

Principles of Microeconomics – Econ1014
Week 3 Homework Assignment (non-mandatory)

Externalities and Social Cost Benefit Analysis

Please complete this and turn it in to the TA at the classroom door at the start of class on Wednesday, September 17th if you wish it to be graded for extra credit. It will be available to be picked up at the EconHelpDesk and you can review it with a TA by Tuesday of the following week. Your name and student number should be written legibly at the top of each page and all submitted pages should be stapled together.

1. Production Externalities

Suppose it is currently 1970 and you are an economic analyst for TEPCO (Tokyo Electric Power Company). Your job is to perform a cost benefit analysis to help the company decide whether or not to build a nuclear power plant in Fukushima Prefecture, on the coast north of Tokyo. Here is the following information you gather in order to perform your analysis and make your recommendation.

- The plant is expected to cost \$3.7 billion in capital costs. This includes site preparation, construction materials and labor costs of construction.
- The plant is expected to cost \$100 million in operating costs per year. This includes the cost of the workers to run and maintain the plant as well as materials to maintain the plant.
- Because of the risky nature of nuclear power generation, you estimate that there is a small chance that an accident can occur and expose a worker to radiation. You estimate that this will be no more than 2 workers injured over the life of the plant and that the cost to TEPCO to compensate these workers and their families will be \$1 million for each worker.
- You expect the plant can continue safely in operation for 50 years.
- Some members of the public and the National Diet (Japanese version of the U.S. Congress) are opposed to the use of nuclear energy fearing that a nuclear accident at a plant built in an earthquake prone country could cause massive damage if built so close to the densely populated region of Tokyo. As a result, you estimate that your company will have to spend on average \$1 million per year on advertising and other forms of public relations to keep support for the building and running of this power plant strong.
- TEPCO will need to borrow money for the building of this plant. The company expects to borrow \$2 billion (this is not a cost since it will be paid back when the company starts to generate revenues). However, the company will have to pay interest on the loan. You estimate that the loan can be paid off in 10 years and that the interest payments will total \$20 million per year.
- You estimate that demand for electricity in Japan will continue to increase over the life of the plant so that revenues generated for TEPCO will be high. You estimate that the company will earn revenue of \$520 million per year over the life of the plant.
- Japan is a very small and energy poor country. As such, it has to import nearly all its oil, coal and gasoline from other countries, which puts it at risk in case of high global energy prices or if those countries decide to stop selling to Japan. You estimate that your company (TEPCO) will gain significant public and government approval by building this plant because it will help to insulate the country from high global energy prices and will help to make the country more energy independent. You place a value of \$3 million per year on this benefit to the company.

- a. What is the rational decision for TEPCO to make regarding the building of the Fukushima Nuclear Power Plant? Do a formal cost benefit analysis using the table below to answer the question: Should TEPCO build this nuclear power plant? All your numbers will be totals for the life of the power plant.

| Private Expected Marginal Benefit | Private Expected Marginal Cost |
|--|--|
| \$520 million x 50 years = \$26 billion (revenues) | \$3.7 billion in capital costs |
| \$3 million x 50 years = \$150 million (value of public and government approval from helping make the country more energy independent) | \$100 million x 50 = \$5 billion (operating costs) |
| | \$1 million x 2 = \$2 million (cost of injured employees) |
| | \$1 million x 50 = \$50 million (cost of advertising) |
| | \$20 million x 10 = \$200 million (interest payment on loan) |
| | |
| \$26.150 billion | \$8.952 billion |

Yes, it is a rational decision for TEPCO to make based on these expectations in 1970. Your cost-benefit analysis tells the company to expect to earn economic surplus of \$26.150 billion - \$8.952 billion = \$17.198 billion if it builds this nuclear power plant.

Now suppose it is 2013 and you are still working for TEPCO but now you are looking back over your original recommendation to the company to try to decide whether or not you made a good decision to recommend the building of this power plant. Over the 43 years since your original decision, you have had the opportunity to gain more accurate information about the power plant and you now revise your cost benefit analysis to include this more accurate information. The following list contains the new information which has to be added to your original information. In other words, assume everything in your original list is correct unless the following list says it was wrong and needs to be revised.

- The plant didn't begin generating energy and revenue until 1976 but it had to be permanently shut down in 2011 after a major earthquake and tsunami damaged the plant beyond repair. This means the plant was only in operation for 35 years.
- TEPCO must spend \$15 billion to fix the damage done at the plant in order to prevent further radiation from leaking into the environment.

- 160,000 residents living within 12 miles of the plant are forced to flee, leaving their homes and all of their possessions. This land will not be safe to use for at least 100 years. This damaged property is worth \$200 billion but government regulations do not force TEPCO to compensate these individuals.
 - 3 workers killed as a result of the nuclear plant disaster and 21 others received significant radiation contamination. TEPCO must pay \$1 million to each.
 - A radioactive plume has contaminated fish in the oceans around Japan. The government has banned fishing in these waters causing the loss of income for Japanese fishermen. This will cost these fishermen \$35 million.
 - Japanese consumers enjoyed lower consumer prices for the 35 years the plant was in operation because of the cheaper electricity generated by the plant. The value to Japanese consumers of lower prices was \$1 billion per year.
- b. What is the rational decision for TEPCO to make regarding the building of the Fukushima Nuclear Power Plant? Do a formal cost benefit analysis using the table below to answer the question: Should TEPCO build this nuclear power plant? All your numbers will be totals for the life of the power plant.

| Private Actual Marginal Benefit | Private Actual Marginal Cost |
|--|--|
| \$520 million x 35 years = \$18.2 billion (revenues) | \$3.7 billion in capital costs |
| \$3 million x 35 years = \$105 million (value of public and government approval from helping make the country more energy independent) | \$100 million x 35 = \$3.5 billion (operating costs) |
| | \$1 million x 24 = \$24 million (cost of injured employees) |
| | \$1 million x 35 = \$35 million (cost of advertising) |
| | \$20 million x 10 = \$200 million (interest payment on loan) |
| | \$15 billion (to repair damage) |
| | |
| \$18.305 billion | \$22.459 billion |

No, although it was rational based on expectations in 1970, it was not a good decision because the company underestimated the probability of a major earthquake, the probability of a tsunami and the cost of any damage that might occur as a result. It turns out that the benefits were less than the costs so