Producer Welfare and the Preference for Price Stability

Andrew Schmitz, Haim Shalit, and Stephen J. Turnovsky

The last few years have witnessed a phenomenal increase in price instability for final goods produced and consumed as well as inputs into production processes. As a result, an extensive literature has developed analyzing the welfare consequences of price stabilization brought about by buffer stock activities. This discussion has focused on the distribution of gains between producers and consumers as well as on the overall benefits to the economy. (For a recent survey of this literature, see Turnovsky 1978.) Much of the theoretical basis for the empirical work on the effects of stabilization policies appeared in the seminal papers by Waugh and Oi. Waugh examined the welfare effects of price instability on consumers while Oi addressed the issue of whether or not producers prefer price instability. For policy makers, the conclusion reached by Oi that producers prefer price instability to stability is somewhat disturbing because most policies—especially those in agriculture—have been aimed at creating price stability.

Recently, Tisdell (1978) extended Oi's analysis in two directions. First, he has shown that precisely the same conclusions hold with respect to instability in input prices. Moreover, under the same conditions to those assumed by Oi for the single-product case, commodity price instability (either in outputs or inputs) raises the expected profit of a multicommodity firm. Thus, the thrust of these contributions is to suggest that, insofar as producers are concerned with expected profit, they will prefer price instability—a result which greatly weakens the argument that producers should support price stabilization policies or any form of marketing arrangement where "pooled pricing" is used.

The purpose of this paper is to generalize the conditions under which producers prefer price stability. A single-product firm is first considered, and results are obtained, opposite to those of Oi, which show that a producer may prefer stability to price instability. Furthermore, this paper explores the welfare implications of price instability for a multiproduct firm, to determine whether or not a theoretical argument can be made that a firm engaged in the production of more than one type of commodity may prefer price stability for some of the commodities it produces but not for the entire set. Unlike in the Tisdell results, the findings in this paper show that a firm may prefer price stability in some products but not in others.

The firm is assumed to maximize its expected utility from profits rather than simply expected profits. The motivation for this assumption is rooted in the fact that every firm faces the possible hazard of a decline in profits that can lead to bankruptcy. Thus, instead of using the criterion of maximum expected present value of profits, over a finite or infinite planning horizon, one could provide a static approximation in the form of maximum expected utility. Then, the concept of risk aversion in the static expected utility maximization model emanates from recognition of the costs of profit variability due to price instability in the dynamic expected profit maximization model.[1] Furthermore, if the decision maker is subjectively risk-averse because of future variable profits, the utility maximization criterion is more than justified. Indeed, it is often argued in the practical stabilization literature that such producers are more concerned with the stability of their earnings than with the expected level, reflecting an attitude of risk aversion. In this case, the expected profit criterion which, in effect, assumes risk neutrality will be an inadequate measure of welfare. Accordingly, the purpose of the present paper is to reassess the benefits to producers from price stabilization in terms of a more general utility function of profits, a procedure used previously by authors in other related contexts (Sandmo, Leland). In doing so, the Oi analysis is generalized with respect to the single product and multiproduct firm.

Single-Product Case

Consider a firm that maximizes its expected utility from profits $E[U(\pi)]$. U is a Von Neumann-Morgenstern utility function assumed to be twice differentiable. It is assumed $U'(\pi) > 0$, reflecting the positive marginal utility of profit, while $U''(\pi) \gtrless 0$, depending upon whether the firm is risk-averse or risk-preferring. (Throughout this paper, the convention of denoting partial derivatives by appropriate subscripts and letting primes denote total derivatives shall be followed.) The profit π is derived from the production process,

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[1] We are grateful to a referee for suggesting this interpretation.

(1) $y = f(\mathbf{x}_1, \ldots, \mathbf{x}_n) \quad f_i > 0, f_{ii} < 0,$

where $i = 1, \ldots, n$, f is a concave production function, $\mathbf{x} = \mathbf{x}_1, \ldots, \mathbf{x}_n$ is a vector of inputs, and y is the (single) output. The firm operates in a competitive environment and cannot influence the price of output or the price of inputs.[2] The prices of inputs are denoted by $w = (w_1, \ldots, w_n)$, while the price of output is p. These are assumed to be random variables with known probability distributions having means $E(w_i) = \bar{w}_i$, $E(p) = \bar{p}$, and a finite variance-covariance matrix. We assume, as did Oi, that the firm's decisions are always executed *ex post,* implying that, once the prices are known, the firm can adjust its inputs so as to maximize its profit. Thus, the firm more properly can be described as operating in a world of price variability rather than price uncertainty as assumed by Tisdell (1963), Sandmo, Leland, and Turnovsky (1973), among others. But the present assumption here is the one generally adopted throughout the stabilization literature. The question to be considered is whether or not the firm prefers unstable prices to prices stabilized at their arithmetic means. In this section, it will be assumed that only one price at a time is variable.

To answer the question, the firm's optimization problem must be considered, which is to

$$\max U(\pi)$$

(2) $$\text{subject to } \pi = pf(\mathbf{x}) - \sum_{i=1}^{n} w_i\mathbf{x}_i.$$

The first-order conditions for a maximum are

(3) $$pf_i(\mathbf{x}) - w_i = 0,$$

where $i = 1, \ldots, n$, where the second-order conditions are that the matrix $F = (f_{ij})$ be negative definite and are automatically satisfied by the assumption of concavity of f.

Solving (3), the optimal values of inputs and associated output are

(4) $$\mathbf{x}_i = \phi^i(p, w_1, \ldots, w_n)$$
$$y = \psi(p, w_1, \ldots, w_n),$$

where $i = 1, \ldots, n$. Substituting (4) into π, the firm's utility resulting from its optimal decisions are

(5) $$U[\pi] = U\left[p\psi(p, w_1, \ldots, w_n) - \sum_{i=1}^{n} w_i\phi^i(p, w_1, \ldots, w_n)\right]$$
$$\equiv V(p, w_1, \ldots, w_n).$$

The function $V(p, w) = V(p, w_1, \ldots, w_n)$, which expresses the producer's utility in terms of the prevailing output and input prices, provides the basis for analyzing the benefits from stabilization.[3] Specifically, Jensen's inequality will be used, which asserts that $EV(p, w) \gtrless V(\bar{p}, \bar{w})$, as V is convex or concave in the relevant prices. That is, the producer's welfare will be determined from the price stabilization program in terms of the convexity/concavity properties of $V(p, w)$.

Suppose that the only variable price is p, with factor prices being nonstochastic and remaining fixed at their arithmetic means. According to Jensen's inequality, the firm will lose (gain) from having p stabilized at its arithmetic mean as $\partial^2V/\partial p^2 >$ (<) 0. The second derivative of (5) with respect to p, taking into consideration that $\mathbf{x}_i$ is implicitly a function of p through (4), yields

(6) $$\frac{\partial^2 V}{\partial p^2} = U' \frac{\partial y}{\partial p} + U''y^2.$$

With some manipulation, (7) can be rewritten to give the criterion

$$\text{sgn}\left(\frac{\partial^2V}{\partial p^2}\right) = \text{sgn}\left[\left(\frac{\mu}{1 + \mu}\right)\epsilon - r\right],$$

where $\epsilon = \frac{\partial y}{\partial p}\frac{p}{y}$, price elasticity of supply, which by virtue of (4) is positive; $r = \frac{-\pi U''}{U'}$, Arrow-Pratt measure of relative risk aversion (see Arrow and Pratt); and $\mu = (py - \sum_i w_i\mathbf{x}_i)/\sum_i w_i\mathbf{x}_i$, profit margin, as measured by profit to cost ratio. Thus, in general, whether or not producers prefer price instability depends upon three parameters: (*a*) the price elasticity of supply, (*b*) the profit margin μ, and (*c*) the coefficient of relative risk aversion r.

If firms are risk-neutral, the criterion (7), and also (6), depend solely on the slope of the supply curve; and as long as this is positive, it will ensure that firms prefer price instability. This, of course, was the basis of the Oi results which will continue to hold if firms are risk takers ($r < 0$). However, if firms are risk-averse, their preference for instability may cease to apply. Indeed, as the degree of relative risk aversion increases, so does the firm's preference for stability over instability. On the other hand, the firm's preference for instability increases with both the profit margin μ and the supply elasticity ϵ. For plausible parameter values, (7) could in fact be of either sign. For example, if the firm's utility function is logarithmic so that $r = 1$ and the profit margin is, say, 20%, so that $\mu = 0.2$, the preference for risk will apply if and only if the elasticity of supply $\epsilon > 6$.

[2] By treating prices as exogenous, this analysis (like the Oi analysis) is only a partial equilibrium one. A complete general equilibrium analysis would require us to endogenize prices, explaining their random movements in terms of stochastic shifts in production and preferences. This analysis does not address itself to the welfare implications for consumers.

[3] The function V is the analogue to the consumer's "indirect utility function," which has proven to be useful in analyzing similar problems for consumers; see, for example, Turnovsky, Shalit, and Schmitz.

Multiproduct Firm

Consider now a multiproduct, multi-input firm as developed within a deterministic context by Pfouts and Henderson and Quandt. The firm now produces m outputs, the prices of which $p = p_1, \ldots, p_m$ are random and uses n inputs, the prices of which $w = w_1, \ldots, w_n$ are also random. As in the single output case, all of these prices are assumed to be known prior to production decisions.

The production process of the firm producing m outputs from n inputs is characterized by the transformation function,

$$(8) \qquad H(y_1, \ldots, y_m, x_1, \ldots, x_n) = 0,$$

where H is assumed to be twice differentiable. It is assumed that H is written in such a way that the partial derivatives with respect to outputs y_j are normally positive, while those for inputs x_i are normally negative.

Thus, the firm's objective is now to max $u(\pi)$. where

$$(9) \qquad \pi = \sum_{j=1}^{m} p_j y_j - \sum_{i=1}^{n} w_i x_i,$$

subject to the production transformation process as expressed by (8). Constructing the Lagrangean expression

$$(10) \quad L \equiv U\left[\sum_{j=1}^{m} p_j y_j - \sum_{i=1}^{n} w_i x_i\right] + \lambda H(y_1, \ldots, y_m, x_1, \ldots, x_n),$$

the first-order conditions for a maximum are

$$(11a) \qquad U'(\pi)p_j + \lambda \frac{\partial H(\cdot)}{\partial y_j} = 0,$$

where $j = 1, \ldots, m$,

$$(11b) \qquad -U'(\pi)w_i + \lambda \frac{\partial H}{\partial x_i} = 0,$$

where $i = 1, \ldots, n$, together with (8) above, where λ denotes the Lagrange multiplier.

The second-order conditions require that the principal minors of the bordered Hessian matrix alternate in sign.

Solving the first-order conditions, the following solutions for the optimal inputs and outputs are obtained:

$$(12) \qquad \begin{aligned} x_i &= \phi^i\,(p, w) \\ y_j &= \psi^j\,(p, w) \end{aligned}$$

where $i = 1, \ldots, n, j = 1, \ldots, m$. Substituting (12) into π and into the firm's utility function, we derive the multiproduct analogue of (5), namely,

$$(13) \quad U[\pi] = U\left[\sum_{j=1}^{m} p_j \psi^j\,(p, w) - \sum_{i=1}^{n} w_i \phi^i\,(p, w)\right] \equiv V(p_1, \ldots, p_m, w_1, \ldots, w_n).$$

Expression (13) provides the basis for evaluating the desirability of price stabilization for a multiproduct firm.

For expositional ease, consider the important case where only one of the commodity prices is stabilized. Whether or not producers benefit from having the price p_j stabilized at its mean depends upon the convexity/concavity properties of V in terms of p_j. Following the same procedure used in the case of a single-output firm, it can be seen that

$$(14) \quad \operatorname{sgn}\left[\frac{\partial^2 V}{\partial p_j^2}\right] = \operatorname{sgn}\left[\left(\frac{\mu}{1+\mu}\right)\frac{\epsilon_j}{\alpha_j} - r\right],$$

where $\epsilon_j = \dfrac{\partial y_j}{\partial p_j}\dfrac{p_j}{y_j}$, elasticity of supply of good with respect to its own price, $\alpha_j = p_j y_j \Big/ \sum_{j=1}^{m} p_j y_j$, share of total revenue contributed by good j, and μ measures the profit margin, as defined above.

The comments made previously with respect to ϵ_j, μ, and r in connection with the single-product firm continue to apply. The interesting difference to note is that now, whether or not a firm prefers price instability with respect to a single commodity of the many it produces depends, in addition, upon the share of the total revenue contributed by this commodity. Thus, the rather strong conclusion can be drawn that a risk-averse firm may prefer instability in some of the markets for its products and not in others. However, as (14) shows, the firm is more likely to prefer price instability in those products that contribute a relatively small proportion to its total revenue.

To give the above result some real-world significance, consider the Australian and Canadian case of marketing wheat. In both countries, marketing boards are the sole sellers of wheat abroad, and the prices received by producers for a given crop year are pooled, such that each producer receives the same price regardless of when during the year the product is sold. (Interestingly, such a system also has been suggested for the United States.) However, in Canada, for crops such as flax and rapeseed, prices fluctuate on a daily basis because these are sold through the Winnipeg Commodity Exchange and not through the Board. Thus, for those crops, the timing of sales is crucial for producers. While producers generally support the Canadian Wheat Board in the marketing of wheat, recently a vote was taken among grain producers to determine if they also wanted a similar marketing system for other crops. The answer was no, and they argued that price stability through pooling was already created for the major crop, wheat, and that they wanted instability in nonmajor crops.

Conclusions

The results of this paper show that, for a multiproduct firm, stability may be preferred for some of the products produced but not for others. Also, for a single-product firm, price stability may be preferred to price instability. These results, given the assumptions on which they are based, lend at least some support to price stabilization policies. It was shown by Massell and Samuelson that society cannot be made better off by manufacturing price instability once both consumers and producers are taken into account. The results in this paper suggest that stability may be preferable even without considering explicitly the consuming sector.

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