ECON1922 spring 2023
University of Oslo

EXAM

Instructions:

(i) All problems should be solved. Weights are reported in brackets.

(ii) Each exercise indicates how the question should be answered, whether we expect you to explain in words, provide a graphical illustration or use calculus.

(iii) Restrict your answer to what the exercise asks for, non-relevant information is given no credit. Full credit is only given to figures and graphs that are fully explained, correctly illustrated and with notation on the axes.

This exam consists of 4 main questions.
The weight of each question is indicated, and the maximum is 100 points.

Question 1. Optimal pollution (40 points)

Consider a country where the population enjoys private consumption, C. This consumption is associated with a negative externality: environmental pollution, E. Each consumption unit emits one unit of emissions, $C = E$. The damage function $D(E)$ is convex and the benefit function $B(C)$ is concave. The net social benefit (NB) of the population can be described by:

$$NB = B(E) - D(E)$$

The functions are illustrated in Figure 1:

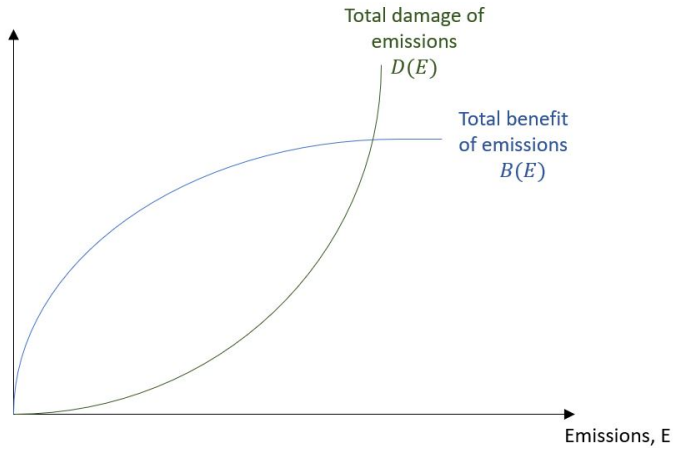

Figure 1: Total damage of emissions and total benefit of emissions.

(a) **(10 points - short answer - words)**
Explain how we can interpret the benefit function, and what is the assumption for making the social benefit of emissions concave?

(b) **(10 points - short answer - words and figure)**
Use Figure 1 to indicate the optimal emission level, E^*. Explain in words what we mean with the "optimal" level of emission?

(c) **(10 points - short answer - words and figure)**
Show how we can draw the figure with marginal values instead of total values, and indicate the Business as Usual (BaU) emission level E^{BaU}. Under what circumstances does the population experience this level of emissions, and why is it not optimal?

(d) **(10 points - short answer - words and figure)**
Under what conditions can it be optimal with zero emission pollution? Explain in words and show in a figure.

Question 2. Climate change policy (30 points)

Consider a country with a new green government that is eager to implement policies to mitigate climate change. However, before they make any policy decisions, they have asked for expert advice from an environmental economist.

(a) **(6 points - short answer - words)**
The policy makers ask you to explain what economists mean by describing climate change as a "public bad" and carbon emissions as "negative externalities". Include the definition of these two market failures.

(b) **(6 points - short answer - words)**
The policy makers need to know the difference between economic incentives policies and command-and-control. Give them a brief explanation of the pros and cons of the two types of regulations.

(c) **(6 points - short answer - words)**
Explain to the policy makers why the global carbon tax should be equal across countries.

(d) **(6 points - short answer - words)**
Explain what could be the effect of implementing a substantial domestic carbon tax, that is higher than the carbon tax in the rest of the world, without a carbon border adjustment mechanism (CBAM)?

(e) **(6 points - critical disucssion - words)**
The policy makers need to decide what value for the discount rate they will use in the government's cost benefit analysis (CBA). Either, they can use a high discount rate of 7%, like the Trump administration, or a lower discount rate of 2.5% like the Obama administration. Explain to the policy makers the implications of the choice of discount rate when doing a CBA of investments in climate mitigation.

Question 3. The Environmental Kuznets Curve (20 points)

In this exercise you will be explaining concepts related to the so called *The Environmental Kuznets Curve* (EKC). The curve is a hypothesized relationship between various indicators of environmental degradation and per capita income, se Figure 2 for an illustration:

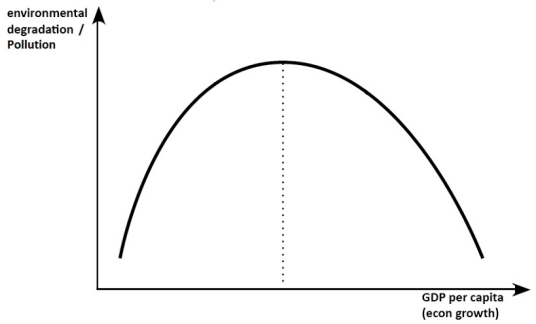

Figure 2: The Environmental Kuznets curve

(a) **(10 points - critical disucssion - words)**
What are the suggested mechanisms that might explain why we have this hump-shape in the relationship between environmental degradation and economic growth.

(b) **(10 points - critical disucssion - words)**
On the y-axis in Figure 2 we measure the level of "environmental degradation/pollution", but its not clear from the hypothesis of the Environmental Kuznets Curve what this measure. Discuss some arguments for why the relationship in the Kuznets curve is more likely to hold for local than for global pollution.

Question 4. Total emissions (10 points)

The *Kaya identity* is a useful equation for quantifying the total emissions of carbon dioxide (CO_2). The identity breaks down CO_2 emissions (left side of the equation) into key driving elements (right side of the equation):

$$Total\ CO_2\ emissions = Population \times \frac{GDP}{Population} \times \frac{Energy}{GDP} \times \frac{CO_2}{Energy} \tag{1}$$

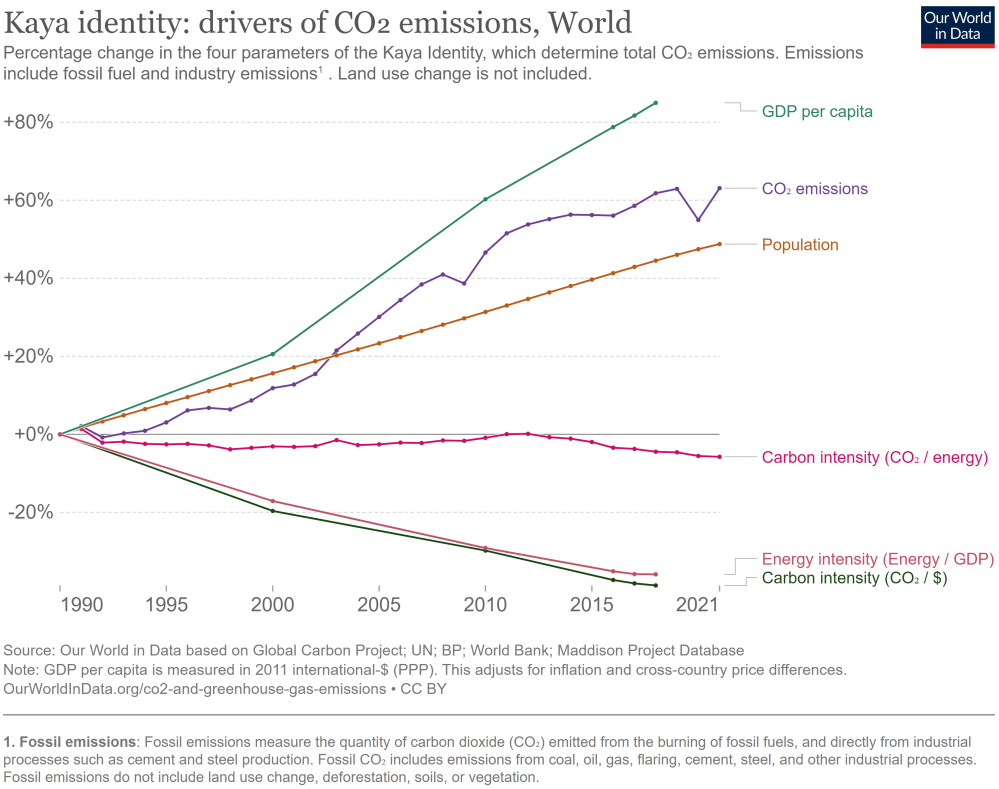

Figure 3: Drivers of CO_2 emissions, world. Percentage change relative to the year 1990. Source: Our World in Data

In figure 3 we see a visualization of the Kaya indentity for the World from 1990 until 2021. Help us to correctly read the figure by answering the questions below:

(a) **(5 points - short answer - words)**
Explain how we should interpret Figure 3, what do we measure on the y-axis?

(b) **(5 points - short answer - words)**
What does it mean when "Energy intensity" is downward sloping, and "Carbon intensity" is almost flat, and below zero?