14.02 Principles of Macroeconomics

Problem Set 1 Solutions

Fall 2017

Question 1: Economic Data (Lecture 2)

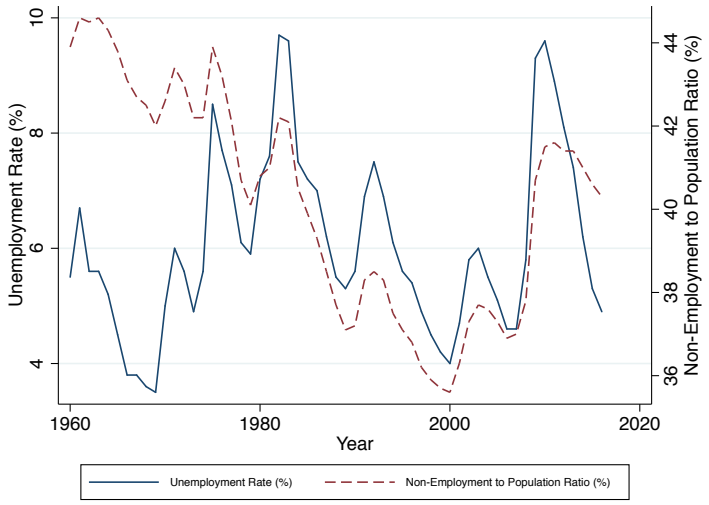

Figure 1: Unemployment rate and non-employment to population ratio

(a). Unemployment and Non-employment

1. The blue solid line in Figure 1 shows the evolution of unemployment rate over the period of 1960-2016.

2. The red dashed line in Figure 1 shows the evolution of non-employment to population ratio over the period of 1960-2016.

3. Non-employment to population ratio is the fraction of people not having a job over the civilian population[1]. Unemployment rate is the fraction of people not having a job **and looking for a job** over the labor force. As you can see from Figure 1, as of 2016, the unemployment rate is similar the pre-crisis level, while non-employment to population ratio is substantially higher than the pre-crisis level. This means many people stopped looking for a job after the financial crisis, while people who look for a job are finding jobs. Why is this? This is pretty much still an open question.

You also notice there is one more period where two statics behave very differently, 1960-80. This is the period where female labor force participation grew substantially.

(b). Okun's Law and Phillips Curve

4. The left panel of Figure 2 shows the Okun's Law.

5. The right panel of Figure 2 shows the Phillips Curve.

[1]Civilian population refers to noninstitutional (not in military, polic, jail, etc) population with age over 16. This is not important here.

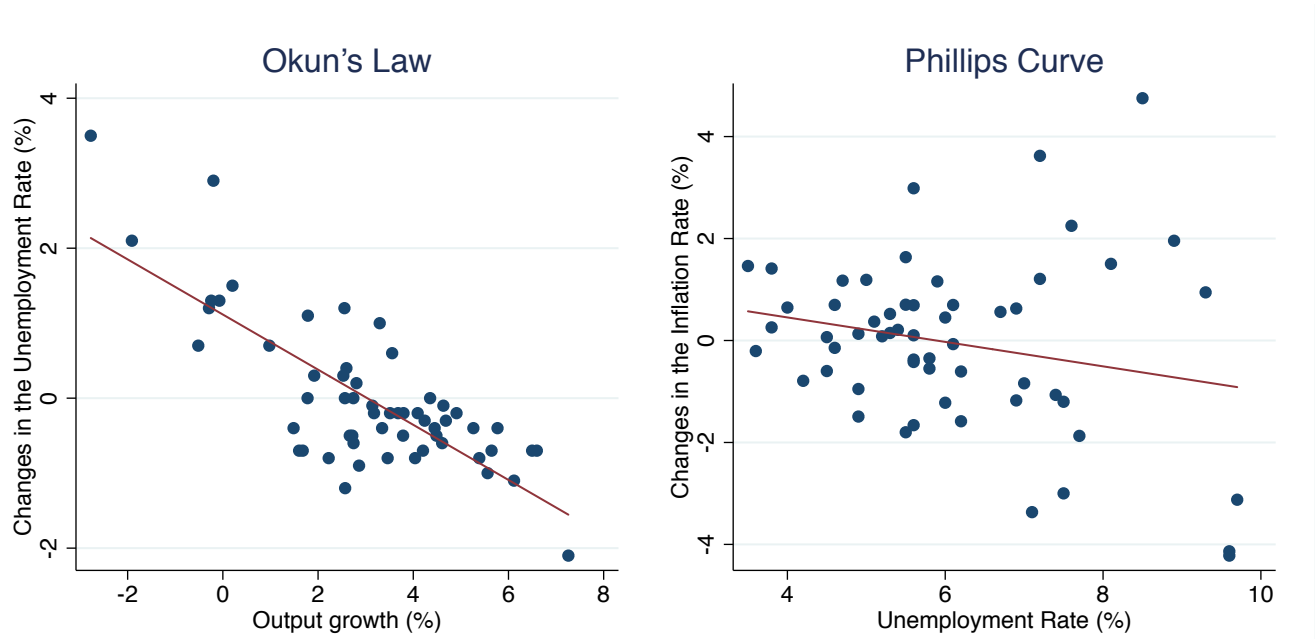

Figure 2: Unemployment rate and non-employment to population ratio

Question 2: NGDP, RGDP, Inflation (Lecture 2)

(a) Three Ways to Measure GDP

1. The final good in this economy is a car, and its value is \$500. Therefore GDP as the value of final goods and services produced in this economy is \$500.

2. The value added of steel company is $\$130 - \$40 = \$90$. The value added of oil company is $\$200 - \$110 = \$90$. The value added of car company is $\$500 - \$20 - \$160 = \$320$. Hence, GDP as the sum of the value added in the economy is computed as $\$90 + \$90 + \$320 = \$500$.

3. The sum of labor income is $\$10 + \$70 + \$220 = \$300$. The sum of profit income is $\$80 + \$20 + \$100 = \$200$. Hence, GDP as the sum of incomes in this economy is $\$300 + \$200 = \$500$.

(b) Real and Nominal GDP

Year	Nominal GDP	Real GDP (base=2015)	GDP Deflator	Inflation Rate
2014	\$12,000	\$9,000	1.33	
2015	\$18,000	\$18,000	1	-25%
2016	\$20,400	\$24,000	0.8500	-15%

Table 1: Two-goods Example Economy

4. Nominal GDP is the sum of prices times quantities. Nominal GDP in 2014 is $\$2,000 \times 5 + \$200 \times 10 = \$12,000$. Nominal GDP in year 2015 is $\$1,000 \times 10 + \$400 \times 20 = \$18,000$. Nominal GDP in year 2016 is $\$1,200 \times 12 + \$200 \times 30 = \$20,400$.

5. Real GDP with base year 2015 can be computed as the sum of 2015 prices times quantities. Real GDP in 2014 is $\$1,000 \times 5 + \$400 \times 10 = \$9,000$. Real GDP in 2015 is $\$1,000 \times 10 + \$400 \times 20 = \$18,000$. Real GDP in 2016 is $\$1,000 \times 12 + \$400 \times 30 = \$24,000$.

6. GDP deflator, P_t, can be computed as the ratio of nominal GDP to real GDP:

$$P_t = \frac{\text{Nominal GDP}_t}{\text{Real GDP}_t}.$$

Inflation rate is defined as

$$\pi_t = \frac{P_t - P_{t-1}}{P_{t-1}}.$$

See Table 1 for computed values.

Question 3: Government Spending Multiplier (Lecture 3)

(a). Exogenous G and T

1. Substituting the expression for the disposable income, the consumption function can be written as

$$C = c_0 + c_1(Y - T).$$

Plug this expression into the demand equation to obtain

$$Z \equiv c_0 + c_1(Y - T) + I + G.$$

The equilibrium requires $Y = Z$. So

$$Y = c_0 + c_1(Y - T) + I + G,$$

which can be solved for Y:

$$Y = \frac{1}{1 - c_1}(c_0 + I + G - c_1 T). \tag{1}$$

2. The government spending multiplier is $\frac{1}{1-c_1}$. This value is greater than one, which means the increase in output is larger than the initial shift in demand. This comes from that a initial shift in government spending increases production and income, which further increases demand because consumers increase spending in response to an increase in income.

3. The equilibrium requires $Y = Z$. Therefore

$$Y = C + I + G.$$

Subtracting T from both sides and move C to the left side:

$$Y - T - C = I + G - T.$$

Because the left hand side is simply S, we have the IS relation:

$$S = I + G - T. \tag{2}$$

4. Because I and T are exogenous, in order the IS relation to hold, S must increase by the same amount as G.

(b). Balanced Budget, $G = T$

5. We can simply set $T = G$ in equation (1):

$$Y = \frac{1}{1 - c_1}(c_0 + I) + G.$$

6. The government spending multiplier in this economy is 1. This is smaller than the one we derived in 2. This is because households' taxes increase by the same amount that the government increases demand. Therefore households income is unchanged, which does not trigger multiplier effects.

7. We can simply set $T = G$ in equation (2):

$$S = I.$$

8. As is clear from the above equation, saving only depends on I, and does not depend on G. Therefore private saving does not change.

(c). Endogenous Tax Revenue

We now assume tax revenues depend on output. That is, we assume

$$T = t_0 + t_1 Y$$

with $t_0 \geq 0$, $0 < t_1 < 1$. Also assume G is exogenous.

9. The consumption function is now

$$\begin{aligned} C &= c_0 + c_1(Y - T) \\ &= c_0 + c_1(-t_0 + (1 - t_1)Y). \end{aligned}$$

Plug this expression into the demand equation to obtain

$$Z \equiv c_0 + c_1(-t_0 + (1 - t_1)Y) + I + G.$$

The equilibrium requires $Y = Z$. So

$$Y = c_0 + c_1(-t_0 + (1 - t_1)Y) + I + G,$$

which can be solved for Y:

$$Y = \frac{1}{1 - c_1(1 - t_1)}(c_0 + I + G - t_0 c_1). \tag{3}$$

10. The government spending multiplier in this economy is $\frac{1}{1-c_1(1-t_1)}$. This is greater than one, but smaller than the expression we derived in 2. This is because an increase in income is partly, but not fully, offset by an increase in taxes.

11. The public saving can be expressed as

$$\begin{aligned} T - G &= t_0 + t_1 Y - G \\ &= t_0 + \frac{t_1}{1 - c_1(1 - t_1)}(c_0 + I + G - t_0 c_1) - G \\ &= t_0 + \frac{t_1}{1 - c_1(1 - t_1)}(c_0 + I - t_0 c_1) - \frac{(1 - c_1)(1 - t_1)}{1 - c_1(1 - t_1)} G. \end{aligned}$$

Therefore public saving decreases by the amount $\frac{(1-c_1)(1-t_1)}{1-c_1(1-t_1)}$. This value is less than one because the government's tax revenue increases to partly offset the increase in expenditure.

12. From equation (3), we can see that multiplier on t_0 is $-\frac{c_1}{1-c_1(1-t_1)}$. It is negative because an increase in tax decreases demand.