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SECTION 1: Econometrics Review

1.1. Causal Inference in Social Science

- Much of social science (psychology, anthropology, sociology, political science, epidemiology and large parts of economics) concerns analyzing correlations among variables, e.g., the correlation between education and income, the correlation between obesity and heart disease, the correlation between happiness and longevity.
- Correlation describes the statistical relationship between two observed variables. Correlation has no necessary relation to cause and effect. You can measure the correlation between happiness and longevity with great precision and yet know nothing about how making someone happier affects their longevity. (Let's say that happier people live longer. Does that mean that happiness causes longevity? Perhaps people are happy precisely because they feel fortunate to have lived so long.)
- However, science advances primarily through analyzing cause and effect relationships, not by documenting correlations (though correlations are not irrelevant). Causal questions are for example:
  - What is the effect of education on income?
  - What is the effect of obesity on heart disease?
  - What is the effect of happiness on longevity?
  - What is the effect of the minimum wage on employment?
- Causal questions are much harder to answer than the correlational questions. Correlations are readily measured from observational data. Causal effects can never be measured directly.

1.2. Regressions and Ordinary Least Squares (OLS)

- A regression is a statistical way of estimating a causal relationship between a dependent variable and one or more explanatory or independent variables:
  - Explanatory variables (x_s) are the ones that make things happen
  - Dependent variables (y) are the ones that changes as a result.
- When we use Ordinary Least Squares we assume a linear relationship between a dependent variable and one or more explanatory variables:

$$y = \underbrace{\beta_0 + \beta_1 x_1 + \beta_2 x_2 + ... + \beta_K x_K}_{\text{Linear Regression function}} + \underbrace{u}_{\text{Unobserved error term}}$$

where $\beta_0, \beta_1, \beta_2, ..\beta_K$ are called regression coefficients and are unknown parameters that need to be estimated. For example β_1 represents the change in the dependent variable y when the first regressor x_1 increases by one unit while the other regressors are kept constant. As you estimate the regression coefficients, you are basically "drawing the best possible line through your data", and you get:

$$\widehat{y} = \widehat{\beta_0} + \widehat{\beta_1} x_1 + \widehat{\beta_2} x_2 + ... + \widehat{\beta_K} x_K$$

i.e., for each value of $x_1, x_2, ..., x_K$, you can determine the best linear approximation of y, and call it $\widehat{y}$.

- Example: Health Care Expenditures

1. You may believe that a person's annual health care expenditures depend on their age. Annual health care expenditures are the dependent variable and age is the explanatory variable. The equation you would like to estimate is a linear relationship between health care expenditures and age:

$$HCE = \beta_0 + \beta_1 AGE + u$$

Using data from the Medical Expenditure Panel Study (MEPS) data, a dataset looking at people's health care expenditures, this relationship is estimated as:

$$\widehat{HCE} = 38.77 + 92.91 AGE$$

so basically $\widehat{\beta_0} = 38.77$ and $\widehat{\beta_1} = 92.91$. It means that expected health care expenses increase by \$92.91 as a person ages by one year, and that, if $AGE = 0$, then $HCE = \$38.77$.For example, the predicted health care expenses for a person of age 30 would be:

$$\widehat{HCE} = 38.77 + 92.91 \times 30 = 2826.16$$

2. If you wanted to include gender, you might generate a male dummy variable (a variable that takes the value 1 if a person is male and 0 if they are not) and estimate the equation:

$$HCE = \gamma_0 + \gamma_1 AGE + \gamma_2 MALE + \epsilon$$

Again from the MEPS data, this is estimated as:

$$\widehat{HCE} = -244.96 + 93.56 \times AGE + 587.17 \times MALE$$

i.e. $\widehat{\gamma_0} = -244.96, \widehat{\gamma_1} = 93.56, \widehat{\gamma_2} = 587.17$.This suggests that expenses rise by about \$93.56 per year of life (different from \$92.91 found above!) and that, if they have the same age, men have expenses of about \$587.17 higher than women. For example, The predicted expenses for a 30 year old male would be:

$$\widehat{HCE} = -244.96 + 93.56 \times 30 + 587.17 \times 1 = 3149.17$$

- Why are $\widehat{\beta_1}$ and $\widehat{\gamma_1}$ different? After all, they measure the effect of the same explanatory variable (AGE) on the dependent variable (HCE). In the second specification we used, we controlled for the gender of the individual (using the variable $MALE$), so we are estimating a different model. Hence, $\widehat{\beta_1}$ and $\widehat{\gamma_1}$ are usually different:

  1. $\widehat{\beta_1}$ is the estimated change in health expenditures for an individual as I increase his age by one year.
  2. $\widehat{\gamma_1}$ is the estimated change in health expenditures for an individual as I increase his age by one year, after controlling for his gender.

  In the second specification we used, $\widehat{\gamma_2}$ gives us the estimated (average) difference in health expenditures between men and women of the same age (whatever their age!), and $\widehat{\gamma_1}$ gives us changes in health expenditures that can be entirely attributed to age, and that have no relation to the gender of the individual.

  Intuition: assume for simplicity that in our sample we have only young women and old men, and that old men have significantly higher health care expenditures. Then $\widehat{\beta_1}$ will be positive (HCE increases with AGE). It is however likely that $\widehat{\gamma_1}$ is smaller than $\widehat{\beta_1}$ (it might even be close to zero) given that, once we control for the gender of the individual, AGE is not really a significant determinant of health expenditures. On the contrary, $\widehat{\gamma_2}$ will be large and significant, indicating that men have significantly higher health expenditures than women.

1.3. The Fundamental Problem of Causal Inference

- Assume you are interested in measuring the effect of the introduction of a new Health Insurance Program, which has been extended to a selected sample of individuals. What you want to estimate is the impact of the Health Insurance Program on Health Care Expenditures for individuals who get selected (the $TREATED$). Then what you want to estimate is (β_0 and β_1 are not the same used in the previous section!):

$$HCE = \beta_0 + \beta_1 TREATED + u$$

- To illustrate the fundamental problem of casual inference, let's for now call $Y = HCE$ (dependent variable) and $X = TREATED$ (explanatory variable)

- For each individual you observe: Y_i and X_i.Let Y_i be the outcome of interest for individual i. We'll suppress the subscript i where possible.

- We want to consider two possible outcomes for i:

  - Let's define Y_0 to be the value of an individual's Y if $X = 0$ (the individual is not covered by the new Health Insurance Program) and
  - Let's define Y_1 be the value of an individual's Y if $X = 1$.(the individual is covered by the new Health Insurance Program).

  Thus, for every unit i, we can imagine two potential outcomes $\{Y_0, Y_1\}$ that we would observe if the unit were treated ($X = 1$) or untreated ($X = 0$).

- We only observe either Y_0 or Y_1, but we assume that both are well defined. That is, there is a precise alternative state of the world that would have occurred had we chosen $X = 1$ instead of $X = 0$ or vice versa.

- In this framework, the causal effect of X on Y is $T = Y_1 - Y_0$, where T stands for "*Treatment Effect*".

- The problem that this immediately reveals is that we never observe $Y_1 - Y_0$ for a single unit i. Instead, we observe $Y_i = Y_{1i}X_i + Y_{0i}(1 - X_i)$, that is:

  - if $X_i = 1$, we observe $Y_i = Y_{1i}$
  - if $X_i = 0$, we observe $Y_i = Y_{01}$

  but not both!

- *Fundamental Problem of Causal Inference*: it is not possible to observe the value Y_{1i} and Y_{0i} for the same unit i, so we cannot measure the causal effect of X on Y for unit i, i.e. we cannot measure the treatment effect for a specific individual!

1.4. Average Treatment Effect (ATE)

- We might, however, be satisfied to settle for some kind of population average treatment effect instead (using the regression framework, we could be satisfied with estimating β_1 in the specification above):

$$T^* = E[Y_1 - Y_0 | X = 1]$$

  where $E[.]$ is the expectations operator, denoting the mean of a random variable. This expression above defines the effect of "treatment on the treated", that is the causal effect of the treatment (the new Health Insurance Program) on the people who actually received it (people to whom the health insurance coverage was extended, i.e., for whom $X = 1$). How do we estimate it?

- We could compare HCE among those taking the treatment ($E[Y|X=1]$) versus those not taking the treatment ($E[Y|X=0]$) to estimate the causal effect of the treatment on HCE and use:

$$\widetilde{T} = E[Y_1|X=1] - E[Y_0|X=0]$$

to estimate T^*.The problem is that people who are not covered by the new Health Insurance Program are likely to be quite different from those who are (that is $E[Y_0|X=0] \neq E[Y_0|X=1]$). If so, they will not provide a good comparison group.

- What would a good comparison look like? It would be one in which the expected counterfactual outcomes are comparable between the treatment and comparison (control) groups. Specifically:

$$\begin{aligned} E[Y_1|X &= 1] = E[Y_1|X=0] \\ E[Y_0|X &= 1] = E[Y_0|X=0]. \end{aligned}$$

- If these conditions are satisfied. then it's straightforward to see that a contrast of the outcomes of the treatment and control groups will provide a valid estimate of the causal effect of treatment for the treated group (i.e. we are able to estimate β_1 "correctly", the estimator $\widehat{\beta_1}$ will be unbiased). Specifically,

$$\widetilde{T} = E[Y_1|X=1] - E[Y_0|X=0] = E[Y_1|X=1] - E[Y_0|X=1] = T^*$$

- Returning to our invalid estimator $\widetilde{T}$, let's ask how likely is it that the counterfactual outcomes would be balanced among a set of people selected from the population according to whether or not they are currently receiving the treatment. It can be for example the case that individuals with lower disposable income (not controlled for in the regression above)[1] are more covered by the new Health Insurance Program. Formally, this would imply that:

$$\begin{aligned} E[Y_1|X &= 1] < E[Y_1|X=0] \\ E[Y_0|X &= 1] < E[Y_0|X=0] \end{aligned}$$

- In words, patients receiving the drug are more likely to have lower HCE whether or not they are receiving the treatment.

- So, if we calculated the contrast $\widetilde{T} = E[Y_1|X=1] - E[Y_0|X=0]$, what would we get?

$$\begin{aligned} E[Y_1|X &= 1] - E[Y_0|X=0] = \\ &= \underbrace{\{E[Y_1|X=1] - E[Y_0|X=1]\}}_{\substack{T^* \\ \text{What we are interested in}}} + \underbrace{\{E[Y_0|X=1] - E[Y_0|X=0]\}}_{\substack{Bias \\ \text{What we are concerned about}}} \end{aligned}$$

- The first term on the right-hand side of this equation is the true, causal effect of the new Health Insurance Program on those who get covered (the effect of 'treatment on the treated'). The second term is the potential bias that occurs if the counterfactual (non-treated) outcomes of the comparison group (those not taking treatment) differ from the counterfactual (non-treated) outcomes of the treatment group (those taking treatment).

- We've just argued above that $E[Y_0|X=1] < E[Y_0|X=0]$. Thus, the bias in this case is negative, which means that it goes in the direction of generating an estimate $\widetilde{T}$ (or $\widehat{\beta_1}$) that is smaller than the true casual effect T^* (or β_1).

- Final remarks:

  - if the sample of individuals treated is randomly assigned, then the average treatment effect T^* is "correctly" estimated because the treated and non-treated (control) groups are perfectly comparable.
  - we can include regressors such as AGE and $MALE$ to control for the differences in the treatment and control groups, so that our estimate of β_1 is as accurate as possible.

[1] Analogously, we can for example think about how treated and non-treated individuals differ by age or by gender.

1.5. Difference in Differences (also known as "Diff in Diff")

- Assume you have data on all individuals before and after the introduction of the new Health Insurance Program (treatment), you can use Diff-in-diff to estimate the impact of the program. One of the groups (treatment group) is exposed to a treatment in the second period but not in the first period. The second group (control group) is not exposed to the treatment during either period.

- Define for example the average difference $HCE_B = HCE_B^T - HCE_B^C$, where B stands for before, T is the treatment group and C is the control group, and similarly $HCE_A = HCE_A^T - HCE_A^C$, where A stands for after. Then:

$$DD = \underbrace{HCE_A^T - HCE_A^C}_{\substack{\text{Difference between the two} \\ \text{groups } \textit{after} \text{ the Program} \\ \text{is introduced}}} - \underbrace{[HCE_B^T - HCE_B^C]}_{\substack{\text{Difference between the two} \\ \text{groups } \textit{before} \text{ the Program} \\ \text{is introduced}}}$$

  DD will be estimated "correctly" (it will be unbiased) if the parallel trend assumption holds: absent the change, difference across T and C would have stayed the same before and after, i.e. $DD = 0$. Therefore, diff-in-diff is most convincing when groups are similar (in their characteristics) to start with.

- Estimating the treatment effect using diff-in-diff corresponds to estimating the parameter γ_3 in the regression (again, the $\gamma's$ are not the ones defined previously!):

$$HCE = \gamma_0 + \gamma_1 AFTER + \gamma_2 TREATED + \gamma_3 AFTER \times TREATED + \epsilon$$

  then:

$$\widehat{HCE} = \widehat{\gamma_0} + \widehat{\gamma_1} AFTER + \widehat{\gamma_2} TREATED + \widehat{\gamma_3} AFTER \times TREATED$$

- Example: Marginal Tax Rate changes following the Tax Reform Act of 1986, which reduced the top marginal income tax rate. Summary statistics:

Table IIa
Marginal Tax Rate

Group	Before TRA86	After TRA86	Change	Relative Change
High	.521 (.002)	.382 (.001)	-.139 (.002)	
75th Percentile	.365 (.001)	.324 (.001)	-.041 (.001)	**-.098** **(.002)**
90th Percentile	.430 (.001)	.360 (.001)	-.07 (.001)	**-.069** **(.002)**

The marginal tax rate is calculated using family wage and salary, self-employment, interest, dividend, farm and social-security income. I assume all couples file jointly, and that all itemize their deductions. Itemized deductions and capital gains are imputed using Statistics of Income data. These figures include the secondary earner deduction, as well as social security taxes. Standard errors are in parentheses. Before TRA86 is tax years 1983-1985; After TRA86 is tax years 1989-1991.

Source: Eissa 1995

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SECTION 2: Theoretical Tools of Public Finance

2.1. True or False Questions

1. When Mindy is maximizing $U(x, y)$ subject to her budget constraint, then, when consuming the optimal bundle the marginal utilities of x and y will be equal. (Show algebra)

2. An agent values leisure and bread and has convex indifference curves. The agent strictly prefers $a = (10\ hrs, 4\ loaves)$ to $b = (2\ hrs, 10\ loaves)$. There is another allocation $c = (6\ hrs, 7\ loaves)$. Someone says, "Allocation c is a mixture of a and b. And a is strictly better than b. Therefore, the agent necessarily prefers a to c".

3. Suppose that, when the price of hot dogs increases, Frank Furter's total expenditure on hot dogs also increases. Therefore, for Frank, hot dogs must be an inferior good.

4. Two football teams A and B are competing for a championship. Team A has 1,000 fans and Team B has 100. A team A fan's payoffs when A wins, ties, and loses are 100, 70, and 50 in that order. A team B fan's payoffs when B wins, ties, and loses are 200, 30, and 10 in that order. Team A should win according to the utilitarian criterion.

5. There are two agents, A and B. Consider the set X of feasible allocations which contains four allocations $x_1, ..., x_4$. The utilities that the two agents receive in each allocation are given below.

	x_1	x_2	x_3	x_4
u_A	3	5	0	4
u_B	9	0	8	4

   Suppose agent's A utility from outcome x is not given by $u_A(x)$ but by $\widetilde{u}_A(x) = u_A(x) + c$, where c is a positive constant. Then, no matter how large c is, x_3 can never be the best allocation according to Rawls' criterion.

2.2. Exercises

- Exercise 13 p.59, *Gruber*

  Consider Bill and Ted, the two citizens in the country of Adventureland described in Problem 9 from Chapter 1. Suppose that Bill and Ted have the same utility function $U(Y) = Y^{1/2}$. where Y is consumption (which is equal to net income).

  a. Rank the three tax policies discussed in Problem 9 from Chapter 1 for a utilitarian social welfare function.
  b. How would your answer change if your utility function was instead $U(Y) = Y^{1/5}$?
  c. Suppose that Bill and Ted instead have different utility functions: Bill's utility is given by $U^B(Y) = 1/4Y^{1/2}$, and Ted's is given by $U^T(Y) = Y^{1/2}$. (This might happen, for example, because Bill has significant disabilities and therefore needs more income to get the same level of utility.) How would a Rawlsian rank the three tax policies now?

Effects of Redistributive Policies in Adventureland

	0%	25%	40%
Bill's pre-tax income	\$1000	\$800	\$400
Bill's taxes	0	\$200	\$160
Bill's net income	\$1000	\$600	\$240
Ted's pre-tax income	\$120	\$120	\$120
Ted's transfer payments	0	\$200	\$160
Ted' net income	\$120	\$320	\$280

- Exercise 14 p.59, *Gruber*

  You have \$3,000 dollars to spend on entertainment this year (lucky you!). The price of a day trip (T) is \$40 and the price of a pizza and a movie (M) is \$20. Suppose that your utility function is $U(T, M) = T^{1/3}M^{2/3}$.

  1. What combination of T and M will you choose?
  2. Suppose that the price of price of day trips rises to \$50. How will this change your decision?

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SECTION 3: Public Goods

3.1. Exercises

- Exercise 12 p.201, *Gruber*

  Andrew, Beth and Cathy live in Lindhville. Andrew's demand for bike paths, a public good, is given by $Q = 12 - 2P$. Beth's demand is $Q = 18 - P$, and Cathy's is $Q = 8 - P/3$.The marginal cost of building a bike path is $MC = 21$. The town government decides to use the following procedure for deciding how many paths to build. It asks each resident how many paths they want, and it builds the largest number asked for by any resident. To pay for these paths, it then taxes Andrew, Beth and Cathy the prices a, b and c per path respectively, where $a + b + c = MC$. (The residents know these tax rates before stating how many paths they want).

  a. If the taxes are set so that each resident shares the cost evenly ($a = b = c$), how many paths will get built?

  b. Show that the government can achieve the social optimum by setting the correct tax prices a, b and c. What prices should it set?

- Exercise 14 p.201, *Gruber*

  The town of Musicville has two residents, Bach and Mozart. The town currently funds its free outdoor concert series solely from the individual contributions of these residents. Each of the two residents has a utility function over private goods (X) and total concerts (C), of the form $U = 3 \times \log(X) + \log(C)$. The total number of concerts given, C, is the sum of the number paid for by each of the two persons: $C = C_B + C_M$. Bach and Mozart both have income of 70, and the price of both the private good and a concert is 1. Thus, they are limited to providing between 0 and 70 concerts.

  a. How many concerts are given if the government does not intervene?

  b. Suppose the government is not happy with the private equilibrium and decides to provide 10 concerts in addition to what Bach and Mozart may choose to provide on their own. It taxes Bach and Mozart equally to pay for the new concerts. What is the new total number of concerts? How does your answer compare to (a)? Have we achieved the social optimum? Why or why not?

  c. Suppose that instead an anonymous benefactor pays for 10 concerts. What is the new total number of concerts? Is this the same level of provision as in (b)? Why or why not?

- Exercise 15 p.201, *Gruber*

  Consider and economy with three types of individuals, differing only with respect to their preferences for monuments. Individuals of the first type get a fixed benefit of 100 from the mere existence of monuments, whatever their number. Individuals of the second and third type get benefits according to:

$$\begin{aligned} B_{II} &= 200 + 30M - 1.5M^2 \\ B_{III} &= 150 + 90M - 4.5M^2 \end{aligned}$$

  where M denotes the number of monuments in the city. Assume that there are 50 people of each type. Monuments cost \$3,600 each to build. How many monuments should be built?

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SECTION 4: Externalities

4.1. Exercises

- A tannery has a cost l^2 of tanning l tons of leather. Tanned leather can be sold at \$100 per ton. The tannery maximizes profits. The tanning process gives off unpleasant smells. Each ton of leather processed by the tannery has a social cost of \$10 (how much the neighborhood is willing to pay to avoid the smell).

  1. Assuming the tannery ignores the effect of the smell, how much will it produce?
  2. Consider a social planner who maximizes the tannery's profits plus the neighborhood's utility. How much will the social planner have the company produce?
  3. Is it possible to achieve the social planner's preferred production level by imposing a tax on tanned leather? If not explain why not, if yes describe the tax and its level.

- The inverse demand function for a good is given by $P = 10 - Q$. The marginal cost per unit of the good to the producer is constant at 2. The toxic gas emanated during the production generates air pollution that amounts to 4 per unit.

  1. What is the socially optimal quantity?
  2. Suppose the industry is perfectly competitive and firms ignore pollution. What is the market equilibrium? That is, what is P and Q? Is this outcome socially optimal?
  3. Now suppose the firms that acted in a perfectly competitive fashion in b) merge into one firm. What is the monopoly P and Q? Is this outcome socially optimal? Explain.

4.2. Readings

- Measuring Rates of Return for Lobbying Expenditures: An Empirical Analysis Under the American Jobs Creation Act, *by Raquel Alexander, Susan Scholz and Stephen Mazza*

  1. What is the main result of this study?
  2. What are the treatment and the control groups?
  3. What do we mean by lock-out effect?
  4. How do repatriating companies differ from non-repatriating companies?
  5. Which factors are associated with repatriating larger amounts?
  6. What are the policy implications of the results presented in this paper?

- Pounds that Kill: The External Costs of Vehicle Weight, *by Michael Anderson and Maximilian Auffhammer*

  1. What are the most important things to control for in determining the effect of vehicle weight on traffic fatalities?
  2. What are the two counterfactual scenarios the authors consider?
  3. Are there any other externalities to driving heavier vehicles other than the cost to the struck driver?
  4. What is the most direct intervention to correct to the external externality of vehicle weight?
  5. What are potential problems with this proposal?
  6. Is there a more practical correction/intervention?
  7. Does this solve the problem and how does it compare to the more direct intervention?

Measuring Rates of Return for Lobbying Expenditures:

An Empirical Analysis Under the American Jobs Creation Act

by Raquel Alexander, Susan Scholz and Stephen Mazza

Main conclusions:

In this paper we use audited corporate tax disclosures relating to a tax holiday on repatriated earnings created by the American Jobs Creation Act of 2004 to examine the return on lobbying. We find firms lobbying for this provision have a return in excess of $220 for every $1 spent on lobbying, or 22,000%. Repatriating firms are more profitable overall, but surprisingly, profitability is not a predictor of repatriation amount. Rather, industry and firm size are most predictive of repatriation. Cash on hand, a proxy for ability to repatriate, is not associated with the repatriation decision or the repatriation amount. This paper provides compelling evidence that lobbying expenditures have a positive and significant return on investment.

Data:

- ***Measure tax saving*:** Researchers outside the Internal Revenue Service cannot access this tax liability data because tax returns are confidential and, to date, no corporation publicly discloses tax return information. The dividend repatriation provision of the American Jobs Creation Act of 2004 (AJCA) provides a unique opportunity to quantify the returns to lobbying as the tax benefits were limited to a single taxable year and the benefits accruing to each company were publicly disclosed in financial statements.
  The AJCA allowed U.S. multinationals a one-time opportunity to bring home foreign earnings and pay taxes on only 15% of this repatriated income. Because the amounts repatriated typically had a material effect on companies' taxes, information about the repatriation is usually disclosed in the financial statements of publicly traded companies. Further, public accounting firms audit financial statements disclosures and attest to their accuracy.
- ***Measure lobbying expenditures:*** lobbying data from the Senate database on lobbying expenditures, the Federal Election Commission, and from annual reports of all publicly traded firms.

Issues:

- A domestic corporation's ability to defer indefinitely U.S. tax on income derived by its foreign subsidiary until such income is repatriated in the form of dividends is a long-standing, but controversial, component of U.S. international tax policy. Commentators describe the deferral issue slightly differently, viewing the residual U.S. tax imposed on the foreign source earnings, once repatriated, as a barrier to repatriation. This is known as the **"lock out" effect** and has been viewed as creating a disincentive to repatriate offshore earnings.
- Incentives for repatriation have somehow been created for repatriation of taxable dividends, but list of permitted uses to benefit from tax advantages suffered from an overall there was a lack of clarity in the legislation => the IRS's broad interpretation of the permitted uses in section 965(b) did little to ensure that corporations used the repatriated funds for job creation purposes, some of its statements may have run counter to the legislation's efforts to encourage job creation.

Previous literature:

In addition to our own, several studies have examined the impact of the AJCA on repatriated earnings.

- Most studies reveal that the repatriation holiday did not stimulate economic activity within the U.S. These same studies further find that corporations frequently used the repatriated earnings to support share repurchases, one of the nonpermitted uses.
- Public source data also reveal increases in mergers and acquisitions activity after Congress enacted section 965, as well as a boost in the dollar exchange rate. These effects may have improved the financial health of corporations and the U.S. economy as a whole, but there is little evidence that these improvements translated into job creation.
  In fact, American Shareholders Association statistics show decreases in job creation throughout much of 2005, despite the large amounts of offshore earnings corporations were repatriating. Along these same lines, Bureau of Labor Statistics data shows no spike in employment in 2005. Instead, the data reveal only a gradual increase from April 2003 through March 2006. Industry-specific data also shows no connection between repatriations and job growth.78

Summary statistics:

- Most of our analysis focuses on these three categories of companies, comparing the repatriating companies to the combined set of companies that considered, but decided not to repatriate. That is, they either clearly stated they would not repatriate or considered repatriation, but never reported doing so.
- Statistically significant differences between the two groups are noted with an asterisk:

Table 1: Comparison of repatriating and non-repatriating companies

	Repatriating Companies	Non-Repatriating Companies	
Number of companies:	466	774	
Panel A: Averages			
Assets ($M)	24,833.1	6,702.8	*
Cash / Assets	15%	20%	*
Liabilities / Assets	22%	22%	
Revenues ($M)	7,371.8	3,063.1	*
Percent profitable (pre-tax)	91%	75%	*
Pre-tax Income / Revenues	12%	-32%	
Operating Cash Flow / Sales	15%	-8%	
Panel B: Medians			
Assets ($M)	2,510.5	570.1	*
Cash / Assets	10%	13%	*
Liabilities / Assets	20%	17%	*
Revenues ($M)	2,039.6	517.3	*
Pre-tax Income / Revenues	10%	6%	*
Operating Cash Flow / Sales	12%	8%	*

Therefore:

a. repatriating companies are very large - with assets of nearly $25 billion. This is nearly four times greater than the non-repatriating companies' average
b. repatriating companies had significantly less cash on hand at the end of 2004

c. the average repatriating company reported revenues of over $7 billion in 2004, more than twice the amount reported by non-repatriating companies
d. a higher percentage of repatriating companies were profitable, but despite large differences in profit and cash flow margins, the average differences are not statistically significant.

Overall, repatriating companies appear to be relatively large, mature, and profitable enterprises.

- *Composition of repatriating companies:* more than 60% of the repatriating companies in our sample are in manufacturing industries (SIC codes 2000 - 3900). Within these larger groups, there are several concentrations in more specific industry groups. Twelve percent of all repatriating companies are found in SIC code 2800 – Chemicals and Allied Products. This group includes pharmaceutical companies, which account for 6% of all repatriating companies. Manufactures of various computer, electronic and medical instrument manufacturers each represent 8%-9% of all repatriating companies.

<u>Econometric analysis:</u>

- Logistic regression analysis, shown in Table 3, provides a combined analysis of these characteristics, to provide an assessment of which factors are most significant in determining whether a company repatriated

Table 3: Logistic Regression Results:
Repatriating companies = 1, Non-repatriating companies = 0

	Regression Coefficient	Significance Level
Total assets (natural log)	.415	.000
Cash /Assets	.225	.640
Liabilities / Assets	-.409	.269
Reporting pre-tax income (vs. loss)	.729	.001
Operating Cash Flows / Sales	1.918	.000
Indicator for each industry group in table 2	varies	> .600

These results confirm that larger, profitable companies, generating relatively higher cash flows from their revenues were more likely to repatriate. On the other hand, relative cash and liability balances do not appear to be significant factors

- Similar to the logistic regression analysis above, we use regression analysis to weigh which factors are associated with repatriating higher amounts

Table 5: OLS Regression Results:
Dependent variable = amount repatriated[11]

	Regression Coefficient	Significance Level
Total assets	.915	<0.001
Cash /Assets	3.702	<0.001
Liabilities / Assets	1.186	0.085
Reporting pre-tax income (vs. loss)	-.314	0.330
Operating Cash Flows / Sales	1.679	0.023
Indicator for SIC 3800	2.196	0.085
Indicator for other industry groups in table 2	varies	> .125

Our results indicate that larger companies with both more cash and more leverage are likely to repatriate higher amounts. While pre-tax profitability does not appear to be a factor (at least profitability in 2004), higher relative cash flows are associated with repatriating more dollars. After controlling for company financial characteristics, the only two-digit industry that appears to repatriate relatively higher amounts is SIC 3800, Medical and Laboratory Equipment.

- Lobbying expenditures:

Table 6: Lobbying expenditures for repatriating companies

	No Lobbying	Lobbying with coalition	Lobbying no coalition	Overall
	357	39	54	450
Repatriated amounts				
Total ($M)	89,257.2	155,667.4	53,435.4	298,360.0
Percent of total repatriations	30%	52%	18%	100%
Per company average ($M)	250.0	3,991.5	989.5	663.0
Estimated tax savings				
Total ($M)	26,554.3	46,157.5	15,897.0	88,608.8
Per company average ($M)	74.4	1,183.5	294.4	196.9
Lobbying expenditures				
Total ($M)	n/a	179.6	103.1	282.7
Per company average ($M)	n/a	4.6	1.9	3.0
Lobbying expenditure / repatriated amount				
Overall percentage	n/a	0.1%	0.2%	0.1%
Per company average percentage	n/a	0.8%	1.4%	1.2%
Savings / lobbying expenditure				
Overall return on lobbying	n/a	257	154	220
Per company average return	n/a	767	943	869
Average return for lobbying > $1M	n/a	276	198	243
Per company median	n/a	206.3	151.9	172.2

- ***Tax savings:*** because relatively few companies quantify the tax benefits of repatriation, and because it is not always clear how reported benefits are calculated, we use a simple estimate of tax savings based on the most likely marginal tax rate (35%). Thus, our estimated tax savings for each company is 85% of the amount that would otherwise have been paid for taxes: (amount repatriated x 35% x 85%). Using this measure, the total estimated savings by these firms is over $88 billion dollars, with more than 50% of the total savings accruing to the 39 coalition companies. The average tax savings for each of these companies is over $1 billion
- We also provide comparisons of lobbying ***amounts relative to dollars repatriated and estimated tax savings***. Overall, the amount spent on lobbying was .1% of the total amount repatriated. However, because some companies spent much more than others, the average of the per company percentages of the amount spent on lobbying compared with the amount eventually repatriated was 1.2%. This percentage was lower for the coalition participants (.8%), because their repatriations were so great.
- Dividing the estimated tax savings by the estimated amount spent on lobbying gives an ***estimate of each companies' return on their lobbying investment***. This measure gives an overall return of 220 times the investment. ((46,157.5 + 15,897.0)/282.7). That is, for every dollar spent on lobbying, there was a tax savings equal to about $220. In percentage terms, this is a 22,000% return. As might be expected, returns are higher for coalition participants.
- However, some companies invested very little in lobbying, but repatriated large amounts, giving returns of thousands of dollars for every lobbying dollar. (The highest return is more than $13,000

for each lobbying dollar.) Therefore, the average of the per company returns are much higher: 767 times for the average coalition participant, and 943 times for the average non-coalition company lobbying for the Act.

Implications/conclusions:

- We find that firms lobbying for this provision had a return in excess of twenty-two thousand percent on their lobbying expenses. Repatriating firms were more profitable overall, but surprisingly, profitability was not a predictor or repatriation amount. Rather industry and firm size was most predictive. Cash on hand, which proxies for ability to repatriation, was not associated with the repatriation decision or the repatriation amount.
- *The* ***tax policy implications are troubling***, particularly in light of recent efforts by some members of Congress to renew the repatriation holiday for a second time. The tax benefits are accrued to older, larger firms that are declining in market value. Many economic development policies are aimed at supporting emerging firms and industries; this tax provision appears to be doing the opposite as it provides tax subsidies to well-established firms and industries with declining opportunities and market growth. Coupled with recent research that suggests firms used repatriation funds to repurchase stock and bolster their financial position instead of pursuing business opportunities, the efficacy of another repatriation holiday is highly questionable.
- Our results also raise ***larger issues about optimal lobbying expenditures*** by firms and firms' incentives to lobby for some benefits and not others. One would expect firms to devote to lobbying an amount that produces an acceptable, but modest, rate of return. Our results question how firms calculate an acceptable rate of return and whether firms view lobbying for tax benefits differently than other types of lobbying. Compared to other rent-seeking behavior, lobbying for tax benefits is relatively transparent. And while one might expect that the rate of return to lobbying would be lower in cases in which (1) the potential benefits are capable of being estimated in fairly specific dollar terms and (2) the information about these benefits is available to lobbyists, legislators, and other interest groups, our results seem to indicate just the opposite. Using our existing data and compiling additional data on lobbying efforts by firms to re-enact the repatriation holiday a second time, we will explore these issues in a future paper.

Summary of: Pounds that Kill: The External Costs of Vehicle Weight

Michael Anderson & Maximilian Aufhammer

Working paper: June 2011

Main conclusions

In this paper we estimate the increased probability of fatalities from being hit by a heavier vehicle in a collision. We show that, controlling for own-vehicle weight, being hit by a vehicle that is 1,000 pounds heavier results in a 47% increase in the baseline fatality probability. Estimation results further suggest that the fatality risk is even higher if the striking vehicle is a light truck (SUV, pickup truck, or minivan). We calculate that the value of the external risk generated by the gain in fleet weight since 1989 is approximately 27 cents per gallon of gasoline. We further calculate that the total fatality externality is roughly equivalent to a gas tax of $1.08 per gallon. We consider two policy options for internalizing this external cost: a gas tax and an optimal weight varying mileage tax. Comparing these options, we find that the cost is similar for most vehicles.

Data

- The data set consists of the population of police-reported accidents for eight states: Florida, Kansas, Kentucky, Maryland, Missouri, Ohio, Washington and Wyoming. These data come from the State Data System, maintained by the National Highway Traffic Safety Administration (NHTSA). The SDS data include information on injuries and fatalities, geographic location, weather conditions, use of safety equipment, and driver and occupant characteristics.
- We selected these eight states out of the 32 states currently participating in the SDS as they report the vehicle identification number (VIN) for the majority of vehicles in the data set. We purchased data tables from DataOne Software to match the first 9 digits of the VIN to curb weight data for each vehicle.
- For analytic purposes, we decompose the data set into three sub-samples, two-vehicle crashes, three-vehicle crashes, and single-vehicle crashes. The two-vehicle crash data set is the focus of most of our analyses. It contains 4.8 million vehicles in collisions in which both vehicles have complete curbside weight data.

Issues

- One important feature of the SDS data is that accidents only appear in the data set if the police take an accident report. According to NHTSA documentation, various estimates suggest that only half of all motor vehicle accidents are police reported. While many of the unreported accidents are single vehicle accidents, some no doubt involve two vehicles as well. This sampling frame could affect our estimates if vehicle weight affects the probability of a police report, all other factors held constant.
- If vehicle weight positively affects the reporting probability of minor accidents, then our estimates will represent a lower bound on the effect of weight on external fatalities. If vehicle weight negatively affects the reporting probability of minor accidents, however, then our estimates of the effect of weight on external fatalities could be upwardly biased.

Previous literature

Previous work on the "arms race" on American roads has focused on the internal and external risks posed by the largest vehicles – pickup trucks and sport utility vehicles (SUVs) – relative to the typical passenger car. White (2004), Gayer (2004), Anderson (2008), and Li (forthcoming) all conclude that light trucks (pickups and SUVs) impose significant risks relative to passenger cars. This study expands upon that literature by considering the fundamental role that vehicle weight plays in determining external risk. We recognize that *any* vehicle that is heavier than the smallest feasible vehicle poses some external risk to other roadway users. We quantify that risk and find that the total external costs of vehicle weight substantially exceed the external costs that accrue only from light trucks. Our comprehensive results span the entire range of the vehicle fleet and allow us to consider the broader implications of vehicle weight for energy policy.

Summary Statistics

Table 1: Summary Statistics for Two-Vehicle Collision Data Set

	Base Sample		Complete Covariates Sample	
	Mean (Std Dev)	Sample Size	Mean (Std Dev)	Sample Size
Weight	3,076 lbs (685)	4,849,575	3,113 lbs (694)	2,829,768
Light Truck	24.5% (43.0)	4,849,575	25.8% (43.8)	2,829,768
Model Year	1992 (5.6)	4,849,575	1993 (5.7)	2,829,768
Accident Year	1998 (4.4)	4,849,575	1999 (4.3)	2,829,768
Occupants	1.41 (0.84)	2,608,821	1.45 (0.87)	1,476,441
Fatality	0.19% (4.36)	4,849,575	0.23% (4.83)	2,829,768
Serious Injury	2.7% (16.1)	4,849,575	3.4% (18.0)	2,829,768
Alcohol Involved	8.3% (27.6)	2,753,533	10.0% (30.1)	1,723,694

Notes: Both samples are limited to collisions involving two light vehicles built post-1980. The complete covariates sample is further limited to collisions in which all covariates in our preferred specification are non-missing.

Econometric Analysis

Linear probability model and probit model shown in Table 2 with various controls.

Table 2: Effect of Vehicle Weight on Fatalities

Dependant Variable: Presence of Fatalities in Struck Vehicle

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Weight of Striking Vehicle (1000s of lbs)	0.00088	0.12885	0.00093	0.12797	0.00101	0.13440	0.00110	0.00065	0.00064
	(0.00004)	(0.00653)	(0.00015)	(0.00616)	(0.00005)	(0.00815)	(0.00006)	(0.00006)	(0.00006)
Effect of 1000 lb Increase in Striking Vehicle Weight/ Percent Increase Over Sample Mean	0.00088	0.00877	0.00093	0.00883	0.00101	0.00886	0.00110	0.00065	0.00064
	46%	45%	42%	38%	46%	37%	47%	48%	48%
Weight of Struck Vehicle (1000s of lbs)	-0.00047	-0.08156	-0.00153	-0.09548	-0.00101	-0.13988	-0.00097	-0.00060	-0.00065
	(0.00004)	(0.00644)	(0.00014)	(0.00727)	(0.00005)	(0.00815)	(0.00006)	(0.00006)	(0.00006)
Striking Vehicle is Light Truck	0.00117	0.15977	0.00105	0.13016	0.00088	0.10113	0.00095	0.00054	0.00054
	(0.00006)	(0.00662)	(0.00008)	(0.00958)	(0.00009)	(0.01275)	(0.00009)	(0.00010)	(0.00010)
Struck Vehicle is Light Truck	-0.00034	-0.02541	-0.00036	-0.05192	-0.00001	-0.03605	0.00021	-0.00015	-0.00012
	(0.00006)	(0.00987)	(0.00007)	(0.01081)	(0.00007)	(0.01154)	(0.00006)	(0.00009)	(0.00009)
Specification	OLS	Probit	OLS	Probit	OLS	Probit	OLS	OLS	OLS
Weather, Time, and County Fixed Effects			Yes	Yes	Yes	Yes	Yes	Yes	Yes
Driver Characteristics					Yes	Yes	Yes	Yes	Yes
City Fixed Effects							Yes	Yes	Yes
Occupants and Seat Belt Usage									Yes
Sample Size	4,849,575	4,849,575	3,572,479	3,536,684	3,223,746	3,197,482	2,829,268	1,470,596	1,470,596

Note: Each column represents a separate regression. The estimation sample is limited to collisions involving two vehicles. Parentheses contain standard errors clustered at the collision level. Effects of a 1,000 lb increase in striking vehicle weight are compared to the average effect of a 1,000 lb increase in weight across all observations included in the regression. All regressions include as right-hand-side variables the weight of each vehicle, indicators for whether each vehicle is a light truck, and year fixed effects. Weather, time, and county fixed effects controls include rain, darkness, day of week (weekday versus weekend), Interstate highway, a quadratic in model year for each vehicle, and year, hour, and county fixed effects. Driver characteristic controls include quadratics in driver age, indicators for drivers under 21 or over 60, indicators for male drivers and young male drivers, and indicators for any seat belt usage in the vehicle.

Column (7) is the preferred specification (note too many regressors to reliably estimate a probit model and thus only OLS estimated for 7-9). A 1000 lbs increase in stricking vehicle weight increases the probability of a fatality by 47%.

The results in Table 2 suggest that selection bias has little impact on the striking vehicle weight coefficient but may affect the struck vehicle weight coefficient. In particular, the addition of driver characteristic controls in columns (5) and (6) has a notable impact on the struck vehicle weight coefficient but almost no impact on the striking vehicle weight coefficient.

The results in Table 2 also suggest that the external risk posed by light trucks is not due solely to their heavy weight. The coefficient on the indicator for whether the striking vehicle is a light truck is positive and statistically significant in every column. In our preferred specification, column (7), the coefficient implies that being struck by a light truck increases the probability of a fatality by 0.09 percentage points (t = 10.3), even after conditioning on striking vehicle weight.

Policy Implications

We now explore whether the estimated causal effect of vehicle weight on fatalities is economically significant and compare two possible price based policies to distribute the external costs across drivers. To quantify the magnitude of the external costs of increased vehicle weight, we design the following counterfactual experiment. We consider the externality at the individual level, whereby purchasing and driving a heavy vehicle increases the probability of a fatality in a collision with other vehicles on the road. We conduct a thought experiment in which an individual chooses a vehicle of a certain weight; we then calculate the external costs from this individual's vehicle choice. We carry out this calculation for each driver on the road while holding the remainder of the fleet constant. We sum across individuals to get the total externality from all individuals' vehicle choices.

- For the purposes of this calculation, we assume that the individual chooses a vehicle weighing as much as the average 2005 model year vehicle in our data (3,616 pounds). We calculate total external costs against two baseline vehicles that the individual could buy – a slightly lighter vehicle and the lightest possible vehicle. The "slightly lighter" counterfactual vehicle is a proxy for the average 1989 model year vehicle in our data, which weighs 2,953 pounds. The "lightest possible" counterfactual vehicle is the smallest drivable car in mass production in 2005, which weighs 1,850 pounds.

All of our scenarios represent partial equilibrium approaches to arriving at total external costs – they assume that our regression estimates would not change if the vehicle fleet changed in response to the policies considered (in reality, there could be a modest change in the regression coefficients if the vehicle fleet changes in response to policy). When summed across all individuals, our counterfactual scenario computes the total external cost of a 2005 model year vehicle fleet over the representative 1989 model year vehicle. Our experiment is not affected by the specific distribution of vehicle weight within the fleet as the probability of a fatality is assumed linear in striking vehicle weight – the linearity ensures that mean vehicle weight is a sufficient statistic for our policy analysis.

- If our simulated individual chooses a vehicle weighing 3,616 lbs instead of one weighing 2,953 lbs, she causes an additional 0.000027 external fatalities per year in expectation, valued at $154.39. Summing this figure across all vehicles, the **total external cost of vehicle weight gain relative to the 1989 baseline vehicle is $35 billion per year**. This figure represents the "weight gain since 1989" scenario but does not encompass the total external costs of vehicle weight.

- Our second counterfactual scenario assumes the individual purchases the 3,616 lb vehicle (wi) over a vehicle weighing 1,850 lbs (wcf), which represents the lightest vehicle in mass production that can transport at least two adult passengers and is classified as an automobile. This is the approximate weight of Toyota's iQ, Mercedes Benz's Smart Car, or the first generation Honda Insight. The intuition behind calculating the total external cost using this baseline vehicle is that individuals privately choose the size of the externality by choosing a heavier vehicle than required to provide baseline transportation services. **If our simulated individual chooses a vehicle weighing 3,616 lbs instead of one weighing 1,850 lbs, she causes an additional 0.000071 external fatalities per year in expectation, valued at $411.34. Summing across all drivers, this translates into a total external cost of $93 billion per year.**

  - This scenario, however, ignores the external fatality risks that vehicles pose to pedestrians and motorcyclists. In 2005, there were 2,659 motorcycle crash fatalities (involving light vehicles) and

5,864 non-motorist fatalities due to fatal crashes (NHTSA 2010). This is equivalent to an external "baseline" fatality cost of $49.4 billion. The total external cost of "excess" vehicle weight and baseline fatality risk is therefore $142.4 billion.

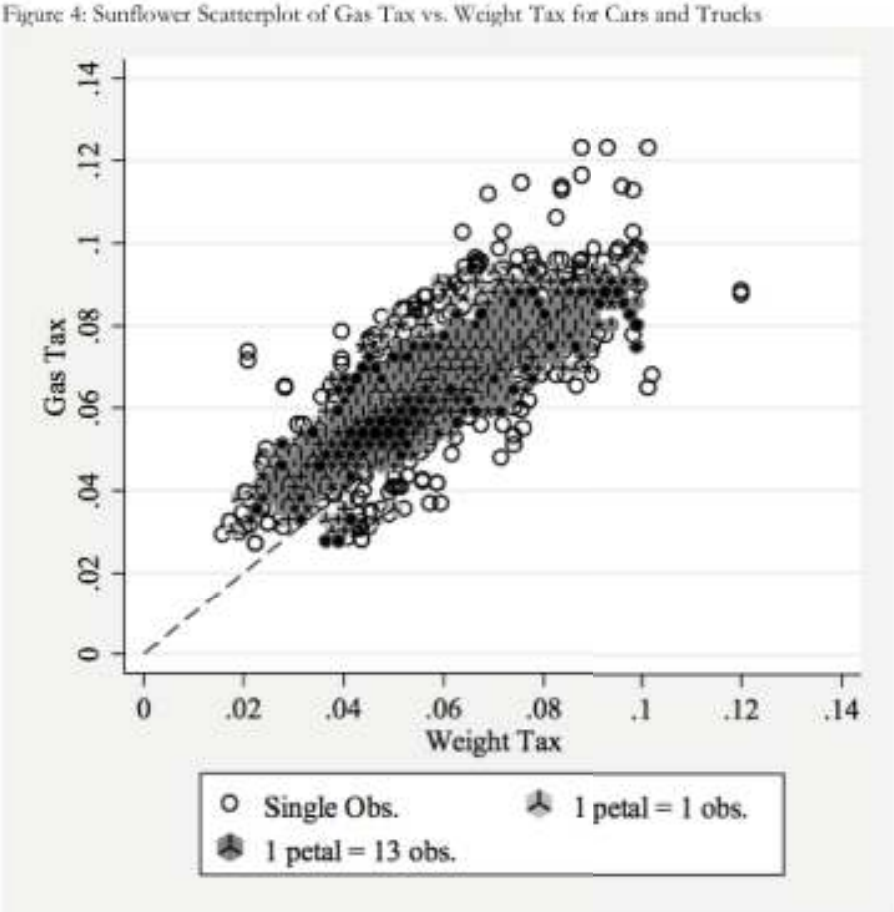
While the magnitude of the total external costs is a straightforward calculation, translating it into an optimal policy is not. Our results demonstrate that the per mile insurance charge should vary sharply by weight – a heavier car generates greater expected per mile external costs than a lighter car. **In order to assess a tax that varies per pound and per mile, one needs accurate information on vehicle miles travelled (VMT) for each vehicle, which creates substantial monitoring challenges.**

A practical policy alternative is to distribute the total external costs by raising the gasoline tax assessed per gallon. **Taxing gasoline is appealing because it is simple and because gasoline usage is positively related to both miles driven and vehicle weight.**

- The United States consumed 140 billion gallons of gasoline in 2005 (EIA 2010). If we spread the total external costs calculated above across 140 billion gallons of gasoline, **this translates into 27 cents per gallon in the "weight gain since 1989" scenario** ($38 billion/140 billion gallons = 27 cents/gallon). The total externality due to vehicle fatalities **when the baseline vehicle is 1,850 pounds translates into a tax of 73 cents per gallon** ($101.6 billion/140 billion gallons = 73 cents/gallon). Including pedestrian and motorcycle fatalities translates into a tax of $1.08 per gallon ($151 billion/140 billion gallons = $1.08/gallon).

A natural question is how close the gasoline tax comes to achieving the desired weight varying mileage tax. We perform a back of the envelope calculation using a large set of vehicles for which we have vehicle weight and mpg ratings from Knittel (forthcoming). Figure 4 presents a scatterplot of the gas tax versus the weight tax for all models from 1997–2006 in the cleaned Knittel (forthcoming) database.

Figure 4: Sunflower Scatterplot of Gas Tax vs. Weight Tax for Cars and Trucks



Notes: The graph above displays the joint distribution of the weight tax and gas tax per mile for the sample of cars and trucks with model years 1997-2006 from the database provided by Knittel (forthcoming). We remove boutique cars, flex fuel vehicles, and a few outliers with incorrectly recorded fuel ratings. The sunflower plot bunches multiple observations into single flowers, where the number of petals indicates the total number of observations represented by the flower. The petals of light flowers represent one observation each and the petals of darker flowers represent 13 observations each.

The difference between the two taxes is small for most models, but it can be significant at the extremes, ranging between –3.7 cents to 5.3 cents per mile. A one cent difference per mile equates to $110 dollars on an annual basis. **For 62% of the models in our database, the absolute value of the difference between the two taxes is less than one cent per mile, and for 95% of the models the absolute value of the difference is less than 2 cents per mile. The average difference between the two taxes is 0.69 cents per mile, which represents 12.9% of the average value of the per mile weight tax.**

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SECTION 6: Solutions Problem Set 1 and Tiebout Model

6.1. Solutions Problem Set 1

- Exercise 5

  Assume the cost of commuting to work for an individual with wage w is wln(n) by car and wx + t by BART, where n is the number of cars on the road (one car per driver), t is the cost of commuting by BART and x is the time spent commuting by public transport. Let there be N total commuters.

  a. Assume everyone makes the same wage. What will the equilibrium number of drivers be? How does this equilibrium number of drivers change with wage?
  b. What is the socially efficient number of drivers? How does the socially efficient number of drivers change with equilbrium wage?
  c. What are four ways you could enforce the social optimum? Which of these seems the most plausible?

6.2. Tiebout Model

- Experiment instructions

  Community Structure: This is a classroom exercise in which you will be able to choose where you prefer to live. There are initially five communities with locations marked by manila envelopes. Each of you will now be assigned to one of these communities. I will now distribute several playing cards to each of you. The cards have a number and a suit (Hearts , Clubs , Diamonds , and Spades). The suit corresponds to a particular type of public good. The number reflects the intensity of your preference for that type of public good. For example, if your cards are 3 , 4 , 9 , and 2 , then your intensity is 3 for , 4 for , 11 (9+2) for . For example, you might think of these as possible types of museums, such as medical ( ), agricultural ( ), military ( ), and baseball ( ).

  Community Choice: Your community must choose to provide one (and only one) of these public goods. In addition, the community must decide on the level of that good to provide. For example, a community may decide to provide a level of 6 (which means the levels of the other three goods are zero). These decisions will be made by a series of votes that follow an initial discussion of preference and negotiations. All votes will be decided on the basis of majority rule. These votes and discussions will be coordinated by a mayor, someone who I will now appoint for each community. The mayor will chair meetings, announce the community's choice of public good, and the individual tax rate (individual cost). If the mayor moves to another community, he/she should appoint another mayor before leaving. In the event of a tie, the mayor, who votes individually as well, can cast a second vote to break the tie .

  Preferences: Your voting decision may be guided by the cards that you have. In general, you prefer the community adopt a high level of the public good for the suit in which you have a high card number (or sum of numbers). You will be happiest if the community chooses a level that corresponds exactly to the total number that you have for that suit. The cost of providing the public good is two times the level. All members of the community must share this cost equally, so a high provision results in higher taxes. Therefore, you would not want your community to choose a level of the public good that is higher than the number you have for that suit.

  (Example 1) Suppose your cards are: 10 , 2 , 5 , 6 , and that your community has 6 people and decides on a level of 6 . The cost of this decision is 2x6 = 12, which is to be divided by the number of people (6), yielding an individual cost of 2. Your payoff is 2 (since you have a 2 of) minus the individual cost, 2, which equals 0.

(Example 2) Now suppose another community member's cards are: 7 , 10 , 3 , 4 . This member's could potentially receive a benefit of 10 for Spades, but the person's payoff is capped at 6 (the level voted upon). The net benefit is, therefore, 6 minus the individual cost, 2, which equals 4.

(Example 3) Now it is your turn to work an example . A person is in a community of 5 people which chooses Clubs at a level of 5, i.e. 5 , for a total cost of ____. A person with the following cards: 9 , 4 , 6 , 10 would receive a benefit of ____, pay a tax of ____ , and hence would have a net benefit of ____.

Choosing Communities: The residents of each community will make their decision (suit and level) by voting, in a meeting conducted by the mayor. After all communities have made decisions, we will ask the mayors to announce their decisions, thus completing the first round. Then, people will be free to switch to a community with a public good decision more to their liking, with the understanding that newly configured communities will vote again at the start of the round on the type and level of the good to be provided. Using the provided table, please record your card distribution (suits and numbers), community/location in each round, the community decision, and your payoffs after each round. You may move communities to improve your well being, or you may choose to remain in a community. Communities may dissolve and re-emerge during this process.

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SECTION 7: Tiebout Model and Cost-Benefit Analysis

7.1. Tiebout Model

- Exercise 10 p. 287, *Gruber* Chapter 10

  Rhode and Strumpf (2003) evaluated a century of historical evidence to investigate the impact of changes in moving costs within the Tiebout model.

  1. What does the Tiebout model predict should happen to the similarity of residents within a community as the costs of moving fall?
  2. Rhode and Strumpf found that while mobility costs have steadily fallen, the differences in public good provision across communities have fallen as well. Does Tiebout sorting explain this homogenization of public good provision, or must other factors have played a larger role? Explain.

- Based on Exercise 14 p. 288, *Gruber* Chapter 10

  There are two types of residents in Berkeley and Oakland, economics students and biology students. Economics students spent $T = 12$ hours a day studying while biology students only spend $T = 4$ hours a day studying (they have much less work!). Both Berkeley and Oakland provide nature conservancies for their citizens. Biology students value Berkeley more than Oakland because Berkeley has better preserved nature conservancies. On the other hand, economics students prefer Oakland since they don't have time to enjoy nature conservancies, but have to pay for them. The value of nature conservancies to each individual takes the form $N^2 + 2TN$. The per-resident cost of maintaining nature conservancies is $32N$.

  1. What is the marginal value of maintaining nature conservancies for each type of individual? What is the marginal cost to each type of individual?
  2. How much do biology students want to spend on nature conservancies? How much do economics students want to spend?
  3. Assume that residents are distributed as follows:

	Berkeley	Oakland
Economics Students	60	75
Biology Students	100	45

     If the amount spent for the maintenance of nature conservancies in each town is an average of the amounts preferred by the individuals living in that town, how much will each town spend on nature conservancies? What about if they use majority voting? In each of the two cases, how many residents are unsatisfied with the amount spent on nature conservancies? Who will want to move, and where?

- Based on Exercise 1 p. 287, *Gruber* Chapter 10

  The (identical) citizens of Boomtown have \$2 million to spend either on park maintenance or private goods. Each unit of park maintenance costs \$10,000.

  1. Graph Boomtown's budget constraint.
  2. Suppose that Boomtown chooses to purchase 100 units of park maintenance.Draw the town's indifference curve for this choice.
  3. Now suppose that the state government decides to subsidize Boomtown's purchase of park maintenance by providing the town with 1 unit of maintenance for every 2 units the town purchases. Draw the new budget constraint. Will Boomtown purchase more or fewer units of park maintenance? Will Boomtown purchase more or fewer units of the private good? Illustrate your answer, and explain.

4. Assume that with a 125,000$ block grant from the state government, Boomtown would consume 110 units of park maintenance. Suppose then that, what Boomtown really receive is a conditional block grant of 125,000$ for park maintenance. How much park maintenance will Boomtown purchase? Are "Boomtowners" better off under a block grant or under a conditional block grant? Under what conditions are they equally happy in the two cases?

7.2. Cost-Benefit Analysis

- Exercise 14 p. 225, *Gruber* Chapter 8

  Jellystone National Park is located 10 minutes away from city A and 20 minutes away from city B. Cities A and B have 200,000 inhabitants each, and residents in both cities have the same income and preferences for national parks. Assume that the cost for an individual to go to a national park is represented by the cost of the time it takes her to get into the park. Also assume that the cost of time for individuals in cities A and B is $.50 per minute.

  You observe that each inhabitant of city A goes to Jellystone ten times a year while each inhabitant of city B goes only five times a year. Assume the following: the only people who go to the park are the residents of cities A and B; the cost of running Jellystone is $1,500,000 a year; and the social discount rate is 10%. Also assume that the park lasts forever.

  1. Compute the cost per visit to Jellystone for an inhabitant of each city.
  2. Assuming that those two observations (cost per visit and number of visits per inhabitant of city A, and cost per visit and number of visits per inhabitant of city B) correspond to two points of the same linear individual demand curve for visits to Jellystone, derive that demand curve. What is the consumer surplus for inhabitants of each city? What is the total consumer surplus?
  3. There is a timber developer who wants to buy Jellystone to run his business. He is offering $100 million for the park. Should the park be sold?

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SECTION 8: Tax Incidence

8.1. True/False/Uncertain Questions

1. Under a horizontal equitable tax system economics grad students should pay the same tax as investment banking analysts.
2. If infra-marginal impacts of a tax break are very large, then provision by the government is preferred to a tax break.
3. The incidence of a land value tax is borne equally by both land owners and buyers. A land value tax is a tax on the unimproved value of land, i.e. excluding the value of buildings, personal property and other improvements.
4. A gasoline tax is likely to be progressive.
5. The government has imposed a new tax on all airline travel. The market has two types of travelers: business and leisure. Business travelers have a price elasticity of demand of -1.2, leisure travelers have a price elasticity of demand equal to -3.0. Airlines can price discriminate between these two groups (i.e. charge different prices to each type).

   Then Business travelers will bear the larger burden of the tax.
6. Consumers are always better off, if a taxed good is provided in a competitive market rather than a monopoly.

8.2. Exercises

- Exercise 12 p.556, *Gruber* Chapter 18

  Your employer allows you to purchase a parking permit with "pretax dollars" - that is, you don't have to pay taxes on the money that you used to purchase this permit. Does allowing some people to purchase certain goods or services using pretax dollars increase or decrease equity in the U.S. tax system? Explain.
- Exercise 13 p. 586, *Gruber* Chapter 19

  Massive Products Inc. is a monopolist whose cost of production is given by $10Q + Q^2$ (so its marginal cost curve - equivalently its inverse supply curve - is given by $10+2Q$). Demand for Massive Products' massive products is $Q = 200 - 2P$.

  (a) What price will the monopolist charge, and what profits will the monopolist earn? What will the consumer surplus be?

  (b) How will the monopolist's price and profits change if a tax of \$15 per unit is imposed on the buyers of the product?

  (c) What is the deadweight burden of the tax?
- Suppose that the demand for a good is described by the inverse demand function $p = 10 - 3q$ and the supply of the good is given by the inverse supply function $p = 2 + 2q$.

  (a) What is the equilibrium price and quantity of the good in this market?

  (b) Suppose the government imposes a \$1 per unit tax on suppliers. Now what is the equilibrium price and quantity of the good in this market.

  (c) Determine the incidence of the tax, who bears what shares of the tax?

  (d) Calculate the elasticities of demand and supply at the equilibrium allocation in the absence of the tax. Explain how these elasticities work to determine the incidence of the tax.

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SECTION 9: Efficiency Cost of Taxation

9.1. Exercises

- Exercise 10 p.617, *Gruber* Chapter 20

  The market demand for stuffed rabbits is $Q = 2600 - 20P$, and the government intends to place a \$4 per bunny tax on stuffed rabbit purchases. Calculate the deadweight loss of this tax when:

  (a) Supply of stuffed rabbits is $Q = 400$

  (b) Supply of stuffed rabbits is $Q = 12P$

  (c) Explain why the deadweight loss calculations differ between (a) and (b)

- Exercise 14 p.618, *Gruber* Chapter 20

  The demand for snorkels in Berhama is given by $Q_S = 500 - 8P_S$ and the supply of snorkels in Berhama is given by $Q_S = 200 + 4P_S$. The demand for kayaks is given by $Q_k = 650 - 6P_k$ and the supply of kayaks is given by $Q_k = 50 + 1.5P_k$. Both goods are currently untaxed, but the government of Berhama needs to raise \$5,000 (to finance a new lighthouse) by taxing snorkels and kayaks. What tax should it levy on each of the two goods?

9.2. Article

- Theoretical exercise

  A representative worker is paid \$20 per hour and has disutility $(0.004)h^2$ of working h hours in one year. The worker solves

  $$\max_h (1-t)20h - (0.004)h^2$$

  where t denotes the income tax rate.

  (a) How much will the worker work if $t = 0$?

  (b) US workers put in the longest hours on the job in industrialized nations, clocking up 1,966 hours per capita in 1997. In Norway and Sweden hours worked in 1997 were, respectively 1,399 and 1,552 per year. Suppose workers in all three nations solve the problem above, but with country-specific tax rates t_{US}, t_{NOR}, and t_{SWE}. Solve for the country-specific tax rates that would induce workers to work as much as they are observed to work in each country.

  (c) Assume the wage per hour is higher in the US than it is in Sweden and Norway (assume it is slightly higher than \$20 per hour), because productivity is higher. Would the tax rate in the US be higher or lower than what you found in (b)?

- Questions

  1. What is Edward Prescott's explanation of the observed differences in labor supply between Americans and Europeans?
  2. What do we mean by "social multiplier" theory?
  3. What are the consequences of facing higher tax rates? Discuss the pros and cons.

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SECTION 10: Taxes on Labor Supply and Savings

10.1. True/False Questions

1. Making child care costs tax-deductible reduce the "tax wedge" associated with the fact that market work is taxed but home work is not. Moreover, it increases social efficiency.

2. 401k plans significantly increase the return to retirement savings by deferring tax payments.

3. Bracket creep decreases taxes for someone with constant real income.

10.2. Earned Income Tax Credit

- Exercise

  Consider the case of a single woman, Grace, who is deciding how many hours to work each month. Suppose she is limited to working a maximum of 200 hours per month. She has no other source of labor income. If she works, she receives a wage of \$10 for each hour worked. However, a payroll tax on labor income ($\tau = 0.10$ or 10%) is assessed on the worker for all labor income and is present throughout the problem. Assume Grace's utility function over division of total labor supply endowment per month between leisure (L) and all other consumption expenditure (C) takes the following form:

$$U = 6\ln(L) + 4\ln(C)$$

  1. Sketch the budget constraint facing Grace in leisure (L) and other consumption expenditure (C) space.
  2. Solve for Grace's optimal choice of labor supply.
     (a) How many hours of work will she provide?
     (b) What is the corresponding level of her other consumption expenditure (earned income - payroll taxes)?

  Suppose the state government introduces a work incentives program similar to the EITC to promote work among low-earning workers. Under this program:

  - Workers receive a 20% government refundable tax credit for wages on the first \$500 of earned income. The maximum subsidy, then, is \$100.
  - Workers retain the full \$100 credit for earnings above \$500, provided that total earned income does not exceed \$700.
  - Workers whose earned income exceeds \$700 have their credit amount reduced by 20% of earned income above \$700 up to the point that the credit is \$0.
  - The credit is fully phased-out at \$1200 of earned income, and workers whose earned income exceeds \$1200 receive no credit.

  3. Demonstrate graphically the revised budget constraint facing Grace. Label interesting facets of the budget constraint.
  4. Calculate the effective marginal tax rate (EMTR) and average tax rate (ATR) at the following earnings levels both BEFORE and AFTER implementing the labor subsidy program:
     (a) Earned Income = \$100
     (b) Earned Income = \$600
     (c) Earned Income = \$1000

(d) Earned Income = $1400

5. Intuitively, how might you expect labor supply throughout the economy to respond to the imposition of this work subsidy program, assuming heterogeneity (differences) in preferences over L and C across agents? Be explicit about responses for agents with various optimal initial labor allocations, differentiating along intensive/extensive margins. Is the impact on total labor supply positive, negative, or ambiguous?

6. Solve for Grace's optimal choice of labor supply (a qualitative answer is enough).

   (a) How has her labor supply changed from in (b) and how has her level of other consumption expenditure changed?

   (b) How has the work subsidy program impacted Grace's welfare?

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SECTION 11: Taxes on Savings

11.1. True/False Questions

1. According to the precautionary savings model, individuals save more if their uncertainty about future labor income taxes increases.

2. In a defined contribution pension plan, the employer bears all the risk of the pension payments.

3. Capital income taxation distorts the individual's intertemporal choice less than labor income taxation.

11.2. Long Questions

- Exercise 3 page 673, *Gruber* chapter 22.

  Mallovia two tax brackets. The first \$20,000 in income is taxed at a 10% marginal rate, and income above \$20,000 is taxed at a 30% marginal rate. All income—earned income and nominal interest, dividend, and capital-gains income—is treated the same. The threshold for the 30% rate is currently indexed for inflation, and the real interest rate is 5%.

  1. How does inflation affect the return to savings in Mallovia? Compare the likely savings rate when expected inflation is 10% with the likely savings rate when expected inflation is zero.
  2. How would your answer change if the threshold for the 30% rate were not indexed for inflation?

- Exercise 7 page 673, *Gruber* chapter 22

  Two countries with comparable levels of income per capita each propose raising the amount of savings that can be tax-deferred by \$2,000. In Wenti, the current maximum amount of savings that can be tax-deferred is \$2,000, while in Schale, the current limit is \$5,000. In which country are savings likely to rise by more? In which country is the inframarginal response likely to be greatest? Which savings incentive will likely cost its government the most? Explain.

- Exercise 13 page 673, *Gruber* chapter 22.

  Consider a model in which individuals live for two periods and have utility functions of the form $U = \ln(C_1) + \ln(C_2)$. They earn income of \$100 in the first period and save S to finance consumption in the second period. The interest rate, r, is 10%.

  1. Set up the individual's lifetime utility maximization problem. Solve for the optimal C_1, C_2, and S. (Hint: Rewrite C_2 in terms of income, C_1, and r.) Draw a graph showing the opportunity set.
  2. The government imposes a 20% tax on labor income. Solve for the new optimal levels of C_1, C_2, and S. Explain any differences between the new level of savings and the level in part a, paying attention to any income and substitution effects.
  3. Instead of the labor income tax, the government imposes a 20% tax on interest income. Solve for the new optimal levels of C_1, C_2, and S. (Hint: What is the new aftertax interest rate?) Explain any differences between the new level of savings and the level in a, paying attention to any income and substitution effects.

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SECTION 12: Corporate Taxation

12.1. True/False Questions

1. In the U.S. capital gains are taxed on accrual.
2. Assume Andrew buys Apple's stocks for a value of \$1,000 and pass the stocks to his son when he dies. The value of the stocks when Andrew dies is \$1,200. John, Andrew's son, decides to keep the stocks for two years, and eventually sell them for \$1,150. He will have to pay positive taxes on capital gains.
3. When a company buys equipment or a new building, it can deduct the full costs of the machine from its taxable income, in the same way as it can fully deduct the salary of the workers it is employing in a given year.
4. The share of federal revenue coming from the corporate tax has decreased over time, whereas the share of the payroll tax has more than doubled between 1960 and 2008.

12.2. Long Questions

- Exercise 8 page 700, *Gruber* chapter 23.

  When Bill died in 2006, he left his children \$200,000 in cash (generated from labor earnings), a \$1.1-million-dollar home he had purchased (with labor earnings) for \$100,000 in 1980, and \$1.2 million in stock that he had purchased (with labor earnings) for \$200,000 in 1985. Evaluate the argument that the estate tax represents double taxation of Bill's income.

- Exercise 3 page 735, *Gruber* chapter 24.

  Suppose that new machines cost \$504, and the marginal benefit from new machines is $MB = 246 - 6K$, where K is the number of machines purchased. The depreciation rate is 15% and the dividend yield is 10%.

  1. What amount of capital will you purchase? Why?
  2. What amount of capital would you purchase if there were a 25% tax rate on cash earnings minus labor costs?

- Exercise 4 page 735, *Gruber* chapter 24.

  Suppose that dividend yield is 6%, depreciation is 12%, and the corporate tax rate is 35%. What would be the marginal cost of each dollar of machinery investment under the following situations?

  1. Firms are allowed to expense the machine.
  2. There is an investment tax credit of 8%.

- Exercise 11 page 735, *Gruber* chapter 24.

  Suppose that the corporate income tax rate is 30%, the personal income tax rate on dividend income and the interest tax rate are both 35%, and the capital gains tax rate is 20%. Compare the after-tax returns on each dollar of corporate earnings under three investment financing strategies:

  1. The corporation finances using debt.
  2. The corporation finances by issuing equity but does not pay dividends.
  3. The corporation finances by equity and pays all its income in dividends.

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SECTION 13: Social Insurance

13.1. Long Questions

- Exercise 14 page 348, *Gruber* chapter 12.

  Billy Joe has utility of $U = \log(C)$, while Bobby Sue has utility of $U = \sqrt{C}$. Which person is more risk averse? Which person would pay the higher insurance premium to smooth consumption?

- Exercise 15 page 349, *Gruber* chapter 12.

  Chimnesia has two equal-sized groups of people: smokers and nonsmokers. Both types of people have utility $U = \ln(C)$, where C is the amount of consumption that people have in any period. So long as they are healthy, individuals will consume their entire income of \$15,000. If they need medical attention (and have no insurance), they will have to spend \$10,000 to get healthy again, leaving them with only \$5,000 to consume. Smokers have a 12% chance of requiring major medical attention, while nonsmokers have a 2% chance.

  Insurance companies in Chimnesia can sell two types of policies. The "low deductible" (L-) policy covers all medical costs above \$3,000, while the "high deductible" (H-) policy only covers medical costs above \$8,000.

  (a) What is the actuarially fair premium for each type of policy and for each group?

  (b) If insurance companies can tell who is a smoker and who is a nonsmoker and charge the actuarially fair premiums for each policy and group, show that both groups will purchase the L-policy.

  Suppose that smoking status represents asymmetric information: each individual knows whether or not they are a smoker, but the insurance company does not.

  (c) Explain why it is impossible, at any price, for both groups to purchaseL-policies in this setting. Which group, if any, do you expect to buy L-policies, and at what price?

  (d) Show that it is possible for both groups to purchase insurance, with one group buying L-policies and one group buying H-policies.

- Exercise 17 page 387, *Gruber* chapter 13.

  Consider an economy that is composed of identical individuals who live for two periods. These individuals have preferences over consumption in periods 1 and 2 given by $U = \ln(C_1) + \ln(C_2)$. They receive an income of 100 in period 1 and an income of 50 in period 2. They can save as much of their income as they like in bank accounts, earning an interest of 10% per period. They do not care about their children, so they spend all their money before the end of period 2.

  Each individual's lifetime budget constraint is given by $C_1 + C_2/(1+r) = Y_1 + Y_2/(1+r)$. Individuals choose consumption in each period by maximizing lifetime utility subject to this lifetime budget constraint.

  1. What is the individual's optimal consumption in each period? How much saving does he or she do in the first period?
  2. Now the government decides to set up a social security system. This system will take \$10 from each individual in the first period, put it in the bank, and transfer it to him or her with interest in the second period. Write out the new lifetime budget constraint. How does the system affect the amount of private savings? How does the system affect national savings (total savings in society)? What is the name for this type of social security system?

3. Suppose instead that the government uses the $10 contribution from each individual to start paying out benefits to current retirees (who did not pay in to a social security system when they were working). It still promises to pay current workers their $10 (plus interest back) when they retire using contributions from future workers. Similarly, it will pay back future workers interest on their contributions using the contributions of the next generation of workers. An influential politician says, "This is free lunch: we help out current retirees, and current and future workers will still make the same contributions and receive the same benefits, so it doesn't harm them, either." Do you buy this argument? If not, what is wrong with it?

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Practice Exercises

Externalities

1. The picturesque village of Horsehead, Massachssetts, lies on a bay that is inhabited by the detectable crustacean, *homarus americanus,* also known as the lobster. The town council of Horsehead issues permits to trap lobsters and is trying to determine how many permits to issue. The economics of the situation is this:

   - It costs \$2,000 dollars a month to operate a lobster boat.
   - If there are x boats operating in Horsehead Bay, the total revenue from the lobster catch per month will be $f(x) = \$1,000 \times (10x - x^2)$

   (a) What is the average revenue of a boat operating in Horsehead Bay? What is its marginal revenue?

   (b) If the permits are free of charge, how many boats will trap lobsters in Horsehead, Massachussetts?

   (c) What number of boats maximizes total profit?

   (d) If horsehead, Massachussetts, wants to restrict the number of boats to the number that maximizes total profits, how much should it charge per month for a lobstering permit? (Hint: with a license fee of F thousand dollars per month, the marginal cost of operating a boat for a month would be $(2 + F)$ thousand dollars per month).

2. In El Carburetor, California, population 1,001, there is not much to do except to drive your car around town. Everybody in town is just like everybody else. While everybody likes to drive, everybody complains about the congestion, noise, and pollution caused by traffic. A typical resident's utility function is $U(m, d, h) = m + 16d - d^2 - \frac{6h}{1000}$, where m is the resident's daily consumption of Big Macs, d is the number of hours per day that he, himself, drives, and h is the total amount of driving (measured in person-hours per day) done by all other residents of El Carburetor. The price of Big Macs is \$1 each. Every person in El Carburetor has an income of \$40 per day. To keep calculations simple, suppose it costs nothing to drive a car.

   (a) If an individual believes that the amount of driving he does won't affect the amount that others drive, how many hours per day will he choose to drive? (Hint: what value of d maximizes $U(m, d, h)$)?

   (b) If everybody chooses his best d, then what is the total amount h of driving by other persons?

   (c) What will be the utility of each resident?

   (d) If everybody drives 6 hours a day, what will be the utility level of a typical resident of El Carburetor?

   (e) Suppose that the residents decided to pass a law restricting the total number of hours that anyone is allowed to drive. How much driving should everyone be allowed if the objective is to maximize the utility of the typical resident? (Hint: rewrite the utility function, substituting $1,000d$ for h, and maximize with respect to d)

   (f) The same objective could be achieved with a tax on driving. How much would the tax have to be per hour of driving? (Hint: the price would have to equal an individual's marginal rate of substitution between driving and Big Macs when he is driving the "right" amount).

Public Goods

1. Muskrat, Ontario, has 1,000 people. Citizens of Muskrat consume only one private good, Labatt's ale. There is one public good, the town skating rink. Although they might differ in other respects, inhabitants have the same utility function. This function is $U(X_i, G) = X_i - 100/G$, where X_i is the number of bottles of Labatt's consumed by citizen i and G is the size of the town skating rink, measured in square meters. The price of Labatt's ale is \$1 per bottle and the price of the skating rink is \$10 per square meter. Everyone who lives in Muskrat has an income of \$1,000 per year.

   (a) Write down an expression for the absolute value of the marginal rate of substitution between skating rink and Labatt's ale for a typical citizen. What is the marginal cost of an extra square meter of skating rink (measured in terms of Labatt's ale)?

   (b) Since there are 1,000 people in town, all with the same marginal rate of substitution, you should now be able to write an equation that allows you to get the socially optimal amount of G.

   (c) Suppose that everyone in town pays an equal share of the cost of the skating rink. Total expenditure by the town on its skating rink will be $\$10G$. Then the tax bill paid by an individual citizen to pay for the skating rink is $\$10G/1000 = \$G/100$. Every year the citizens of Muskrat vote on how big the skating rink should be. Citizens realize that they will have to pay their share of the cost of the skating rink. Knowing this, a citizen realizes that if the size of the skating rink is G, then the amount of Labatt's ale he will be able to afford is....?

   (d) Therefore we can write a voter's budget constraint as $X_i + G/100 = 1,000$. In order to decide how big a skating rink to vote for, a voter simply solves for the combination of X_i and G that maximizes his utility, subject to the budget constraint, and votes for the amount G. How much G is that in our example?

   (e) If the town supplies a skating rink that is the size demanded by the voters, will it be larger than, smaller than, or the same size as the socially optimal rink?

   (f) Suppose that the Ontario cultural commission decides to promote Canadian culture by subsidizing local skating rinks. The provincial government will pay 50% of the cost of skating rinks in all towns. The costs of this subsidy will be shared by all citizens of the province of Ontario. There are hundreds of towns like Muskrat in Ontario. It is true that to pay for this subsidy, taxes paid to the provincial government will have to be increased. But there are hundreds of towns from which this tax is collected, so that the effect of an increase in expenditures in Muskrat on the taxes its citizens have to pay to the state can be safely neglected. Now, approximately how large a skating rink would citizens of Muskrat vote for? (Hint: rewrite the budget constraint for individuals observing that local taxes will be only half as large as before and the cost of increasing the size of the rink only half as much as before. Then solve for the utility maximizing combination).

   (g) Does this subsidy promote economic efficiency?

2. Lucy and Melvin share an apartment. They spend some of their income on private goods like food and clothing that they consume separately and some of their income on public goods like the refrigerator, the household heating, and the rent, which they share. Lucy's utility function is $2X_L + G$ and Melvin's utility function is $X_M G$, where X_L and X_M are the amounts of money spent on private goods for Lucy and for Melvin and where G is the amount of money that they spend on public goods (so notice that $p_X = p_G = 1$). Lucy and Melvin have a total of \$8,000 per year between them to spend on private goods for each of them and on public goods.

   (a) What is the absolute value of Lucy's marginal rate of substitution between public and private goods? What is the absolute value of Melvin's?

   (b) Write an equation that express the condition for provision of the socially optimal quantity of the public good.

   (c) Suppose that Melvin and Lucy each spend \$2,000 on private goods for themselves and they spend the remaining \$4,000 on public goods. Is this a socially optimal outcome?

   (d) Give an example of a socially optimal allocation in which Melvin gets more than \$2,000 and Lucy gets less than \$2,000 worth of private goods.

(e) Give an example of another social optimum in which Lucy gets more than \$2,000

(f) The socially optimal allocations that treat Lucy better and Melvin worse will have (more of, less of, the same amount of) public good as the social optimum that treats them equally.

3. Cowflop, Wisconsin, has 1,000 people. Every year they have a fireworks show on the Fourth of July. The citizens are interested in only two things- drinking milk and watching fireworks. Fireworks cost 1 gallon of milf per unit. People in Cowflop are all pretty much the same. In fact, they have identical utility functions. The utility function of each citizen i is $U_i(x_i, g) = x_i + \sqrt{g}/20$, where x_i is the number of gallons of milk per year consumed by citizen i and g is the number of units of fireworks exploded in the town's Fourth of July extravaganza. (Private use of fireworks is outlawed).

   (a) Solve for the absolute value of each citizen's marginal rate of substitution between fireworks and milk.

   (b) Find the socially optimal amount of fireworks for Cowflop.

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Practice Exercises, Final

1.1. True/False

1. The deadweight loss created by a tax is proportional to the square root of the tax rate.
2. The introduction of an Earned Income Tax Credit (EITC) raises the labor supply of all individuals, irrespective of their pre-reform level of income.
3. Indexing the income tax brackets with inflation keeps the real value of taxes unchanged if real income remains the same over time.
4. In an economy with present-biased individuals, the introduction of a social security system that taxes individuals when they are young and pays pension benefits when they are old increases national savings, but reduces private savings.
5. A risk-averse individual who is offered an actuarially fair premium will never choose full insurance if the probability of a bad event happening is very low.

1.2. Short Answer

1. Describe the main determinants of a firm's investment decision and show that an increase in the depreciation rate reduces the amount of capital chosen by the firm.
2. Illustrate the trade-offs a firm faces while choosing between financing its investment decisions with equity rather than with debt.

1.3 Long Answer

Suppose there is a 5 percent chance that Max gets in a car accident. If there is no accident, he gets to spend his full income of 9 dollars. If there is an accident, he has to spend 5 dollars on car repairs so he only gets to spend 4 dollars for his other needs. He has a utility function $U(w) = \sqrt{w}$

1. What is the expected utility with no insurance?
2. Suppose he can buy insurance, at a cost of 5 cents for one dollar of coverage (he pays 5 cents for insurance, which pays out one dollar if there is an accident). How , much coverage will he buy? How much will he spend on insurance? How does his utility compare to the case with no insurance?
3. Suppose now that he can buy insurance, but it costs 6 cents for one dollar of coverage. How much coverage does he buy now? Is this utility higher or lower compared to part 2?
4. Now suppose that he can buy insurance at a cost of 5 cents for one dollar of coverage, but he also has to pay 0.02 dollars in underwriting fees (fixed cost) in addition to whatever he pays for coverage. What is the expression for the total cost of insurance? How much coverage does he buy now and how does it compare to parts 2 and 3? How does his utility compare to part 2? Should he buy insurance? If the fixed cost became 0.05, should he still buy insurance?
5. Now think about the problem from the point of view of the insurance company. Write an expression for the profits of the insurance company (from selling one dollar of coverage) as a function of m, the insurance premium (the cost of one dollar of coverage). What has to be true about m for profits to be zero?

6. Suppose there is only one insurance company monopolizing the auto industry (and only one consumer of insurance). The company cannot charge a fixed cost, but can set the premium m however it wants. Write down an expression for the insurance company's profits as a function of m (Hint: first figure out how much coverage the consumer buys as a function of m, then substitute this into the expression for the monopolists total profits and maximize profits with respect to m).

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Practice Exercises Solutions, Final

1.1. True/False

1. **The deadweight loss created by a tax is proportional to the square root of the tax rate.**

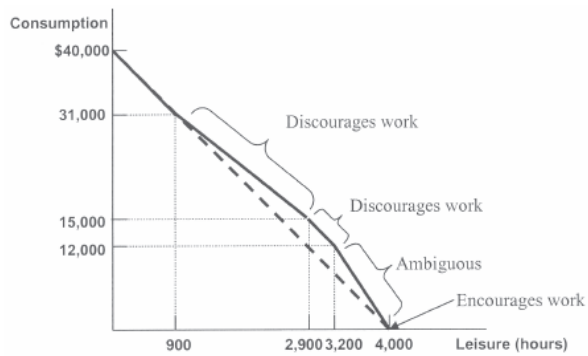
   False. The deadweight loss created by a tax is:

$$DWL = -\frac{\eta_s \eta_d}{2(\eta_s - \eta_d)} \times \tau^2 \times \frac{Q}{P}$$

   Therefore the deadweight loss rises with the square of the tax rate.

2. **The introduction of an Earned Income Tax Credit (EITC) raises the labor supply of all individuals, irrespective of their pre-reform level of income.**

   False. The labor supply response of the individual depends on his pre-reform level of income. The EITC has both income and substitution effects on labor supply decisions.



   Using the figure above:

   - For people not in the labor force, the EITC will raise their labor supply.
   - For people already in the labor force who earn less than $8,000 dollars, who are on the upward-sloping "phase-in" portion of the EITC schedule, the effect on labor supply is ambiguous since income and substitution effects go in opposite directions.
   - For people already in the labor force who earn between $8,000 dollars and $11,000 dollars, the income effect lowers labor supply (there is no substitution effect in this case).
   - For people already in the labor force who earn between $11,000 and $31,000, both income and substitution effects go in the same direction by reducing labor supply.
   - People who earn more than $31,000 before the introduction of the EITC are not affected by the program, therefore do not change their labor supply decision.

3. **Indexing the income tax brackets with inflation keeps the real value of taxes unchanged if real income remains the same over time.**

   True. To see this, assume that at time t_0 the price level is normalized to one and that the individual pays a 10 percent tax on earnings below $10,000 dollars and 20 percent for earnings above $10,000 dollars. Assume he is earning $12,000, then his tax liability at t_0 will be:

$$Tax_0 = 10,000 \times 0.10 + 2,000 \times 0.20 = 1,400$$

Assume that at time t_1 prices go up by 10 percent. Then the threshold for the first tax bracket will move from \$10,000 to \$11,000 dollars. Moreover, if the individual has the same real income as before, his nominal income will be \$13,200 dollars (so that \$13,200/1.1=\$12,000). The real value of taxes he is paying is then:

$$Tax_1 = \frac{11,000 \times 0.10 + 2,200 \times 0.20}{1 + 0.10} = \frac{1,100 + 440}{1.1} = 1,400$$

4. **In an economy with present-biased individuals, the introduction of a social security system that taxes individuals when they are young and pays pension benefits when they are old increases national savings, but reduces private savings.**

   False. Before the introduction of the system, national savings equal private savings and they are both zero because the individual is present biased and does not value his future consumption. After the introduction of the system, the government forces the individual to save by taxing him when he is young, therefore increasing national savings. However, private savings are still zero, given that the individual doesn't value savings and will not save anything besides what he is force to do.

5. **A risk-averse individual who is offered an actuarially fair premium will never choose full insurance if the probability of a bad event happening is very low.**

   False. As long as the premium is actuarially fair, a risk averse individual will always choose full insurance when that is an available option. The probability p of a bad event is irrelevant to the decision.

1.2. Short Answer

1. **Describe the main determinants of a firm's investment decision and show that an increase in the depreciation rate reduces the amount of capital chosen by the firm.**

   The firm sets its optimal investment by solving:

$$\begin{aligned} MC &= MB \\ (\delta + \rho)(1 - \tau z) &= MP_k \end{aligned}$$

   Therefore its investment decision depends on the depreciation rate δ, on the dividend yield ρ, on the corporate tax rate τ, on the PDV of depreciation allowances z, and on the marginal product of capital MP_k.

   Given that the MP_k curve slopes downward (because of decreasing marginal productivity of capital), and that an increase in the depreciation rate shifts the MC curve upwards, the optimal K decreases when δ increases.

2. **Illustrate the trade-offs a firm faces while choosing between financing its investment decisions with equity rather than with debt.**

   At first sight, it might seem optimal for the firm to finance all their investment using debt, given that the interest it pays to finance the debt is exempt from corporate taxation. However, there are a number of reasons why the firm might be choosing equity instead of debt. The main reason relates to the idea that debt requires fixed payments, but equity does not. For a more detailed analysis, Gruber p.723-727.

1.3 Long Answer

Suppose there is a 5 percent chance that Max gets in a car accident. If there is no accident, he gets to spend his full income of 9 dollars. If there is an accident, he has to spend 5 dollars on car repairs so he only gets to spend 4 dollars for his other needs. He has a utility function U(w) =$\sqrt{w}$

1. **What is the expected utility with no insurance?**

   With no insurance:

$$\begin{aligned} EU_{NI} &= (1-0.05)\times\sqrt{9}+0.05\times\sqrt{4} \\ &= 0.95\times 3+0.05\times 2 = 2.95 \end{aligned}$$

2. **Suppose he can buy insurance, at a cost of 5 cents for one dollar of coverage (he pays 5 cents for insurance, which pays out one dollar if there is an accident). How much coverage will he buy? How much will he spend on insurance? How does his utility compare to the case with no insurance?**

   With insurance, his expected utility is:

$$EU_I = 0.95\times\sqrt{9-0.05b}+0.05\times\sqrt{4-0.05b+b}$$

   Taking the derivative wrt b and setting it equal to zero:

$$\begin{aligned} \frac{\partial EU_I}{\partial b} &= -0.95\times\frac{1}{2\sqrt{9-0.05b}}\times 0.05+0.05\times\frac{1}{2\sqrt{4-0.05b+b}}\times 0.95 = 0 \\ &\Rightarrow \sqrt{9-0.05b}=\sqrt{4+0.95b} \\ &\Rightarrow 9-0.05b = 4+0.95b \\ &\Rightarrow b^* = 5 \end{aligned}$$

   Therefore his expected utility will be:

$$\begin{aligned} EU_I^* &= 0.95\times\sqrt{8.75}+0.05\times\sqrt{8.75} \\ &= \sqrt{8.75} \end{aligned}$$

   The premium is actuarially fair, therefore the individual buys full insurance, and equalizes his consumption across states of the world. He will spend 0.25 dollars on insurance and, given that $\sqrt{8.75}\approx 2.958 > 2.95$, he will be better off with insurance than with no insurance.

3. **Suppose now that he can buy insurance, but it costs 6 cents for one dollar of coverage. How much coverage does he buy now? Is this utility higher or lower compared to part 2?**

   The individual is now maximizing:

$$EU_I = 0.95\times\sqrt{9-0.06b}+0.05\times\sqrt{4-0.06b+b}$$

   Taking the derivative wrt b and setting it equal to zero:

$$\begin{aligned} \frac{\partial EU_I}{\partial b} &= -0.95\times\frac{1}{2\sqrt{9-0.06b}}\times 0.06+0.05\times\frac{1}{2\sqrt{4-0.06b+b}}\times 0.94 = 0 \\ &\Rightarrow \frac{0.057}{2\sqrt{9-0.06b}} = \frac{0.047}{2\sqrt{4-0.06b+b}} \\ &\Rightarrow b^* \approx 2.16 \end{aligned}$$

   The individual will be higher coverage than before, and his expected utility will be:

$$EU_I = 0.95\times\sqrt{9-0.06\times 2.16}+0.05\times\sqrt{4+0.94\times 2.16}\approx 2.952$$

   The premium is less than actuarially fair in this case, and the individual will not fully insure. His utility will be lower compared to part 2, but still higher than the no insurance case.

4. **Now suppose that he can buy insurance at a cost of 5 cents for one dollar of coverage, but he also has to pay 0.02 dollars in underwriting fees (fixed cost) in addition to whatever he pays for coverage. What is the expression for the total cost of insurance? How much coverage does he buy now and how does it compare to parts 2 and 3? How does his utility compare to part 2? Should he buy insurance? If the fixed cost became 0.05, should he still buy insurance?**

   In this case the total cost of insurance will be:

$$TC = 0.02 + 0.05b$$

   The individual will choose b to maximize:

$$EU_I = 0.95 \times \sqrt{9 - 0.05b - 0.02} + 0.05 \times \sqrt{4 - 0.05b + b - 0.02}$$

   The FOC wrt b gives:

$$\begin{aligned}
\frac{\partial EU_I}{\partial b} &= -0.95 \times \frac{1}{2\sqrt{9 - 0.05b - 0.02}} \times 0.05 + 0.05 \times \frac{1}{2\sqrt{4 - 0.05b + b - 0.02}} \times 0.95 = 0 \\
&\Rightarrow \sqrt{9 - 0.05b - 0.02} = \sqrt{4 + 0.95b - 0.02} \\
&\Rightarrow b^* = 5
\end{aligned}$$

   Therefore, the introduction of underwriting fees doesn't affect the decision of the individual compared to part 2. The idea is that the individual cares about minimizing differences in consumption across states of the world: lowering consumption by 0.02 in both states of the world doesn't affect his decision on the optimal b.

   His expected utility will be lower than that found in part 2 ($\sqrt{8.73} < \sqrt{8.75}$). However he should still buy insurance given that $\sqrt{8.73} \approx 2.954 > 2.95$.

   If the underwriting fees were 0.05, his expected utility by choosing $b^* = 5$ (the optimal choice) would be $\sqrt{8.70} \approx 2.949 < 2.95$. In that case he shouldn't buy insurance.

5. **Now think about the problem from the point of view of the insurance company. Write an expression for the profits of the insurance company (from selling one dollar of coverage) as a function of m, the insurance premium (the cost of one dollar of coverage). What has to be true about m for profits to be zero?**

   The expected profits of the insurance company when it sells one dollar of coverage ($b = 1$) are:

$$\pi = m - p$$

   For profits to be zero, we need $m = p$, i.e. that the premium is actuarially fair.

6. **Suppose there is only one insurance company monopolizing the auto industry (and only one consumer of insurance). The company cannot charge a fixed cost, but can set the premium m however it wants. Write down an expression for the insurance company's profits as a function of m (Hint: first figure out how much coverage the consumer buys as a function of m, then substitute this into the expression for the monopolists total profits and maximize profits with respect to m).**

   The company will set m to maximize its expected profits. Given that the consumer maximizes:

$$EU_I = (1 - p) \times \sqrt{9 - mb} + p \times \sqrt{4 - mb + b}$$

   the FOC for the consumer will give:

$$\begin{aligned}
\frac{\partial EU_I}{\partial b} &= -\frac{(1-p)m}{2\sqrt{9 - mb}} + \frac{p(1-m)}{2\sqrt{4 - mb + b}} = 0 \\
&\Rightarrow \frac{m}{\sqrt{9 - mb}} = \frac{p}{\sqrt{4 - mb + b}} \\
&\Rightarrow m^2(4 + b(1-m)) = p^2(9 - mb) \\
&\Rightarrow b^* = \frac{9p^2 - 4m^2}{m^2(1-m) + mp^2}
\end{aligned}$$

Therefore the firm maximizes:

$$\begin{aligned}\pi &= mb - pb \\ &= (m-p) \times \frac{9p^2 - 4m^2}{m^2(1-m) + mp^2}\end{aligned}$$

The optimal m is found by solving $\frac{\partial \pi}{\partial m} = 0$. Computations are quite lengthy here, so here it would be enough to show how the profit function depends on m, as shown above.

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ECON 131, Spring 2012

Practice Exercises Solutions, Long Answer

1.3 Long Answer

Suppose there is a 5 percent chance that Max gets in a car accident. If there is no accident, he gets to spend his full income of 9 dollars. If there is an accident, he has to spend 5 dollars on car repairs so he only gets to spend 4 dollars for his other needs. He has a utility function $\mathbf{U(w)} = \sqrt{w}$

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   Taking the derivative wrt b and setting it equal to zero:

$$\begin{aligned} \frac{\partial EU_I}{\partial b} &= -0.95\times\frac{1}{2\sqrt{9-0.05b}}\times 0.05+0.05\times\frac{1}{2\sqrt{4-0.05b+b}}\times 0.95 = 0 \\ &\Rightarrow \sqrt{9-0.05b}=\sqrt{4+0.95b} \\ &\Rightarrow 9-0.05b = 4+0.95b \\ &\Rightarrow b^* = 5 \end{aligned}$$

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the FOC for the consumer will give:

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\frac{\partial EU_I}{\partial b} &= -\frac{(1-p)m}{2\sqrt{9-mb}} + \frac{p(1-m)}{2\sqrt{4-mb+b}} = 0 \\
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&\Rightarrow m^2(4+b(1-m)) = p^2(9-mb) \\
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Therefore the firm maximizes:

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The optimal m is found by solving $\frac{\partial \pi}{\partial m} = 0$. Computations are quite lengthy here, so here it would be enough to show how the profit function depends on m, as shown above.

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Solution Practice Exam

Public Goods

1. **Lucy and Melvin share an apartment. They spend some of their income on private goods like food and clothing that they consume separately and some of their income on public goods like the refrigerator, the household heating, and the rent, which they share. Lucy's utility function is $2X_L + G$ and Melvin's utility function is $X_M G$, where X_L and X_M are the amounts of money spent on private goods for Lucy and for Melvin and where G is the amount of money that they spend on public goods (so notice that $p_X = p_G = 1$). Lucy and Melvin have a total of \$8,000 per year between them to spend on private goods for each of them and on public goods.**

   (a) **What is the absolute value of Lucy's marginal rate of substitution between public and private goods? What is the absolute value of Melvin's?**

   For Lucy, the absolute value of marginal rate of substitution between public and private goods is:

   $$MRS^L_{G,X} = \frac{MU^L_G}{MU^L_X} = \frac{1}{2}$$

   In words, Lucy likes private consumption twice as much as public good consumption at all levels of consumption. If she could, she would consume only the private good.

   For Melvin, it is:

   $$MRS^M_{G,X} = \frac{MU^L_G}{MU^L_X} = \frac{X_M}{G}$$

   In words, Melvin preferences for the public good relative to the private good depend on his levels of public and private goods consumption.

   (b) **Write an equation that express the condition for provision of the socially optimal quantity of the public good.**

   The socially optimal quantity of the public good is obtained by setting the social marginal benefit of public good to the social marginal cost of providing the public good. Social efficiency is maximized when the marginal cost is set equal to the sum of the $MRSs$:

   $$\begin{aligned} MRS^L_{G,X} + MRS^M_{G,X} &= MC = \frac{p_G}{p_X} \\ \frac{1}{2} + \frac{X_M}{G} &= 1 \end{aligned}$$

   (c) **Suppose that Melvin and Lucy each spend \$2,000 on private goods for themselves and they spend the remaining \$4,000 on public goods. Is this a socially optimal outcome?**

   Given that $X_M = X_L = 2000$ and $G = 4000$ in this case, the condition above is satisfied:

   $$\frac{1}{2} + \frac{2000}{4000} = 1$$

   Therefore this is a socially optimal outcome that satisfies the budget constraint of the individuals

   (d) **Give an example of a socially optimal allocation in which Melvin gets more than \$2,000 and Lucy gets less than \$2,000 worth of private goods.**

   An example could be $X_M = 2500$, $X_L = 500$ and $G = 5000$. In this case, the condition above is still satisfied and the allocation is consistent with Melvin getting more than \$2,000, Lucy getting less than \$2,000 worth of private goods, and the budget constraint being satisfied.

(e) **Give an example of another social optimum in which Lucy gets more than \$2,000**

An example could be $X_M = 1000$, $X_L = 5000$ and $G = 2000$.

(f) **The socially optimal allocations that treat Lucy better and Melvin worse will have (more of, less of, the same amount of) public good as the social optimum that treats them equally.**

It will have less of public good as the social optimum that treats them equally. While Lucy's consumption of the private good increases, the amount of public good has to decrease, so that $MRS^M_{G,X} = \frac{X_M}{G}$ is maintained constant at $\frac{1}{2}$.

Assume first that to increase Lucy's consumption of the private good, one is reducing X_M, so that $X_M + X_L + G = 8000$ is still satisfied and $\frac{X_M}{G} \downarrow$ (since the numerator decreases). Then, assuming that we started at $\frac{X_M}{G} = \frac{1}{2}$, one need to decrease G as well to bring the ratio back to $\frac{1}{2}$. Therefore, both G and X_M will decrease.

Assume instead that to increase Lucy's consumption of the private good, one is reducing G, so that $X_M + X_L + G = 8000$ is still satisfied and $\frac{X_M}{G} \uparrow$ (since the denominator decreases). Then, assuming that we started at $\frac{X_M}{G} = \frac{1}{2}$, one need to decrease G as well to bring the ratio back to $\frac{1}{2}$. Therefore, once again both G and X_M will decrease.