EXPERIMENT 3

POLLUTION, TAXES, AND PERMITS

STUDENT INSTRUCTIONS

Introduction

Winter nights get cold on the Isle of Effluvia. With heavy blankets, one can get along without heat, but a warm fire is much appreciated, especially by those whose houses are not well insulated. The surrounding seas are turbulent, the coastal shores are treacherous, and no trading boats can bring fuel. Solar panels and green technology have not reached Effluvia. The only available fuel is locally mined coal, which Effluvians burn in old coal stoves. Heating a house for the season requires 1 unit of coal. Coal stoves pollute the air, emitting soot particles that cause health problems to all Effluvians.

The island has a coal market where residents can buy coal from the mine owners. Each unit of coal that is purchased will result in additional pollution that harms all Effluvians. Because of this pollution, trades that benefit both the buyer and seller have side effects that harm others not involved in the transaction. Such side effects are known as *harmful externalities.* Because of these externalities, unrestricted trade in the coal market will lead to an inefficient outcome in which 'too much' coal is burned. This experiment explores market interventions that are designed to reduce the amount of pollution and to benefit all Effluvians.

In this experiment, there are three possible scenarios. They all share the distribution of buyers and sellers and a similar procedure to formalize a transaction. Your instructor may decide to run all three or just some of them.

Instructions (for all scenarios)

You will try to make profits by buying or selling one unit of coal. In each Market Scenario, you will be assigned a role, either as a mine owner who

can supply one unit of coal, or as a demander who can buy one unit of coal (Figure A).

If you are a mine owner, you will be assigned a Seller Cost (the cost of extracting coal) and you can sell at the most one unit of coal per round. If you sell a unit of coal for a price P, and your Seller Cost is SC, then your profit from the transaction is the difference, $P - SC$. If $P < SC$, you are better off not selling and taking zero profits rather than doing it for a loss.

If you are a demander, you will be assigned a Buyer Value. You can buy at the most one unit of coal per round. If your Buyer Value is BV, and you buy one unit of coal for a price P, your profit from the transaction will be $BV - P$. If you have to pay more than your buyer value for a unit of coal, you are better off not buying any coal and taking zero profits rather than doing it for a loss.

At the beginning of the experiment, the instructor will tell you the amount of damage imposed on everyone by pollution from burning one unit of coal. If, for example, one unit of coal causes €0.50 damage to everyone, and if 20 units are sold, then every participant in the experiment, including those who make no trades, will have to suffer a pollution cost of €10, and the profits of each participant in the experiment will be reduced by €10. Everyone in Effluvia, whether they buy, sell, or do not transact at all, will suffer the pollution cost. You will learn the cost of pollution at the end of each round, once the total number of transactions is known.

Your instructor will announce whether you are using online or offline trading.

Online trading

In the online market, coal miners can send a selling price that demanders will see in the contracts section of their screens (Figure B). Similarly, buyers can send a buying price that suppliers will see in the contracts section of their screens. Whether you are a supplier or a demander, your offer (if you made one) and all standing offers you can accept are shown in the contracts section of your screen. You can withdraw your offer and make a new one only if it has not been accepted yet. You can accept an offer by clicking on the 'accept' button. Note that once you accept an offer or your offer gets accepted, all other offers are automatically rejected as you can only trade one unit of coal.

When a buyer accepts a selling offer or a seller accepts a buying offer, the transaction takes place and is displayed on the instructor's screen. Since only one unit can be traded in each round, the buyer and the seller cannot make any more transactions until the next round. Standing buying and selling offers are also displayed on the instructor's screen (Figure C). Look at it frequently for a general picture of standing offers and to get an idea of the price at which coal is being traded.

Offline trading

Sellers and buyers must find each other and agree on a price. If they reach an agreement, the seller should type the price and the buyer's ID into their screen and click the 'SELL' button. The buyer must accept the offer to finalize the contract (Figure D).

Sales contracts are publicly displayed on the instructor's screen (Figure E). Look at this screen frequently to get an idea of the price at which coal is being traded.

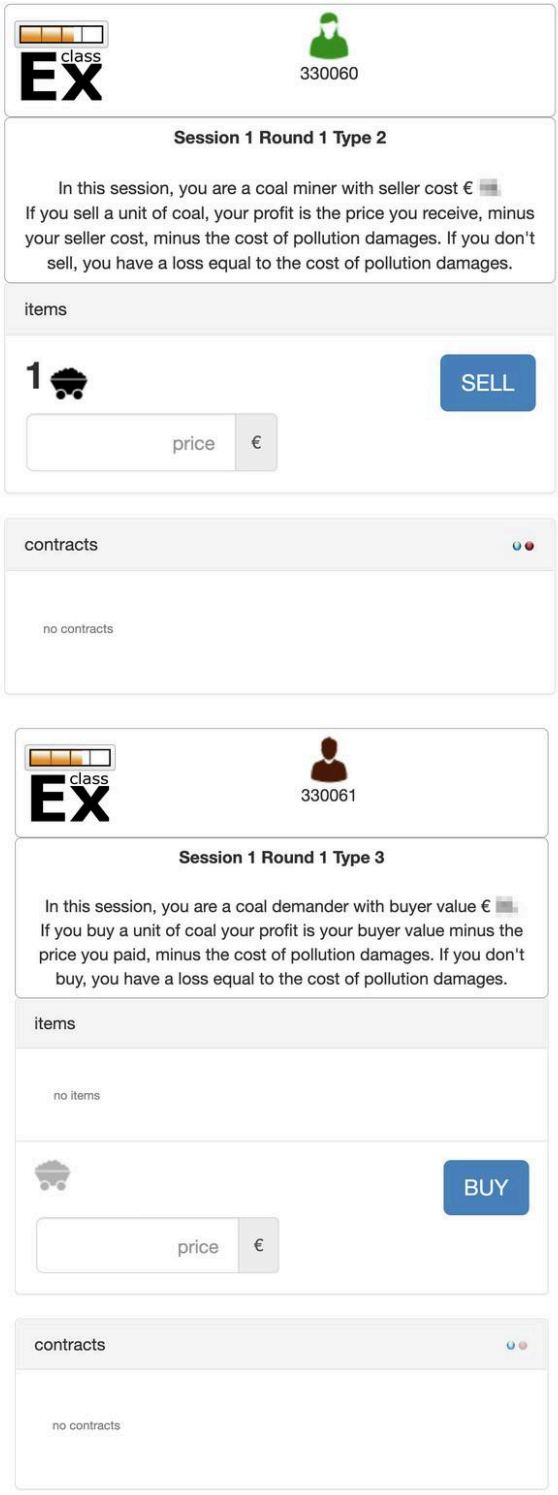


Figure A Screenshots of mine owners and coal demanders.

1. The supply side
Screenshot of a coal mine owner or supplier of coal.

2. The demand side
Screenshot of a coal demander for online trading. The 'Buy' button does not show in offline trading (see Figure D).

It is a good idea to think in advance what you will do the first time you are in the market and start bargaining with other students. There are many strategies you could use and there is not a single right answer. But remember to 'shop around' and look at the prices that have already been posted on the instructor's screen.

Instructions for Scenario 2 (Pollution Tax)

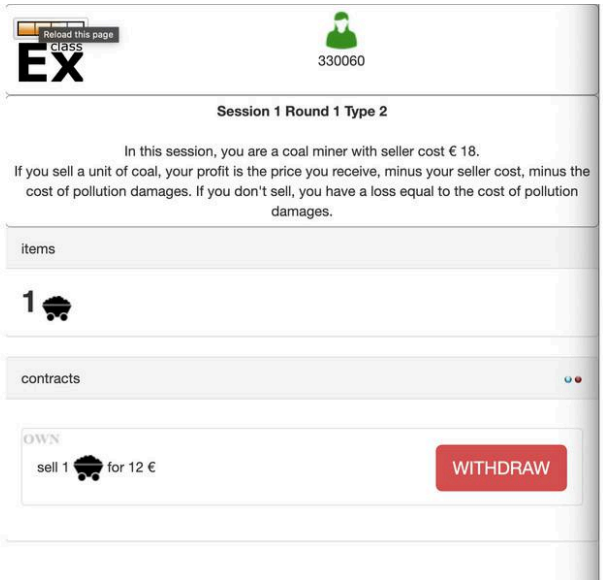
In the second scenario, the 'government' imposes a pollution tax, which is collected from mine owners. The tax revenue that the government collects will be redistributed in equal shares to all participants. In this scenario, if a mine owner with Seller Cost *SC* sells a unit of coal to a demander with Buyer Value *BV* for price *P*, and if the tax per unit of coal is *T*, then the mine owner's after-tax profit from the transaction is $(P - SC - T)$ and the buyer's profit is $(BV - P)$. In addition to any profits that you may make from buying or selling coal, you will receive an equal share of the government's tax revenue, and will suffer a loss of income equal to the amount of pollution cost caused by the coal that is used by demanders.

If you are a mine owner, remember you only have to pay the tax if you sell your unit of coal. If your cost of selling a unit of coal (including taxes) is higher than the price you are offered, you are better off not selling any coal and taking zero profits rather than selling for a loss.

Instructions for Scenario 3 (Pollution Permits)

In the third scenario, a mine owner is allowed to sell a unit of coal only if they have a *pollution permit*. At the beginning of each round, some participants will receive marketable pollution permits (Figure F). The original owner of a pollution permit can resell this permit to anyone else, but a pollution permit can be used only once to sell a unit of coal and only by a mine owner. Pollution permits are traded on paper. When someone buys a pollution permit, the buyer and the seller of the permit must write their ID numbers (found underneath the player icon on their devices) and the sales price on the permit. The seller of the pollution permit receives a profit equal to the price at which the permit was sold. Unlike coal, pollution permits can be resold in the permits' market.

Having a pollution permit, a mine owner is allowed to sell a unit of coal to a demander. In order to do so, a mine owner must obtain a code from the instructor in exchange for the pollution permit. The mine owner must type this code on their screen, in addition to the buyer's ID and the price (Figure G).



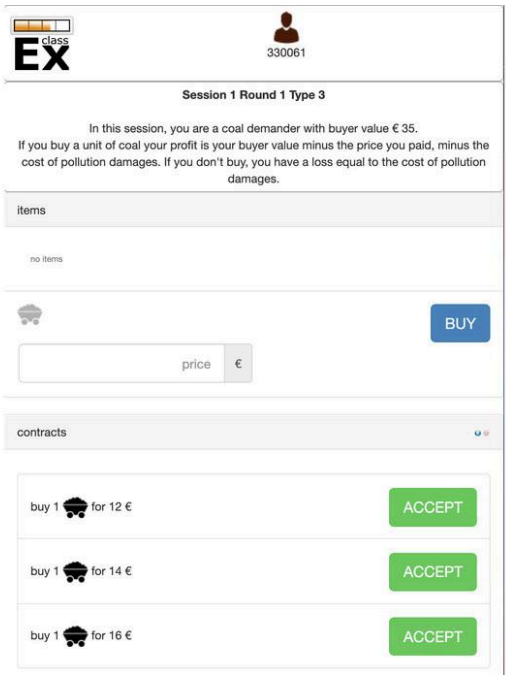


Figure B Example of seller's and buyer's screen for online trading.

1. Selling
A seller has sent a selling offer (marked as OWN) and has received one buying offer. The seller can still withdraw the offer as no buyer has accepted it yet.

2. Buying
A coal buyer has received three selling offers and must decide whether to accept any of them or none. The buyer has not made a buying offer yet.

A mine owner's profit is the price they receive for a unit of coal, minus their Seller Cost, minus the price they pay for a pollution permit (if they need to buy one). A buyer's profit from the purchase of a unit of coal is their Buyer Value minus the price they pay for the unit of coal. In addition to profits (or losses) that individuals make from buying or selling coal, they can also make profits from buying and selling permits. As before, all participants will suffer a loss of profits equal to the amount of pollution cost imposed on each person by the amount of coal used.

$$\begin{aligned}\text{Total Profits} = {} & \text{profits(losses) from buying/selling coal} \\ & + \text{profits(losses) from trading permits} \\ & - \text{pollution costs}\end{aligned}$$

HOMEWORK QUESTIONS

Your instructor shared with you the following information regarding the experiment: transactions, prices, and profits in the last round of each scenario; the distribution of buyer values and seller costs; the pollution cost and pollution tax; and, if you are analysing Scenario 3, the number of pollution permits distributed.

Comparing Scenarios 1 and 2

Exercise 8.3 (https://tinyco.re/5845630) in *The Economy* shows how to draw supply and demand 'curves' when they are step functions.

1. Calculate the total costs of pollution and the total profits (net of pollution costs) for each scenario and compare them.
2. Using the distribution of types, draw a graph showing both the demand and supply curves, with and without the pollution tax, and calculate the predictions of the theory for a competitive market.
3. Compare the theoretical predictions for price, quantity, and surplus at equilibrium with the experimental results.

Figure C Instructor's screen showing one completed transaction and standing buying and selling offers.

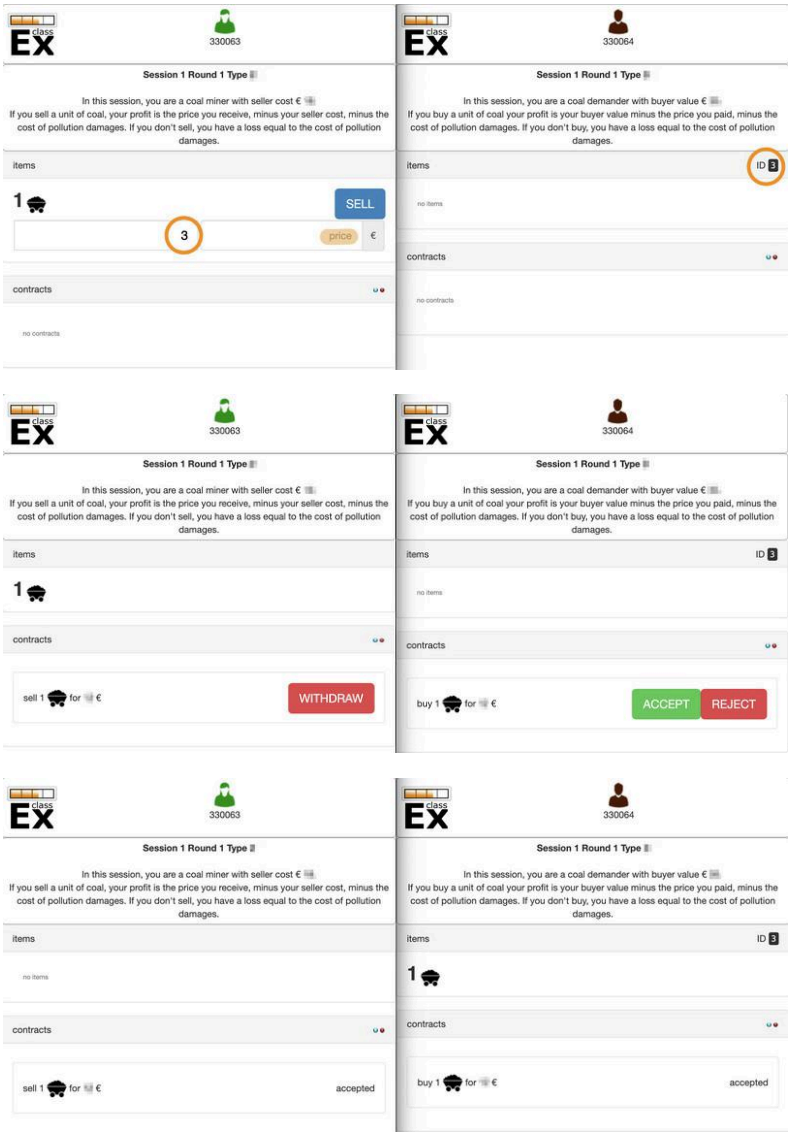


Figure D Offline trading. Once a buyer and a seller have reached a verbal agreement, they can formalize the transaction in their devices.

1. Selling

The seller types in the agreed price and the buyer's ID on their screen and clicks the 'SELL' button.

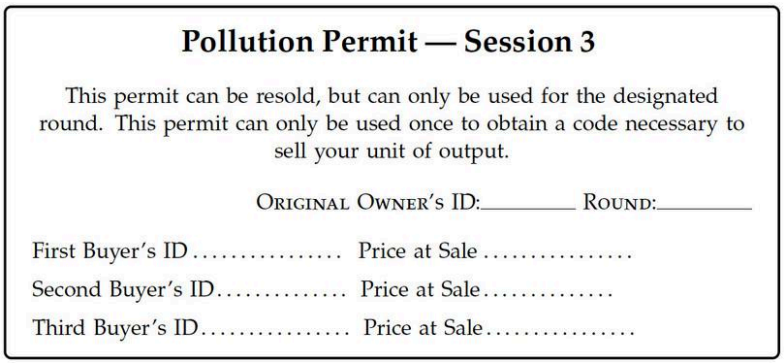
2. Buying

The buyer must accept the offer to finalize the transaction. Before the transaction is finalized, both the buyer and the seller can withdraw.

3. The transaction

Once the buyer has accepted the transaction, the unit of coal moves from the seller to the buyer. They cannot do anything else until the next round, as a maximum of one unit of coal can be bought or sold in each round.

Figure E Instructor's screen showing completed transactions.



Pollution Permit — Session 3

This permit can be resold, but can only be used for the designated round. This permit can only be used once to obtain a code necessary to sell your unit of output.

ORIGINAL OWNER'S ID:_____ ROUND:_____

First Buyer's ID..... Price at Sale .....

Second Buyer's ID..... Price at Sale.....

Third Buyer's ID..... Price at Sale.....

Figure F Example of tradable pollution permit.

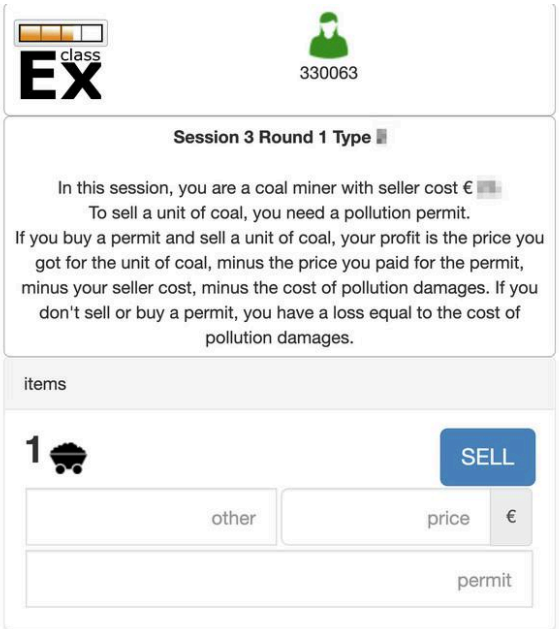


Figure G Screen for a mine owner in Session 3. The mine owner must type in the code obtained in exchange for a pollution permit, the buyer's ID, and the agreed price in order to formalize the transaction.

Scenario 3

1. For Scenario 3, the supply curve becomes vertical at the number of permits issued. The demand function is the same in all three scenarios. Use the demand and supply curves to find the equilibrium price of a unit of coal. (If there is a range of competitive equilibrium prices, assume that the price is at the midpoint of its range.)
2. Use the equilibrium price of a unit of coal to calculate the maximum amount that each type of supplier would be willing to pay for a pollution permit.
3. Use the information in the previous question to draw the demand curve for pollution permits. On the same graph, draw a vertical supply curve at the number of permits that were issued in the experiment, and find the competitive equilibrium price for permits.
4. Compare your findings in the previous questions with the experimental results.

FURTHER READING

- 'How to make a carbon pricing system work' (https://tinyco.re/5540374) (Financial Times, March 28, 2018) explores the challenges facing the implementation of carbon pricing by a Pigouvian carbon tax or a cap and trade policy.
- 'Pigouvian taxes' (https://tinyco.re/6963012) (The Economist, August 19th, 2017) explains negative externalities, Pigouvian taxes, and problems policymakers face when implementing them.
- Muller, Mendelsohn and Nordhaus (2011) estimate gross and net external (accounting) damages of air pollution in 'Environmental Accounting for Pollution in the United States Economy' (https://tinyco.re/2367745). *American Economic Review* 101 (5): 1649–75.
- 'The One-Page Plan To Fix Global Warming' Planet Money podcast (https://tinyco.re/0851739) talks to Henry Jacoby and John Reilly (MIT) on a global carbon tax.
- CORE *The Economy*, Unit 8, Unit 12, and Unit 20.
- CORE *Economy, Society, and Public Policy*, Sections 7.9–7.12 and Unit 11.