Problem Set #1 [KEY]
Due: beginning of class October 1

1. **Inflation in Zirconia (20 points)** The ZIS (Zircon Institute of Statistics) just published inflation estimates for 2011, based on partial data for the year. The Association of Zirconian Consumers (AZC) believes that the estimates were manipulated for political reasons (general elections are to be held next Spring). You are part of a team of foreign experts that AZC hired to produce independent estimates. Luckily, Zirconia produces only watches and gold chains. You were provided with the following data that have been carefully verified by the watch and chain manufacturers themselves:

Year	Watches		Gold Chains	
	Quantity ('000)	Price ($ per unit)	Quantity ('000)	Price ($ per unit)
2000	100	20	1,000	1.0
2010	250	18	1,800	1.7
2011	300	19	1,700	2.1

Table 1: Commonwealth of Zirconia: quantities and prices in selected years.

Using 2000 as the base year, you compute the following for 2011:

a. The GDP deflator, a fixed price measure. (3 points)

Nominal GDP:
$$Y_{2000} = 100*20+1000*1 = 3000$$
$$Y_{2011} = 300*19+1700*2.1 = 9270$$

Real GDP:
$$\overline{Y_{2000}} = 100*20+1000*1 = 3000$$
$$\overline{Y_{2011}} = 300*20+1700*1 = 7700$$

GDP Deflator:
$$p_{2000} = 3000/3000 = 1.000$$
$$p_{2011} = 9270/7700 = 1.204$$

b. The CPI index, a fixed quantities measure, normalized so that the CPI in 2000 equals 100. (3 points)

CPI:
$$p^{cpi}_{2000} = 100*20+1000*1 = 3000$$
$$p^{cpi}_{2011} = 100*19+1000*2.1 = 4000$$

Normalizing the CPI so that it equals 100 in the base year:
$$p^{cpi}_{2000} = 3000/3000*100 = 100$$
$$p^{cpi}_{2011} = 4000/3000*100 = 133.333$$

c. Report the continuously compounded annual inflation rate from 2000-2011 using both the GDP deflator and the CPI. (The example about Korea on page 4 of the Math Review discusses compound growth rates.) (4 points)

GDP Deflator:
$$\text{inflation} = \ln(1.204/1.0)/11*100 = 1.69\%$$

CPI:
$$\text{inflation} = \ln(133.333/100)/11*100 = 2.62\%$$

d. Write a short (2 paragraph max) executive summary that reports the rates of inflation, why they differ, and what issues exist that might bias the measure of inflation no matter what index is used. (10 points)

Our calculations show that inflation in Zirconia has averaged 1.69% and 2.62% per year as measured by the GDP deflator and the CPI over the period 2000-2011. We have calculated inflation 2 ways: as a fixed price index, commonly known as the GDP deflator, and as a fixed basket index—the consumer price index, or CPI.

A fixed basket index, like the CPI, tends to overstate inflation because it does not reflect the tendency of consumers to shift away from goods whose price is increasing on a relative basis. Fixed price indexes tend to have the opposite bias, since the shifting basket typically places increasing weight on goods with lower relative prices. Regardless of the index used, it should be kept in mind that while these price indices are representative of the economy as a whole, actual purchases by any individual or group of individuals may differ from those used in the index. Thus the indices may not represent the price levels of each individual or of important demographic groups in Zirconia. Further, statisticians have a difficult time incorporating changes in the quality of goods and newly-invented goods into price indices.

2. **Capital Accumulation and Growth (30 points)** As a consultant to a major consumer goods producer you are charged with surveying Libya as a potential future market. You are asked to forecast economic growth in a post-war Libya. Technical reports on the country reveal that the share of income paid to capital is 33 percent (i.e., $\alpha = 1/3$), capital depreciation is 15 percent per year, and the saving rate is 25 percent per year.

a. Use the Solow Growth Model to compute the steady state capital stock for Libya when the available labor, L, is 100. Assume that there is no population growth or technological growth and that $A = 1$. Also assume that the entire population works, that is, L is the entire population. (5 points)

$$K_{ss} = \left(sA/\delta\right)^{1/1-\alpha} L = \left(0.25/0.15\right)^{1/(1-1/3)} * 100 = 215.17$$

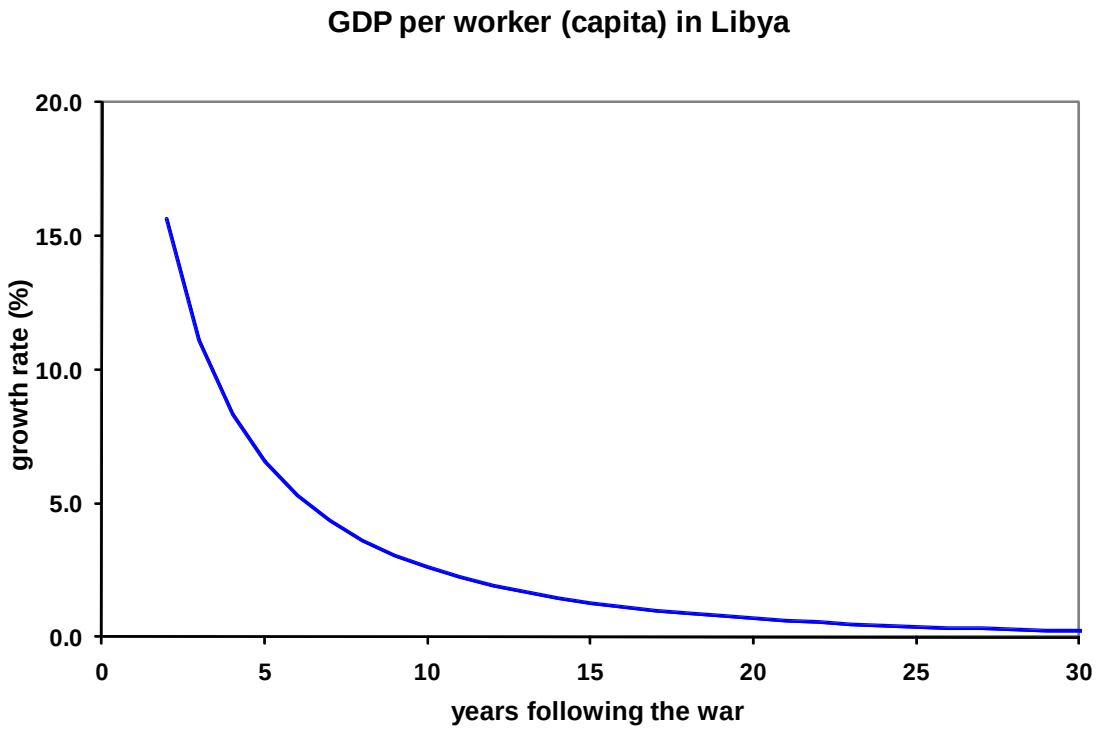
b. What is the value of steady state output and output per capita? (5 points)

$$Y_{ss} = K_{ss}^{\alpha} L^{1-\alpha} = 215.17^{1/3} 100^{2/3} = 129.10$$
$$Y_{ss}/L = 129.1/100 = 1.29$$

c. Suppose that after the war, Libya is left with only 10% of its steady state capital stock. What is output per capita in Libya? (5 points)

$$Y = \left(0.10K_{ss}\right)^{1/3} L^{2/3} = \left(0.10 * 215.17\right)^{1/3} 100^{2/3} = 59.92$$
$$Y/L = 59.92/100 = 0.60$$

d. Using a spreadsheet similar to the one we constructed in class, compute the capital stock, output per capita, and the growth rate in output per capita in Libya for 30 years following the war. Turn in a neat, well labeled graph of the growth rate of output/capita for the 30 years following the war. (5 points)



e. Write a short (3 paragraphs, 1 figure/table max) report that summarizes your findings. To help convince your client that your forecast is reasonable, you present some historical evidence. (Data for some European countries is available on Blackboard, or you may use your own sources.) Include a section in the report that compares post-war Libya to a country, or a group of countries, in Europe following World War II. Be sure to address the respects in which Libya may differ from post-war Europe, and how these differences may affect your forecast. (10 points)

Our forecast predicts brisk growth in output per capita in Libya as capital is rebuilt after the war, followed by moderate growth as Libya returns to its steady state level of capital. This analysis is based on the Solow Growth Model. After the destruction of much of the country's capital stock, the low capital-worker ratio implies high returns to the early additions to the capital stock. As the capital stock increases, the diminishing marginal product of capital (a consequence of the production technology used in Libya and elsewhere) means that each additional unit of capital will add less to output per worker than the one added before. These diminishing marginal returns to capital are what drive the slowdown in the growth rate.

Out forecast is consistent with other post-war growth episodes, such as those in Europe following World War II. The figure below plots the GDP per capita growth rate averaged

over Austria, France, Germany, Italy, the Netherlands and Norway, whose experiences were typical of the period. During the war, output per capita fell dramatically as capital was destroyed. Following the war, GDP per capita grew quickly as Western Europe rebuilt its capital stock. After a period of fast growth, growth rates diminished as capital stocks returned to pre-war levels. We expect a similar pattern in post-war Libya.

3. **Capital Depreciation and Growth (20 points)** Over the past 30 years the composition of the capital stock has changed dramatically with the rise of new information and computer technologies. One feature of this change is that computers and software depreciate rather quickly compared to equipment and structures. Prepackaged software, for example, depreciates at 55 percent per year while equipment used in producing wood products depreciates at 14 percent per year.[1] In this question, we analyze the potential consequences for economic growth from this change.

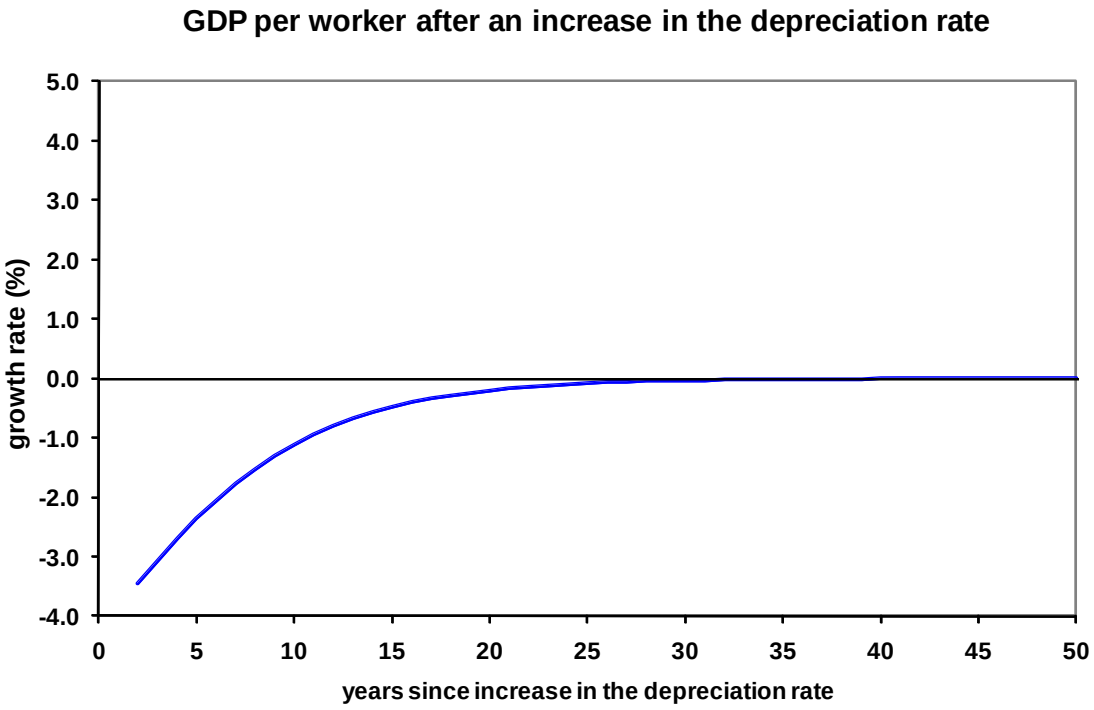
    a. First, copy your Solow model worksheet from problem 2 into a new worksheet. In the entry for the year one capital stock, enter the steady state capital stock from 2a. If you did this correctly, the growth rate in output per worker should be zero. Briefly explain why. (2 points)

    The growth rate in output per worker is zero because the economy is already as its steady state level of capital. When the capital stock is at the steady state level, the new investment exactly offsets the capital lost to depreciation so the capital stock does not change over time. Without productivity growth, there is nothing to drive growth of output per worker.

[1] A publication by the Bureau of Economic Analysis, posted on Blackboard, lists depreciation rates for many different kinds of capital. Did you know an F-14 fighter jet depreciates at 8 percent per year?

b. Now calculate the effects of a change in the depreciation rate on the economy that follow from the introduction of new, but quickly depreciating capital goods. Do this by changing the depreciation rate from 15 percent to 25 percent. Turn in a neat, well labeled graph of the growth rate of output/capita for the 30 years following the change. Report the long run effects on output and capital. (8 points)

The steady state capital stock falls to 100, output falls to 100, and output per worker falls to 1.



c. Write a short explanation of the effects in (b) focusing on the mechanics of the Solow model. Critically asses the results by discussing any features of the data that may be missing from the model. (10 points)

The increased rate of depreciation leads to a smaller steady state capital stock (and, thus, smaller steady state output) because more resources have to be devoted to replacing the capital that now wears out more quickly. While it is true that the shorter useful life of many high tech products is bad for an economy, these products have created huge increases in productivity, which we have not modeled in this exercise. The net effect of the increasing importance of computers and software is positive.

If these new kinds of capital increased productivity by 66 percent ($A = 1.67$) the effect of the higher depreciation rate would be exactly offset and the steady state level of capital and output would be the same. This can be seen in the formulas in the answer to 2a.

4. **National Accounts in Margaritaville (30 points)** Jimmy Buffett has decided to apply for membership to the European Union on behalf of his newly sovereign nation, Margaritaville. As part of his application, Jimmy must provide the EU technocrats with a complete set of national accounts. You have been hired as the Chief National Accountant and have received the following reports, along with an official Coral Reefer Crew™ t-shirt, the official uniform of the government of Margaritaville.

- The local Cheeseburger in Paradise™ cafes sold $50,000 worth of cheeseburgers to local consumers. Their expenses were: imported beef and sesame seeds ($7,000), locally produced catsup ($10,000), wages and benefits ($20,000), and rent ($3,000). Hint: you will need to compute the profit earned by the cafes.
- Local tomato growers sold $8,000 worth of tomatoes to domestic catsup producers and exported $2,000 worth of tomatoes to the United States. They paid land rent ($1,000) and wages ($9,000).
- The producers of the Margaritaville Frozen Concoction Maker™ sold $100,000 worth of machines, 40% of which were exported to Europe, the remainder to local consumers. Their expenses were $15,000 worth of imported metal, $15,000 for a new CNC machine imported from Germany, and $70,000 in wages.
- The newly formed government collected $10,000 in taxes from its citizens and paid government regulators, who oversee food and beverage safety, $10,000 in wages.
- The domestic catsup industry sold $10,000 worth of product to local cafes. They purchased $8,000 worth of tomatoes from domestic growers and paid $2,000 in wages.

Using this data, construct the national accounts for Margaritaville.

a. Compute GDP and the expenditure components of GDP (consumption, investment, government spending, exports and imports). Report them in the table below. (8 points)

	GDP	Consumption	Investment	Government	Exports	Imports
Value	140	110	15	10	42	37

$$C = 50(\text{burgers}) + 60(\text{blenders})$$
$$I = 15(\text{CNC machine})$$
$$G = 10\ (\text{regulation services})$$
$$EX = 40(\text{blenders}) + 2(\text{tomatoes})$$
$$IM = 7(\text{seeds, beef}) + 15\ (\text{metal}) + 15(\text{CNC})$$

b. Calculate savings and investment. Why are they different? (7 points)

$$S = Y - C - G = 140 - 110 - 10 = 20$$
$$I = 15$$

Savings is larger than investment because net exports are positive. The extra savings that is not being invested domestically is being invested abroad.

c. Compute the distribution of value added by industry. That is, compute the GDP produced by each industry (Cafes, Tomatoes, Blenders, Government, and Catsup). Report the values in the table below. (10 points)

	GDP	Cafes	Tomatoes	Blenders	Government	Catsup
Value	140	33	10	85	10	2

Cafes: $50-7-10=33$
Tomatoes: $10-0=10$
Blenders: $100-15=85$
Government: $10-0=10$
Catsup: $10-8=2$

d. Jimmy looks over your expenditure based calculation of GDP from part a. and is nervous that you might have made a mistake. Over a few Land Shark Lagers™ you explain to him that GDP can be computed 3 different ways. Compute and report the payments to labor and capital in the economy, as well as GDP. (5 points)

$$\textit{labor payments} = 20+9+70+10+2 = 111$$
$$\textit{capital payments} = 10+3+1+15 = 29$$
$$GDP = \textit{labor payments} + \textit{capital payments} = 140$$