Journal of Competition Law & Economics, 12(2), 279–285
doi:10.1093/joclec/nhw004
Advance Access publication 10 May 2016

THE ECONOMICS OF PASS-THROUGH WITH PRODUCTION CONSTRAINTS

Dov Rothman, * *Philipp Tillmann*† *& David Toniatti*‡

ABSTRACT

This article reviews the implications of production constraints for pass-through. We consider production technology that can only be adjusted in discrete intervals and/or is costly to adjust. We show that, because of production constraints, a firm may not be willing to adjust its level of production in response to small changes in cost. Because price is determined by demand and the quantity produced, production constraints may result in a firm not changing price in response to a change in cost. This result has important implications for antitrust litigation—for example, the extent to which overcharges resulting from anticompetitive conduct upstream in the supply chain are passed through to purchasers downstream in the supply chain.

JEL: K21; L11; L41

I. INTRODUCTION

Pass-through is an important issue in many antitrust cases. For example, consider a cartel of sellers of an input. If successful, the cartel raises the price of the input and so raises the costs of the manufacturers of a finished product. The ultimate effect of the cartel on the purchasers of the finished product depends on the pass-through of the overcharge through the supply chain.[1]

It is widely recognized that pass-through depends on the competition in a given market and the characteristics of demand for the product.[2] Another important determinant of pass-through that has received less attention is the nature of production. In some industries, firms can easily adjust production in response to changes in cost. For example, services firms with low overhead may be able to change supply in response to an increase in labor costs. In other industries, however, firms may only be able to adjust production by discrete

* Vice President, Analysis Group, Inc. Email: dov.rothman@analysisgroup.com.
† Analysis Group, Inc. Email: philipp.tillmann@analysisgroup.com.
‡ Analysis Group, Inc. Email: david.toniatti@analysisgroup.com.

1 *See* George Kosicki & Miles B. Cahill, *Economics of Cost Pass Through and Damages in Indirect Purchaser Antitrust Cases*, 51 ANTITRUST BULL. 599–630 (2006).

2 *See*, *e.g.*, Michal Fabinger & E. Glen Weyl, *Pass-Through as an Economic Tool: Principles of Incidence Under Imperfect Competition*, 121 J. POL. ECON. 528–83 (2013).

amounts, and/or adjusting production may be costly. Examples include electric utilities and capital-intensive manufacturing.[3]

The effect of production constraints on pass-through is conceptually similar to the effect of menu costs on pass-through. A large literature, first developed in the 1970s, addresses the effect of menu costs on the frequency of price changes and nominal price rigidity.[4] This literature demonstrates that price does not always respond to changes in cost when changing price is costly.[5] Similarly, price may not always respond to changes in cost when changing the quantity produced is costly.

This article examines how constraints on production technology affect whether or not a firm passes through a change in the cost of an input. We examine two types of constraints on production technology. First, we consider a manufacturer that can only adjust production in discrete intervals (for example, increments of 100). Second, we consider a manufacturer that incurs a fixed cost to adjust production. In both cases, we show that given sufficiently large production constraints (that is, sufficiently large discrete intervals of production or sufficiently large fixed costs to changing production), the firm may be unwilling to change its level of production. Because price is determined by demand and the quantity produced, a change in input cost that does not affect demand or the quantity produced will not affect price. As a result, under certain conditions, the firm does not change price in response to a change in input cost, and pass-through is zero.

In the remainder of this article, we describe in more detail each type of constraint on production technology, illustrate each constraint with an example from manufacturing, and derive expressions for average pass-through.

II. PASS-THROUGH WITH DISCRETE PRODUCTION LEVELS

Consider a manufacturer that produces and assembles a product in shifts and can adjust the number of units produced by adding or subtracting shifts. Because there are fixed costs associated with running a shift, it only makes sense to run a shift at full capacity, and so each shift produces a fixed number of units. Consequently, reducing or increasing the number of shifts results in discrete changes in the number of units produced. For example, if each shift produces 100 units, adding one shift adds 100 units to the production schedule. Given

[3] *See, e.g.*, Stephen Peck, *Alternative Investment Models for Firms in the Electric Utilities Industry*, 5 BELL J. ECON. & MGMT. SCI. 420–58 (1974); Russell W. Cooper & John C. Haltiwanger, *On the Nature of Capital Adjustment Costs*, 73 REV. ECON. STUD. 611–33 (2006).

[4] *See, e.g.*, Eytan Sheshinski & Yoram Weiss, *Inflation and Costs of Price Adjustment*, 44 REV. ECON. STUD. 287–303 (1977); George Akerlof & Janet Yellen, *A Near-Rational Model of the Business Cycle, with Wage and Price Inertia*, 100 Q.J. ECON. 823–38 (1985); Gregory Mankiw, *Small Menu Costs and Large Business Cycles: A Macroeconomic Model of Monopoly*, 100 Q.J. ECON. 529–38 (1985).

[5] *See* Alexi Alexandrov, *Pass-Through Rates in the Real World: The Effect of Price Points and Menu Costs*, 79 ANTITRUST LAW J. 349–60 (2013) (discussing average pass-through given menu costs).

the significant fixed costs associated with adding a shift, the manufacturer would not find it profitable to add, for example, 25 units to the production schedule.

If input cost rises, the manufacturer may consider reducing the quantity of units it sells, because doing so would allow it to charge higher prices (and effectively pass through some of the higher input cost). Given the nature of production, however, the manufacturer must determine if it is profitable to manufacture 100 fewer units.

Suppose the manufacturer would produce 230 units absent production constraints, but with production constraints must decide between producing 100, 200, or 300 units, and chooses to produce 200 units. Now suppose the cost of an input used to make the product goes up and the profit-maximizing quantity absent production constraints falls from 230 to 210. However, because of production constraints the manufacturer can only choose between making 100, 200, or 300 units, and so continues to make 200 units. And because the demand for the 200 units is not affected by the cost of the input, the manufacturer chooses the same price and does not pass through any of the higher input cost.

As a counterexample, suppose the increase in the input cost is much larger and the profit-maximizing quantity absent production constraints falls from 230 units to 150 units. In this case, the manufacturer may find it profitable to decrease production from 200 to 100 units. Because the manufacturer can charge a higher price if it only needs to sell 100 units, the manufacturer may raise its price in response to the higher input cost.

Figure 1 below shows profit curves as functions of quantity produced. The solid curve shows the manufacturer's profit when it acquires the input at the competitive cost. The dashed curve shows the manufacturer's profit when it acquires the input at an inflated cost. (The dashed curve can be derived by subtracting the input cost inflation from the solid curve.) The manufacturer can only produce at one of three quantity levels, q_L, q_M, or q_H.

In Figure 1, the manufacturer's profit is highest when it produces q_M (rather than q_L or q_H), regardless of whether it acquires the input at the competitive cost or at the inflated cost. That is, because the manufacturer can only produce at one of three quantity levels, the inflated input cost does not affect the manufacturer's profit maximizing quantity. And because the inflated input cost does not affect the profit maximizing quantity, the inflated input cost does not affect the profit maximizing price.

Figure 2 below depicts the same information as Figure 1 except the input cost inflation is larger. The manufacturer's profit maximizing quantity is q_M when the manufacturer acquires the input at the competitive cost, but now decreases to q_L when the manufacturer acquires the input at the inflated cost. Thus, because the inflated input cost causes the profit maximizing quantity to decrease, the inflated input cost causes the profit maximizing price to go up.

More generally, each input cost is associated with a profit maximizing price-quantity pair (p_H, q_L; p_M, q_M; p_L, q_H). Because the manufacturer can only

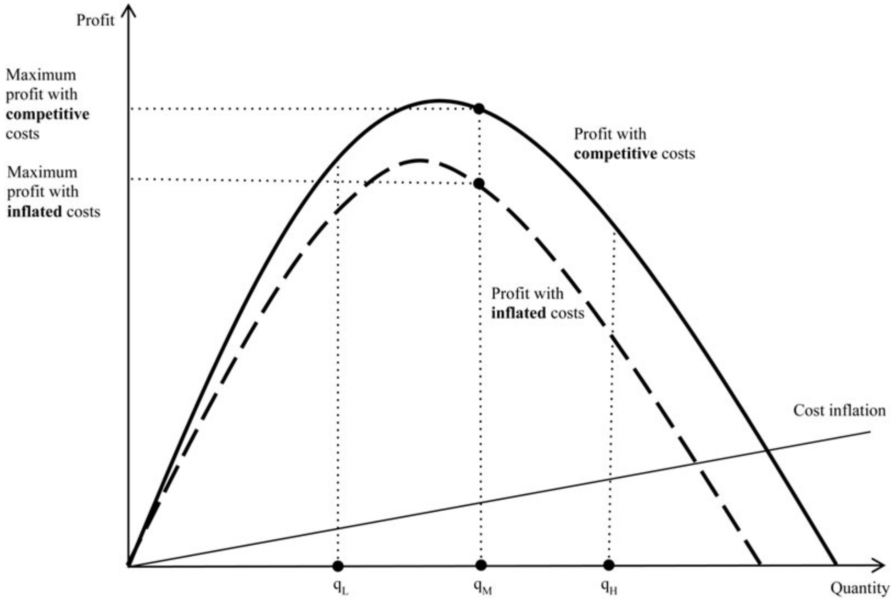

Figure 1. Manufacturer profits with discrete quantity production levels: Zero pass-through

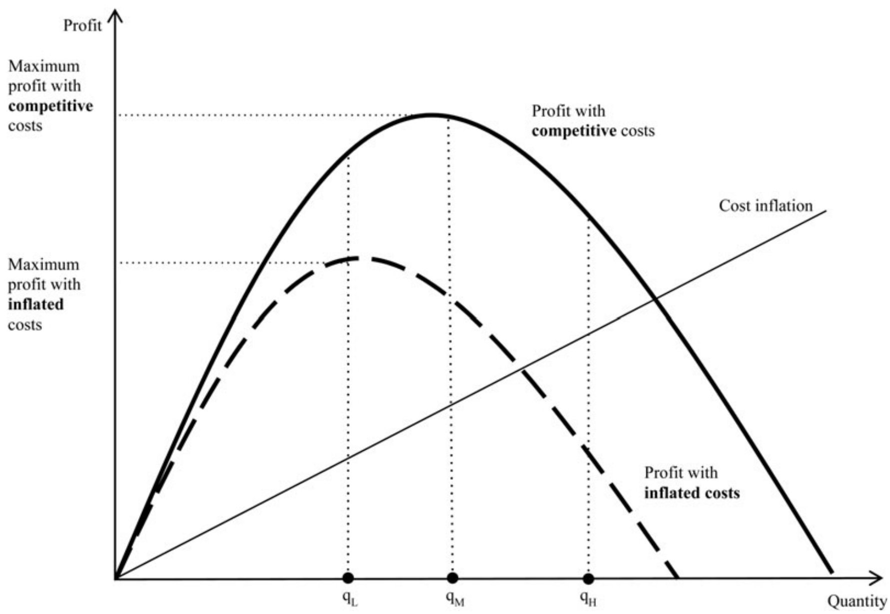

Figure 2. Manufacturer profits with discrete quantity production levels: Positive pass-through

produce at one of three quantity levels, q_L, q_M, or q_H, there are ranges of costs over which the manufacturer chooses the same price-quantity pair. Let c_{ML} and c_{MH} denote the *lowest* and *highest* costs at which the manufacturer chooses

$\{p_M, q_M\}$. Suppose that cost is uniformly distributed over the range, c_{ML} to c_{MH}. It follows that the probability that an increase in cost from c to $c+\delta$ results in a change in price is $Pr(c+\delta > c_{MH}) = \delta / (c_{MH} - c_{ML})$ and the pass-through rate is the change in price divided by the change in cost, $(p_H - p_M) / \delta$. Similarly, the probability that an increase in cost from c to $c+\delta$ does not result in a change in price (that is, pass-through is zero) is $Pr(c+\delta < c_{MH}) = 1 - \delta / (c_{MH} - c_{ML})$.[6]

From this expression, holding production technology constant, pass-through is more likely to be zero for smaller cost increases. Similarly, holding the size of the cost increase constant, pass-through is more likely to be zero when the differences in the levels of production that a manufacturer can choose from are larger.[7]

Finally, the average pass-through rate is equal to the change in price divided by the size of the cost increase multiplied by the fraction of manufacturers that change price in response to the cost increase. When cost is uniformly distributed, average pass-through is equal to $[(p_H - p_M) / \delta] \times [\delta / (c_{MH} - c_{ML})]$, or $(p_H - p_M) / (c_{MH} - c_{ML})$.[8] Different distributions in cost can increase or decrease the fraction of manufacturers that change price in response to a given cost increase, so average pass-through can be large or zero. For example, if a large share of manufacturers are close to the upper threshold c_{MH}, pass-through will be more likely, and average pass-through will be closer to $(p_H - p_M) / \delta$. On the other hand, if many manufacturers are close to the lower threshold c_{ML}, average pass-through will be closer to zero as fewer manufacturers will change price.

III. PASS-THROUGH WITH QUANTITY ADJUSTMENT COSTS

Consider a manufacturer that can change its level of production in small increments, but incurs a fixed adjustment cost whenever it does so (for example, changing production requires coordination of pricing, procurement, production, and supply chain management teams within the firm). Using the same example as above, suppose the manufacturer initially maximizes profit by

6 For any given c, the probability that $c+\delta$ is greater than c_{MH} can be written as $Pr(c+\delta > c_{MH}) = Pr(c > c_{MH} - \delta) = 1 - Pr(c < c_{MH} - \delta)$. When c is uniformly distributed between c_{ML} and c_{MH}, we can express $1 - Pr(c < c_{MH} - \delta)$ as $1 - (c_{MH} - \delta - c_{ML}) / (c_{MH} - c_{ML}) = \delta / (c_{MH} - c_{ML})$. More generally, we can express the probability that pass-through is non-zero according to the cumulative distribution function F corresponding to the distribution for c—that is, $1 - Pr(c < c_{MH} - \delta) = 1 - F(c_{MH} - \delta)$.

7 Pass-through is more likely to be zero given larger differences in the levels of production that a manufacturer can choose from because larger differences lead to a wider range of costs over which a given price-quantity pair is profit-maximizing.

8 The average pass-through rate, $(p_H - p_M) / (c_{MH} - c_{ML})$, cannot be compared with the pass-through rate without production constraints. More information is needed about what costs lead to prices p_H and p_M without production constraints. For example, if cost c_H would cause the manufacturer to set price p_H, and cost c_M would cause the manufacturer to set price p_M, the pass-through rate without production constraints given a cost shock from c_M to c_H is $(p_H - p_M) / (c_H - c_M)$. The average pass-through rate with discrete quantity levels is larger (smaller) than the average pass-through without production constraints if $c_H - c_M$ is larger (smaller) than $c_{MH} - c_{ML}$.

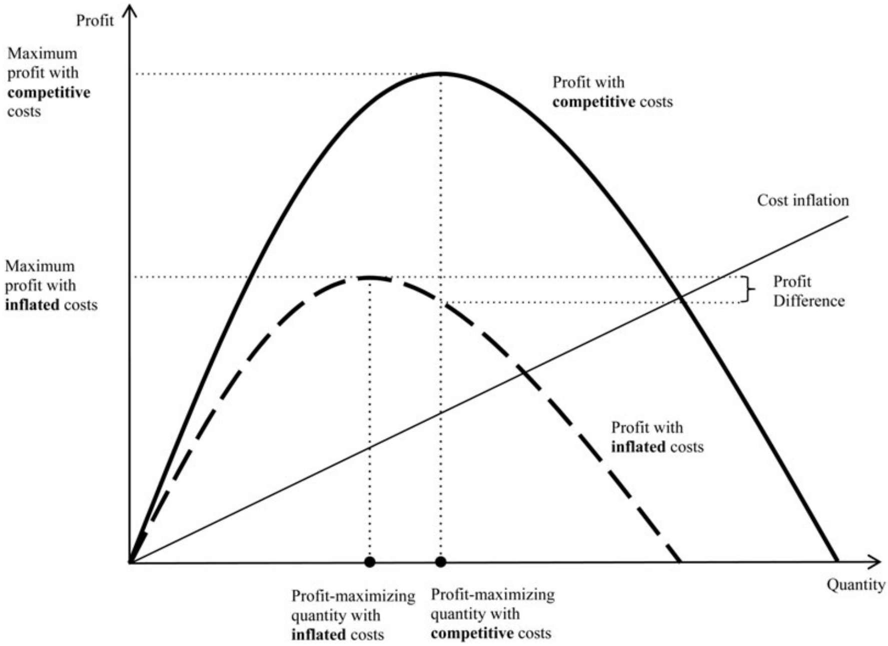

Figure 3. Manufacturer profits with adjustment costs

producing 230 units. Suppose also that its input costs go up and as a result the profit-maximizing quantity decreases to 210. Given the higher input costs, producing 210 units and charging a higher price would yield a profit of $1,000, while producing 230 units would yield a profit of $950. However, the cost of changing the production schedule is $70. Thus, changing production to 210 units would yield a profit of ($1,000 – $70) = $930, whereas the manufacturer can earn a profit of $950 if it continues producing 230 units. Consequently, the manufacturer would choose to continue producing 230 units. Because consumer demand for 230 units is independent of the manufacturer's input cost, the firm chooses the same price and does not pass through any share of the higher input cost.

Figure 3 above depicts profit curves as functions of quantity. The solid curve shows the manufacturer's profit when it acquires the input at the competitive input cost. The dashed curve shows the manufacturer's profit when it acquires the input at the inflated input cost. Faced with an inflated input cost, the distance represented by "Profit Difference" is the additional profit the manufacturer would get if it changed quantity to the profit maximizing level (absent production constraints). As long as the quantity adjustment cost is larger than this additional profit, it is optimal not to adjust quantity in response to a higher input cost.

If the manufacturer decides to change the quantity produced, price changes accordingly and the pass-through rate is the same as if the firm did not incur an adjustment cost. If the manufacturer does not change quantity, the pass-through rate is zero. A zero pass-through rate is more likely (1) with larger adjustment costs, (2) when the cost increase is small, and (3) the more elastic the demand curve.

The intuition for (1) is straightforward: For a given cost increase and a given production technology, a sufficiently large adjustment cost leaves the optimal production schedule unchanged, and thus pass-through is zero. Regarding (2), holding adjustment cost fixed, a small cost increase yields only small benefits to adjusting quantity. For sufficiently small cost increases, pass-through is zero. The intuition for (3) is more subtle. When demand is more elastic, changes in quantity are accompanied by smaller changes in price, which leads to smaller changes in profit. This relationship between changes in quantity and changes in profit is represented by the curvature of the profit function: the more elastic demand, the less curvature in the profit function and the less additional profit generated by a quantity change after an increase in cost.

Finally, the average pass-through rate is equal to the pass-through rate without production constraints multiplied by the fraction of manufacturers that change price in response to the cost increase. All else equal, the average pass-through rate is lower when adjustment costs are higher, cost increases are smaller, and demand is more elastic.

IV. CONCLUSION

We have examined the effect of two types of production constraints on pass-through. First, we consider a manufacturer that can only adjust production in discrete intervals (for example, increments of 100). Second, we consider a manufacturer that incurs a fixed cost to adjust production. In both cases, we show that given sufficiently large production constraints (that is, sufficiently large discrete intervals of production or sufficiently high fixed costs to changing production) and/or small changes in production cost, the firm may be unwilling to change its production level. Because price is determined by demand and the quantity produced, a change in cost that does not affect demand or the quantity produced will not affect price. As a result, under certain conditions, the firm sets the same price in response to a change in cost and pass-through is zero.

Production constraints limit how firms optimally set prices and quantities in the real world. These issues may result in pass-through that deviates from standard textbook economic models. Analysis of firm behavior in antitrust litigation that ignores such deviations may lead to incorrect assessments of harm.