# Price Theory 1 - Problem Set 2 - Question 2

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## 1 Question: Cigarette tax/ban with an outside market

This is a partial equilibrium setting where we are looking only at the cigarette market: the legal and the illegal one which are linked via the market price for cigarettes. There are five types of homogeneous agents: adult smokers, adolescent smokers (demand side), legal and illegal cigarette producers (supply side) and the government who collects the tax revenue We know that:

Production side:

- legal cigarettes produced and distributed at a constant marginal cost c
- (assume) there is a unit per-cigarette tax $\tau$ levied on the production side [due to the tax equivalence result we know it does not matter which side of the market they are levied from]
- only way to avoid the taxes is to produce and sell cigarettes illegally
- illegal producers exist in the marketplace, but have a small market share

Consumption side:

- elasticity of demand of cigarettes with respect to its retail price is around -1/2
- cigarettes are harmful to a smoker's health - assume a cost to an individual = k per cigarette (in monetary terms)
- we will assume that cigarettes are also harmful for other individuals and impose a constant negative health externality on society equal to a constant h per cigarette (in monetary terms)

### 1.1 How is it possible for tax-free illicit cigarettes to coexist with taxable cigarettes? What are some of the variables determining the market shares of those two products?

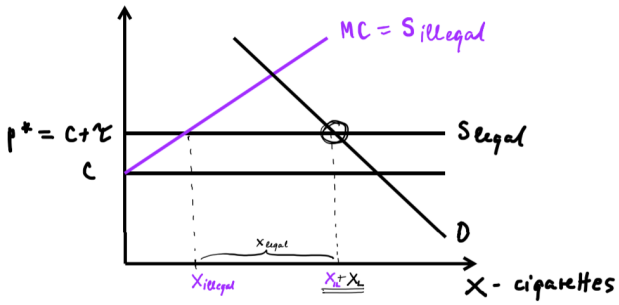
It is reasonable to assume that there are *fixed repercussions for being caught selling illegal cigarettes* (assume buyers are always unpunished because the legal and illegal cigarettes are indistinguishable). We can also assume that the *probability of being caught rises exponentially with the amount of cigarettes that the criminals are selling* (i.e. with the absolute size of the illegal market). Note, that we could also have the case where the illegal market is also perfectly elastic, due to free entry and a fixed cost on users through the punitive measures; we believe the case of the governments raising their punishments and search efforts with increases in the quantity of illegal drugs supplied a more reasonable one. If criminals are risk neutral and perceive the additional costs as Pr(getting caught)×repercussions, their marginal cost of producing each additional cigarette will be rising linearly with the amount of cigarettes produced. Assume that the underlying "production technology" is the same in the illegal market so that- without taking into account the probability of getting caught and the punishment - both producers have the same marginal cost c.

Assuming perfect competition in the legal market means that profits are zero and the legal supply is perfectly elastic at price $p^* = c + \tau$. Conversely, due to the rising marginal cost of producing and selling

each additional cigarette in the illegal market, criminal supply will be upwards sloping (starting from the constant cost c) and will cross the legal supply curve at (p*=c+$\tau$, $x_{illegal}$).

Assuming that individuals are indifferent between legal and illegal cigarettes (identical) that are sold at the same price, criminals cannot charge a price higher than the legal p*=c+$\tau$, otherwise everyone would just buy the cheaper legal cigarettes. It would also be suboptimal for the criminals to sell them for less. Thus, criminals will be selling $x_{illegal}$ cigarettes at the price $p^* = p_{illegal} = c + \tau$.

Equilibrium in the cigarette market




In this set-up, the market share of illegal cigarettes will depend on:

- how steep the illegal supply curve is - i.e. how much does the risk of getting caught increase with each additional cigarette illegally sold (market share decreases with $\partial MC_{illegal}/\partial$x)
- size of the tax ($\tau$) relative to the marginal cost of production $c$, which reflects the size of the "comparative advantage" of the illegal production of cigarettes that is un-taxed (market share increases with $\tau$)

We could also imagine that, maybe, consumers prefer to buy legal cigarettes and will have to be compensated by a lower price $p_{illegal}$ = p*-$\delta$ to buy illegal ones. In this case, the illegal market share would be inversely proportional to $\delta$. Nevertheless, we omit that from further analysis because the parameter itself does not add any new insights.

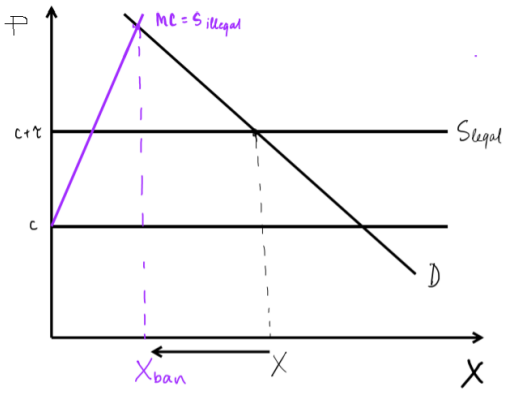
## 1.2 TRUE/FALSE/UNCERTAIN. The small size of the illicit market is good evidence that a ban on cigarettes would eliminate the majority of smoking.

This statement is uncertain - it depends on what the tax $\tau$ relative to the marginal cost $c$ is, or where the intersection of the demand function with the constant marginal cost $c$ is, among others.

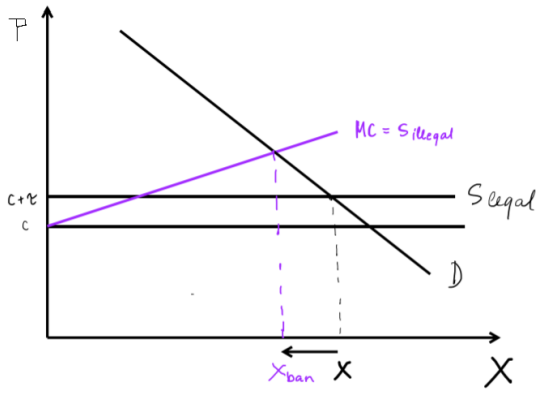
We know from the set-up of the question that the illegal market share is small. This could be due to a low tax $\tau$ (low "comparative advantage" of illegal sales) or due to a high slope of the supply (MC) curve for the illegal producers (risks of getting caught increase quickly with the amount sold).

If we know that the taxes are sufficiently high relative to the marginal cost $c$- and there is a a low market share - this means that banning cigarettes will reduce the majority of smoking because we can infer that the illegal supply curve is very steep. $->$ We could infer that the statement would be TRUE

If we know that the taxes are low - and there is a a low market share - it might be the case that the supply curve of criminals is fairly flat (low risk of getting caught as production increases) $->$ In which case the statement will most likely be FALSE




High tax - small market share implies steep illegal MC
- banning cigarettes reduces majority of smoking




Low tax - small market share does not imply steep illegal MC
- banning cigarettes doesn't necessarily reduce majority of smoking

## 1.3 Suppose the health cost of each cigarette exceeds the amount of the excise tax.

### 1.3.1 Is it socially beneficial to ban cigarettes? Does it matter whether "social benefit" includes the welfare of criminals?

What should we assume the tax $\tau$ to be? Obviously, from the question, it could be anything which is lower than the overall health cost of one cigarette on both the smoker(k) and the environment(h). Still, unless the government has some irremovable revenue requirement which might induce it to impose inefficient taxes, a very reasonable assumption would be that the government set them to be equal to the marginal externality of cigarette smoke imposed on society per cigarette (h) - which would be the optimal (Pigouvian) tax in a legal-market-only world. Since:

$$\text{Total health cost per cigarette} = \text{cost to the smoker (k)} + \text{negative externality (h)}$$

,

the optimal Pigouvian tax $\tau$=h is by default lower than the total health cost of a cigarette h+k. So, let's assume - also for simplicity of the forthcoming analysis - that the unit tax $\tau$ set by the government is equal to the marginal externality of smoking h. Without the illegal market, this would ensure that the smokers are faced with the correct "social cost" of smoking a cigarette - and this would eliminate the deadweight loss of the smoking externality h.

[Assume throughout that consumers have quasilinear preferences so that we can measure deadweight losses/consumer surplus with the area under the Marshallian demand curve]

With the illegal market, the tax $\tau$ = h still involves a deadweight loss in the form of lost taxes (red triangle in GRAPH 1)

In this framework it is **definitely not socially beneficial to ban cigarettes**, no matter whether we include criminals' welfare. **[This assumes that criminals are punished in a non-monetary way.]**

Whether we include criminal welfare or not will only affect how big the total surplus drop is. **If we include criminals' welfare, it will make total welfare drop by less in the complete-ban case because they are the only ones whose welfare (producer surplus) increases with the complete ban**, because all the cigarettes are now supplied by them and at a higher price than before.

The reduction in overall social welfare occurs because banning cigarettes all-together means that **all cigarettes need to be obtained from the illegal sector, which is relatively inefficient in producing cigarettes because it involves the non-monetary punishment cost which induces a benefit to no one.** Conversely, the tax revenue collected from legal producers goes into government revenue, which could later be re-distributed to consumers and does not constitute lost surplus.

Thus, **with the ban, there will be a production inefficiency, lost tax-revenue and a drop in consumer surplus (CS) - which cannot be overweighted by the increase in criminals' production surplus (PS). The increase in criminals' PS only partially offsets the drop in CS, while there are**

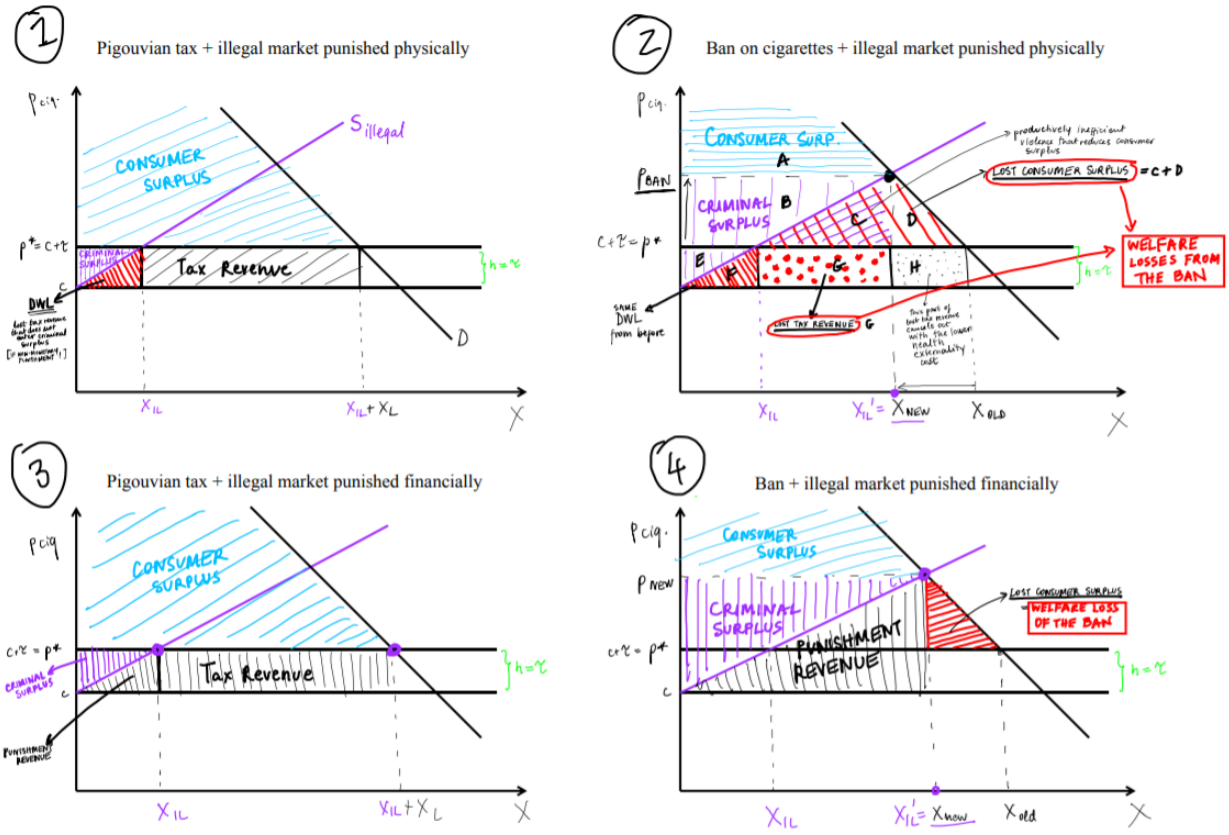
**also lost taxes (red dots square) and "productively inefficient" violence (red/purple triangle)** (see Graph and calculation below).

Total surplus (TS) = Consumer Surplus + Producer (criminal) Surplus + Tax Revenue - Health Cost

$$TS1 = A + B + E + C + D + E$$

$$TS2 = A + B + E - G$$

Can see from the graphs why social welfare is always lower with a full ban on cigarettes than with the Pigouvian unit tax $\tau$=h.




### 1.3.2 Does it matter whether the criminals are punished monetary finer rather than prison, fines etc.?

In short - yes and no.

Yes, because punishing the criminals with violence is a cost to the criminals but a benefit to no one. Conversely, **punishing them with monetary fines** which would be (for the criminals) equivalently as costly as violence/prison **increases the size of the pie**. The cost to the criminals stays the same, while this cost is transferred directly as extra revenue (surplus) to the government. So this is definitely better welfare-wise in both cases (taxes or ban) than the violence/prison punishment.

No, because it does not change the conclusion that **taxes are still better than the ban**. Taxes accompanied with a monetary punishment are actually Pareto optimal - no dead-weight losses - while the ban imposes a dead-weight loss on the consumer-surplus side (triangle B).

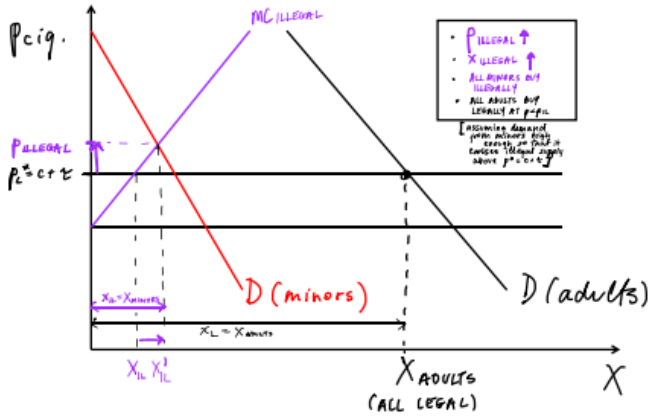
These results can be seen from the collection of graphs above.

### 1.4 Retailers are currently prohibited from selling cigarettes to minors, and this prohibition is enforced with the same rules and resources that enforce excise-tax payment. What does economic theory say about <u>whether</u> and <u>how</u> minors receive their cigarettes?

Let's look at demand from adults and minors separately. Assume that adults do not buy the cigarettes for the minors, and that minors have a similar demand function as adults.

This means that minors can acquire cigarettes only in the illegal market. Therefore, illegal and legal cigarettes are not perfect substitutes anymore–the condition that the price of legal and illegal cigarettes has to be the same in equilibrium does not hold. Since minors can only purchase cigarettes in the illegal market, they drive up the price of illegal cigarettes by increasing their demand. Minors crowd out adults buying illegal cigarettes because in order for minors to acquire cigarettes kids must be willing to pay more than the legal price.

As more minors buy illegal cigarettes, thereby increasing the illegal price of cigarettes, more adults will buy cigarettes from the legal market, which would also increase the tax revenue.

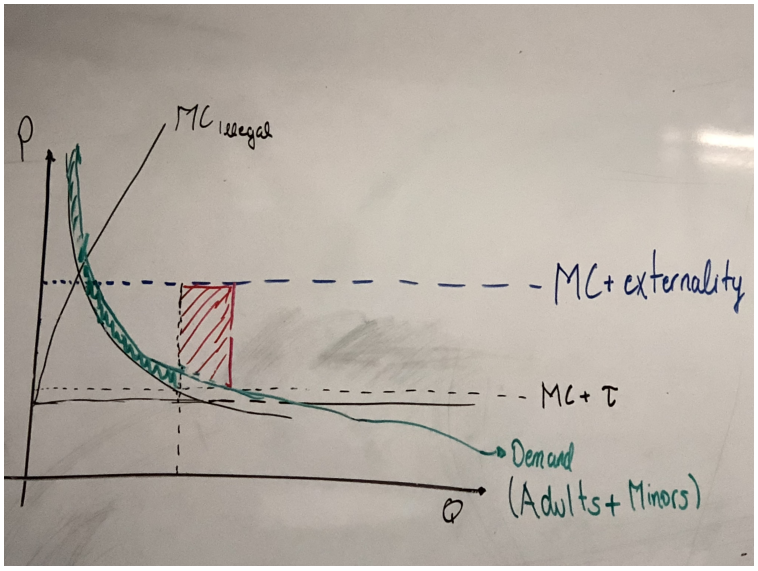



### 1.5 Would it be socially beneficial to legalize sales to minors?

Assuming again that minors have a similar demand function as adults, legalizing sales to minors would be equivalent to increasing the demand side of the market base. There will be more people willing to buy any quantity of cigarettes at a given price.

Since the marginal price of cigarettes $c$ is constant, the market clearing price will be the same, but the quantity will increase by the number of cigarettes that children are willing to purchase at that price. Therefore, if no externalities were considered, society will be strictly better off as consumer surplus would increase more than the decrease in producer surplus (previous illegal surplus).

If externalities were considered, however, the specific effect on total social surplus would be uncertain as it would depend on the specific value and form (i.e. $functional form$) of the externality. The main effects would be captured by the increase in minor's consumer surplus, and the additional externality due to their consumption.




### 1.6 If it were shown that minors were receiving their cigarettes from adults who were purchasing them from legitimate retailers, does that strengthen the case for prohibiting cigarettes for adults, too?

Let's assume that the adults are completely willing to give legally-purchased cigarettes to kids, and that this action entails zero cost to the adults (no police knocking on their door if they give cigarettes to minors).

This case is completely equivalent to legalizing cigarette sale to minors. Illegal market sells at price p*=c+tax (Pigouvian tax equal to smoking externality h). Quantity sold equal to the amount adults+minors are willing to buy a the given market price. No dead-weight loss [IF we assume that minors smoking, per se, does NOT represent a societal cost, and illegal sellers are punished in a monetary way which ends up being government revenue] - the cigarette market is Pareto efficient.

In this case it would, obviously, not be beneficial to impose a full ban on cigarettes for everyone.

Still:

1) If there is some monetary risk (e.g. a fine which ends up as government revenue) to adults for giving cigarettes to minors, and minors have to pay a premium over the price p* to get the cigarettes, then there will be a consumption inefficiency.Still, banning all cigarettes would impose a worse inefficiency because everything would be produced by the illegal sector (graph...)

2) If we believe kids smoking are imposing an externality to themselves (too young/immature to understand the health cost, then adults giving them cigarettes is also inefficient. If this externality is very high and there are a lot of minors who demand cigarettes, then there might be a trade-off question whether to ban cigarettes all together or not.

#### 1.6.1 Would your answer be different if evidence showed that minors were stealing cigarettes from adults and from retailers?

If minors are stealing cigarettes from RETAILERS, their marginal cost of production, in expectation, goes up because of the stolen cigarettes

Cost increase to legal producers =(no of cigarettes stolen*c

This increase is directly transferred to minors. But there is a welfare loss to adult consumers because now they have to pay a higher price for each cigarette purchased in the legal market. There is also a health externality equal to (no. of minor cigarettes*h) which is not compensated by tax revenue because kids do not have to pay taxes on stolen cigarettes.

If minors are stealing cigarettes from ADULTS, and they (in expectation) take this into account, the adult demand curve will shift inwards. The overall welfare effect will depend on whether the kids steal from the people with the highest reservation value or the lowest one - this will determine how much adult consumer surplus is lost.

Both of these cases are worse than the case where kids just get the cigarettes from adults for free. Still, it would not be welfare improving to ban all cigarettes because, if we assume the kids will keep on stealing from adults and illegal retails, the situation is the same, only worsened by the loss in consumer surplus by the illegal-only production which is relatively expensive and ends up in less cigarettes sold and at a higher price.

## 1.7 TRUE/FALSE/UNCERTAIN. If innovation were to cut the health cost of smoking by a factor of four, that would approximately double the cigarette sales.

Consumers of cigarettes face two types of costs, monetary and health costs. They will consume cigarettes at the point where the marginal cost of smoking a cigarette and the marginal benefit of smoking a cigarette are equal. The price elasticity of demand is $-\frac{1}{2}$. This means that if we were to reduce the price by a factor of four, we would double the quantity demanded.

Firstly, elasticity is a local measure, and is not true for the entire demand curve. Large changes such as reducing the price by a factor of four would not be approximated well by the linearization used in these elasticity calculations. Let us abstract from the error caused by this miscalculation by assuming a functional form of demand that faces the same price elasticity of demand.

$$p(q) = \frac{c}{\sqrt{q}}$$

The cost of smoking a cigarette is a combination of the health cost and the monetary cost. The "true price" is therefore a combination of both. So if the health costs are reduced by a factor of four, this does not mean that that the actual price paid by the consumer has reduced by as much. When the health cost is reduced, consumers will desire more cigarettes for a given monetary price. However as the health cost is only a portion of the cost faced, they will not increase by as much as the elasticity implies. The price has reduced by less than a factor of four, so the sales will increase by less than double.