

ECON 5110 Class Notes

Overview of New Keynesian Economics

1 Introduction

The primary distinction between Keynesian and classical macroeconomics is the flexibility of prices and wages. In classical models (e.g., RBC model, Lucas supply model, etc.), prices and wages are completely flexible so that labor and goods markets continually clear. In Keynesian models, prices and/or wages are temporarily inflexible so that in response to outside shocks (e.g., changes in fiscal or monetary policy), quantities adjust. New Keynesian economics refers to the retooling of traditional Keynesian models to be consistent with microeconomic fundamentals.

2 Traditional IS-LM-AS Model

The traditional IS-LM model describes the aggregate demand (AD) side of the economy. The analysis is static and not grounded in microfundamentals.

2.1 Aggregate Demand: An IS-LM Framework

2.1.1 IS Curve

The IS relationship describes all combinations of interest rates (r) and output (Y) that generate equilibrium in the goods market. The building blocks are

$$\begin{aligned} C &= C(Y - T) && \text{(Consumption Function)} \\ I &= I(r) && \text{(Investment Demand)} \\ G &= \bar{G} && \text{(Government Spending)} \\ T &= \bar{T} && \text{(Taxes)} \\ NX &= \overline{NX} && \text{(Net Exports)} \\ Y &= C + I + G + NX. && \text{(Goods Market Equilibrium)} \end{aligned}$$

Therefore, the IS curve can be written as

$$Y = C(Y - \bar{T}) + I(r) + \bar{G} + \bar{NX}, \quad (1)$$

where there is an inverse relationship between r and Y . A higher interest rate reduces investment demand, which requires a reduction in output to restore equilibrium between output and expenditures. Total differentiation of (1) with some algebra produces various multipliers. For example, the government spending multiplier is

$$\frac{dY}{d\bar{G}} = (1 - C_Y)^{-1}$$

where $C_Y = dC/dY$ is the marginal propensity to consume. Because $0 < C_Y < 1$, the government spending multiplier is greater than one.

2.1.2 LM Curve

The LM relationship describes all combinations of interest rates (r) and output (Y) that generate equilibrium in the money market. The building blocks are

$$(M/P)^d = L(Y, r) \quad (\text{Money demand})$$

$$(M/P)^s = M/P \quad (\text{Money Supply})$$

$$(M/P)^d = (M/P)^s. \quad (\text{Money Market Equilibrium})$$

Therefore, the LM curve can be written as

$$M/P = L(Y, r)$$

where there is a positive relationship between r and Y . A higher interest rate reduces the demand for real money balances so that income must rise in order to bring demand back to the level that equates it with the fixed money supply.

2.1.3 AD Curve

The AD curve depicts combinations of P and Y that simultaneously clear the goods and money markets. The AD curve is found by using r to combine the IS curve

$$Y = C(Y - \bar{T}) + I(r) + \bar{G} + \bar{NX}$$

and the LM curve

$$M/P = L(Y, r).$$

The AD curve slopes down because a higher P reduces the supply of real money balances and thus Y decreases (and r increases) to restore equilibrium in the money and goods markets. Assuming the LM curve is not horizontal, the government spending multiplier is smaller when incorporating the money market because the increase spending raises interest rates and ends up crowding out some private investment. The IS-LM relationship involves three endogenous variables (r , P and Y) and only two equations. Therefore, we need aggregate supply (AS) to determine the general equilibrium.

2.2 Aggregate Supply

In the short run, there are various theories as to why the aggregate supply curve (P on the vertical axis and Y on the horizontal axis) has an upward slope. We will explore several of these theories in later papers. In the long run, the AS curve is vertical such that output is determined by technology and the factors of production. The AS curve takes the form

$$Y = \bar{Y} + \alpha(P - P^e)$$

where the natural level of output (\bar{Y}) is given by the production function, the capital stock (\bar{K}) and the labor force (\bar{L})

$$\bar{Y} = F(\bar{K}, \bar{L}).$$

Since $\alpha > 0$, when the price level (P) is higher than expected (P^e), output is above its natural rate. Conversely, when $P^e > P$, output is below its natural rate. Finally, when $P^e = P$, output is at its natural rate (i.e., $Y = \bar{Y}$). The IS-LM-AS equations uniquely determine the equilibrium levels of r , P and Y for given values of the exogenous variables.

The advantage of the traditional IS-LM-AS framework is its simplicity. It can be a useful tool for analyzing, for example, how changes in government policy will impact the macroeconomy. However, the traditional IS-LM-AS model lacks microfundamentals, dynamics and a well-specified expectations mechanism.

3 Microfoundations of the Canonical New Keynesian Model

Dynamic New Keynesian (NK) models are typically represented by three equations: an IS curve, a Phillips curve and a monetary policy rule.

3.0.1 IS curve

The IS curve in NK models is similar to the one in traditional Keynesian models except it incorporates expected future output. The IS curve takes the form

$$x_t = -\varphi[i_t - E_t\pi_{t+1}] + E_t x_{t+1} + \nu_t \quad (2)$$

where the variables are defined as

- $y_t \equiv$ output
- $\tau_t \equiv$ potential (or trend) output
- $x_t = y_t - \tau_t \equiv$ output gap
- $i_t \equiv$ nominal interest rate (measured as deviation from long-run level)
- $\pi_t \equiv$ inflation (measured as deviation from long-run level)
- $r_t = i_t - E_t\pi_{t+1} \equiv$ real interest rate
- $\nu_t \equiv$ demand shock.

The output gap is negatively related to the real interest rate because higher returns induce agents to save more today (i.e., the intertemporal substitution effect), which reduces current output demand. The output gap is positively related to the expected future output gap because agents wish to smooth their consumption over time. Higher expected output next period will raise their desire to consume today and thus current output demand increases.

Microeconomic Derivation Equation (2) can be derived from the consumers' problem. Consider the standard RBC framework where the representative agent maximizes

$$E_t \sum_{i=0}^{\infty} \beta^{t+i} (1-\sigma)^{-1} c_{t+i}^{1-\sigma}$$

subject to the usual constraints. The Euler equation for consumption is

$$c_t^{-\sigma} = \beta E_t [c_{t+1}^{-\sigma} ((1-\delta) + r_{t+1})] \quad (3)$$

where we have used the fact that the real interest rate is

$$r_t = \frac{\partial y_t}{\partial k_t} = i_t - E_t \pi_{t+1}.$$

Linearize (3) to get

$$\hat{c}_t = E_t \hat{c}_{t+1} + \alpha E_t \hat{r}_{t+1} \quad (4)$$

where hats ($\hat{\cdot}$) over variables indicate proportional deviations from steady state and $\alpha = -\beta r / \sigma$. Next, we substitute in the resource constraint $\hat{y}_t = \hat{c}_t + \hat{g}_t$, which ignores investment and trade. This produces

$$\hat{y}_t - \hat{g}_t = E_t [\hat{y}_{t+1} - \hat{g}_{t+1}] + \alpha E_t \hat{r}_{t+1}$$

or rearranged to give

$$\hat{y}_t = \alpha E_t \hat{r}_{t+1} + E_t \hat{y}_{t+1} + \eta_t$$

where $\eta_t = -E_t \Delta g_{t+1}$. Finally, noting that $\hat{y}_t = x_t$, $\hat{r}_t = r_t$, $\alpha = -\varphi$ and $\nu_t = \eta_t$, we get the IS curve in equation (2). For a more detailed derivation of the IS curve, see Yun's (1996) *Journal of Monetary Economics* article.

3.0.2 Phillips Curve

The NK Phillips curve

$$\pi_t = \lambda x_t + \gamma E_t \pi_{t+1} + \mu_t \quad (5)$$

also differs from its traditional form. Although inflation is positively related to the output gap (or inversely related to unemployment), it also depends on expected future inflation ($E_t \pi_{t+1}$) and a cost-push shock (μ_t).

Microeconomic Derivation – Lucas Imperfect Information Model One microeconomic derivation of (5) is Lucas' (1972) model of imperfect information. As you learned last semester, the Lucas model assumes that producers have limited information about the overall price level and attempt to infer whether changes in the price of their output is an overall price level increase or an increase in relative prices. As Lucas shows, the rational inference is that it is a little of both, causing firms to increase production. This leads to the following aggregate supply curve

$$q_t = q + \pi(p_t - E_t p_{t+1}) + \epsilon_t,$$

which after first-differencing can be written in the form of equation (5).

Microeconomic Derivation – Monopolistic Competition with Price Staggering Following Yun (1996), there are two sectors – an intermediate and a final goods sector. The final goods sector is perfectly competitive and produces the final good Y_t according to the technology

$$Y_t = \left[\int_{i=0}^{\infty} \left\{ y_t(i)^{(\eta-1)/\eta} \right\} di \right]^{\eta/(\eta-1)}$$

where $y_t(i)$ is the intermediate good. Given prices $P_t(i)$ and P_t for the intermediate and final goods, the implied demand for intermediate goods is

$$y_t(i) = Y_t \left[\frac{P_t(i)}{P_t} \right]^{-\eta}.$$

The intermediate goods sector is monopolistically competitive. They produce the intermediate good using a Cobb-Douglas production function

$$y_t(i) = F(K_t, L_t)$$

by hiring labor (L_t) and renting capital (K_t) in competitive input markets. Market power in the intermediate goods sector implies that factor payments will be distorted according to

$$W_t = MC_t F_L(K_t, L_t)$$

$$R_t = MC_t F_K(K_t, L_t)$$

where marginal cost (MC_t) is independent of the level of output given the assumption of constant returns to scale. Finally, to introduce a nominal rigidity (i.e., price stickiness), it is assumed that prices are set in a staggered manner (Fischer 1977). Each period $1/N$ of the firms set their price for the next N periods. The remaining fraction of firms $(1 - 1/N)$ leave their prices fixed. Aggregation of this type of staggered-price scheme is tedious. A simpler but similar scheme is credited to Calvo (1983). In each period, each firm has probability $(1 - \nu)$ of changing price and probability ν of leaving price fixed. As a result, the probability of changing price is independent of time and the average duration of price stickiness is $1/(1 - \nu)$.¹ As Yun (1996) shows, this leads to the linearized aggregate Phillips curve

$$\pi_t = \lambda mc_t + \gamma E_t \pi_{t+1} + \mu_t$$

where mc_t is real marginal cost. Real marginal cost (through appropriate restrictions on preferences, technology and the labor market) can then be linearly related to the output gap to arrive at the familiar Phillips curve.

3.0.3 Monetary Policy Rule

There are various ways to represent monetary policy. Traditional IS-LM models assumed that the money supply was exogenous. In accordance with the times, early work by John Taylor (e.g., 1979 AER paper to be presented) assumed that the policy instrument was the money stock (m_t), which was assumed to follow an accommodative form like

$$m_t = \phi w_t$$

where w_t is the aggregate wage level and ϕ is a parameter measuring the degree of accommodation of aggregate demand to wage changes. More recently central banks around the world have begun to use interest rates, as opposed to the supply of money, as policy instruments. In more current work, Taylor has shown that a simple policy rule such as

$$i_t = i + \theta_x E_t x_{t+1} + \theta_\pi E_t \pi_{t+1}$$

appears to do a good job of fitting the recent dynamics of the U.S. federal funds rate. The money supply, under these so-called Taylor rules, is assumed to adjust as necessary to reach the target nominal interest

¹If intermediate producers are free to change price in every period ($\nu = 0$), they will choose prices that lead to a price index for the final good that is a constant markup over marginal cost $P_t = \kappa MC_t$, where $\kappa > 1$.

rate, i_t . A third alternative is to specify a central bank objective such as minimization of

$$E_t \sum_{i=0}^{\infty} \beta^i [\lambda x_{t+i}^2 + \pi_{t+i}^2]$$

by choosing a target interest rate i_t , which will produce an optimal policy rule.

3.0.4 Summary

In sum, the dynamic New Keynesian model can be represented by three equations

$$x_t = -\varphi[i_t - E_t \pi_{t+1}] + E_t x_{t+1} + \nu_t \quad (\text{IS curve})$$

$$\pi_t = \lambda x_t + \gamma E_t \pi_{t+1} + \mu_t \quad (\text{Phillips curve})$$

$$i_t = i + \theta_x E_t x_{t+1} + \theta_\pi E_t \pi_{t+1}, \quad (\text{Interest rate rule})$$

where the endogenous variables are x_t , π_t and i_t . Furthermore, because three equations above are derived from microeconomic fundamentals, the parameters $(\varphi, \lambda, \gamma, \theta_x, \theta_\pi)$ are tied back to the economic primitives.