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- (i) *Automobile manufacturers are updating their technologies for locking vehicles to prevent theft. A truly theft-proof locking system would be unfortunate for them, because then they would lose the future automobile sales associated with additional updates to the locking systems.*

False. (I'm not sure whether this question is about deciding on optimal duration or durables goods, or a combination of both)

First, notice that a system that prevents thefts is equivalent to a reduction in the depreciation rate, which implies that the price of cars today will be higher:

$$P_t = R_t + P_{t+1} \frac{(1 - \delta)}{(1 + r)}$$

This increase in prices would be higher for bigger reduction in the probability of theft. And if the demand is inelastic enough this will increase the profits of the firm. Moreover, car depreciate for other reasons so consumers will still update them and at a higher prices as mentioned before. And the new system could also increase car sales if consumers who did not buy cars due to the likelihood of theft now are willing to buy them. (EJ)

(I think it might be about the firm losing out on profits from infinitely many incremental updates to their theft system over time, though it's not completely clear to me either)

The question suggests that a firm with a technology to make cars completely theft proof is better off not selling it, and instead selling a stream of updates over the infinite future (or at least for a long time).

It's not clear if people are willing to buy a new car purely for an updated anti-theft system, but let's denote whatever increase the firm gets in each period with the incremental system as b_t and it's profit from just selling the theft proof technology cars now as B . We can then say the firm should not release the completely car proof technology if, given a discount rate δ for the firm covering both their time preference and also the probability that some other firm sells a car with the theft-proof technology,

$$B < \sum_t^{\infty} \delta^t b_t$$

But it's not obvious that this inequality holds. Furthermore, if there are many firms producing cars, there's a high chance that one of the other firms also produce a truly theft-proof locking system and releases a car with it. In our equation this would show up as a very low δ . The answer is therefore Uncertain. (EIH)

[Comment: Question talks about "manufactures" and "them" so safe to assume that the technology is available to all manufactures.]

False. According to the question, manufacturers earn sales revenue from selling updates to the locking system and that revenues from such sales would be lost if the manufacturers were to introduce a truly theft-proof locking mechanism (since, by definition, the system requires no update). The question then suggests that, it is for this reason that the manufacturers would earn less profits by selling cars with truly theft-proof locking systems.

However, lower sales revenue does not necessarily imply lower profits. To see this, we can think of the theft-proof locking system as one aspect of the overall "quality" of a car, and think about how the manufacturers would price the premium that it would charge for the theft-proof locking mechanism. The price would depend on the willingness to pay for the marginal purchase who cares about this aspect of the quality of cars (these are the individuals who would be purchasing the updates, and who would determine the price of such updates). If we assume that all firms have access to this technology (as the framing of the question suggests), then, in equilibrium, the premium would be set so that it equals the discounted

revenue from the future updates to the locking system. Thus, in equilibrium, we would expect manufacturers to be indifferent between selling cars with truly theft-proof locking system and those without. That is, we would not expect manufacturers to be "worse off" by selling cars with a truly theft-proof locking system.

Moreover, to the extent that there are many individuals at the margin, the introduction of cars with a truly theft-proof locking system may induce those that did not otherwise purchase cars before to purchase cars—which would increase sales. (Tak)

- (ii) *For a competitive industry, a lump sum tax (that requires each firm in an industry that produces a positive level of output to pay a fixed annual amount to the government) will be more efficient than a per unit tax (that taxes each unit of output produced a fixed amount) if the two tax systems raise the same amount of revenue for the government.*

Uncertain. Both tax systems produce the same revenue at the industry level, but this does not mean that each firm is paying the same. If firms are homogeneous, we should expect that each of them pay the same under both systems, but with a per unit tax their production decision is changed and so in this sense a lump sum tax is more efficient. However, if firms are heterogeneous the systems are different from their perspective because firms with higher production would pay more under a per unit tax, and firms with lower production would pay more under a lump sum system. Therefore, a small firm could run out of business if paying a lump sum tax, this could make production to decrease more than a per unit tax which is not efficient. (EJ)

False. Note that the lump sum tax essentially works as a fixed cost for the firms. In a competitive market where everyone makes zero profits, this tax would then drive them all out of business, which is clearly not efficient. Alternatively, if the tax is known in advance the market would instead become a standard market with fixed costs. The main issue is that the tax is not a true lump sum tax as the firms can avoid it by choosing not to produce. (EIH)

[Comment: I'm not sure why you say the issue is that firms can avoid it by choosing not to produce — this is the same as in the standard case when you can exit the market no?]

Uncertain. We know from textbooks that lump sum taxes is more efficient than a per unit tax as the former does not affect the firm's pricing decisions.

Now, take the extreme case where the tax revenue to be raised is sufficiently high so that firms profits (which depends on the average cost) are all wiped out by the lump sum tax. In this case, under the lump sum tax, all firms would produce nothing (i.e. exit the market) whereas firms may still produce under per-unit tax. Clearly, in this case, lump sum tax is less efficient than a per-unit tax.

We can also think about cases in which case there are differently sized firms in the industry. Since the amount of lump sum tax is dependent only on whether the firm is in the market or not (rather than how much they are producing), the lump sum tax is likely to be more burdensome for smaller firms (with presumably smaller profits) than for larger firms, and may even drive smaller firms out of the market. This would not be the case since a per-unit tax would imply that tax payment adjusts proportionately with the quantity sold by each firm in the industry. (Tak)

- (iii) *Factor-augmenting technical progress can change relative factor rental rates, but it cannot actually reduce any of the rental rates (relative to the price of output).*

False. Imagine an industry where capital and labour are substitutes, i.e. $F_{KL}(K, L) < 0$. In this case, technical progress for capital would lead to increased investment in capital, leading to reduced marginal product of labour, leading to reduced "rental rate" for labour. (EIH)

[Comment: It sounds right but I wouldn't know how to show this...]

False. Let us take the case of labour-augmenting technical progress: $F(K, AL)$, where F is constant returns to scale. Then, solving the firm's problem gives us that

$$F_L\left(\frac{K}{AL}, 1\right) = \frac{w}{A}, \quad F_K\left(\frac{K}{AL}, 1\right) = r$$

We know that, in the long run, supply of capital is perfectly elastic so that the long-run value of $\frac{K}{AL}$ is constant. This also pins down $F_L\left(\frac{K}{AL}, 1\right)$ in the long run. Hence, if A increased permanently, then w must fall in the long run. Finally, note that w is the rental rate of labour relative to the price of output. (Tak)

[What about in the short-run? Can we say anything? Also how to show that A affects relative factor rental rates, w/r]

- (iv) *A great many manufacturers use machines and labor in fixed proportions. That is inconsistent with an industry or economy wide aggregate Cobb-Douglas production function.*

False. These are not inconsistent. Consider heterogeneous firms that have different Leontief production functions, where some are capital or labor intensive. Suppose that we raise wages, and so labor intensive firms see their marginal cost increase more relative to capital intensive firms, and so their production is cut back more. At the industry level it will appear that firms substituted labor for capital, which could be consistent with a Cobb-Douglas production function. (EJ)

I have nothing to add to this.. (EIH)

False. Aggregate C-D production function implies that factor shares are constant; i.e. with $F(K, L) = K^\alpha L^{1-\alpha}$,

$$\frac{wL}{rK} = \frac{1-\alpha}{\alpha}$$

rather than that the ratio K/L is constant. This suggests that as w/r changes K/L should also change at the aggregate level. Put differently if w/r and α are common across the manufactures, then we would expect K/L to be constant.

Suppose instead that w/r and/or α are not common across the manufactures. For example, we can suppose that manufactures have different Leontief production functions: e.g. $F(K, L) = \min\{\beta K, L\}$, where β may differ across firms. This situation can still be consistent with economy-wide aggregate C-D production function. For example, if w increases relative to r , then firms that are labour intensive (i.e. $\beta < 1$) would reduce output while those that are capital intensive (i.e. $\beta > 1$) would increase output. When aggregate, it will appear that the representative firm substituted labour for capital, which can be consistent with C-D production function.

- (v) *An improvement in the quality of cell phones produced by one cell phone manufacturer would be expected to reduce the sales of other cell phone manufacturers cell phones.*

Uncertain. This is not necessarily true in the presence of network effects. In the case in which network effects are relevant even if one company has an improvement in quality consumers could decide not to change if the value of the other network is higher. However, if the increase in quality is high enough the marginal consumers could decide to change to the less valuable network, increasing its value. This could generate a cascade effect and we could see many consumers migrating. Therefore, the reduction on sale depends on the relevance of network effects relative to the increase in quality. (EJ)

[I didn't initially think about network effects here. But I guess you mean something like BBM where you need a BB phone to use BBM? And the "high enough" increase in equality is like the introduction of iPhones?]

Uncertain. Imagine for simplicity that there are only two cell phone producers, and a uniform continuum of consumers with type between 0 and 1 denoting their preference for quality. Assume the firms set price equal marginal cost, which equals the quality level they choose. The consumers then buy the best phone whose price is below their type. Then clearly an increase in quality from one of the producers will lead to an increase in sales for the other producer, as a part of the consumers are not willing to pay for the quality increase in the other producer's phone.

Alternatively consider a market where the consumers simply enjoy quality phones, and one of the producers manage to increase the quality of his phones without changing his marginal cost. Clearly this competitive edge should lead to him servicing a greater share of the market, leading to a reduction in the other producer's sales. So Uncertain (EIH)

["Clearly" in the first paragraph is unclear to me...]

Uncertain. When buyers decide on what phones to buy, they take into account both price and quality. Even if one phone is of higher quality, if that comes at too "steep" a price, then individuals would not purchase the higher quality phone. To make the problem interesting, let us assume that one cell phone manufacturer produces a higher quality while keeping the same price. Let's also suppose that quality can be objectively measured in an interval, say, $[0,1]$ (to avoid the following, rather boring, answer: if the cell phone is of higher quality with respect to a dimension that no consumers care about, then sales of other phones will not be affected.).

To the extent that there are buyers who value the higher quality phone (and would otherwise have had to purchase the lower quality phone from the other manufacturer), introduction of a higher quality phone by one manufacturer would lead to lower sales for the other manufacturer. However, it is possible that buyers of the new phone are those who found existing phones subpar and did not purchase phones at all. In this (rather extreme case), we would find that introduction of the new phone would not affect the sale of other manufacturers. [To discuss. My answer is crap.] (Tak)

- (vi) *Making it easier to quit smoking (say by the introduction of a new pill that reduces the negative effects of quitting) can increase the number of smokers and the total quantity of cigarettes smoked.*

Uncertain. This innovation will have two effects on the number of people who smoke. Since quitting is easier, more people who wish to quit will actually quit, driving smoking rates down. But, at the same time, more people may start smoking due because it is now less addictive. Therefore, the overall result on smoking rates is ambiguous. (EJ)

Uncertain. Note that, under the standard rational addiction model (with certainty and perfect information), there is no scope for quitting. An individual weighs, in advance, the cost and benefits of smoking taking into account that smoking is addictive, and decide whether to smoke. Thus, under this framework, the introduction of the new pill that reduces the negative effects of quitting (to the extent that this pill does not alter the health cost of smoking) does not change behaviour.

But consider an individual making a decision whether to quit or not. Such an individual may still continue to smoke if he finds that it is too costly to quit given the negative effects from quitting. An introduction of the pill in this case may allow such individuals to quit, leading to a reduction in the number of smokers. All else equal (in particular, those that smoke without intention of quitting does not change behaviour), this would also reduce the quantity of cigarettes smoked.

It is possible that smoking rates increases as a result of this pill. However, for this to hold, we would need individuals making decisions as to whether/when to start smoking as well as when to quit smoking. (Perhaps the individual is in a temporary setting where smoking is considered "normal".) If this were the case, then lowering the cost of quitting may induce individuals to start smoking. (Tak)