When Producer Surplus Underestimates Rents

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This paper demonstrates for the long run that producer surplus exactly equals the sum of rents paid to competitively purchased inputs and fails to account for rents paid to monopsonized inputs. Therefore, in the long run, whenever one or more inputs are subject to monopsony buying power, producer surplus underestimates rents. Because the concept of producer surplus is often used to help compare the welfare effects of alternative economic policies, the result is significant. (JEL D0, D6) *Atlantic Econ. J., 29(4): pp. 393-405, Dec. 01.*

Introduction

Consumer surplus and producer surplus have been used to evaluate the welfare effects of alternative policies in many economic areas. Such areas include industrial organization, international trade, resource and environmental economics, and agricultural economics [Kalt, 1989; Babcock and Foster, 1992; Walters, 1993; Constantine et al., 1994; Fuglie, 1995; Martin and Alston, 1997]. This paper focuses on producer surplus in long-run equilibrium. In graphs, producer surplus conventionally is associated with the area above the competitive industry supply curve for output and below the equilibrium price. This area's economic meaning is clear for the short run, but its meaning is not at all obvious for the long run.[1] This is simply because in the long run, profits under competition are zero.

Suppose the rent to an input is taken as equal to the area above the input supply curve and below the equilibrium input price.[2] Helmberger and Rosine [1980] demonstrated under special conditions that in the long run, producer surplus equals the sum of the rents paid to factors of production. A paper by Frasco [1994] demonstrated that this result holds under very general conditions. However, as in all previous works on the topic, it was assumed that every input is purchased competitively.

Here, it is assumed that one or more inputs are purchased competitively and that one or more inputs are subject to monopsony buying power. It is demonstrated that producer surplus exactly equals the sum of the rents paid to the former and that producer surplus fails to account for rents paid to the latter. Hence, whenever one or more inputs subject to monopsony buying power exist, rents exceed producer surplus, and traditional welfare analyses are subject to substantial inaccuracies. Assuming that the long-run average cost curve of the firm is U-shaped, this result holds regardless of the form of the firm's production function, the form of the input supply functions, and the number of inputs.

Some works minimize the role of producer surplus and focus only on consumer surplus. These papers include theoretical analyses [Posner, 1975] as well as many empirical computable general equilibrium models [Hazilla and Kopp, 1990; Boyd and Krutilla, 1992].

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In such analyses, the long-run supply curve for output is assumed to be horizontal, which yields a zero producer surplus. Even in this case, however, the potential for substantial inaccuracies exists because rents will not equal zero if one or more inputs are subject to monopsony buying power.

An industry supply for output is defined only when the output-selling market is competitive and the combination of a competitive output-selling market with one or more monopsonized inputs is not commonly considered in the literature. Therefore, the second section provides some background for this particular combination of market structures. In the third section, a theoretical model is presented. The fourth section provides an explanation for the model's results, and the fifth section offers concluding comments.

Throughout this paper, it is assumed that all sellers of inputs behave competitively, that is, no seller of any input possesses market power in the sale of its input. Why? Rents cannot be calculated without input supply curves, and input supply curves do not exist when sellers of inputs possess market power.

Monopsony with Competition in the Output Market

Presented here is an outline of theoretical sources of monopsony power in the labor market, and some examples are given which combine monopsony buying power with a competitive output market. For the most part, the theoretical outline is taken directly from Boal and Ransom [1997], who use the term "monopsony" to refer to any situation in which labor supply is upward sloping to one or more individual firms.[3]

The standard model of monopsony involves a geographically isolated labor market for which there is only one employer. Oligopsony models also involve the conventional notion of market power. Under oligopsony, the major employers are relatively few in number and together account for a large percentage of the total amount of labor hired in the market. The following are less traditional reasons why labor supply to individual firms might have an upward slope:

1) In classic differentiation models, firms are heterogeneous in relation to one or more characteristics that are important to workers (for example, location or working conditions), and workers have heterogeneous preferences over these characteristics.
2) After a job seeker becomes employed at a particular firm, the worker might develop firm-specific skills, and costs associated with changing employers will exist. These facts result in the possibility of post-hiring exploitation.
3) Both workers and firms lack perfect information and must incur search costs. Optimization by individual agents must take into account such costs.
4) If firms suffer diseconomies of scale in relation to the monitoring of worker performance, then as more workers are hired, the firm might need to increase the wage to maintain an appropriate penalty for shirking.[4]

Presented here are examples that involve monopsony in the labor market and competition in the output market. Except for the first example, the source of monopsony power in these examples falls mainly into the conventional market power category.

For the U.S., one modern example involves the labor market for tipped restaurant servers (the output market is at least monopolistically competitive). The argument here is taken from Wessels [1997]. For the most part, tips are calculated as a certain percentage of a meal's price (provided that the quality of service is within reasonable bounds). Suppose a restaurant considers hiring more servers and assume that the demand curve for its output is given (does not shift). If the restaurant hires more servers, then each server will serve fewer meals, thus each server will earn fewer tips. Hence, when a restaurant hires more servers, it will need to increase the wage it pays (even if the labor market is competitive). Thus, the supply curve of servers to restaurants slopes up.

For the U.S., other modern examples that combine monopsony power in the labor market with competition in the output market include the sale of chicken broilers in the South, upholstered furniture, surface coal mining in the West, and other types of mining, such as molybdenum mining in Idaho.[5] Historical examples include deep-mined coal and textiles.

For developing countries, the combination of a monopsonistic labor market with a competitive output market is likely to occur with greater frequency. Examples include the production of magnetic heads for map reading in Razlog, Bulgaria, the production of heavy machinery at the industrial complex in Stalowa Wola, Poland, and the Mexican timber industry.[6]

Given monopsony power in the labor-buying market, conventional analyses assume monopoly in the output-selling market. By contrast, this present paper emphasizes the possibility that the output-selling market can be competitive. Which assumption is more applicable can only be determined case by case. It could be argued that the reality of ever-increasing international competition tends to favor the assumption of competition. McCulloch and Yellen's [1980] comment seems germane: "Monopsony and monopoly power need not coexist. A single producer...may be constrained in output markets by international competition but still free to act as a factor market monopsonist at home."

The Theoretical Model

Minimization of Average Cost

Assume inputs 1 through C are purchased competitively and that inputs $(C+1)$ through $(C+L)$ are subject to monopsony buying power (hence, $C+L$ equals the total number of inputs). For any given monopsonized input, it is assumed that the input supply curve faced by each firm is identical.

The output-selling market is competitive. As noted by Silberberg [1990], under this market structure in the long run, each firm can be viewed as minimizing average cost over the input quantities. Average cost is given as:

$$AC(I_1, \ldots, I_{C+L}, \delta) \equiv \frac{\sum_{j=1}^{C} W_j I_j + \sum_{j=C+1}^{C+L} W_j(I_j)\, I_j}{f(I_1, \ldots, I_{C+L})} \quad , \tag{1}$$

where I_j denotes the quantity of the jth input at the level of the firm; W_j denotes the price of the jth input; (δ) denotes $(W_1, \ldots, W_C)$, the vector of input prices for competitively purchased inputs; $W_j(I_j)$ denotes the inverse input supply of the jth input to each firm for $j = (C+1), \ldots, L$; and $f(I_1, \ldots, I_{C+L})$ denotes the production function of the firm. The parameters for the firm are W_j for $j = 1, \ldots, C$. Therefore, the solution to minimization of

AC in (1) is of the form $I_{j*}(W_1, \ldots, W_C) \equiv I_{j*}(\delta)$.[7] Let AC_* denote minimized average cost. Then AC_* is written as:

$$AC_*\left[I_{1*}(\delta), \ldots, I_{C+L,*}(\delta), \delta\right] \equiv \frac{\sum_{j=1}^{C} W_j I_{j*}(\delta) + \sum_{j=C+1}^{C+L} W_j\left[I_{j*}(\delta)\right] I_{j*}(\delta)}{f\left[I_{1*}(\delta), \ldots, I_{C+L,*}(\delta)\right]} \quad . \tag{2}$$

Equilibrium

Equilibrium requires that output price equal minimum average cost and that supply equal demand in the markets for the competitively purchased inputs. These are expressed as:

$$P - AC_*\left[I_{1*}(\delta), \ldots, I_{C+L,*}(\delta), \delta\right] = 0 \quad , \tag{3}$$

and

$$NI_{j*}(\delta) - S_j(W_j) = 0 \ , \quad j = 1, \ldots, C \quad , \tag{4}$$

where P denotes the price of output, N denotes the number of firms, and $S_j(W_j)$ denotes the industry supply of the jth competitively purchased input.[8]

In (3), the setting of price equal to minimum average cost ensures that price equals marginal cost. In turn, this ensures that the firm maximizes profit in relation to all of its decision variables. Consequently, separate equations for profit maximization in the input markets are not needed.[9,10] Profits and profit maximization will be considered in the third section, which makes use of a somewhat different approach.

In (3) and (4), there are $(C+1)$ equations and $(C+2)$ unknowns, namely, W_1 through W_C, N, and P. Hence, it is permissible to treat one of the unknowns as exogenous. To derive the long-run industry supply curve for output, the price of output, P, is viewed as exogenous. Hence, the solution to (3) and (4) is of the form $N_E(P)$ and $W_{jE}(P)$ for $j = 1, \ldots, C$, where the subscript E signifies an equilibrium value. Substituting these solutions back into (3) and (4) yields (5) and (6). For ease of notation, let:

$$\left[\delta_E(P)\right] \equiv \left[W_{1E}(P), \ldots, W_{CE}(P)\right] \quad .$$

Then:

$$P - AC_{*E}\left[I_{1*E}\left(\delta_E(P)\right), \ldots, I_{C+L,*}\left(\delta_E(P)\right), \delta_E(P)\right] \equiv 0 \quad , \tag{5}$$

and

$$N_E(P) I_{j*E}\left[\delta_E(P)\right] - S_j\left[W_{jE}(P)\right] \equiv 0 \ , \quad j = 1, \ldots, C \quad . \tag{6}$$

The Equality of Producer Surplus with the Rents Paid to the C Competitive Inputs

The demonstration here will show that producer surplus equals the rents paid to the C competitive inputs. In other words, producer surplus completely neglects the rents paid to the monopsonized inputs.

Let $Q(P)$ denote the long-run industry supply curve for output. To calculate producer surplus, an expression for $Q(P)$ is needed. For ease of notation, $\delta_E(P)$ will sometimes be written as δ_E. That is, the fact that δ_E is a function of P will sometimes be suppressed from this point on. Note that $f\,[I_{1*E}(\delta_E),\dots,I_{C+L,*E}(\delta_E)]$ is the minimum efficient scale of the firm in long-run equilibrium:

$$Q(P) \equiv N_E(P)\, f\left[I_{1*E}(\delta_E),\dots,I_{C+L,*E}(\delta_E)\right] \quad . \tag{7}$$

Let P^H be any price chosen on the long-run supply curve for output, and let P_{VERT} be the vertical intercept of the long-run industry supply curve for output. Then producer surplus, $PS(P^H)$ is given by:

$$PS(P^H) \equiv \int_{P_{VERT}}^{P^H} Q(P)\,dP \equiv \int_{P_{VERT}}^{P^H} N_E(P)\, f\left[I_{1*E}(\delta_E),\dots,I_{C+L,*E}(\delta_E)\right] dP \quad . \tag{8}$$

For the competitively purchased inputs, the rents paid to input j, $R_j(P^H)$, are given by:[11]

$$R_j(P^H) \equiv \int_{W_{jE}(P_{VERT})}^{W_{jE}(P^H)} S_j(W_j)\,dW_j \ , \quad j = 1,\dots,C \quad . \tag{9}$$

Now use (9) and employ the change of variables theorem.[12] For ease of notation, the fact that W_{jE} is a function of P will be suppressed:

$$R_j(P^H) \equiv \int_{P_{VERT}}^{P^H} S_j(W_{jE})\,(dW_{jE}/dP)\,dP \quad . \tag{10}$$

Identity (11) is found by using (6) and substituting for $S_j(W_{jE})$ on the right-hand side of (10):

$$R_j(P^H) \equiv \int_{P_{VERT}}^{P^H} N_E(P) I_{j*E}\left[\delta_E(P)\right](dW_{jE}/dP)\,dP \quad . \tag{11}$$

Next, use (11) and sum the rents over the competitive inputs, that is, sum the left and right sides of (11) from $j = 1$ to $j = C$:

$$
\begin{aligned}
\sum_{j=1}^{C} R_j(P^H) &\equiv \sum_{j=1}^{C} \left\{ \int_{P_{VERT}}^{P^H} N_E(P) I_{j*E}\big[\delta_E(P)\big](dW_{jE}/dP)\,dP \right\} \\
&\equiv \int_{P_{VERT}}^{P^H} \left\{ \sum_{j=1}^{C} \Big[N_E(P) I_{j*E}\big[\delta_E(P)\big](dW_{jE}/dP)\Big] dP \right\} \\
&\equiv \int_{P_{VERT}}^{P^H} \left\{ \Big[N_E(P) \sum_{j=1}^{C} I_{j*E}\big[\delta_E(P)\big](dW_{jE}/dP)\Big] dP \right\} \quad .
\end{aligned}
\tag{12}
$$

A comparison of (12) with the expression for producer surplus in (8) reveals that if (13) can be proved, then producer surplus will equal the sum of rents paid to the competitively purchased inputs:

$$
\sum_{j=1}^{C} I_{j*E}\Big[\delta_E(P)\,(dW_{jE}/dP)\Big] \equiv f\Big[I_{1*E}(\delta_E), \ldots, I_{C+L,*E}(\delta_E)\Big] \quad . \tag{13}
$$

Identity (13) can be given the following interpretation. Let $\blacktriangle P$ denote an infinitely small and given change in the price of output. Suppose each side of (13) were to be multiplied by $N_E \blacktriangle P$. Then the right-hand side of (13) can be viewed as the (graphical) change in producer surplus which results from $\blacktriangle P$. On the left-hand side of (13), let N_E be inserted inside the summation sign. The left-hand side can be viewed as the (graphical) change in the rents paid to the competitively purchased inputs which results from $\blacktriangle P$. It is next demonstrated that (13) is true, using two different methods of proof.

One Proof of (13)

For ease of exposition, (5) is repeated:

$$
P - AC_{*E}\Big[I_{1*E}\big(\delta_E(P)\big), \ldots, I_{C+L,*}\big(\delta_E(P)\big), \delta_E(P)\Big] \equiv 0 \quad ,
$$

Differentiating (5) with respect to P yields (14) (recall that $[\delta_E(P)] \equiv [W_{1E}(P), \ldots, W_{CE}(P)]$:

$$
\begin{aligned}
1 - \left\{ \sum_{j=1}^{C+L} (\partial AC_{*E}/\partial I_{j*E}) \Big[\sum_{k=1}^{C} (\partial I_{j*E}/\partial W_{kE})\,(dW_{kE}/dP) \Big] \right\} \\
- \sum_{Z=1}^{C} (\partial AC_{*E}/\partial W_{ZE})\,(dW_{ZE}/dP) \equiv 0 \quad .
\end{aligned}
\tag{14}
$$

Because the AC_{*E} function in (14) has been minimized over the input quantities, $\partial AC_{*E}/\partial I_{j*e} \equiv 0 \; \forall j$. Hence (15) follows from (14) and can be viewed as a result of the envelope theorem:

$$1 - \sum_{Z=1}^{C} (\partial AC_{*E} / \partial W_{ZE} (dW_{ZE} / dP)) \equiv 0 \quad . \tag{15}$$

Identity (16) follows simply from replacing the variables in (2) with their equilibrium counterparts:

$$AC_{*E}\left[I_{1*E}(\delta_E), \ldots, I_{C+L,*E}(\delta_E), \delta_E\right]$$
$$\equiv \frac{\sum_{j=1}^{C} W_{jE} I_{j*E}(\delta_E) + \sum_{j=C+1}^{C+L} W_{jE}\left[I_{j*E}(\delta_E)\right] I_{j*E}(\delta_E)}{f\left[I_{1*E}(\delta_E), \ldots, I_{C+L,*E}(\delta_E)\right]} \quad . \tag{16}$$

Differentiating (16) with respect to W_{ZE} (where Z is between 1 and C) yields (17). Recall that $\partial AC_{*E}/\partial I_{j*E} \equiv 0 \; \forall \, j$:

$$\partial AC_{*E} / \partial W_{ZE} \equiv I_{Z*E}(\delta_E) / f\left[I_{1*E}(\delta_E), \ldots, I_{C+L,*E}(\delta_E)\right] \quad . \tag{17}$$

Now substitute (17) into (15):

$$1 - \sum_{Z=1}^{C} \left\{I_{Z*E}(\delta_E) / f\left[I_{1*E}(\delta_E), \ldots, I_{C+L,*E}(\delta_E)\right]\right\} (dW_{ZE} / dP) \equiv 0 \quad . \tag{18}$$

Identity (13) is found by bringing the second term of (18) over to the right-hand side and multiplying both sides by f:

$$f\left[I_{1*E}(\delta_E), \ldots, I_{C+L,*E}(\delta_E)\right] \equiv \sum_{Z=1}^{C} I_{Z*E}(\delta_E)\,(dW_{ZE} / dP) \quad .$$

A Different Proof of (13)

Although a second proof is not strictly necessary, it is instructive to see how the results can be obtained through the conditions that must hold in relation to profits. Let π_{*E} denote the profits of a firm in long-run equilibrium. Then π_{*E} can be written as in (19). Again, for ease of notation, let $[\delta_E(P)] \equiv [W_{1E}(P), \ldots, W_{CE}(P)]$:

$$\begin{aligned} &\pi\left[I_{1*E}(\delta_E(P)), \ldots, I_{C+L,*E}(\delta_E(P)),\ \delta_E(P),\ P\right] \\ &\quad \equiv P\,f\left[I_{1*E}(\delta_E(P)), \ldots, I_{C+L,*E}(\delta_E(P))\right] \\ &- \sum_{j=1}^{C} I_{j*E}\left[\delta_E(P)\right] W_{jE}(P) - \sum_{j=C+1}^{C+L} I_{j*E}\left[\delta_E(P)\right] W_{jE}\left[I_{j*E}(\delta_E(P))\right] \quad . \end{aligned} \tag{19}$$

In long-run equilibrium, the profit of each firm equals zero. Identity (20) simply sets the first part of (19) identically equal to zero:

$$\pi\left[I_{1*E}(\delta_E(P))\,,\ldots,I_{C+L,*E}(\delta_E(P))\,,\delta_E(P)\,,P\right] \equiv 0 \quad . \tag{20}$$

Let ¥ denote the symbol for total derivative, and differentiate both sides of (20) with respect to *P*. This yields:

$$\begin{aligned} ¥\pi_{*E}/¥P \equiv {} & \textstyle\sum_{j=1}^{C+L}\left[(\partial\pi_{*E}/\partial I_{j*E})\left\{\sum_{k=1}^{C}(\partial I_{j*E}/\partial W_{ke})\,(dW_{ke}/dP)\right\}\right] \\ & + \textstyle\sum_{j=1}^{C}(\partial\pi_{*E}/\partial W_{jE})\,(dW_{jE}/dP) + \partial\pi_{*E}/\partial P \equiv 0 \quad . \end{aligned} \tag{21}$$

Because a firm must be maximizing profit in long-run equilibrium, it follows that $\partial\pi_{*E}/\partial I_{j*E} \equiv 0 \;\forall\, j$. Hence, (21) reduces to:

$$¥\pi_{*E}/¥P \equiv \textstyle\sum_{j=1}^{C}(\partial\pi_{*E}/\partial W_{jE})\,(dW_{jE}/dP) + \partial\pi_{*E}/\partial P \equiv 0 \quad . \tag{22}$$

Rearranging terms in (22) yields:

$$\partial\pi_{*E}/\partial P \equiv -\textstyle\sum_{j=1}^{C}(\partial\pi_{*E}/\partial W_{jE})\,(dW_{jE}/dP) \quad . \tag{23}$$

Next, substitute for some of the terms in (23). From (19), it follows that:

$$\partial\pi_{*E}/\partial P \equiv f\left[I_{1*E}(\delta_E(P))\,,\ldots,I_{C+L,*E}(\delta_E(P))\right] \quad ,$$

and

$$\partial\pi_{*E}/\partial W_{jE} \equiv -I_{j*E}\left[\delta_E(P)\right] \text{ for any } j = 1\,,\ldots,C \quad .$$

Using the results in (23) yields (13). For ease of notation, the fact that δ_E is a function of *P* will now be suppressed:

$$f\left[I_{1*E}(\delta_E)\,,\ldots,I_{C+L,*E}(\delta_E)\right] \equiv \textstyle\sum_{j=1}^{C} I_{j*E}(\delta_E)\,(dW_{jE}/dP) \quad .$$

Explanation of Results and Discussion

Explanation

Consider the process by which an upward-sloping, long-run industry supply curve for output is generated and contrast how this process works under the conventional assumptions (of competition in all markets) with how this process works under the assumptions of this present paper. Let S^{LR} denote the long-run industry supply for output and let *MIN LATC* denote the minimum long-run average total cost of the firm. In what follows, it is essential to recall that at each point, the vertical distance up to S^{LR} equals *MIN LATC*.

Assume that the price of output changes due to an exogenous change in the demand for output. This generates a change in the demand for inputs by firms. Under the conventional assumptions of competition in all markets, S^{LR} slopes upward only because of the following. First, under competition, firms perceive individual input supply curves that are horizontal. The changed demand for inputs generates a movement along industry input supply curves and changes in input prices that are not anticipated by firms. The unanticipated changes in input prices cause a shift in the horizontal individual input supply curves that are perceived by firms. Second, the unanticipated change in input prices causes the entire *LATC* curve of the firm to shift, and most importantly, this of course generates a change in *MIN LATC*.

Now consider the model herein and focus upon the input markets over which firms exert monopsony buying power. Changes in the prices of these inputs occur through movements along (not shifts of) the monopsonized input supply functions. The changes in these prices are under the conscious control of the firm and are not unanticipated. Such changes therefore do not directly result in a shift of the firm's *LATC* curve and do not directly affect *MIN LATC*. Hence, the rents in these input markets play no role in the generation of (graphical) producer surplus in the output market.[13]

An extreme example might be helpful for purposes of reinforcement. Recall that in all cases, the output-selling market is assumed to be competitive. Now assume that all inputs are subject to monopsony buying power, that is, no inputs are purchased competitively. In this case, there is only one possible *MIN LATC*.[14] In long-run equilibrium, increases in the industry quantity of output take place only through an increase in the number of firms, with each firm producing at the one possible minimum average cost. The long-run industry supply curve for output is horizontal, and producer surplus is zero. Importantly, even though producer surplus in this case equals zero, positive rents would still exist in the input markets!

Discussion

In this present model, it is implicitly assumed that when new firms enter the industry, each firm enters with monopsony buying power over one or more inputs. As previously indicated, this assumption does have real-world applicability, perhaps especially when firms are geographically separated in an international or developing country scenario. Nonetheless, it might be argued that a model with oligopsony would have more applicability to real-world situations. A few comments about this possible modification seem merited.

A modification to oligopsony would not alter the fundamental result of this present paper. Namely, if firms have buying power over one or more inputs and if an exogenous change in the demand for output does not generate unanticipated changes in input prices in these input markets, then the rents in these input markets will not contribute to (graphical) producer surplus and producer surplus will underestimate rents.

An analysis of oligopsony would be interesting in the following respect. Under some assumptions about the nature of oligopsony, an exogenous change in the demand for output would lead to unanticipated changes in input prices for those input markets in which firms have buying power. Hence, the rents in these input markets would in fact be expected to affect producer surplus. However, under oligopsony, the mechanism through which unanticipated changes in input prices occur need not be the same as when input markets are competitive. Under oligopsony, the input supply curves perceived by individual firms are not horizontal, and there is not necessarily a simple smooth (unanticipated) movement along an industry input supply curve as would be true for the conventional case in which all markets are competitive. A final complication is that under oligopsony, when considering input markets over which firms exert buying power, changes in input prices may result from a combination of both anticipated and unanticipated mechanisms.

What then will be the relationship between producer surplus and rents under oligopsony? There is no general answer, except that producer surplus and rents in general will not be equal. Preliminary work indicates that the relationship depends upon the assumptions that underlie the oligopsony, the assumptions that underlie the process of entry and exit, and possibly the specific forms of the input supply curves and the firm's production function.

Conclusions

The area above the competitive long-run industry supply curve for output and below the equilibrium price line, commonly referred to as producer surplus, has been used to help derive policy implications for a wide variety of applied microeconomic problems. For example, in any output market, consider the typical deadweight welfare loss triangle which might come about as a result of a tax. When a supply curve is present, one-half (analytically speaking) of that welfare loss is producer surplus.

In the long run, economic profits are zero. Hence, even though it is widely used, the economic significance of producer surplus in the long run is not obvious.

This present paper has demonstrated that producer surplus exactly equals the rents paid to inputs that are purchased competitively and that producer surplus fails to account for any and all rents paid to inputs which are subject to monopsony buying power. Consequently, whenever there are one or more inputs subject to monopsony buying power, total rents will exceed producer surplus. Assuming that the long-run average cost curve of the firm is U-shaped, this result holds regardless of the form of the firm's production function, the form of the input supply functions, and the number of inputs.

Footnotes

1. For many years, a debate existed over the meaning of this area for the long run. Some claimed this area had no particular meaning except under very special circumstances [Formby, 1972; Mishan, 1968, 1981]. Others argued that this area is equal to the rents paid to factors of production [Shepherd, 1970].
2. The debate in literature stemmed in part from a lack of consensus as to how rent should be defined. The appropriateness of various definitions of rent is beyond the scope of this paper.

3. For a work which indicates that monopsony power might be more prevalent than is commonly supposed, see Blair and Harrison [1993]. That work does not focus on the labor market.
4. Card and Krueger [1995] argue that many low-wage markets are characterized by monopsony power arising from these less traditional sources. Boal and Ransom [1997] state that "monopsonistic exploitation arising from supply frictions...is probably widespread but small on average."

   Certain observed phenomena in the low-wage market are difficult to explain using the standard model of competition in the labor-buying market. Such phenomena include but are not limited to the persistent wage dispersion across different firms for seemingly identical employees, the large amount of resources employers use for recruitment purposes, the existence of persistent and large numbers of vacancies, the observed positive correlation between wages and the size of the firm, and the existence of wage discrimination [Boal and Ransom, 1997; Card and Krueger, 1995, chap. 1, 5, 11].
5. The example of chicken broilers is from Rob T. Masson, and the other examples are from Barry J. Seldon. According to Masson, who worked for the Antitrust Division of the Justice Department at the time, the example of chicken broilers was valid at least until the 1970s. In this example, processors exercised monopsony power over the farmers who raised the chicks for the processors. Refer to National Broiler Marketing Association v. United States 436 U.S. 816 [1978].
6. These examples are from Iliana Ilieva, Kazamierz Dadak, and Roy Boyd.
7. Because input markets $(C+1)$ through $(C+L)$ are subject to monopsony buying power, W_{C+1} through W_{C+L} are determined endogenously. Hence, W_{C+1} through W_{C+L} are not arguments of the I_{j*} functions.
8. It is assumed that the input supply functions of the competitively purchased inputs are independent of one another and independent of the input supply functions subject to monopsony buying power. Interdependence is permitted among the input supplies subject to monopsony buying power.
9. The statement applies when all inputs are purchased competitively and when (as herein) some inputs are subject to monopsony buying power. The only salient difference between the two cases pertains to the definition of marginal cost. This note explains how the definition of marginal cost would be different when some inputs are subject to monopsony buying power and can be omitted with no loss of continuity.

   Let Q denote the firm's quantity of output. The problem for the firm in minimizing total cost is shown as follows:

$$\text{minimize} \left[\sum_{j=1}^{C} W_j I_j + \sum_{j=C+1}^{C+L} W_j(I_j) I_j\right] \text{ subject to } f(I_1, \ldots, I_{C+L}) = Q \quad .$$

   Again, let $\delta \equiv (W_1, \ldots, W_C)$. The solution to the problem would be of the form $I_{j*}(\delta, Q)$ for $j = 1, \ldots, (C+L)$. Hence, the optimal total cost function would be of the following form. For ease of notation, let I_{j*} (in this footnote only) denote $I_{j*}(\delta, Q)$:

$$TC_*(\delta, Q) \equiv \left[\sum_{j=1}^{C} W_j I_{j*} + \sum_{j=C+1}^{C+L} W_j(I_{j*}) I_{j*}\right] \quad .$$

   Marginal cost of course is the derivative of the optimal total cost function with respect to Q, that is, $MC(\delta, Q) \equiv \partial TC_*/\partial Q$. From the form of TC_*, it follows that marginal cost in the current case allows for the prices of the monopsonized inputs to change. By contrast, when all inputs are purchased competitively, the definition of marginal cost holds all input prices constant.

10. The following is another way to be convinced that equations for profit maximization in the input markets are not needed. Suppose the equations below were added to the model. Here, P is the price of output, MP_j is the marginal product of the jth input, MIC_j is the marginal input cost of the jth input, and the * between P and MP denotes multiplication:

$$P * MP_j\left[I_{1*}(\delta), \ldots, I_{C+L,*}(\delta)\right] - W_j = 0 \quad \text{for} \quad j = 1, \ldots, C \quad ,$$

and

$$P * MP_j\left[I_{1*}(\delta), \ldots, I_{C+L,*}(\delta)\right] - MIC_j\left[I_{j*}(\delta)\right] = 0 \quad \text{for} \quad j = (C+1), \ldots, (C+L) \quad .$$

Incorporation of these equations into the model would have no effect on the subsequent analysis. The equations listed in the body of the paper are necessary conditions for equilibrium, and if the conditions of the implicit function theorem are satisfied, then it is logically permissible to proceed with fewer than the total number of necessary conditions (assuming that such a procedure yields meaningful results). It can also be observed that if the equations in this footnote were incorporated into the model, then technically the system would be left with more equations than unknowns.

11. This present paper focuses on one industry and can be viewed as reflecting what would happen in a world with only one output market. Suppose one or more other output markets also employ input j. Then technically, $R_j(P^H)$ gives only a fraction of the total rents earned by input j, namely, that fraction due to employment by the output market under consideration.
12. For an explanation of the change of variables theorem, see Marsden [1974].
13. A shift in monopsonized input supply functions does not occur unless there is a change in a relevant nonprice parameter, such as technology or the weather. A shift in monopsonized input supply functions would generate a shift in the firm's *LATC* curve and hence a change in *MIN LATC*.
14. Of course, this statement assumes that other relevant parameters remain constant. Other relevant parameters include the technological parameters of the production function and the (nonprice) parameters of the input supply functions.

References

Babcock, Bruce A.; Foster, William E. "Economic Rents Under Supply Controls with Marketable Quota," *American Journal of Agricultural Economics*, August 1992, pp. 630-7.

Blair, Roger D.; Harrison, Jeffrey L. *Monopsony: Antitrust Law and Economics*, Princeton, NJ: Princeton University Press, 1993.

Boal, William M.; Ransom, Michael R. "Monopsony in the Labor Market," *Journal of Economic Literature*, March 1997, pp. 86-112.

Boyd, Roy; Krutilla, Kerry. "Controlling Acid Deposition: A General Equilibrium Assessment," *Environmental and Resource Economics*, 2, 1992, pp. 307-22.

Card, David; Krueger, Alan B. *Myth and Measurement: The New Economics of the Minimum Wage*, Princeton, NJ: Princeton University Press, 1995.

Constantine, John H.; Alson, Julian M.; Smith, Vincent H. "Economic Impacts of the California One-Variety Cotton Law," *Journal of Political Economy*, October 1994, pp. 951-74.

Formby, John P. "A Clarification of Rent Theory," *Southern Economic Journal*, January 1972, pp. 315-24.

Frasco, Gregg P. "Rents, Producer Surplus, and the Long-Run Industry Supply Curve," *Southern Economic Journal*, April 1994, pp. 989-94.

Fuglie, Keith O. "Measuring Welfare Benefits from Improvements in Storage Technology with an Application to Tunisian Potatoes," *American Journal of Agricultural Economics*, February 1995, pp. 162-73.

Hazilla, M.; Kopp, R. "Social Cost of Environmental Quality Regulations: A General Equilibrium Analysis," *Journal of Political Economy*, 98, 1990, pp. 853-73.

Helmberger, Peter; Rosine, John. "Measuring Producer's Surplus," *Southern Economic Journal*, April 1980, pp. 1175-9.

Kalt, Joseph P. "Exhaustible Resource Price Policy, International Trade, and Intertemporal Welfare," *Journal of Environmental Economics and Management*, September 1989, pp. 109-26.

Marsden, Jerrold E. *Elementary Classical Analysis*, San Francisco, CA: W. H. Freeman, 1974.

Martin, Will; Alston, Julian M. "Producer Surplus Without Apology? Evaluating Investments in R&D," *Economic Record*, June 1997, pp. 146-58.

McCulloch, Rachel; Yellen, Janet L. "Factor Market Monopsony and the Allocation of Resources," *Journal of International Economics*, May 1980, pp. 237-47.

Mishan, E. J. "Rent as a Measure of Welfare Change," *American Economic Review*, June 1959, pp. 386-94.

__. "What is Producer's Surplus?," *American Economic Review*, December 1968, pp. 1269-82.

__. *Introduction to Normative Economics*, New York, NY: Oxford University Press, 1981.

Posner, Richard A. "The Social Costs of Monopoly and Regulation," *Journal of Political Economy*, August 1975, pp. 807-27.

Shepherd, A. Ross. "Economic Rent and the Industry Supply Curve," *Southern Economic Journal*, October 1970, pp. 209-11.

Silberberg, Eugene. *The Structure of Economics: A Mathematical Analysis*, New York, NY: McGraw-Hill, 1990.

U.S. Supreme Court. *National Broiler Marketing Association v. United States, 436 U.S. 816*, 1978.

Walters, Steven J. K. *Enterprise, Government, and the Public*, New York, NY: McGraw-Hill, 1993, pp. 40-2, 57-9, 419-21, 426-30, 456-8.

Wessels, Walter John. "Minimum Wages and Tipped Servers," *Economic Inquiry*, April 1997, pp. 334-49.