ECON 3123: Macroeconomic Theory 1

Problem Set #3

Due Date: April 28, 2020

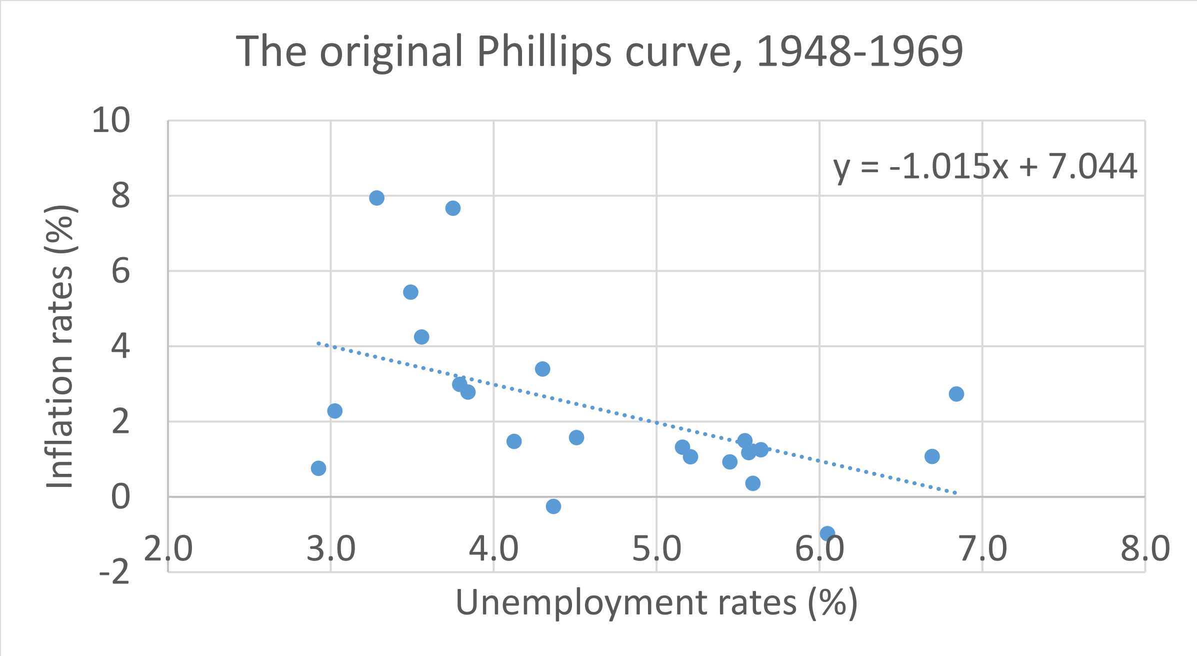
1. The Phillips curve in the United States

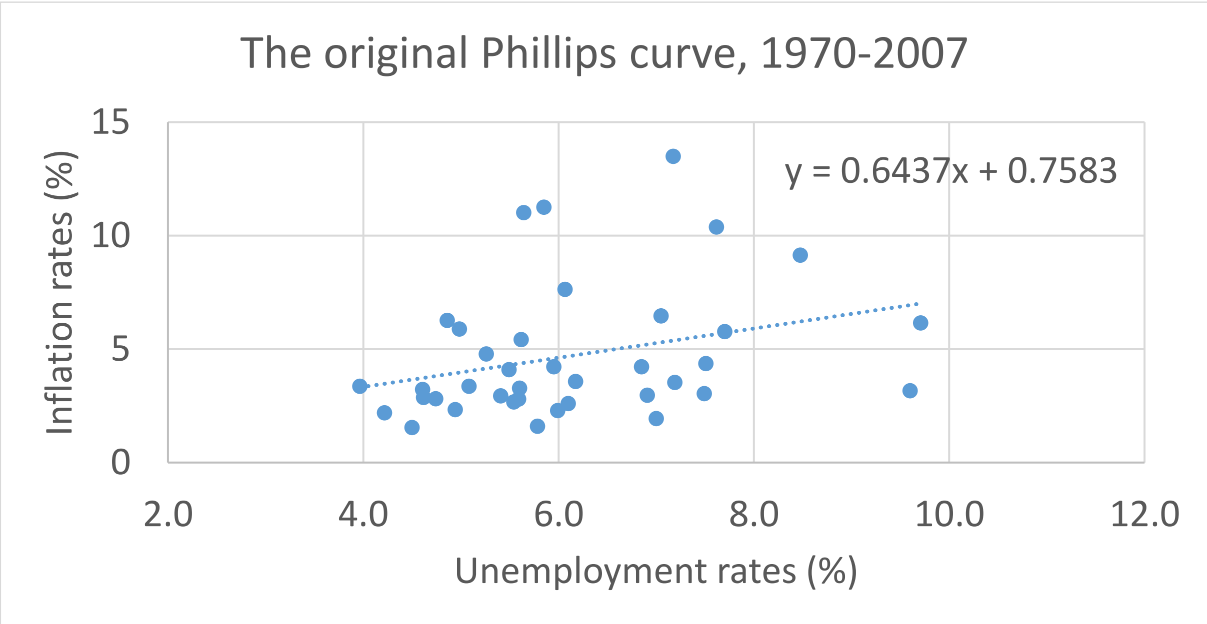
In this question, you will replicate some of the results in the lecture slides and estimate the Phillips curve by yourself.

(a) First, go to FRED, a webpage maintained by Federal Reserve Bank of St. Louis (https://fred.stlouisfed.org/). We will download data for the following variables in the US from 1947 to 2007: CPI[CPIAUCSL], unemployment rate[UNRATE], real GDP[GDPC1], and potential output[GDPPOT]. You can use the identifiers in the square brackets to find each variable. For example, you can search GDPPOT on FRED to find the real potential GDP. Click "EDIT GRAPH" button and modify frequency to annual by averaging monthly or quarterly series. Set the date from 1947 to 2007 and download the data.

(b) Compute the inflation rate, $\pi_t = \frac{P_t - P_{t-1}}{P_{t-1}} \times 100$, using the CPI. We multiply 100 to express the inflation rate in percent. Draw a scatter plot of π_t against u_t for two different sample periods: (i) 1948-1969, and (ii) 1970-2007. Does this version of the Phillips curve, $\pi_t = \beta - \alpha u_t$, match the data well? Add a trend line in each graph. Display the equation for the trend line. If you use Excel, you may find the following page useful: https://www.excel-easy.com/examples/trendline.html. Do not forget to label axis, specify units, and add a title for each figure.

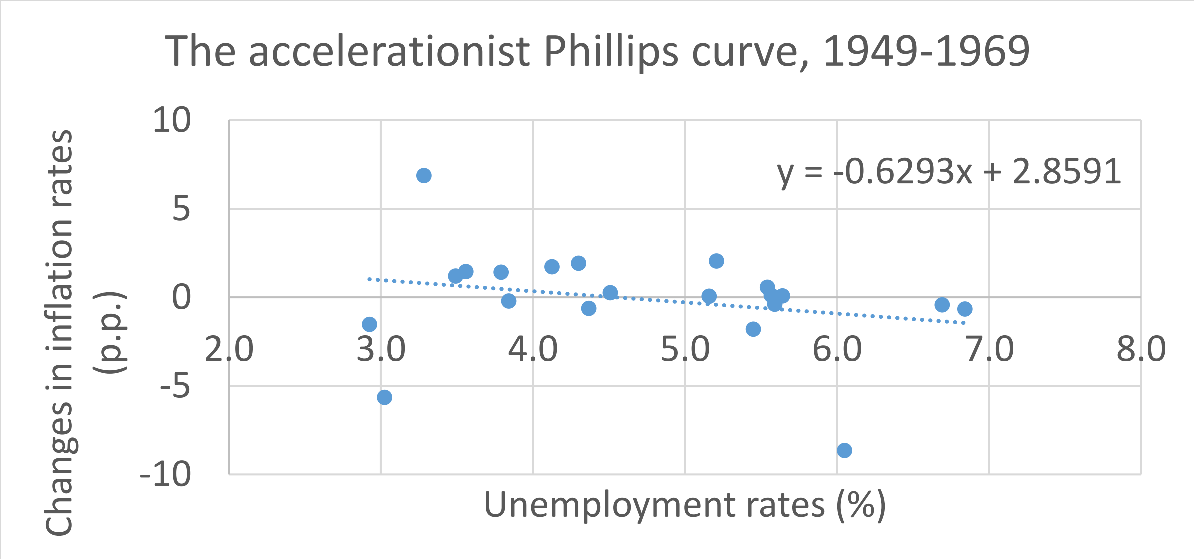
Although this version of the Phillips curve matches the data well before 1970, the negative relationship between π_t and u_t disappears after 1970.

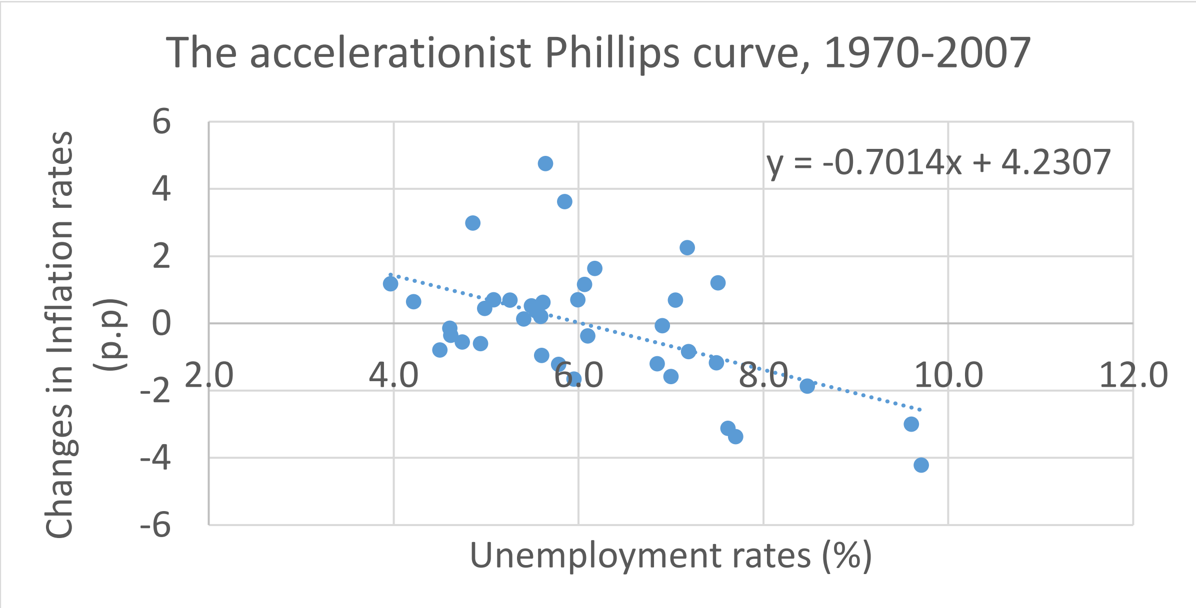




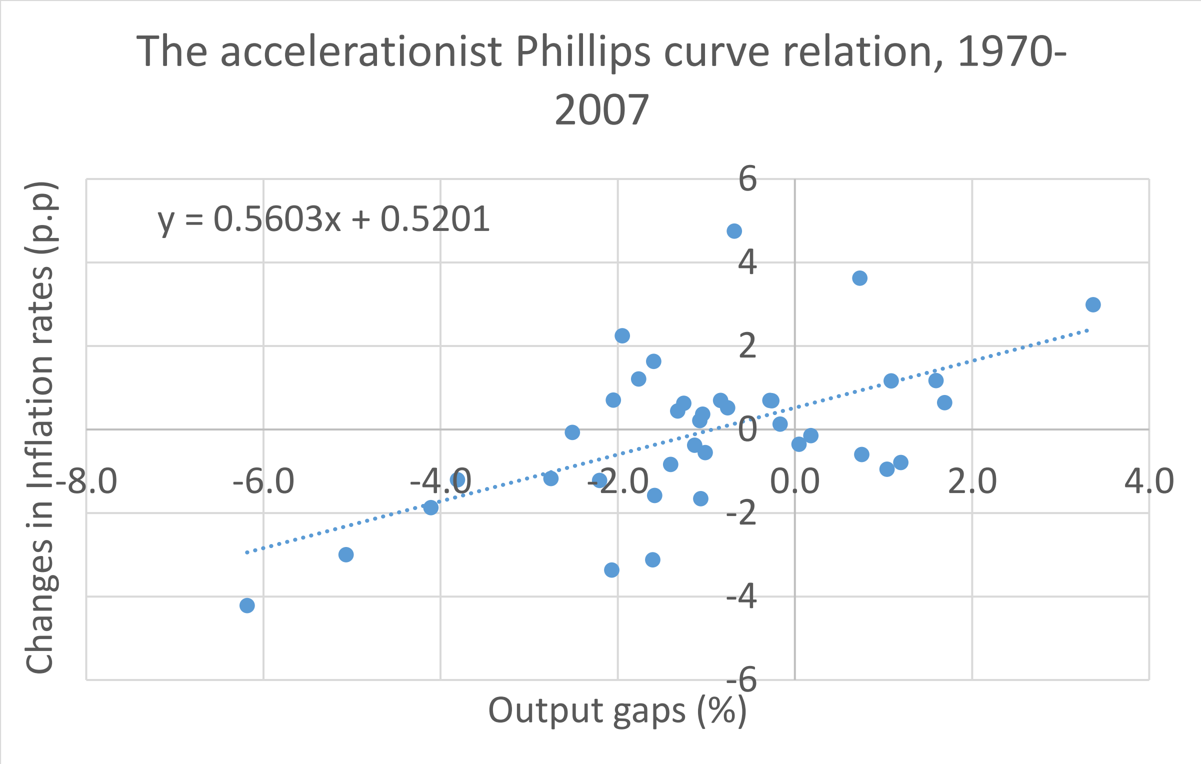
(c) To study the accelerationist Phillips curve, define a new variable, $\Delta\pi_t = \pi_t - \pi_{t-1}$. Draw a scatter plot of $\Delta\pi_t$ against u_t for two different sample periods: (i) 1949-1969, and (ii) 1970-2007. Does this version of the Phillips curve, $\Delta\pi_t = \gamma - \alpha u_t$, match the data well? Add a trend line in each graph. Display the equation for the trend line. Do not forget to label axis, specify units, and add a title for each figure.

For the periods after 1970, the accelerationist Phillips curve fits the data reasonably well.





(d) Next, we turn to the Phillips curve relation. For this question, we express the output gap in a percentage deviation of real GDP from the potential output. That is, we consider a relationship between $\Delta\pi_t$ and $\frac{Y_t - Y_{n,t}}{Y_{n,t}} \times 100$, where $Y_{n,t}$ is the potential output in year t. Draw a scatter plot, add a trend line, and display the equation for the trend line based on the sample from 1970 to 2007. Do you find a positive relationship between the two variables as expected from the theory?



Yes. When output increases by 1% of the potential output, $\Delta\pi_t$ increases by 0.56 percentage points on average.

2. Derivation of the Phillips curve

Suppose that the price-setting relation and the wage-setting relation are given by

$$P = (1+m)\frac{W}{\mathcal{A}}, \qquad W = \mathcal{A}P^e F(u,z),$$

where $m = 0.15$, $F(u,z) = 1 - \alpha u + z, z = -0.05$, *and* $\alpha = 2$.

(a) Derive the Phillips curve.

$$\pi_t = \pi_t^e + (m+z) - \alpha u_t = \pi_t^e + 0.1 - 2u_t.$$

(b) Compute the natural rate of unemployment, u_n, in this economy.

$$u_n = \frac{m+z}{\alpha} = 0.05 = 5\%.$$

(c) Suppose that the aggregate production function is given by $Y = \mathcal{A}N$, where $\mathcal{A} = 1$ and $L = 100$. Compute the natural level of output in this economy.

$$Y_n = \mathcal{A}N_n = \mathcal{A}L(1 - u_n) = 1 \times 100 \times (1 - 0.05) = 95.$$

(d) Redo (b)-(c) when $\mathcal{A} = 1.1$.

Because u_n does not depend on $\mathcal{A}$, only Y_n increases by 10 percent to $1.1 \times 95 = 104.5$.

3. (A Version of Blanchard (2017), #5-6, p. 193.)

Suppose that the Phillips curve is given by

$$\pi_t = \pi_t^e + 0.1 - 2u_t.$$

(a) Suppose that $\pi_t^e = \pi_{t-1}$ and inflation in the previous period was 2%. In year t, the central bank decide to bring the unemployment rate to 4% forever. Derive the rate of inflation in year t, $t+1$, $t+2$, and $t+3$.

When $u_t = 0.04$, $\pi_t - \pi_t^e = \pi_t - \pi_{t-1} = 0.1 - 0.08 = 0.02$. Thus, we have the following result.

Year	$t-1$	t	$t+1$	$t+2$	$t+3$
π	0.02	0.04	0.06	0.08	0.10

(b) After observing the evolution of π_t, the central bank decides to change u_{t+4} and u_{t+5} to u_n. Compute π_{t+4} and π_{t+5}.

In this economy, $u_n = 0.05$. When $u_{t+4} = u_n$, we have $\pi_{t+4} - \pi_{t+3} = 0$. Thus, $\pi_{t+4} = \pi_{t+3} = 0.10$. Similarly, $\pi_{t+5} = \pi_{t+4} = 0.10$.

(c) Because π_{t+5} is too high, the central bank tries to reduce it to 2%. What should be u_{t+6} to make $\pi_{t+6} = 2\%$?

Note that $\pi_{t+6} = \pi_{t+5} + 0.1 - 2u_{t+6}$. To have $\pi_{t+6} = 0.02$, given $\pi_{t+5} = 0.10$, u_{t+6} should be 9%, higher that u_n by 4 percentage points.

Rearranging the Phillips curve in terms of the unemployment gap helps us to better understand the situation. Because $\Delta\pi_{t+6} = -2(u_{t+6} - u_n)$, we need to raise u to a value greater than u_n to lower inflation (i.e. $\Delta\pi < 0$).

(d) Redo (a)-(c) when the inflation expectation is anchored to $\bar{\pi} = 2\%$.

In this case, $\pi_t = 0.02 + 0.1 - 2u_t = 0.12 - 2u_t$. The results are shown in the following table.

Year	$t-1$	t	$t+1$	$t+2$	$t+3$	$t+4$	$t+5$	$t+6$
u	-	0.04	0.04	0.04	0.04	0.05	0.05	0.05
π	0.02	0.04	0.04	0.04	0.04	0.02	0.02	0.02

(e) Explain why the FRB needed to induce a recession in the early 1980s to end the period of the Great Inflation in the 1970s and stabilize the rate of inflation at a low value.

The inflation dynamics in the US economy since 1970 (at least until the Great Recession) are well captured by the accelerationist Phillips curve. Therefore, the central bank needed to induce a recession (or, higher u than u_n) to lower the inflation.

4. The effects of a fiscal expansion when the inflation expectation is anchored

In this question, you are asked to investigate the short and medium run effects of a fiscal expansion when $\pi_t^e = \bar{\pi}$. When you draw a diagram below, label all curves, lines, axes, and relevant points clearly.

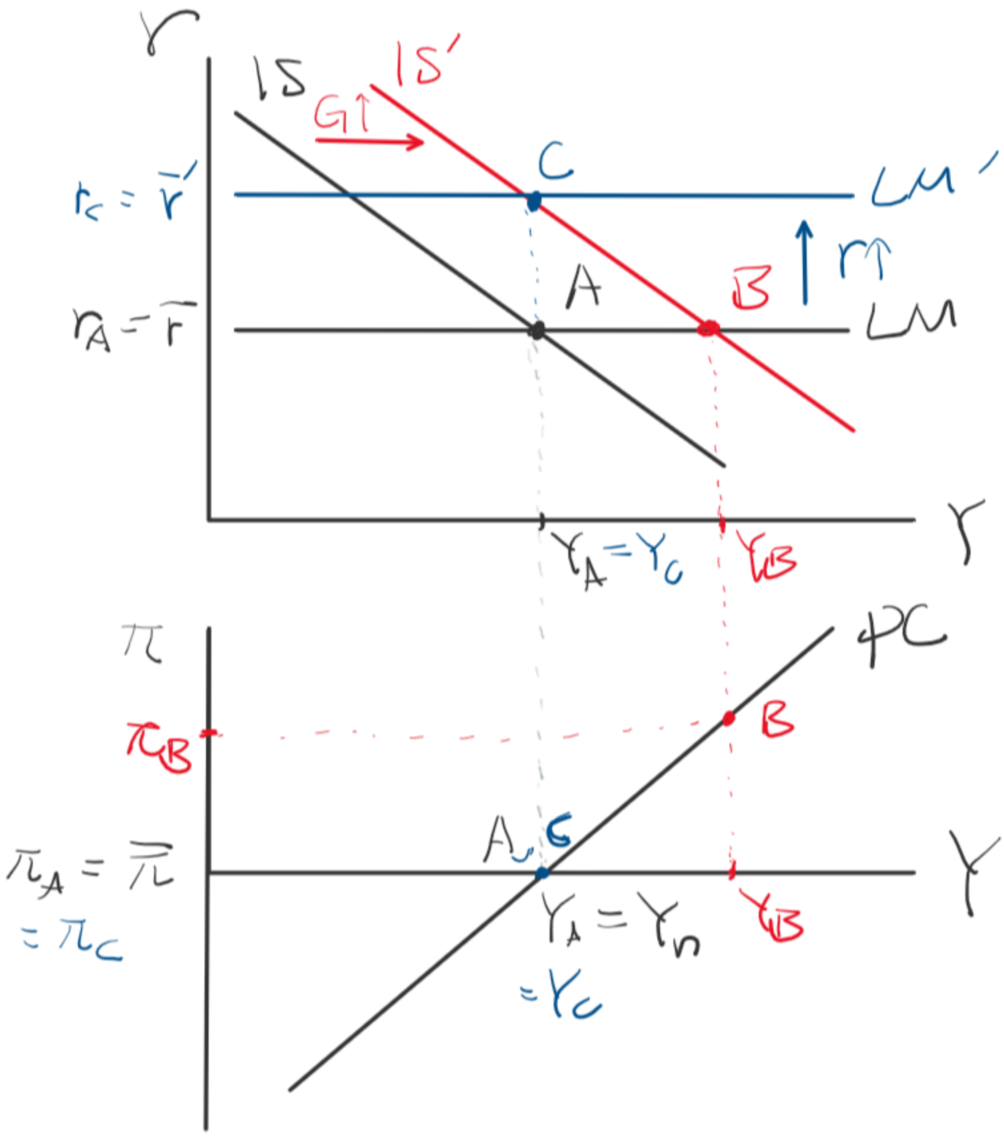
(a) Draw a diagram for the IS-LM-PC model. Denote the initial equilibrium by point A. For simplicity, assume that output at point A is equal to the natural level of output ($Y_A = Y_n$).

(b) Suppose that the government increases G. Denote the new short-run equilibrium by point B. What will be the effect of this change on Y, C, I, π, u, i, and r?

The IS curve shifts to the right. Given the new IS curve, labelled by IS', the economy moves from point A to point B. Thus, Y increases. As the disposable income increases, C increases. Because Y increases and r does not change, I increases. As the economy moves along the PC curve from point A to point B, π increases. To produce more output, N increases and u decreases in the labor market. r stays at the same level. Because $i = r + \pi^e = \bar{r} + \bar{\pi}$, i also does not change in the short run.

(c) Suppose that the central bank adjusts i to stabilize output in response to an increase in G. Denote the medium-run equilibrium by point C. Compare Y, C, I, π, u, i, and r under points A and C.

The central bank raises r to $\bar{r}'$. The LM curve shifts upward to the new curve, labelled by LM'. At point C, the medium-run equilibrium, $Y_C = Y_n = Y_A$. Because the same disposable income is the same at points A and C, $C_C = C_A$. As $r_C > r_A$, $I_C < I_A$. Because $Y = C + I + G$ and Y and C do not change, I should decrease by the amount that G increases. At the medium-run equilibrium, $\pi_C = \pi_C^e = \bar{\pi} = \pi_A$. As $Y_C = Y_A$, $u_C = u_A$. Because $r_C > r_A$, $i_C = r_c + \bar{\pi} > r_A + \bar{\pi} = i_A$.


r
IS
IS'
G↑
C
$r_C = \bar{r}'$
LM'
r↑
A
B
$r_A = \bar{r}$
LM
Y
$Y_A = Y_C$
Y_B
π
PC
π_B
B
A, C
$\pi_A = \bar{\pi}$
$= \pi_C$
Y
$Y_A = Y_n$
$= Y_C$
Y_B