Problem Set 8: Macroeconomic Policy

Due April 27/28

A) Public Goods: During the reign (27 BC-14 AD) of Gaius Julius Caesar Octavianus Imperator Divi Filius Augustus, the estimated population of Rome was one million people, with an average income *per capita* of 1 sestertius (say, $1 at today's prices) a day. Suppose that you are advising Marcus Vipsanius Agrippa on the renovation/construction of the aqueducts of Rome —the Aquae Appia, Anio, Claudia, Marcia, Julia, and Virgo, and perhaps more. Suppose that the value of the system of aqueducts to the average Roman, in sesterces per day, is given by the table to the right:

Suppose that the interest rate used to properly amortize the cost of renovating the aqueducts is 5%/year, and that depreciation—the cost of keeping the aqueducts in good repair—is an additional 5%/year, so that the total amortization cost of investing in aqueducts is 10%/year.

Aquae Romae

Number of Aqueducts	Total Value per Roman per Day
0	0.0000
1	0.2500
2	0.3125
3	0.3403
4	0.3559
5	0.3659
6	0.3728
7	0.3779
8	0.3819
9	0.3849
10	0.3874

1. With 365 days/year, what is the annual value of the first aqueduct to the average Roman? How much, at a 10%/year amortization rate, is the average Roman's willingness to pay for one aqueduct?

The annual value to the average Roman is 0.25HS/day x 365 days/year = 91.25HS/year. At an amortization rate of 10%/year, he or she would have a willingness-to-pay of 912.5HS for the capital value for the first aqueduct.

2. What is the annual value of 10 aqueducts to the average Roman? How much, at a 10%/year amortization rate, is the average Roman's willingness to pay for ten aqueducts?

The annual value to the average Roman is 0.3874HS/day x 365 days/year = 141.45HS/year. At an amortization rate of 10%/year, he or she would have a willingness-to-pay of 1,414.5HS for the capital value of ten aqueducts.

3. With 1 million Romans and at a 10%/year, what is the maximum willingness-to-pay of the entire population of Rome for one aqueduct? For ten aqueducts?

Simply multiply the answers to (1) and (2) by one million, and get: 912,500,000HS and 1,414,500,000HS, respectively.

4. Suppose that renovating each aqueduct costs 10,000,000HS. How many aqueducts should Marcus Vipsanius Agrippa use his *imperium* to command that they be renovated/constructed? What is the optimum number of aqueducts?

Renovating/building the ninth aqueduct boosts the capitalized value to Romans of the aqueduct system by 11,265,432HS. Renovating the tenth aqueduct would boost the capitalized value to Romans of the aqueduct system by only 9,125,000HS. M. Vip. Agrippa should stop after aqueduct number 9 to maximize societal surplus.

5. What are the overall benefits and costs if M. Vip. Agrippa commands the renovation/ construction of the optimum number of aqueducts? What is the benefit/cost ratio?

The total benefits are 1,414,163,054HS. The total costs are 90,000,000HS. The benefit/cost ratio is 15.7

6. In a first-century BC Rome where the average wage is only 3HS/day, how can it possibly be worthwhile spending such unbelievably large amounts of money—the total pay for an entire legion of soldiers for three years—on building stone ditches to carry water from upstream to the city of Rome?

The Tiber River has a flow of 4 billion gallons/day—at least 1000 times as much as would be needed to water a population of 1,000,000. Yet without relatively clean water from upstream a city the size of Classical Rome would have been unsustainable. Individual willingness-to-pay is relatively high. And aqueducts that capture even a small portion of the total flow produce water in an abundance large enough to become a *public good*.

B) Macro Policy: The level of real potential output in the United States in 2022 might be $19 trillion, it might be $20 trillion, and it might be $21 trillion. Suppose that the Keynesian multiplier is 3, that private-spending flows are such that $c_o+I_o+NX = \$4.5$ trillion, and that even the most expansionary Federal Reserve policy cannot push the long-term risky real interest rate r below zero.

1. What should the government set real government purchases at in 2022 if potential GDP will be $19 trillion?

The government should aim to make total real spending equal to potential output. It should thus take its estimate of potential GDP of $19 trillion, divide it by the multiplier to get $6.333 trillion, subtract off the private spending flows to get $1.8333 trillion—that is the desired level of government purchases in 2022 if potential output will be $19 trillion.

2. What should the government set real government purchases at in 2022 if potential GDP will be $20 trillion?

The government should aim to make total real spending equal to potential output. It should thus take its estimate of potential GDP of $20 trillion, divide it by the multiplier to get $6.667 trillion, subtract off the private spending flows to get $2.167 trillion—that is the desired level of government purchases in 2022 if potential output will be $20 trillion.

3. What should the government set real government purchases at in 2022 if potential GDP will be $21 trillion?

The government should aim to make total real spending equal to potential output. It should thus take its estimate of potential GDP of $21 trillion, divide it by the multiplier to get $7 trillion, subtract off the private spending flows to get $2.5 trillion—that is the desired level of government purchases in 2022 if potential output will be $21 trillion.

4. Suppose the government is uncertain about what the level of real potential GDP will be, but has to choose the level of government purchases in advance. Suppose further that the Federal Reserve does not have to set monetary policy until after the value for government purchases G has been chosen—and the Federal Reserve will not have to choose its monetary policy until after it learns what the level of potential output in 2022 will be. What level of G should the government choose?

The obvious strategy is for the government to choose G as if potential output will be $21 trillion, and then let the Federal Reserve take on the burden and raise interest rates to reduce spending if it learns that the level of potential output will be either $20 trillion or $19 trillion.

5. In October 2015 Governor of the Federal Reserve Lael Brainard said: "The downside risks… argue against prematurely taking away the [low-interest rate] support that has been so critical…. These risks matter more than usual because the ability to provide additional accommodation if downside risks materialize is, in practice, more constrained than the ability to remove accommodation more rapidly if upside risks materialize. The asymmetry in risk management stems from the combination of the likely low current level of the neutral real interest rate and the effective lower bound…. We have considerably greater latitude to adjust the path of policy in response to inflation that exceeds current forecasts than we have to provide additional accommodation in response to additional adverse [spending] shocks…" What is she saying here?

She is saying what your answer to (4) should have been: that the obvious strategy is to create a situation such that if any adjustment is required in Federal Reserve policy, it is that the Federal Reserve should raise interest rates in response to good news about the economy's level of production rather than lower them in response to bad news about the economy's level of production—because it is not at all clear that it will be able to do the latter.

6. Why wasn't your answer to (4): "A government uncertain about what the level of real potential GDP will be that has to choose the level of government purchases in advance should act as if real potential output is relatively low and let the Federal Reserve take on the burden and lower interest rates if it learns that the level of potential output will be high"?

In normal times that would be a fine strategy. But here and now the Federal Reserve's interest-rate tool is maxed out: the interest rate is at its zero lower bound. So the Federal Reserve can deal with a situation in which the actions of the rest of the government are leading spending to be "too high". It cannot, right now, deal with a situation in which the actions of the rest of the government are leading spending to be "too low".

C) Basic Micro: The population of Berkeley is roughly 100,000—and the average Berkeley resident buys one latte a day at an average price per latte of $4.

1. Suppose that the maximum willingness-to-pay for a latte in Berkeley is $14 and that the daily demand for lattes is linear—a straight line. What is the equation for the demand curve?

P = 14 - 0.0001Q

2. Suppose that it is easy and cheap to open a cafe to make lattes, so that there are no fixed costs, and there are neither increasing nor decreasing returns to scale. What do you think the supply curve for lattes would be?

The lack of fixed costs and of economies or diseconomies of scale tells us that the supply curve is flat at marginal cost:

P = 4 is the supply curve.

3. What is the equilibrium price? What is the equilibrium quantity?

We told you this at the start of the question! Q* = 100,000/day; P = $4/latte

4. What is the consumer, producer, and total surplus?

CS = 1/2 * 100,000 * $10 = $500,000/day
PS = 0
TS = $500,000/day

5. What is the contribution of the latte business in Berkeley to GDP?

$400,000/day of final goods and services are sold, so $400,000/day. It is interesting to note that surplus is of the same order of magnitude as GDP contribution—this is, in general, roughly true for physical, rival, and excludible goods, but not true for information goods.

6. Suppose the city of Berkeley grants a monopoly right to sell lattes and all drinks that are close substitutes for lattes to a single monopoly—the Berkeley Monopoly Cooperative. What price would it set for lattes? How many would it sell? How much consumer and producer surplus would be generated?

Remember: the monopolist's marginal revenue curve has the same y-intercept as the (linear) demand curve and twice the slope. The marginal cost curve is simply the supply curve. The MR curve intercepts the MC curve at Q = 50,000/day. The price is then P = $9/latte.

The consumer surplus is cut by 3/4—only half as many people get lattes, and the typical person who gets a latte gets only half the surplus the typical person got in the competitive equilibrium—to $125,000

Producer surplus is 50,000 lattes/day x $5/latte = $250,000/day

1/4 of surplus has been dissipated, and half the surplus has been transferred from consumers to producers…