# Exam #1 (75 points)

- Other than this cheat sheet (which you should tear off), all you are allowed to use for help are the basic functions on a calculator.

- The space provided below each question should be sufficient for your answer, but you can use additional paper if needed.

- *Show your work for partial credit.* It is very difficult to give partial credit if the only thing on your page is "$x = 3$".

- **Expected value** is given by summing likelihood times value over all possible outcomes:

$$\text{Expected Value} \quad = \sum_{\text{Outcomes } i} \text{Probability}(i) \cdot \text{Value}(i).$$

- A **fair bet** is a bet with an expected value of zero.

- The **future value of a lump sum payment** of $\$x$ invested for $n$ years at interest rate $s$ is $\text{FV} = x(1+s)^n$. The **present value of a lump sum payment** of $\$x$ after $n$ years at interest rate $s$ is $\text{PV} = \dfrac{x}{(1+s)^n}$. (Note that this formula also works for values of $n$ that are negative or zero.)

- The present value of an **annuity** paying $\$x$ at the end of each year for $n$ year at interest rate $s$ is

$$\text{PV} = x \left[ \frac{1 - \dfrac{1}{(1+s)^n}}{s} \right].$$

The present value of the related **perpetuity** (with annual payments forever) is

$$\text{PV} = \frac{x}{s}.$$

- The **inflation rate**, $i$, is the rate at which prices rise. The **nominal interest rate**, $n$, is the interest rate in terms of dollars. The **real interest rate**, $r$, is the interest rate in terms of purchasing power. These are related by

$$1 + r = \frac{1+n}{1+i}.$$

When the inflation rate is small, we can approximate this as

$$r \approx n - i.$$

1. A pharmaceutical company comes out with a new pill that prevents baldness. When asked why the drug costs so much, the company spokesman replies that the company needs to recoup the $1 billion it spent on research and development (R&D).

    (a) (5 points) Will a profit-maximizing firm pay attention to R&D costs when determining its pricing? Yes   No (Circle one and explain briefly.)

    (b) (5 points)

    **If you said "Yes" above:** Do you think the company would have charged less for the drug if it had discovered it after spending only $5 million instead of $1 billion? Yes No (Circle one and explain briefly.)

    **If you said "No" above:** Do R&D costs affect the company's behavior *before* they decide whether or not to invest in the R&D, *after* they invest in the R&D, both before and after, or neither?

2. Imagine that you park in front of a parking meter and face the following choice: you can either put $1 in the meter, or not put anything in the meter and risk getting a ticket. If you don't feed the meter, there's a 90% chance that you'll get away with it (and hence pay nothing) and a 10% chance that a meter maid will catch you and give you a $20 ticket.

    (a) (5 points) The expected amount of money you'll pay if you feed the meter is, obviously, $1. What is the expected amount of money you'll pay if you try to risk it?

(b) (5 points) Imagine that the city managers want to save money by firing 90% of the meter maids, meaning that the chance of getting caught will be only 1%. Use your expected value calculation above to suggest a way to do this without changing the expected value (and hence the attractiveness) of cheating. Show your work.

3. Imagine that you own a lake and that you're trying to maximize the present value of catching fish from the lake, which currently has 1000 fish in it. The population growth function of the fish is described in Figure 1.
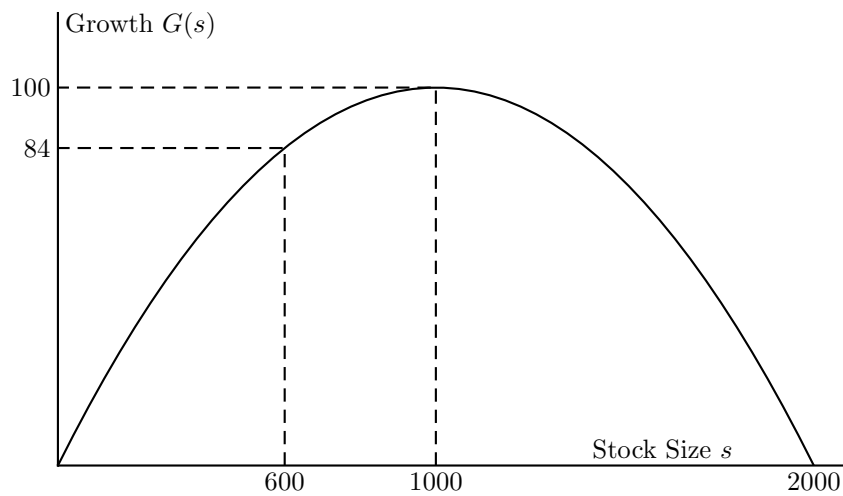


Figure 1: A population growth function for fish.

(a) (5 points) The maximum sustainable yield policy is to catch 100 fish at the end of this year, 100 fish at the end of the next year, and so on, forever. If the price of fish is always $1 per fish, what is the resulting present value at a 5% interest rate?

(b) (5 points) An alternative policy is to catch 400 fish *today* (so that 600 remain in the lake), and then catch 84 fish at the end of this year, 84 fish at the end of the next year, and so on, forever. What is the resulting present value? (Assume as above a price of $1 per fish and an interest rate of 5%.) Is it higher or lower than the present value of the maximum sustainable yield policy?

(c) (5 points) Explain (as if to a non-economist) the phrase "fish are capital", or otherwise explain the importance of the interest rate at the Bank of America in management decisions regarding natural resources such as fish. For full credit, connect this explanation with the somewhat surprising result that you (hopefully) got above, namely that the alternative policy has a *higher* present value than the maximum sustainable yield policy.

4. Just about everybody agrees that the Social Security system faces financial troubles down the road: after the Baby Boomers retire, the money coming into the system through payroll taxes is not expected to be enough to finance the benefits that the system promises to retirees.

   (a) (5 points) The Social Security Board of Trustees has examined the system's deficit over the next 75 years. If you use an interest rate of 6%, it turns out that you can divide that 75-year deficit into annual payments of $225 billion each year for the next 75 years. In present value terms, what is the system's 75-year deficit? (Note: If all the zeroes confuse you or your calculator, use $225 instead of $225 billion. Or keep in mind that a billion is a one with 9 zeroes after it. Go down to 6 zeroes and you get a million; go up to 12 zeroes and you get a trillion.)

   (b) (5 points) *If you didn't get an answer above or don't feel comfortable with it, use $4 trillion for the following question.* Your answer above is the present value of the 75-year deficit of the Social Security system. Explain what this means *in English*, i.e., as if to a non-economist.

(c) (5 points) In a recent op-ed piece in the *Wall Street Journal* ("One Thing We Can All Agree On", January 25, 2005), Treasury Secretary John W. Snow claimed that each year we stick with the existing Social Security system adds $600 billion to the system's long-term deficit. If we stick with the existing system *forever*, he said, the present value of the resulting deficit is $10 trillion. Show that these two claims agree with each other if he's using an interest rate of 6%. (Note: if these numbers confuse you or your calculator then use $600 instead of $600 billion and $10,000 instead of $10 trillion.)

5. Social Security benefits are adjusted for inflation, meaning that payments to retirees increase at the rate of inflation.

   (a) (5 points) How much will Grammy be paid in one year, in two years, and in three years if her current benefit is $1000 and inflation is 3%?

   (b) (5 points) One way to calculate the present value of these three payments is to use brute force: determine the present value of each payment separately and then add them together. Go ahead and do this; in doing so you need to choose between the nominal interest rate (which you should assume to be 5%) and the real interest rate (which you should assume to be 2%).

(c) (5 points) If the nominal interest rate is 5% and the inflation rate is 3%, the rule of thumb tells us that the real interest rate is indeed about 2%. What is a more accurate estimate of the real interest rate?

(d) (5 points) Calculate the present value of receiving $1000 at the end of each year for 3 years if the relevant interest rate is 2%.