Second Best Theory
Supervision 1

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Question 1

The economy produces x_1, generating one unit of pollution for every unit of output. This means that a reduction of pollution can only be effected by reducing production. In this case, a tax levied on production should have the same welfare effects as the usual first-best policy of a tax levied directly on pollution. A tax on exports also reduces production, but only in the export sector. On top of that, taxing exports, but not domestic production, distorts the marginal decision between producing for the domestic market and producing for the export market. One consequence might be that producers choose to redirect some of the lost exports into the domestic market. For this reason alone, a production tax should be preferred. (It also follows that if this economy solely produced x_1 for exports, the welfare effects of the export tax, the production tax, and a pollution tax would be equivalent.)

Question 2

(a)

The subsidy benefits farmers if the incidence falls mostly on them, rather than being passed through lower prices to consumers. We can show that for a competitive market, this depends on the price elasticities of demand and supply in the agricultural market:

With a per unit subsidy s paid to farmers, we have in equilibrium $D(q) = S(q + s)$ where q is the price that consumers pay while $p = q + s$ is the price that farmers receive taking into account the subsidy. Taking the total derivative and manipulating both sides yields

$$\begin{aligned}
\frac{\partial D}{\partial q}\mathrm{d}q &= \frac{\partial S}{\partial p}(\mathrm{d}q + \mathrm{d}s) \\
\frac{\mathrm{d}q}{\mathrm{d}s} &= \frac{\frac{\partial S}{\partial p}}{\frac{\partial D}{\partial q} - \frac{\partial S}{\partial p}} \\
&= \frac{\frac{\partial S}{\partial p}\frac{p}{S}}{\frac{\partial D}{\partial q}\frac{q}{D} - \frac{\partial S}{\partial p}\frac{p}{S}} \\
&= \frac{\varepsilon_S}{\varepsilon_D - \varepsilon_S} \\
&= \frac{1}{\frac{\varepsilon_D}{\varepsilon_S} - 1}
\end{aligned}$$

Where we arrive at the third equality by assuming the starting point is an equilibrium (so that $D = S$) with zero subsidy (so that $q = p$). Presumably $\varepsilon_D \leq 0$ and $\varepsilon_S \geq 0$, so the above means that a subsidy translates to a lower price paid by consumers. As $\frac{\varepsilon_D}{\varepsilon_S}$ approaches $-\infty$, none of the subsidy is passed on to consumers. Likewise, as $\frac{\varepsilon_D}{\varepsilon_S}$ approaches 0, the subsidy is fully passed on to consumers.

We might expect ε_S to be low; it is probably difficult for UK farmers in aggregate to increase the amount of land in cultivation, especially in the short-run or in the middle of the agricultural cycle. The UK's Utilised Agricultural Area was already 72% of UK land area, and has been so since as early as 2000.

Even though we typically think of demand for agricultural products to be price inelastic, ε_D refers to demand for UK agriculture specifically, which should be more price elastic. In 2012, the top UK agricultural products by value were milk and wheat, which are both close to fungible. Even just among the EU member states, the agricultural product in which the UK had the largest production share was sheep and goat meat, which was still only 39% of EU production (the elasticity of demand facing a single producer is inversely proportional to its market share). Mintel's 2016 survey found that only 38% of UK respondents were prepared to pay more for British food; one assumes this figure would be lower for non-UK shoppers.

As such, we can probably guess that $\frac{\varepsilon_D}{\varepsilon_S}$ is highly negative, and that only a small fraction of the subsidy is passed through to lower consumer prices. A plausible guess would be that the subsidies do benefit farmers, though there have been complaints that the scheme disproportionally benefits large-scale farms with economies of scale while only just allowing small-scale farms to meet production costs.

(b)

The social benefit of food security for the UK is $B(x;\bar{x}) = \frac{(x-\bar{x})^{1-\gamma}}{1-\gamma}$. We have

$$\frac{\partial B}{\partial x} = (x-\bar{x})^{-\gamma}$$

which is the marginal benefit (in terms of increased food security) to increasing domestic production. Under a competitive equilibrium with no interventions, there is under-production of food by domestic suppliers. In a first-best world, it would be best to internalise this benefit by giving a subsidy to domestic food producers of $(x^* - \bar{x})^{-\gamma}$ per unit where x^* is the first-best level of production. Two things will happen to correct the under-production:

1. Consumers will switch from imported food to domestically produced food
2. Apart from imported food, consumers will also switch from other goods (whether imported or not) to domestically produced food if they are substitutes for one another

When only a tariff is possible, (2) is no longer a mechanism by which the under-production can be corrected. The tariff incentivises consumers to switch from imported food to domestically produced food, but also creates a distortion at the marginal choice between food and all other goods. In general the tariff should not be set at the level which brings x to its first-best quantity x^*; the marginal social benefit of the tariff starts out large and decreases as x increases, while the marginal social cost of the tariff incurred in other markets starts out small and increases as the distortion worsens. Therefore the tariff should be raised until some point where $x < x^*$. If the UK is a net exporter of food, accounting identities imply that domestic food production exceeds domestic food consumption:

$$\begin{gathered}
\text{Domestic food consumption} \\
= \\
\text{Domestic consumption of UK-produced food} + \text{Domestic consumption of imported food} \\
\& \\
\text{Domestic production of food} \\
= \\
\text{Domestic consumption of UK-produced food} + \text{Foreign consumption of UK-produced food} \\
\& \\
\text{Net food exports} \\
= \\
\text{Foreign consumption of UK-produced food} - \text{Domestic consumption of imported food} > 0 \\
\implies \text{Domestic production of food} > \text{Domestic food consumption}
\end{gathered}$$

In a simple model of a small open economy under perfect competition, this implies the world price is higher than the autarky equilibrium price. In this case, imposing a tariff has no effect on production. In reality, there are probably considerations like increasing returns, monopolistic competition, and consumers' preference for variety, which makes a tariff effective even if the UK is a net exporter of food.

Mathematical Derivation

For a specific example, suppose there is a representative consumer and two representative firms: one which produces food and one which produces a composite good. Suppose further that the social welfare function is utilitarian, which attaches equal weights to the consumer's indirect utility, national income net of production costs (which is equal to tax revenues and the combined profits of the two firms), and the food security objective $B(x; \bar{x})$. Then a social planner maximises

$$v(p_f^* + \tau, p_{nf}) + \tau \left[x_f(p_f^* + \tau, p_{nf}) - y_f(p_f^* + \tau) \right] + \pi_f(p_f^* + \tau) + \pi_{nf}(p_{nf}) + \frac{(x - \bar{x})^{1-\gamma}}{1 - \gamma}$$

where $v(q_f, q_{nf})$ is the consumer's indirect utility, $x_f(q_f, q_{nf})$ is domestic consumption of food, $y_f(p_f)$ is domestic production of food, $\pi_f(p_f)$ and $\pi_{nf}(p_{nf})$ are profits for the food and non-food firms, τ is the per-unit tax, and an asterisk is used to denote the price received by foreign producers. The first-order condition for a maximum is

$$\frac{\partial SWF}{\partial \tau} = \frac{\partial v}{\partial q_f} + \tau \left[\frac{\partial x_f}{\partial q_f} - \frac{\partial y_f}{\partial p_f} \right] + x_f - y_f + \frac{\partial \pi_f}{\partial q_f} + (x - \bar{x})^{-\gamma} = 0$$

By the envelope theorem, $\dfrac{\partial v}{\partial q_f} = -\lambda^* x_f$. If we make the further assumption that the utility function is quasilinear in x_{nf}, and letting $p_{nf} = 1$ as the numeraire good, then $\lambda^* = 1$ and $\dfrac{\partial v}{\partial q_f} = -x_f$. Also, by Hotelling's lemma, $\dfrac{\partial \pi_f}{\partial q_f} = y_f$. Therefore, the first-order condition simplifies to

$$\tau = -\frac{1}{(x - \bar{x})^{\gamma} \left[\dfrac{\partial x_f}{\partial q_f} - \dfrac{\partial y_f}{\partial p_f} \right]}$$

Question 3

Following similar steps as in 2(a), we get

$$D(p + t) = S(p) \implies \frac{\mathrm{d}p}{\mathrm{d}t} = \frac{1}{\frac{\varepsilon_S}{\varepsilon_D} - 1}$$

We have that $\varepsilon_D = 0$ and $0 < \varepsilon_S < \infty$, which means that $\dfrac{\mathrm{d}p}{\mathrm{d}t} = 0$ and the tax incidence falls fully on the consumer. In equilibrium we also have

$$Q = D(p + t) = S(p) \implies \mathrm{d}Q = S'(p)\mathrm{d}p = 0$$

since $\mathrm{d}p = 0$. Therefore the revenue is just τQ. Lastly, if we assume no income effects such that the Marshallian demand is the same as the compensated demand, the deadweight cost is approximately

$$\text{DWL} = \frac{1}{2} \times \mathrm{d}\tau \times \mathrm{d}Q$$

by taking linear approximations of the supply and demand curves and applying the formula for the Harberger triangle resulting from a price/tax change. We worked out that $dQ = 0$, so the efficiency cost is also 0.

If we don't make the assumption that the Marshallian demand is equivalent to the compensated demand, then there is an efficiency cost that arises from the substitution effect. The good is essentially an inferior good and the substitution and income effects cancel out completely.