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Keywords: Producer surplus, profit, rent

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1. Introduction

Almost all economic policy decision-making involves a cost-benefit analysis. The starting point of a cost-benefit analysis is to identify who receives what benefits and who pays what costs. In standard economic textbooks, producer surplus is defined as the difference between the producer's revenue and cost of production. As such, producer surplus is commonly used in cost-benefit analyses to measure the benefit received by the producer from supplying their goods or services to the market. But is producer surplus in fact a surplus to the producer?

This paper clarifies the producer surplus concept in the short-run and the long-run contexts. It shows that in the short run, producer surplus is the sum of economic profit (or loss) to the firm and quasi-rent which goes to owners of fixed factors. In the long run, producer surplus is rent, which goes to owners of specialised factors of production. In either case, producer surplus is not necessarily a surplus received by the producer.

The following section discusses the producer surplus concept in standard texts and presents 3 simple models to clarify what producer surplus measures in the short run and in the long run. Section 3 concludes with some implications of clarified concept.

2. What does producer surplus measure?

The concept of producer surplus may be traced back to (at least) Alfred Marshall's *Principles of Economics*, first published in 1890. Marshall (1961) writes, "...another side of the surplus which a man derives from his surroundings is better seen when he is regarded as producer, whether by direct labor, or by the accumulated, that is, acquired and saved, material resources in his possession. As a worker, he derives a worker's surplus, ... As a capitalist, he derives a saver's surplus..." (p.830-831). It appears what Marshall meant by producer surplus is a surplus to individuals as factors owners. Since the surplus is a payment above the factors' opportunity costs, it is referred to as economic rent. Thus, "worker's surplus" is rent to labor; and "saver's surplus" is rent to capital.

In modern economics texts, "the producer" is synonymous to "the firm", and producer surplus is understood to be the surplus to the producer as the supplier of goods or services to the market. For example, Just et al. (1982, p.53) contend that producer surplus is "the total

benefit to the producer from remaining in business”. Landsburg (1989, p.221) considers producer surplus to be “the producer’s gains from trade; the amount by which his revenue exceeds his variable cost of production.” Gans et al. (2015) state that “[p]roducer surplus is the amount a seller is paid minus the cost of production” (p.154) and that “the area below the price and above the supply curve measures the producer surplus in a market” (p.156).

Underneath these apparently straightforward textbook definitions, there are some notable ambiguities. First, the textbooks seem to define producer surplus in the short-run context. Does this concept have the same meaning in the long run? More importantly, what is the nature of producer surplus? Does it in fact go to the producer (i.e., the firm)? We answer these questions below with the help of some simple models.

2.1. Short-run producer surplus

Consider the standard textbook example of a profit-maximising firm in a perfectly competitive market. The firm’s total cost of production has a fixed and a variable component. As shown in Figure 1, the firm’s short-run supply curve (S) is its marginal cost curve (MC). The firm supplies a quantity of output to the market if the market price is greater than P_0 . When the market price is P_1 , the firm supplies quantity Q_1 and the producer surplus is measured by the area P_1P_0A . Since P_1 is equal to the firm’s average cost (AC) at Q_1 , the firm makes zero economic profit. The entire producer surplus goes to the owners of the fixed factors of production, which may or may not be the owners of the firm. The nature of the producer surplus is “quasi-rent”— “rent” because it is a payment above the opportunity cost of the fixed factors (which is zero in the short run), “quasi” because the rent may not persist in the long run.

[insert Figure 1 here]

Suppose the market price rises to P_2 . The firm responds by increasing its output to Q_2 . The firm makes an economic profit since P_2 is greater than the firm’s average cost at Q_2 . Now the producer surplus is measured by the area P_2P_0B , which equals the payment to fixed factors (“quasi-rent”) plus the firm’s economic profit. If the market price falls to a level between P_0 and P_1 , then the producer surplus is less than the payment to fixed factors, the difference being the firm’s economic loss.

The above result can be derived algebraically with a simple model. Suppose the firm uses three factors of production, labor (L), capital (K) and land (LD). In the short run, K and

LD are fixed and unavoidable, the firm is a price taker in the output market and chooses L to maximise profit. The firm's decision problem is:

$$\max_L \pi = PQ(L, \bar{K}, \bar{LD}) - wL - i\bar{K} - r\bar{LD} \quad (1)$$

where P = market price for the firm's output

Q = output quantity

w = wage rate

i = unit cost of capital

\bar{K} = fixed amount of capital

r = unit land rent

\bar{LD} = fixed amount of land

Solving the decision problem, we obtain the firm's optimal quantity of labor demanded:

$$L^* = L^*(P, w, \bar{K}, \bar{LD}) \quad (2)$$

Substituting equation (2) into the firm's profit function, we have:

$$\pi^* = PQ^*(L^*, \bar{K}, \bar{LD}) - wL^* - i\bar{K} - r\bar{LD} \quad (3)$$

Differentiating equation (3) with respect to P gives us the firm's short-run supply function:

$$Q^* = \frac{d\pi^*}{dP} \quad (4)$$

Producer surplus (PS), measured by the area below the price line and above the supply curve, is determined by the definite integral of Q^* with respect to P , from the firm's shut-down price P_0 to the market price P :

$$PS = \int_{P_0}^P Q^* dP = \pi^* - (-i\bar{K} - r\bar{LD}) = \pi^* + i\bar{K} + r\bar{LD} \quad (5)$$

where π^* is evaluated at the market price P .

From equation (5), we conclude that in the short run, producer surplus is the sum of economic profit (or loss) and quasi-rent.

2.2. Long-run producer surplus

In the long run, more factors of production can vary, and firms can enter or exit the industry. As a result, some quasi-rent will dissipate, and economic profit is driven to zero in the long-run equilibrium. This suggests that long-run producer surplus should be rent to the factors of production that does not dissipate with competition. We refer to such factors as

“specialised” factors. The most obvious example of specialised factor is land. Since the supply of land is fixed even in the long run, land rent does not dissipate over time with competition; on the contrary, it tends to rise over time as competition for land use become more intense. Another example of specialised factor is talent or “innate skills” which cannot be duplicated through schooling or training (Johnson and Libecap, 1982).

To study the nature of long-run producer surplus, we take our earlier model, and examine the long-run decision problem of the firm, assuming land is fixed even in the long run (i.e., there is a fixed site for the firm). Consider first the case where the industry faces a horizontal capital supply curve so that the cost of capital, i , is constant for each individual firm and the industry as a whole. The firm’s decision problem is to choose L and K to maximise profit:

$$\max_{L,K} \pi = PQ(L, K, \overline{LD}) - wL - iK - r\overline{LD} \quad (6)$$

The first-order conditions are:

$$\frac{\partial \pi}{\partial L} = P \frac{\partial Q}{\partial L} - w = 0 \quad (7)$$

$$\frac{\partial \pi}{\partial K} = P \frac{\partial Q}{\partial K} - i = 0 \quad (8)$$

Solving equations (7) and (8), we obtain the firm’s optimal demand for labor and capital:

$$L^* = L^*(P, w, i, \overline{LD}) \quad (9)$$

$$K^* = K(P, w, i, \overline{LD}) \quad (10)$$

Substituting equations (9) and (10) into the firm’s profit function, we have:

$$\pi^* = PQ^*(L^*, K^*, \overline{LD}) - wL^* - iK^* - r\overline{LD} \quad (11)$$

Differentiating equation (11) with respect to P , we have the firm’s short-run supply function:

$$Q^* = \frac{d\pi^*}{dP} \quad (12)$$

Producer surplus (PS) is measured by the definite integral of Q^* with respect to P , from the firm’s exit price P_0 to the market price P :

$$PS = \int_{P_0}^P Q^* dP = \pi^* - (-r\overline{LD}) = r\overline{LD} \quad (13)$$

where π^* is evaluated at the output price P . Since π^* is zero in the long-run equilibrium, producer surplus is equal to land rent.

Next consider the case where the industry faces an upward-sloping supply of capital. Assume there are many firms in the industry such that each individual firm still considers itself as a price taker in the market for capital. Thus, the firm's input decisions will be determined by the same first-order conditions, equations (7) and (8). As illustrated in Figure 2, the firm's optimal demand for capital is determined by the intersection of the firm's marginal revenue product of capital (MPR) and the price of capital which equals the firm's average factor cost of capital (AFC).

[insert Figure 2 here]

After solving the firm's optimal factor demands, we obtain the firm's long-term equilibrium profit function:

$$\pi^* = PQ^*(L^*, K^*, \overline{LD}) - wL^* - i(K^*)K^* - r\overline{LD} \quad (14)$$

Differentiating with respect to P , and then using equations (7) and (8) to simplify, we have:

$$\begin{aligned} \frac{\partial \pi^*}{\partial P} &= P \left(\frac{\partial Q^*}{\partial L^*} \frac{\partial L^*}{\partial P} + \frac{\partial Q^*}{\partial K^*} \frac{\partial K^*}{\partial P} \right) + Q^* - w \frac{\partial L^*}{\partial P} - i \frac{\partial K^*}{\partial P} - \frac{\partial i}{\partial K^*} \frac{\partial K^*}{\partial P} K^* \\ &= Q^* - \frac{\partial i}{\partial K^*} \frac{\partial K^*}{\partial P} K^* \end{aligned} \quad (15)$$

From equation (15), we have the firm's supply function:

$$Q^* = \frac{\partial \pi^*}{\partial P} + \frac{\partial i}{\partial K^*} \frac{\partial K^*}{\partial P} K^* \quad (16)$$

Producer surplus is determined by the definite integral of Q^* with respect to P , from the firm's exit price P_0 to the market price P :

$$\begin{aligned} PS &= \int_{P_0}^P Q^* dP = \int_{P_0}^P \left(\frac{\partial \pi^*}{\partial P} + \frac{\partial i}{\partial K^*} \frac{\partial K^*}{\partial P} K^* \right) dP \\ &= \pi^* + \int_{P_0}^P \frac{\partial i}{\partial K^*} \frac{\partial K^*}{\partial P} K^* dP - (-r\overline{LD}) \\ &= r\overline{LD} + \int_{K^*(P_0)}^{K^*(P)} \frac{\partial i}{\partial K^*} K^* dK \\ &= r\overline{LD} + \int_{i(K^*(P_0))}^{i(K^*(P))} K^* di \end{aligned} \quad (17)$$

The first term of the PS expression is land rent. The second term is the area between the market price of capital and the supply curve of capital. Namely, it is the producer surplus associated with capital supply, and goes to "specialised" factors of production employed in producing the capital good. Thus, we conclude that long-run producer surplus is rent to all specialised factors of production, including the production of inputs.

This conclusion can be illustrated by a simple example with specific functional forms. Assume the firm's production function is:

$$Q = K^\alpha L^\beta \overline{LD}^\gamma \quad (18)$$

where $\alpha + \beta + \gamma = 1$

Substituting equation (18) to the first-order conditions, equations (7) and (8), we obtain the firm's optimal demand for capital:

$$K^* = BP^{\frac{1}{1-\alpha-\beta}} \quad (19)$$

where $B \equiv \left(\frac{\beta}{w}\right)^{\frac{\beta}{1-\alpha-\beta}} \left(\frac{\alpha}{r}\right)^{\frac{1-\beta}{1-\alpha-\beta}} \overline{LD}^{\frac{\gamma}{1-\alpha-\beta}}$

The firm's optimal demand for capital increases with the market price of its output P :

$$\frac{\partial K^*}{\partial P} = \frac{K^*}{P(1-\alpha-\beta)} \quad (20)$$

Assume further that the industry in which the firm operates faces an increasing-cost capital supply:

$$i = a + bK \quad (21)$$

where $a > 0, b > 0$

The slope of the capital supply curve is:

$$\frac{di}{dK} = b \quad (22)$$

From equation (17), producer surplus is:

$$PS = r\overline{LD} + \int_{P_0}^P \frac{\partial i}{\partial K^*} \frac{\partial K^*}{\partial P} K^* dP \quad (23)$$

Substituting equations (19), (20) and (22) into the above equation, we have:

$$\begin{aligned} PS &= r\overline{LD} + b \int_{P_0}^P \frac{1}{P(1-\alpha-\beta)} (B^2 P^{\frac{2}{1-\alpha-\beta}}) dP \\ &= r\overline{LD} + \frac{1}{2} b (B^2 P^{\frac{2}{1-\alpha-\beta}}) \\ &= r\overline{LD} + \frac{1}{2} b (K^*)^2 \end{aligned}$$

where the second term is the area between the capital supply curve and the market price for capital as shown in Figure 2, which measures the producer surplus associated with the supply of capital.

3. Concluding remarks

In this paper, we have clarified the concept of producer surplus. In the short run, producer surplus is the sum of profit (or loss) to the firm and quasi-rent to owners of fixed factors of production. In the long run, producer surplus is rent to specialised factors such as land, patented technologies and talent. This result appears to be in line with Marshall's original conception of producer surplus as "savers' surplus" and "workers' surplus", although "innovators' surplus" and "landlords' surplus" should also be included.

Today we typically consider "the producer" as "the firm", and "the firm" as the entity that organises factors of production to make an output for the market. While the firm may own some fixed or specialised factors (e.g., land), it does not own all of them (e.g., talent and all the patents used in production), and consequently does not receive all the "producer surplus". Therefore, it would cause confusion to use "producer surplus" as a measure of the firm's benefit from supplying the market. To clear the confusion, we could broaden the definition of the "producer" to include all input owners (entrepreneurs, workers, capital owners, land owners, etc.). Alternatively, we could avoid the notion of "producer surplus" altogether and use other concepts, namely, profit (loss), quasi-rent, and rent, that more accurately measure the benefits and identify the beneficiaries.

Applying the standard producer surplus concept in a policy analysis, one would conclude that if a policy has the effect of raising (lowering) output prices, it will increase (reduce) producer surplus. For instance, a government subsidy of homeownership would increase producer surplus and benefit suppliers of new residential dwellings; and a government restriction on high-technology exports would reduce producer surplus and harm domestic sellers of high-tech products. With the clarification of the producer surplus concept, we can be more precise about the effects, especially the distributional effects, of the policies. For example, a government subsidy of homeownership tends to push up the price of new homes. In the short run, residential real estate developers may benefit in the form of larger profits; but in the long run, land prices will rise and the beneficiaries will be existing land owners. In the case of a government restriction of high-technology exports, the short-run

effects may be reduced profits for sellers of high-tech products. In the long run, the value the technology patents themselves will decline; and the wage premium of engineers and other talents in the industry may fall as well.

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Figure 1. Producer surplus in the short run

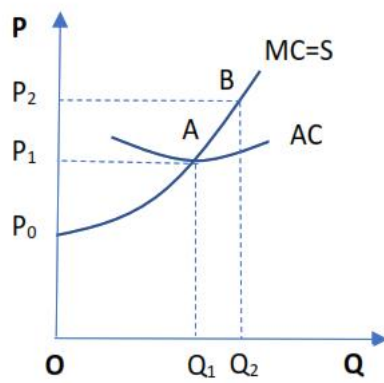


Figure 2. Rent to specialised factors in capital production

