Problem Set #3 - Answers
Due October 5, 1998

1. Jack takes a job as a water carrier that pays him $14 per hour instead of a safer job that pays $12, even though he knows that, across the country, fourteen water carriers have died from falls in the last ten years. Over that period of time, about 800 men and women have been employed (full time – 40 hours/week, 50 weeks/year) as water carriers.

   Based on this information, calculate a value for Jack's life that could be used to measure the benefit to him of a public policy that would make Jack safer. Is this value an upper bound or a lower bound for the value that Jack places on his life?

   Ans:

   Jack finds the extra $2 per hour to be enough to compensate him for the increased probability that he will die on the job. That is, letting that probability be P, he evidently views his life to be worth an amount V such that $2 is more than the expected value of losing it, PV. That probability can be estimated from the experience of those who have worked at this job. Over 10 years, the 800 water carriers have worked a total of $800\times10\times50\times40=16{,}000{,}000$ person-hours. In that time, 14 workers have died, indicating a probability of dying per hour of $P=14/16{,}000{,}000$. Taking this as the probability of Jack himself dying in any given hour of work, he values his life such that $\$2>PV=(14/16{,}000{,}000)\times V$, or $V<\$16{,}000{,}000\times2/14=\$2.3$ mil. As indicated, this is an upper bound, if we assume that Jack is fully cognizant of his situation.

2. The village of West Deadweight, population 3000, currently spends $45,000 a year cleaning its streets. Information from other villages of similar size suggests that, if this expenditure were to be doubled, the improved appearance of the village would cause property values to rise by 10%. The average home in West Deadweight is now valued at $60,000, and there are on average four people in each home. The village collects annual property taxes equal to 0.2% (two tenths of one percent) of the home values, in addition to taxes that it collects from other sources. The nominal interest rate is 7%, and prices of both homes and goods are rising at 4% a year.

   If the only choices are to leave its street-cleaning expenditures unchanged or to double them, which should it do? [Note: Not all of the information provided here is needed for you to answer this question.]

   Ans:

   The cost here is an additional expenditure each year indefinitely, while the benefit is satisfaction the villages receive from living in a cleaner place. That satisfaction is also a benefit that will be repeated ever year indefinitely, so if we could measure it directly, we'd just need to compare it to the increased annual cost.

However, we can't measure it directly. What we can do, though, is infer it from the forecast increase in property values. Since the only obvious reason for property values to increase here is that those who buy the properties think it to be worth something to live in a cleaner town, and the amount they are willing to pay for the property suggests an estimate of what that value is to them. (Actually, it is only a lower bound for that. Many might be willing to pay a good deal more, but don't have to – similar to consumer surplus. But I don't see how to measure that.) The increased property values occur all at once, however, and they represent the capitalized value of the benefits over future time. The appropriate comparison, therefore, is of the total increased property value, measuring the benefit, to the present discounted value of the increase in costs.

The real interest rate is the nominal rate minus the rate of inflation, or 7% – 4% = 3%. Using that rate in the formula for present value of a constant infinite stream, present value of cost is $45,000/.03=$1,500,000=$1.5 mil.

With 3000 people living, on average, 4 to a house, there must be 750 houses. Their average value is $60,000, for a total value of the village housing stock of $750\times60{,}000=\$45{,}000{,}000$. Since this is expected to rise by 10%, the increase in housing values is therefore $4.5 mil. Since this is considerably larger than the present value of the cost, the policy should be undertaken.

You may note (although it is not part of the problem), that the project will *not* be self-financing. With the property tax rate of only 0.2% of the value of the housing stock, taxes collected each year will increase by only $\$4.5\times0.002=\$9{,}000$, which is far less than the $45,000 increase in annual expenditure. The village will therefore have to increase taxes in some way to pay for this change. It could do that by increasing the tax rate on housing (which would lower the housing prices, but that's OK), or by increasing some other tax. Either one of these could cause additional distortions and additional cost, but even a very "leaky bucket" would not be enough to offset the considerable net benefit from the cleaner streets.

3. Suppose that money could be collected from the rich in Hong Kong without distorting anyone's behavior, but that the only way to use that money to help the country's poor is to subsidize their consumption of noodles (remember them?), which the rich do not eat. Using the same information about the Hong Kong noodle market that appeared in Problem Set No. 1, question 3, answer the following:

Ans: The rich lose the cost of the subsidy, which is

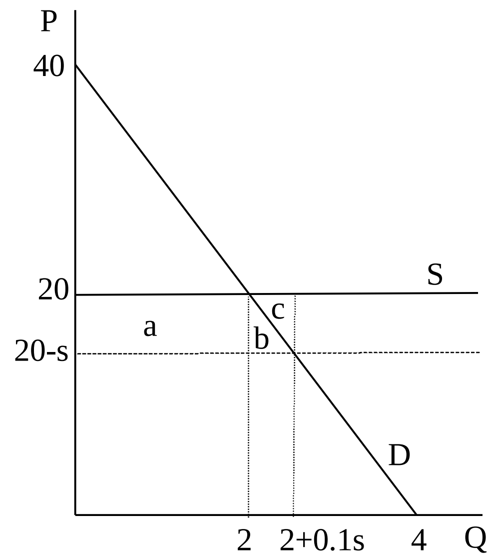
$L=(a+b+c)=s\times(2+0.1s)$

The poor gain the increase in consumer surplus, which is

$G=(a+b)=s\times 2 + s\times(0.1s)/2$

Fraction of L that makes it to the poor is F=G/L

Leaky bucket ratio is R=(L–G)/L=1–F



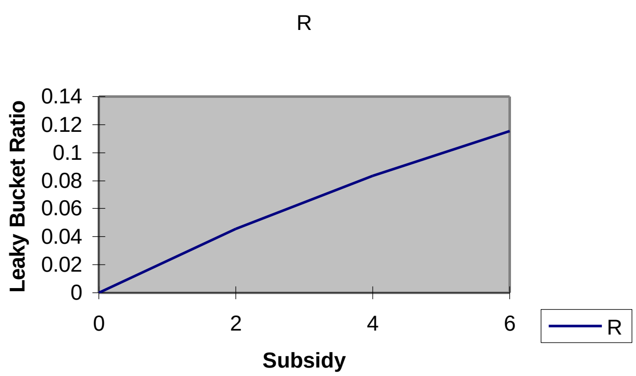
a) If the noodle subsidy is \$2 per bowl, financed by a levy on the rich, how much do the poor gain for each dollar collected from the rich and paid out as subsidy? What, therefore, is the "leaky bucket ratio" for this policy?

b) Repeat part (a) for noodle subsidies of \$4 and \$6.

Ans: Using the formulas above, answers to (a) and (b) are in the table below:

	s	L	G	F	R
a)	2	4.4	4.2	95.5%	4.5%
b)	4	9.6	8.8	91.7%	8.3%
b)	6	15.6	13.8	88.5%	11.5%

c) Graph the leaky bucket ratio as it varies with the size of the subsidy. Optional: Why does this graph look the way it does?



The leaky bucket ratio rises with the size of the subsidy. The reason is that the distortion causes by a subsidy rises more than in proportion to the size of the subsidy.

This can be seen in the graph and in the formulas, where the dead weight loss due to the subsidy rises with the square of the subsidy itself.

4. (Very optional) Who is Jack's co-worker?

Ans: Jill