Homework 6 (48 Points)

Problem 1 (12 Points)

In a village, each person has the following willingness to pay for beer:

1^{st} bottle	\$5
2^{nd}	4
3^{rd}	3
4^{th}	2
5^{th}	1
Further bottles	0

1. The cost of producing beer is \$1.50, and the competitive suppliers sell it at this price. (The supply curve is horizontal.) How many bottles will each villager consume? What is each person's consumer surplus? (2 Points)

2. Suppose producing beer creates pollution. Each bottle has an external cost of \$1. Taking this additional cost into account, what is total surplus per person? (2 Points)

3. A villager, Cindy, decides on her own to reduce her consumption of beer by one bottle. What happens to Cindy's welfare (her consumer surplus minus the cost of pollution she experiences)? How does Cindy's decision affect total surplus in the village? (2 Points)

4. The mayor of the village imposes a \$1 tax on beer. What is consumption per person now? Calculate consumer surplus, the external cost, government revenue, and total surplus per person. Based on your calculations, would you support the mayor's policy? (6 Points)

Problem 2 (4 Points)

There are three industrial firms in Happy Valley.

Firm	Initial Pollution	Cost of Reducing Pollution by 1 Unit
A	70 units	$20
B	80 units	$25
C	50 units	$10

The government wants to reduce pollution to 120 units, so it gives each firm 40 tradable pollution permits.

1. Who sells permits and how many do they sell? Who buys permits and how many do they buy? (2 Points)

2. What is the total cost of pollution abatement in this situation? How much higher would the costs of pollution reduction be if the permits could not be traded? (2 Points)

Problem 3 (4 Points)

The following table shows the marginal costs for each of four firms (A, B, C, and D) to eliminate units of pollution from their production processes. For example, for Firm A to eliminate one unit of pollution, it would cost $54, and for Firm A to eliminate a second unit of pollution it would cost an additional $67.

Firm	A	B	C	D
1st unit	54	57	54	62
2nd unit	67	68	66	73
3rd unit	82	86	82	91
4th unit	107	108	107	111

1. If the government charges a pollution tax of $69 per unit, how many units of pollution would the firms eliminate altogether? (2 Points)

2. If the government wants to reduce pollution from 16 units to 6 units, what levels of pollution tax would achieve that goal? (2 Points)

Problem 4 (6 Points)

There are two firms in the market, company A and company B. Without taxation, both are currently emitting 100 metric tons of greenhouse gas (GHG) each year. To reduce q metric tons of emission, the marginal abatement cost for A is $mc = 5q$. The marginal abatement cost for B is $mc = 10q$.

The government is considering charging a price for emission in the form a carbon tax.

1. Derive the market demand for GHG emission as a function of emission price. (2 Points)
2. It is determined that each metric ton of GHG emission will cause \$100 equivalent of damage to the environment. What is the marginal benefit of emission reduction? What is the optimal level of tax the government should impose? (2 Points)
3. If, instead of taxation, the government implements a cap-and-trade system, what is the level of cap the government should set? (2 Points)

Problem 5 (22 Points)

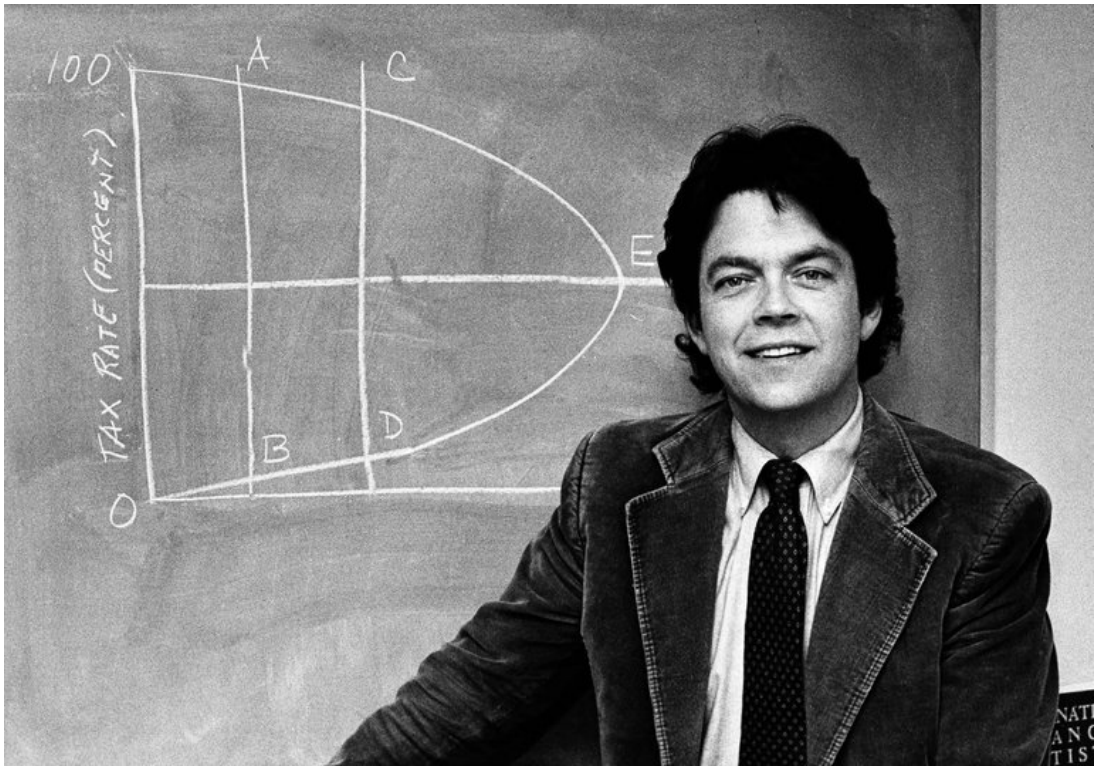
The Laffer curve, named after Economist Arthur Laffer, is a representation of the theoretical relationship between rates of taxation and the resulting levels of government revenue. In this exercise, we derive the Laffer curve for a hypothetical labor market. Suppose the labor market is described by the following supply and demand equations:

$$\begin{aligned} \text{Supply: } Q_S &= 2W \\ \text{Demand: } Q_D &= 100 - 8W \end{aligned}$$

, where W denotes hourly wage, Q_S is the quantity of labor supplied (in hours), and Q_D is the quantity of labor demanded (in hours).

1. What are the equilibrium wage and hours of employment in this market? (2 Points)
2. Now suppose we impose an ad-valorem wage tax $\tau \in (0, 1)$ on the workers. Let W^b denote before-tax wage and let W^f denote after-tax wage[1]. Solve for equilibrium W^b and W^f as a function of τ. (2 Points)

[1] For example, suppose $\tau = 0.1$ (a 10% tax rate), then $W^f = (1 - \tau) W^b = 0.9W^b$.



Arthur Laffer in 1981

3. In the same graph, plot the relationship between τ and W^b, and the relationship between τ and W^f[2]. (2 Points)

4. Solve for tax revenue as a function of τ. (2 Points)

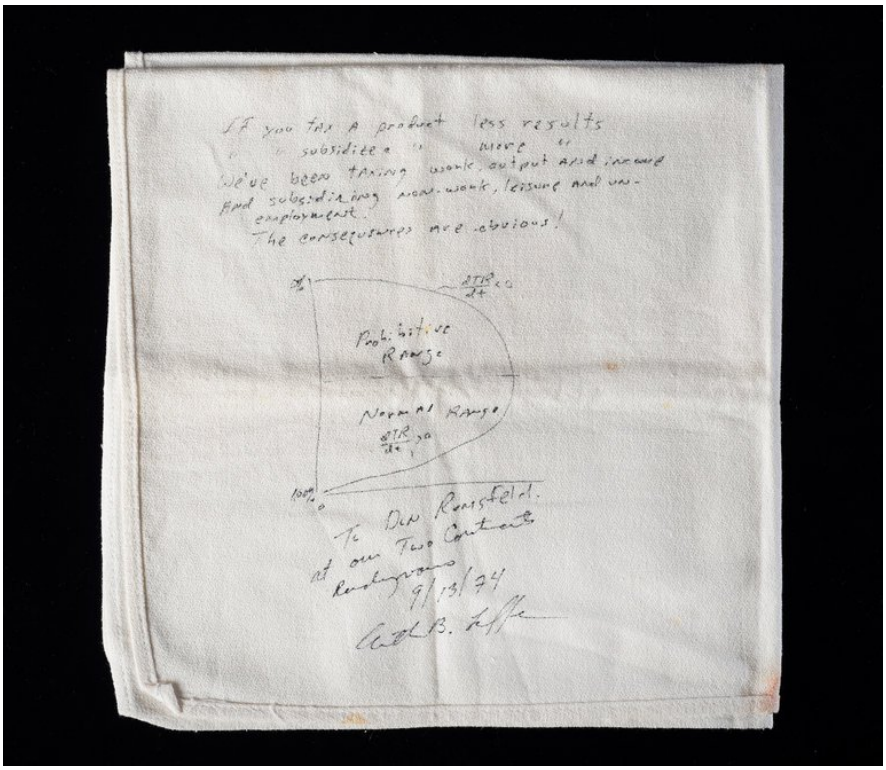
5. Plot the relationship between the tax rate τ and tax revenue – This is the Laffer curve. (2 Points)

6. Let τ^* denote the tax rate at which tax revenue is maximized. Calculate τ^*. (2 Points)

7. Solve for deadweight loss as a function of τ. (2 Points)

8. Plot the relationship between τ and deadweight loss. (2 Points)

[2]For this question and question 6 and 9, plot τ on the horizontal axis.



The Laffer Curve napkin is on display at the National Museum of American History . For the story behind it, read this article.

The Laffer curve shows that at high tax rates ($\tau > \tau^*$), cutting tax can lead to higher tax revenue. Some people, such as Laffer himself, have therefore advocated cutting U.S. income taxes for many years, believing that U.S. income taxes have always been too high and that cutting income taxes can lead to more, not less, government revenue. This is sometimes called the Laffer Hypothesis. Most economists, however, disagree[3].

In this exercise, let us look at what happened to U.S. government revenue after two of the largest tax cuts in recent U.S. history: (a) The Economic Recovery Tax Act of 1981 (ERTA), a.k.a. the 1981 Reagan tax cut, which, among other things, reduced top marginal income tax rate from 70% to 50%; and (b) The Economic Growth and Tax Relief Reconciliation Act of 2001 (EGTRRA), a.k.a. the 2001 Bush tax cut, which, among other things, reduced top marginal rate from 39.6% to 35%[4].

[3]See responses to Question B in the linked article. David Autor, for example, responds: "Not aware of any evidence in recent history where tax cuts actually raise revenue."

[4]Reagan himself believed in the Laffer Hypothesis. Here is what he said before signing the ERTA:

> "...our kind of tax cut will so stimulate the economy that we will actually increase government revenues..." July 7, 1981 speech.

The FRED database at the Federal Reserve Bank of St. Louis contains data on federal government tax receipts . To look at the impact of the 1981 Reagan tax cut, we look at government tax receipts from 1977 to 1986. To look at the impact of the 2001 Bush tax cut, we look at government tax receipts from 1997 to 2006. To adjustment for inflation, divide tax receipts by the GDP Implicit Price Deflator[5]. We will call tax receipts that are not adjusted for inflation "*nominal* tax receipts," and those that have been adjusted for inflation "*real* tax receipts."

10. Plot *real* U.S. government tax receipts from 1977 to 1986. What does the data suggest about the effect of the 1981 Reagan tax cut on government revenue? (2 Points)

11. Plot *real* U.S. government tax receipts from 1997 to 2006. What does the data suggest about the effect of the 2001 Bush tax cut on government revenue? (2 Points)

12. Do the experiences of these two major tax cuts validate the Laffer Hypothesis[6]? (2 Points)

[5]We will talk about inflation and how to adjust for it later in this course. For now, you can just assume that by dividing tax revenue by the GDP deflator, we are able to "get rid of" inflation, which allows us to better compare tax revenues in different time periods.

[6]Our analysis here is of course not rigorous – many things other than tax cuts happened during those years. A careful analysis needs to parcel out the effects of various causes. For more rigorous analysis of the revenue impact of major tax cuts in U.S. history, see the literature summarized here.