}] + d_1 z_t + d_2 z_{t-1} + u_t \\ &= \bar{y} + d_0 m_t - d_0 \pi_1 m_{t-1} + d_1 z_t + (d_2 - d_0 \pi_2) z_{t-1} + u_t \end{aligned}$$



# An observationally equivalent regression

Compare the two models:

**keynesian**  $y_t = \bar{y} + \alpha_0 m_t + \alpha_1 m_{t-1} + c_0 z_t + c_1 z_{t-1} + u_t$

**classical**  $y_t = \bar{y} + d_0 m_t - d_0 \pi_1 m_{t-1} + d_1 z_t + (d_2 - d_0 \pi_2) z_{t-1} + u_t$

- ▶ Estimated regression cannot distinguish between the two competing hypothesis: both models lead to **observationally equivalent** regressions!
- ▶ Estimated parameters may depend on the policy rule.
- ▶ Then, the estimations would be subject to the Lucas (1976) critique: **we cannot tell what would happen if policy changes, because the model parameters might not be invariant to policy itself.**

Lucas and rational expectations

# The Lucas critique

- ▶ Standard practice in applied economics (in all fields —not just macroeconomics) involves estimating a model and then using those estimated coefficients to simulate what would happen if policy were different.
- ▶ The Lucas critique is the warning that **it may not make sense to assume that those estimated coefficients would be the same if an alternative policy regime were in place.**
- ▶ The only way we can respond to this warning is to have some theory behind each of the model's equations. We can then derive how (if at all) the coefficients depend on the policy regime.

# The role of expectations

- ▶ Early work in macroeconomics involved a bold simplifying assumption —that economic agents have static expectations concerning the model's endogenous variables.
- ▶ Conflicting assumptions:
  - ▶ individuals took great pains to pursue a detailed plan when deciding how much to consume and how to operate their firms.
  - ▶ these same individuals were quite content to just presume that many important variables that affect their decisions will never change
- ▶ By 1970, macro theorists had come to regard this approach as unappealing.

## Four approaches to modeling expectations

- ▶ **Static expectations:** Individuals are always surprised by any changes, and so they make systematic forecast errors.
- ▶ **Adaptive expectations:** Individuals forecast each endogenous variable by assuming that the future value will be a weighted average of past values for that variable.
- ▶ **Perfect foresight:** Individuals are so adept at revising their forecasts in the light of new information that they never make any forecast errors.
- ▶ **Rational expectations:** Individuals understand the probability distributions of shocks affecting the economy, so their subjective expectations is consistent with the mathematical expectation implied by the model.

DSGE, RBC, New Keynesian

- ▶ From the late 1980s to the crisis, the new classicals developed the real business cycle (RBC) models based on two premises:
  - ▶ Macroeconomic models should be constructed from explicit microfoundations.
  - ▶ Most fluctuations until the 1970s were the results of imperfections, of deviations of actual output from a slowly moving potential level of output.

- ▶ New Keynesians recognized rational expectations, but believed that much remained to be learned about the nature of market imperfections and their implications for macroeconomic fluctuations.
- ▶ Their work included studying the nature and implications of nominal rigidities, and the menu cost, and efficiency wages.
- ▶ Michael Woodford and Jordi Gali built the new Keynesian model that embodies utility and profit maximization, rational expectations, and nominal rigidities.
- ▶ Since the late 1980s, contributions to growth theory went under the name of new growth theory, led by Robert Lucas and Paul Romer.



- ▶ The DSGE methodology attempts to explain aggregate economic phenomena, such as economic growth, business cycles, and the effects of monetary and fiscal policy, on the basis of macroeconomic **models derived from microeconomic principles**.
- ▶ Microfounded models should not be, at least in theory, vulnerable to the Lucas critique.
- ▶ Since the microfoundations are based on the preferences of the decision-makers in the model, DSGE models feature a natural benchmark for evaluating the welfare effects of policy changes.

# Components of a DSGE

- Preferences** the objectives of the agents in the economy must be specified.
- Technology** the productive capacity of the agents in the economy must be specified.
- Institutions** the institutional constraints governing economic interactions must be specified.
- Expectations** In models with uncertainty, the interaction between the formation of expectations and the implications of those expectations must be specified.

Basic DSGE models are based on three kinds of models:

- ▶ the Solow model
- ▶ the Ramsey model
- ▶ the overlapping generations model.

There are three kind of questions of interest:

- ▶ Transitional dynamics
- ▶ Economic fluctuations that are caused by supply and demand shocks.
- ▶ Implications of heterogeneous agents: income distribution.

At present two competing schools of thought form the bulk of DSGE modeling:

## Real Business Cycle

theory builds on the neoclassical growth model (assumes flexible prices) to study how real shocks to the economy might cause business cycle fluctuations.

## New-Keynesian DSGE

models build on a structure similar to RBC models, but instead assume that prices are set by monopolistically competitive firms, and cannot be instantaneously and costlessly adjusted.

During the years following the seminal papers of Kydland and Prescott (1982) and Prescott (1986), RBC theory provided the main framework for the analysis of economic fluctuations and became the core of macroeconomic theory.

The RBC revolution rested in three basic claims:

- ▶ The efficiency of business cycles.
- ▶ The importance of technology shocks as a source of economic fluctuation.
- ▶ The limited role of monetary factors.

# The New Keynesian Model

The New Keynesian modeling approach combines the DSGE structure characteristic of RBC models with assumptions that depart from those in classical monetary models:

- ▶ Monopolistic competition
- ▶ Nominal rigidities
- ▶ Short run non-neutrality of monetary policy

# First Lessons for Macroeconomics after the Crisis

- ▶ The crisis reflects a major failure of macroeconomics to realize that a relatively small shock like the decrease in U.S. housing prices, could lead to a major financial and macroeconomic global crisis.
- ▶ Much of the work to understand the crisis was carried out outside macroeconomics, in the fields of finance or corporate finance.
- ▶ Researchers have turned their attention to the financial system, the nature of macro financial linkages, and integration of those pieces into large macroeconomic models.

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