ECON 3120 Intermediate Macroeconomics

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A List of Useful Equations

1 GDP

- Real GDP growth rate in year t:

$$g_t = \frac{Y_t - Y_{t-1}}{Y_{t-1}} \times 100\% \tag{1}$$

where Y_t is the real GDP in year t (GDP evaluated at the base year price).

- Nominal GDP growth rate in year t:

$$g_t = \frac{\$Y_t - \$Y_{t-1}}{\$Y_{t-1}} \times 100\% \tag{2}$$

where $\$Y_t$ is the nominal GDP in year t (GDP evaluated at the current year price). We can also obtain $\$Y_t$ by adding up values added at each stage of production.

- Average annual growth rate:

$$g \approx \frac{g_1 + g_2 + \cdots + g_n}{n} \tag{3}$$

where $g_1, g_2, \cdots, g_n$ are annual growth rates.

- Rule of 70:

$$\text{number of years to double} = \frac{70}{g} \tag{4}$$

where g is average annual growth rate.

- National income identity:

$$Y = C + I + G + NX \tag{5}$$

where Y is GDP, C is consumption, I is investment, G is government purchases, and NX is net exports (also net foreign investment). Rearranging gives the "saving equals investment" equality

$$S = S^p + S^g = I + NX \tag{6}$$

where S is national saving, $S^p = Y - T - C$ is private saving, $S^g = T - G$ is public saving (negative of primary deficit), and T is net taxes (taxes net of transfers).

- An important identity:

$$\text{production (GDP)} = \text{expenditure} = \text{national income} \tag{7}$$

- Marginal propensity to consume (MPC)/save (MPS):

$$1 = \frac{\Delta C}{\Delta Y_D} + \frac{\Delta S}{\Delta Y_D} = \text{MPC} + \text{MPS} \tag{8}$$

where ΔC is change in consumption, ΔS is change in saving, and ΔY_D is change in disposable income.

- Goods market equilibrium:

$$Y = c_0 + c_1(Y - T) + I + G + NX \tag{9}$$

where c_0 is autonomous consumption, c_1 is MPC, and $c_0 + c_1(Y - T)$ is consumption. Solving for the equilibrium output gives

$$Y = \frac{1}{1 - c_1}[c_0 + I + G + NX - c_1 T] \tag{10}$$

where $c_0 + I + G + NX - c_1 T$ is autonomous spending and $1/(1 - c_1)$ is multiplier. More generally, goods market equilibrium can be written as

$$Y = C(Y - T) + I(Y, i) + G + NX \tag{11}$$

where i is interest rate. It simply states that aggregate supply (Y) be equal to aggregate demand ($C + I + G + NX$) in equilibrium. The implied negative relation between Y and i is called IS relation.

2 INTEREST RATE/EXCHANGE RATE/PRICE LEVEL

- GDP deflator:

$$P = \frac{\text{nominal GDP}}{\text{real GDP}} \times 100 \tag{12}$$

- Consumer price index (CPI):

$$P = \frac{\text{expenditures in current year}}{\text{expenditures in base year}} \times 100 \tag{13}$$

- Purchasing power:

$$\text{real variable} = \frac{\text{nominal variable}}{\text{current-year price index}} \times 100 \tag{14}$$

- Inflation rate in year t:

$$\pi_t = \frac{P_t - P_{t-1}}{P_{t-1}} \times 100\% \tag{15}$$

where P_t is the price index in year t (GDP deflator or CPI).

- Fisher relation:

$$r_t \approx i_t - \pi^e_{t+1} \tag{16}$$

where r is real interest rate, i is nominal interest rate, and π^e is expected inflation rate.

- Nominal interest rate:

$$i = \frac{\$F - \$P_B}{\$P_B} \times 100\% \tag{17}$$

where $\$P_B$ is the price of one-year bond and $\$F$ is the face value.

- Real exchange rate:

$$e = \frac{E \times P}{P^*} \tag{18}$$

where P (P^*) is domestic (foreign) price of a basket of goods and E is foreign price of domestic currency (i.e. nominal exchange rate). The purchasing power parity condition holds when $e = 1$.

3 UNEMPLOYMENT

- Labor force:

$$\text{labor force} = \text{employed} + \text{unemployed} \tag{19}$$

- Unemployment rate:

$$u = \frac{\text{unemployed}}{\text{labor force}} \times 100\% \tag{20}$$

- Participation rate:

$$\text{participation rate} = \frac{\text{labor force}}{\text{working-age population}} \times 100\% \tag{21}$$

4 MONEY

- Deposit multiplier:

$$\text{deposit multiplier} = \frac{1}{\text{RR}} \tag{22}$$

where RR is the required reserve ratio.

- Quantity equation:

$$M \times V = P \times Y \tag{23}$$

where M is money supply, V is velocity of money, P is price level, and Y is real output. With V being stable, the above equation can be approximated as

$$\pi = g_M - g_Y \tag{24}$$

where g_M is money growth rate, g_Y is real output growth rate, and π is inflation rate.

- Financial market equilibrium:

$$M^s/P = M^d/P = Y \times L(i) \tag{25}$$

where M^s/P is real money supply and M^d/P is real money demand. The implied positive relation between Y and i is called LM relation.