ECO 212 Principles of Macroeconomics

List of Formulas*

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1 Chapter 7. GDP: Measuring Total Production and Income

1. Suppose an economy produces N *final* goods and services. By definition, a direct way to calculate its nominal GDP (NGDP) in year t is:
$$NGDP_t = P_{1,t} \times Q_{1,t} + P_{2,t} \times Q_{2,t} + ... + P_{N,t} \times Q_{N,t} \tag{1}$$
where $P_{1,t}, P_{2,t}, ..., P_{N,t}$ are the prices of the N goods and services in *current year* t, $Q_{1,t}, Q_{2,t}, ..., Q_{N,t}$ are the quantities of the N goods and services produced in *current year* t.

2. Value added approach:
$$NGDP = \text{Total Value Added} \tag{2}$$

3. Income approach:
$$NGDP = \text{Total Income} = \text{Wages} + \text{Profits} \tag{3}$$

4. The spending approach:
$$NGDP = \text{Total Spending} = C + I + G + NX \tag{4}$$
where $NX = X - M$.

5. The above four approaches are equivalent, i.e.
$$NGDP = \text{Total Value Added} = \text{Total Income} = \text{Total Spending} \tag{5}$$

6. Suppose an economy produces N *final* goods and services. Real GDP (RGDP) in year t can be computed as:
$$RGDP_t = P_{1,b} \times Q_{1,t} + P_{2,b} \times Q_{2,t} + ... + P_{N,b} \times Q_{N,t} \tag{6}$$
where $P_{1,b}, P_{2,b}, ..., P_{N,b}$ are the prices of the N goods and services in *base year* b, $Q_{1,t}, Q_{2,t}, ..., Q_{N,t}$ are the quantities of the N goods and services produced in *current year* t.

7. Given NGDP and RGDP, we can calculate the GDP deflator:
$$\text{GDP deflator} = \frac{NGDP}{RGDP} \times 100 \tag{7}$$

8. Standard of living can be measured by RGDP per capita:
$$\text{RGDP per capita} = \frac{RGDP}{\text{population size}} \tag{8}$$

*This list provides selective formulas from my class notes.

2 Chapter 8. Inflation and Unemployment

1. The consumer price index (CPI) is an average of the prices of the basket of goods and services purchased by the typical urban family of four. The Bureau of Labor Statistics (BLS) computes the CPI as:
$$CPI = \frac{\text{expenditure of the basket in } \textit{current year}}{\text{expenditure of the basket in } \textit{base year}} \times 100 \tag{9}$$
BLS assumes the composition of the basket remains unchanged over time.

2. The inflation rate is the percentage change in price index from one year to the next. It is normally calculated using CPI. For example, the inflation in year t can be computed as:
$$\text{CPI Inflation}_t = \frac{CPI_t - CPI_{t-1}}{CPI_{t-1}} \times 100 \tag{10}$$

3. Using CPI, real wage in year t can be computed as:
$$\text{real wage}_t = \frac{\text{nominal wage}_t}{CPI_t} \tag{11}$$

4. CPI can be used to compare market values across time. For example, to compare a salary received in year 1 and a salary in year 2, we need to convert both of them to real salaries first to adjust for inflation. Or, we can convert the salary received in year 1 to its value in year 2 with equal purchasing power as in year 1:
$$\text{value in year 2} = \text{value in year 1} \times \frac{\text{CPI in year 2}}{\text{CPI in year 1}} \tag{12}$$

5. Labor force can be computed as:
$$\text{labor force} = \text{employed} + \text{unemployed} \tag{13}$$

6. Unemployment rate can be computed as:
$$\text{unemployment rate} = \frac{\text{unemployed}}{\text{labor force}} \times 100 \tag{14}$$

7. Labor force participation rate can be computed as:
$$\text{labor force participation rate} = \frac{\text{labor force}}{\text{working age population}} \times 100 \tag{15}$$

8. Employment-population ratio can be computed as:
$$\text{employment-population ratio} = \frac{\text{employed}}{\text{working age population}} \times 100 \tag{16}$$

9. Natural rate of unemployment can be computed as:
$$\text{natural unemployment} = \text{frictional unemployment} + \text{structural unemployment} \tag{17}$$
Or in other words, full employment is when cyclical unemployment = 0.

3 Chapter 9. Economic Growth, Financial System, and Business Cycles

1. Economic growth rate g in year t can be computed as:

$$g_t = \frac{y_t - y_{t-1}}{y_{t-1}} \times 100 \tag{18}$$

where y is RGDP per capita.

2. Rule of 70 gives us a simple rule of thumb to judge how fast an economic variable is growing:

$$\text{number of years to double} = \frac{70}{\text{growth rate}} \tag{19}$$

3. Total saving in the economy (S) is equal to the sum of private saving and public saving:

$$S = S_{private} + S_{public} = Y - C - G \tag{20}$$

Private saving is defined as:

$$S_{private} = Y + TR - C - T \tag{21}$$

Public saving is defined as:

$$S_{public} = T - G - TR \tag{22}$$

When $S_{public} = 0$, there is a balanced budget; when $S_{public} > 0$, there is a budget surplus; when $S_{public} < 0$, there is a budget deficit.

4. Relationship between total saving S and total investment I:

$$S = I + NX \tag{23}$$

In a closed economy $NX = 0$, therefore:

$$S = I \tag{24}$$

5. Real interest rate measures the true cost of borrowing. Given nominal interest rate R and inflation rate π, real interest rate r can be computed as:

$$r \approx R - \pi \tag{25}$$

4 Chapter 10. Long-Run Economic Growth: Sources and Policies

1. Aggregate supply is determined from the (total) production function:

$$Y = AF(K, L) \tag{26}$$

where Y is real GDP, L is total hours worked, A is technology.

2. Assuming the production function exhibits constant returns to scale, i.e. for any positive number x,

$$xY = AF(xK, xL) \tag{27}$$

Let $x = \frac{1}{L}$, then the per-worker production function can be written as:

$$\frac{Y}{L} = AF(\frac{K}{L}, 1) \tag{28}$$

The per-worker production function is subject to diminishing returns to capital per hour worked. The slope of per-worker production function can be computed as:

$$\text{slope} = \frac{\text{change in RGDP per hour worked}}{\text{change in capital per hour worked}} \tag{29}$$

3. Growth accounting formula tells how much of long run growth is due to increases in capital, labor and technology. There are two versions.
   (1) Total RGDP growth:

$$g_Y = \frac{1}{3}g_K + \frac{2}{3}g_L + g_A \tag{30}$$

   where g_Y is the growth rate of RGDP, g_K is the growth rate of capital, g_L is the growth rate of labor and g_A is the growth rate of technology.
   (2) Growth in RGDP per capita:

$$g_y = \frac{1}{3}g_k + g_A \tag{31}$$

   where g_y is the growth rate of RGDP per capita, g_k is the growth rate of capital per capita, and g_A is the growth rate of technology.

5 Chapter 11. Aggregate Expenditure and Output in the Short Run

1. Aggregate expenditure (AE) is defined as:

$$AE = C + I' + G + NX \tag{32}$$

   where I' is *planned* investment.

2. Macroeconomic equilibrium occurs whenever:

$$AE = Y \tag{33}$$

   where $Y = RGDP$. It can be represented by the 45 degree line on the Keynesian cross diagram.

3. The relationship between consumption and income can be represented by the consumption function. There are two versions.
   (1) Generally:

$$C = a + bY \tag{34}$$

   where C is consumption, Y is income, a is consumption with no income, i.e. autonomous consumption. The slope of the consumption function, b, or the marginal propensity to consume (MPC), can be computed as:

$$\text{MPC} = b = \frac{\Delta C}{\Delta Y} \tag{35}$$

   (2) The standard consumption function proposed by Keynes:

$$C = a + bY^D \tag{36}$$

   where Y^D is disposable income:

$$Y^D = Y + TR - T \tag{37}$$

4. The relation between MPC and marginal propensity to save (MPS) can be derived as follows. For the economy as a whole, Income = Expenditure, or

$$Y + TR = C + S + T \tag{38}$$

Assume $\Delta T = 0$, $\Delta TR = 0$, then:

$$\frac{\Delta Y}{\Delta Y} = \frac{\Delta C}{\Delta Y} + \frac{\Delta S}{\Delta Y} \tag{39}$$

That is:

$$1 = \text{MPC} + \text{MPS} \tag{40}$$

5. In the AE model, a change in autonomous expenditure has a multiplied effect on real GDP due to a series of induced increases in consumption. The multiplier can be computed as:

$$\text{multiplier} = \frac{\text{change in RGDP}}{\text{change in autonomous expenditure}} = \frac{1}{1 - \text{MPC}} \tag{41}$$

Given MPC and the size of an autonomous change, say ΔI, the change in RGDP can be calculated as:

$$\Delta Y = \left(\frac{1}{1 - MPC}\right) \Delta I \tag{42}$$

6 Chapter 12. Aggregate Demand and Aggregate Supply Analysis

No formula in this chapter. Focus on graphical analyses.

7 Chapter 13. Money, Banks, and Federal Reserve System

1. The simple deposit multiplier can be computed as:

$$\text{simple deposit multiplier} = \frac{1}{rrr} \tag{43}$$

where rrr is the required reserve ratio.
Given rrr, the change in money supply, ΔM, due to a change in bank reserves, $\Delta reserves$, can be computed as:

$$\Delta M = \left(\frac{1}{rrr}\right) \times \Delta reserves \tag{44}$$

2. The quantitiy theory of money can be formulated as follows:

$$M \times V = P \times V \tag{45}$$

where M is money supply, V is the velocity of money, P is the price level, Y is real output. The velocity of money measures the average number of times each dollor in the money supply is spent in the economy, which can be calculated by:

$$V = \frac{P \times Y}{M} \tag{46}$$

3. Implications of the quantity theory of money. We can derive the following relationship from the quantity theory of money:

$$\pi = g_M + g_V - g_Y \tag{47}$$

Assume $g_V = 0$, the above formula becomes:

$$\pi = g_M - g_Y \tag{48}$$

where π is the inflation rate, g_M is the growth rate of the money supply, g_V is the growth rate of the velocity of money, g_Y is the the growth rate of real output. The formula shows that inflation results from the money supply growing at a faster rate than real output. Data show this is true for the US economy in the long run.
The derivations of the above formula is as follows[1]:
Starting from $M \times V = P \times Y$, take logs of both sides, we have:

$$log(M) + log(V) = log(P) + log(Y) \tag{49}$$

Then take derivatives on both sides, we get:

$$\frac{dM}{M} + \frac{dV}{V} = \frac{dP}{P} + \frac{dY}{Y} \tag{50}$$

or

$$\frac{\Delta M}{M} + \frac{\Delta V}{V} = \frac{\Delta P}{P} + \frac{\Delta Y}{Y} \tag{51}$$

That is:

$$g_M + g_V = \pi + g_Y \tag{52}$$

i.e.

$$\pi = g_M + g_V - g_Y \tag{53}$$

8 Chapter 14. Monetary Policy

1. The Taylor rule links the FED's target for the federal funds rate to economic variables such as inflation gap and output gap. With weights of $1/2$ for both gaps, we have the following Taylor rule:

$$R_t^* = \pi_t + r_t + \frac{1}{2} \times (\pi_t - \pi^*) + \frac{1}{2} \times (\log Y - \log Y^*) \tag{54}$$

where $R^*$is the federal funds target rate, r_t is the real equilibrium federal funds rate, π_t is the current inflation rate, $(\pi_t - \pi^*)$ is the inflation gap, $(\log Y - \log Y^*)$ is the output gap.

9 Chapter 15. Fiscal Policy

1. The ratio of the change in equilibrium real GDP to the initial change in government purchase is known as the government purchase multiplier:

$$\text{Government purchases multiplier} = \frac{\Delta Y}{\Delta G} \tag{55}$$

Tax cuts also have a multiplier effect:

$$\text{Tax multiplier} = \frac{\Delta Y}{\Delta T} \tag{56}$$

[1]The derivations will not be tested.

10 Chapter 18. The International Financial System

1. The nominal exchange rate E is the price of domestic currency in terms of a foreign currency. Economists also calculate the real exchange rate e, which corrects the nominal exchange rate for changes in prices of goods and services:

$$e = \frac{P \times E}{P_f} \tag{57}$$

where P is the domestic price level, P_f is the foreign price level.