Tax Incidence Varies Across the Price Distribution

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Abstract

Traditional treatments of tax pass through examine *the* tax incidence, which makes sense when the law of one price holds. However in markets with a price distribution, a tax may have an uneven effect across the price distribution so that the tax incidence varies across the distribution. We illustrate variation in tax incidence using two relatively simple examples with nondegenerate price distributions: monopoly price discrimination and sales (temporary reductions in prices).

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Tax Incidence Varies Across the Price Distribution

Standard treatments of tax pass through (e.g., Fullerton and Metcalf 2002) examine *the* tax incidence on consumers. Referring to *the* tax incidence makes sense when the law of one price holds. However in many markets, prices vary across consumers or over time. In markets with a price distribution, a tax may have an uneven effect on various parts of the price distribution so that the tax incidence varies across the distribution.

To illustrate variation in tax incidence, we consider two relatively simple examples with nondegenerate price distributions. The simplest case is that of monopoly price discrimination. The second is one where sales—temporary reductions in prices—occur at various times, so that the tax has uneven effects on the distribution of prices over time.

Price Discrimination

If a monopoly price discriminates, the incidence of a tax may—but need not—vary across groups of consumers. For simplicity, we examine a specific tax, τ, but the results are similar for an ad valorem tax.

Suppose a monopoly has a constant marginal cost, m, so that its after-tax marginal cost is $m + \tau$. It sells to n groups of consumers with differing elasticities of demand. Each group i has an inverse demand function of $p_i(Q_i)$, where Q_i is the quantity. The monopoly's objective is

$$\max \sum_i [p_i(Q_i) - (m + \tau)]Q_i.$$

Consider two special cases of the inverse demand curve: linear and constant elasticity. If the groups' inverse demand curves are linear, $p_i = a_i - Q_i$, then the profit-maximizing price for each group is $p_i = (a_i + m + \tau)/2$. Thus, the change in the price when the tax changes is $\Delta p_i = ½$ for each group, and the incidence of the tax, $\Delta p_i/p_i$, is $1/(a_i + m + \tau)$. For example, if $a_1 = 6$, $a_2 = 4$, $m = 1$, and $\tau = 1$, then the incidence of the tax is 1/8 for the first group and 1/6 for the second group. That is, the price effect of the tax is constant across groups, but the incidence varies.

In contrast, with a constant elasticity inverse demand curve, $p_i = Q_i^{1/\varepsilon_i}$, the profit-maximizing price for each group is $p_i = (m + \tau)/(1 + 1/\varepsilon_i)$. Thus, the tax induced change in the price, $\Delta p_i = 1/(1 + 1/\varepsilon_i)$, varies across groups. However, the incidence is constant across the groups, $\Delta p_i/p_i = m + \tau$.

Sales

Similarly, a tax alters the shape of the price distribution over time when a monopoly conducts sales from time to time. We present a highly stylized example in which periodic sales occur. Many competitive firms sell a generic good at marginal cost: $p = m$. A branded-good manufacturer—a dominant firm—sells its differentiated good at a higher price to loyal customers who prefer it. From time to time, the dominant firm places its branded good on sale to steal customers from the generic sector. The elasticity of demand of customers who are loyal to the differentiated product differs from the elasticity of demand of customers who switch between the differentiated and generic products. Consequently, the profit-maximizing dominant firm changes its regular and sales price differently when subject to a tax.

"Loyal" customers, β share of all consumers, buy only the branded product. "Switchers," γ share of consumers, are willing to pay up to a small premium, x, for the branded product, so they buy the branded products if and only if its price is less than or equal to $p + x$. Otherwise, they buy the generic good. The remaining customers, $1 - \beta - \gamma$ share, do not like the differentiated product, so they always buy the generic. (We do not discuss this last group further, which we include to ensure that the generic sector exists even if all the switchers buy the branded good.)

The generic and differentiated goods are storable for n days. Each loyal customer shops once every n days. If the brand name goes on sale on a day that a loyal customer shops, that customer buys at the low price; otherwise, the loyal customer pays the regular price. The initial week in which a loyal customer shops is randomly determined, so that $1/n$ of them shop on any given day within a n-day long period.

Switchers consume one unit a day of whichever good is the best buy. Because switchers either shop daily or pay attention to advertising about sales, they know when the dominant firm puts its good on sale. If they are able to buy the brand name at less than $p + x$, they buy the brand name. If the brand name is too expensive—more than $p + x$—and they have used up their stored goods, they buy the generic product. How much of either good they buy depends on their expectations about future prices.

We propose a strategy for the branded firm and then argue that that strategy maximizes its profit over time. (We ignore discounting for simplicity because our qualitative results are not sensitive to this assumption.) The dominant, branded firm has periodic sales to "sweep out" the switchers. It has the sales as infrequently as possible so as to reduce the share of output that its loyal customers buy on sales.

The dominant firm charges a low, sales price, $s = p + x$, on the first day. For the next $n - 1$ days, it sets its regular (non-sales) branded price b equal to the monopoly price given the demand curve of the loyal customers. It repeats this pattern in subsequent periods. Thus, given this strategy, the dominant firm charges the regular price, b, $(n - 1)/n$ fraction of the time, and the sales price, s, the remaining $1/n$ fraction of time.

During a sale, the switchers buy enough of the branded good to last them for n days. Consequently, the switchers never buy the generic product. They have no incentive to buy lesser or greater amounts as they do not expect a lower sales price in any period and they prefer the brand-name good at $s = p + x$ to the generic good. A fraction of the loyal customers, $1/n$, always buy the good on sale, while the others always pay the regular (monopoly) price.[1]

Could the dominant firm make more money by deviating from this strategy? The dominant firm does not want to place its good on sale more frequently because it would earn less from its loyal customers. If it pays to hold sales at all, it does not want to hold sales less frequently because it would sell fewer units to switchers. The firm lowers its profit if it charges more or less than b in the non-sales periods. In a sales period, it wants to charge the highest price it can and yet still attract switchers, which is $p + x$. If it sets a

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[1] If loyal customers were aware of this sales pattern, they could get on a schedule such that they always bought on sales too (so that this sales strategy would not maximize profit). However, we assume that the loyal customers' shopping schedules are determined independently (e.g., they buy many goods and are not willing to distort their shopping patterns solely to buy this one good on sale or they find it too psychologically costly to pay attention to sales). If one is unwilling to make such an admittedly heavy-handed assumption, we could get similar results by having random sales and having the brand manufacturer place ads where only the switcher see them, or in other ways.

lower price, the quantity sold is unchanged, so its profit falls. If the dominant firm sets a higher price, it loses all switchers.

Holding a sale more or less often than every n-days would lower the firm's profit. Holding a sale more often gains it no extra sales and lowers its profit from loyal customers. Similarly, holding a sale less often causes it to lose profitable sales to switchers. The firm finds that it pays to hold sales if there are enough switchers relative to brand-loyal customers, which we assume it true.[2]

Now suppose that the government applies an ad valorem tax of α to these products. The higher the price, the greater the tax wedge, which equals α times the relevant price. For example, if the consumer pays p_c for the generic good, the firm receives $p_f = (1 - \alpha)p_c$.

Without a tax (or with a specific tax), if the dominant firm wanted to lower its price to consumers by a dollar, it would have to lower its price by a dollar. Now, it can lower its after-tax price by a dollar at a cost of $(1 - \alpha)$. If the other prices were unaffected, this effect would reduce the difference between the sales and the regular price. However, the tax also affects the regular brand price and the generic price, so more analysis is necessary.

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[2] It is profitable for the dominant firm to hold a sale if its loss from selling to some loyal customers at the sales price is less than its extra earnings from selling to switchers. If $f(\bullet)$ is the quantity demanded by a loyal customer, the firm's profit from a loyal customer on a regular-price day is $(b - m)f(b)$ and its (lower) profit on a sales-price day is $(s - m)f(s)$. Its profit from a switcher is $(s - m)n$, since it sells n units to each switcher on a sales day. Suppose there are Z total customers. During an n-day period, the loss from loyal customers due to the sale is $[(b - m)f(b) - (s - m)f(s)]\beta Z/n$. The gain from sales to switchers is $(s - m)n\gamma Z$. Thus, the condition for dominant firm to profit from the sale is $[(b - m)f(b) - (s - m)f(s)]\beta Z/n < (s - m)n\gamma Z$, or $(b - m)f(b)\beta/n < (s - m)[f(s)\beta/n + n\gamma]$. We assume that this condition holds.

Because the marginal cost is constant, the competitive supply curve is horizontal (infinite elasticity of supply). Consequently, consumers' post-tax generic price is $p_c = m/(1 - \alpha)$. The branded sales price is, therefore, $s_c = m/(1 - \alpha) + x$, assuming that the dominant firm still wants to hold sales.

The behavior of the dominant firm depends on the demand curve of the loyal customers. We start by assuming that the loyal customers have a constant elasticity demand curve with an elasticity of $\varepsilon < -1$. In the absence of a tax, the dominant firm charges consumers the monopoly price, $b = m/(1 + 1/\varepsilon) \equiv \mu m$. After the tax, it charges consumers $b_c = \mu m/(1 - \alpha)$. Thus, the incidence on consumers of the non-sales price is $b_c/b = 1/(1 - \alpha) > 1$. In contrast, the incidence of the sales price is $s_c/s = [m/(1 - \alpha) + x]/[m + x]$, which is less than $1/(1 - \alpha)$.

Let $\varepsilon = -2$, $m = 10$, and $x = 5$, then $p = 10$, $b = 20$, and $s = 15$. Given an ad valorem tax rate of $\alpha = 50\%$, the incidence on the regular price is $b_c/b = 2$. The incidence of the tax on the sales price is $s_c/s = [10/0.5 + 5]/[10 + 5] = 25/15 = 5/3 \approx 1.667$, which is less than 2.

Now, in contrast, we suppose that each loyal customer buys one unit of the branded product if the price is no more than B. Here, the dominant firm charges $b = B$, so the incidence is zero (the firm absorbs the tax). The incidence of the tax on the sales price is the same as in the previous example. Thus, the incidence of the tax is greater on the sales price than on the regular price in this example—the opposite of the previous example. We have illustrated that a tax may alter the shape of the price distribution and that the incidence may vary over the distribution.

Summary

Where a market has a nondegenerate price distribution, the tax incidence may vary across customers or over time. Monopoly or dominant firm price discrimination underlies our results in both our examples: pure price discrimination and sales. However, we could produce other examples than do not turn on monopoly or price discrimination. What is crucial is the nondegenerate price distribution.

References

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