Tax Pass-Through under Monopoly

a toy model for the chapter on monopoly, after Weyl and Fabinger (2013)

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November 12, 2026

1 Introduction

In the chapter on partial equilibrium, we showed that a per-unit tax t in a competitive market raises the price that consumers pay by less than the tax. The share of the tax passed on to consumers, the *pass-through rate*, is

$$\rho = \frac{dp_c}{dt} = \frac{\varepsilon_S}{\varepsilon_S + \varepsilon_D},$$

where ε_S and ε_D denote the supply and (absolute) demand elasticities. Hence, under perfect competition, $0 < \rho < 1$, and the less elastic side of the market bears most of the tax.

This handout asks how these results change when the good is sold by a monopolist. Weyl and Fabinger (2013) show two differences. First, under monopoly the pass-through rate does not depend on the elasticity of demand but on its *curvature*, and it can exceed 1: the price may rise by *more* than the tax. Second, the ratio between the losses of consumers and the monopolist takes a simple form, equal to the pass-through rate itself.

2 The model

A monopolist faces inverse demand $p(q)$, with $p'(q) < 0$, and produces at a constant marginal cost c. The government imposes a per-unit tax t on the monopolist. The monopolist solves

$$\max_{q \geq 0} \ \pi = [p(q) - c - t]\, q.$$

The first-order condition sets marginal revenue equal to marginal cost plus the tax,

$$p(q) + qp'(q) = c + t,$$

and the second-order condition is $2p'(q) + qp''(q) < 0$. This condition determines the equilibrium output for every tax, $q(t)$, and the equilibrium price $p(q(t))$.

3 Pass-through under monopoly

Differentiating the first-order condition with respect to t, and using the chain rule,

$$[2p'(q) + qp''(q)]\,\frac{dq}{dt} = 1, \qquad \text{so} \qquad \frac{dq}{dt} = \frac{1}{2p'(q) + qp''(q)} < 0,$$

where the sign follows from the second-order condition. A higher tax reduces output. The price changes by $\frac{dp}{dt} = p'(q)\frac{dq}{dt}$, which yields the pass-through rate

$$\rho \equiv \frac{dp}{dt} = \frac{p'(q)}{2p'(q) + qp''(q)} = \frac{1}{2 - \sigma}, \qquad \text{where} \qquad \sigma \equiv -\frac{qp''(q)}{p'(q)}.$$

To obtain the last expression, we divided the numerator and the denominator by $p'(q)$.

The term σ measures the *curvature* of inverse demand. It is zero for linear demand, positive when inverse demand is convex ($p'' > 0$), and negative when it is concave ($p'' < 0$). Dividing the second-order condition by $p'(q) < 0$ gives $2 - \sigma > 0$, so $\rho > 0$: the price always rises with the tax. In addition,

- $\rho < 1$ if and only if $\sigma < 1$: the price rises by less than the tax;
- $\rho > 1$ if and only if $\sigma > 1$: the price rises by *more* than the tax. This case, which never arises under perfect competition, is known as *overshifting*.

Unlike in the competitive market, the elasticity of demand does not appear in ρ. What matters is how the slope of demand changes as output falls, since the monopolist sets its price using marginal revenue, which depends on that slope.

4 Two examples

Linear demand. Let $p(q) = a - bq$, with $a > c + t$ and $b > 0$. Since $p'' = 0$, the curvature is $\sigma = 0$, and $\rho = \frac{1}{2}$ regardless of a and b. Indeed, the first-order condition $a - 2bq = c + t$ gives

$$q(t) = \frac{a - c - t}{2b} \qquad \text{and} \qquad p(t) = \frac{a + c + t}{2},$$

so the monopolist passes on half of the tax. For instance, with $p(q) = 100 - q$ and $c = 20$, we obtain $p = 60 + \frac{t}{2}$. A tax of $t = 10$ raises the price from 60 to 65 and reduces output from 40 to 35.

Constant-elasticity demand. Let $q = Ap^{-\varepsilon}$, with $A > 0$ and $\varepsilon > 1$, so that the elasticity of demand is ε at every price. Marginal revenue is $p\left(1 - \frac{1}{\varepsilon}\right)$, and setting it equal to $c + t$ yields

$$p(t) = \frac{\varepsilon}{\varepsilon - 1}(c + t), \qquad \text{so} \qquad \rho = \frac{\varepsilon}{\varepsilon - 1} > 1.$$

The monopolist charges a constant markup over marginal cost, as the Lerner index $\frac{p-(c+t)}{p} = \frac{1}{\varepsilon}$ requires. A tax raises marginal cost, and the markup is applied to the tax as well, so the price rises by more than the tax. As a check, inverse demand is $p = \left(\frac{q}{A}\right)^{-\frac{1}{\varepsilon}}$, which gives $\sigma = \frac{\varepsilon+1}{\varepsilon} > 1$ and

$\frac{1}{2-\sigma} = \frac{\varepsilon}{\varepsilon-1}$. For instance, with $\varepsilon = 2$, $A = 400$, and $c = 10$, the price is $p = 2(10 + t)$. A tax of $t = 5$ raises the price from 20 to 30, twice the tax, and reduces output from 1 to $\frac{400}{30^2} \approx 0.44$.

Figure 1 compares the two examples. In each panel, the tax shifts marginal cost up from c (solid red line) to $c + t$ (dashed red line), and the monopolist moves to a lower output along its marginal revenue curve (purple). The price rises by half the tax in the left panel and by twice the tax in the right panel.

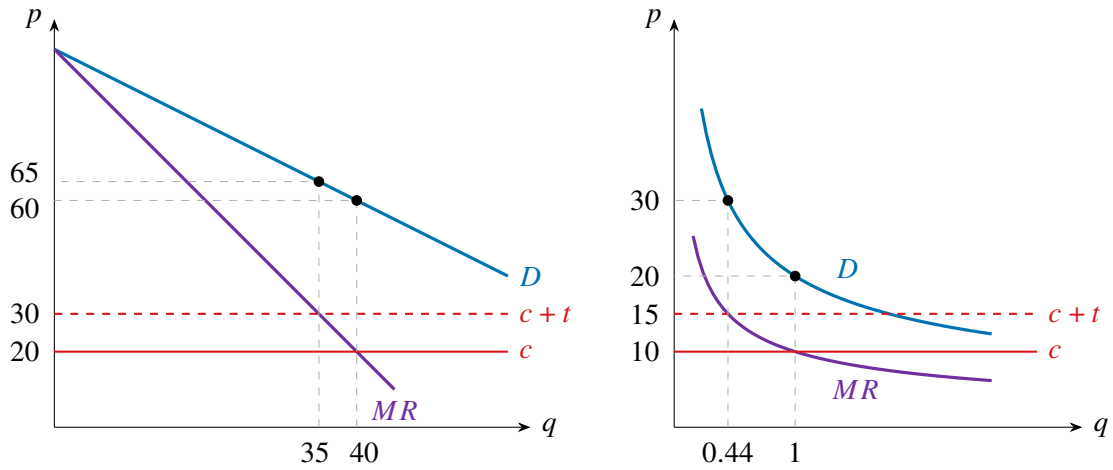


Figure 1: A tax raises marginal cost from c to $c + t$. Left: $p = 100 - q$, $c = 20$, $t = 10$; the price rises by 5. Right: $q = 400p^{-2}$, $c = 10$, $t = 5$; the price rises by 10.

5 Who bears the tax under monopoly

Consider now how a small increase in the tax affects consumers and the monopolist.

Consumers. Consumer surplus falls by the price increase times the quantity bought,

$$\frac{dCS}{dt} = -q\frac{dp}{dt} = -q\rho.$$

The monopolist. Its maximized profit is $\pi(t) = \max_q [p(q) - c - t]\, q$. By the envelope theorem, we can ignore the effect of the tax on the optimal output, and only the direct effect of t remains,

$$\frac{d\pi}{dt} = -q.$$

Intuitively, the monopolist already chose its output optimally, so a small change in output has no first-order effect on its profit.

Welfare incidence. The ratio of the consumers' loss to the monopolist's loss is

$$\frac{\frac{dCS}{dt}}{\frac{d\pi}{dt}} = \frac{-q\rho}{-q} = \rho.$$

Hence, under monopoly, consumers lose more than the monopolist if and only if $\rho > 1$. With linear demand, consumers lose half as much as the monopolist. With constant-elasticity demand, they lose $\frac{\varepsilon}{\varepsilon-1}$ times as much, even though the monopolist is the one that pays the tax to the government.

Under perfect competition, instead, consumers lose $q\rho$ and producers lose $q(1-\rho)$, so the ratio of their losses is $\frac{\rho}{1-\rho}$. Table 1 summarizes the comparison.

Market	Pass-through ρ	Consumers' loss / producers' loss
Perfect competition	$\frac{\varepsilon_S}{\varepsilon_S+\varepsilon_D} \in (0,1)$	$\frac{\rho}{1-\rho} = \frac{\varepsilon_S}{\varepsilon_D}$
Monopoly, linear demand	$\frac{1}{2}$	$\frac{1}{2}$
Monopoly, constant elasticity ε	$\frac{\varepsilon}{\varepsilon-1} > 1$	$\frac{\varepsilon}{\varepsilon-1} > 1$

Table 1. Pass-through and welfare incidence of a small per-unit tax.

Lesson. Under monopoly, the pass-through of a tax depends on the curvature of demand rather than on its elasticity, and it can exceed 1. In addition, the ratio of the consumers' loss to the monopolist's loss equals the pass-through rate. Therefore, whether consumers or the monopolist bear most of a tax depends on the shape of the demand curve, not on who pays the tax to the government.

References

Weyl, E. G., and M. Fabinger (2013) "Pass-Through as an Economic Tool: Principles of Incidence under Imperfect Competition." *Journal of Political Economy* 121(3): 528–583.