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THE WELFARE IMPLICATION OF PRICE STABILIZATION AND RISK AVERSION

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The desirability of price stabilization has long been debated among economists. Much of the discussion has taken place in the context of agricultural commodities where random fluctuations in both demand and supply can be particularly important. In broad terms one can trace out two parallel sets of analyses.

On the one hand, originating with Waugh is the proposition that consumers having a downward sloping demand curve and facing random prices due to stochastic fluctuations in supply are better off than if these prices were stabilized at their means. Using a similar argument, some years later Oi demonstrated that firms having a given upward sloping supply curve and facing random selling prices arising from stochastic shifts in demand will also lose from having these prices stabilized at their means.

These two approaches considered the welfare of one group only, ignoring the effects the price stabilization scheme may have on the other. As a consequence, more recently Massell has integrated these two analyses within the framework of a linear model, obtaining a number of interesting results.

For example, while his model confirm the Oi result, he also shows that if the random price is due to fluctuations in supply then producers will in fact benefit from price stabilization. Second, when both producers and consumers are taken into account simultaneously, price stabilization will always improve total welfare, even though one group may be adversely affected. Hence overall, price stabilization is to be preferred.

A key aspect of the Waugh-Oi Massell analyses is the assumption that producers and consumers are risk neutral, in the sense that their underlying utility function is linear in profit or surplus. This is clearly restrictive, and authors such as Schmitz, Shalit and Turnovsky recognize the costs of profit variability due to price instability and use expected utility as a decision criteria rather than expected profit or surplus. They show that the results of Waugh and Oi are not necessarily true and prove that preferences for the stabilization depend on the coefficient of relative risk aversion. Even if the source of instability arise from the fluctuation in demand (supply),

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producers (consumers) gain from price stabilization when they are highly risk averse.

But their analyses are too implicit and qualitative in its nature that one cannot analyze how a price stabilization policy has effects on producers expected profit and its variance. We need more quantitative effects of a stabilization scheme for the derivation of an optimal stabilization policy.

The purpose of this paper is to consider the welfare effects for both producers and consumers using well known mean-variance analysis and to derive optimal stabilization policy under some specific assumptions.

I. The Waugh-Oi Massell Model

Consider a competitively priced commodity market in which demand and supply are described by the linear relations.

(1) $S = \alpha p + x \qquad \alpha > 0$

(2) $D = -\beta p + y \qquad \beta > 0$

Where D = quantity demanded, S = quantity supplied, p = price, and α, β = constants, and x and y jointly distributed random variables with means μ_x and μ_y and finite variances σ_x^2 and σ_y^2 respectively and to have zero covariance. This last assumption means that the random shifts in the demand and supply schedules are independent of one another. In the case of agricultural commodities, there are typical shifts in supply because of factors related to the weather, which are unrelated to the factors influencing demand such as changes in income and tastes.

In the absence of price stabilization, the equilibrium price and quantity traded will be

(3) $p = (y - x)/(\alpha + \beta)$

(4) $q = (\alpha_y + \beta_x)/(\alpha + \beta)$

(5) $\mu_p = (\mu_y - \mu_x)/(\alpha + \beta)$

(6) $\sigma_p^2 = (\sigma_y^2 + \sigma_x^2)/(\alpha + \beta)^2$

Consider that the mean price; μ_p, is known, and that a decision is made to eliminate price fluctuations by establishing a buffer stock authority that is willing to buy or sell at μ_p. Stocks held by the authority are stored at zero cost.

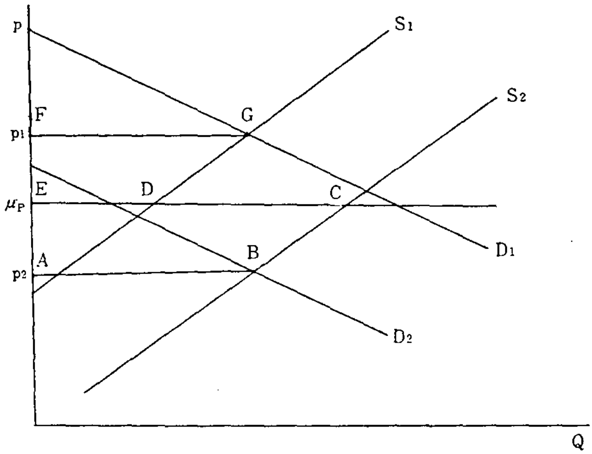
Measuring producers' welfare by the expected value of producers' surplus(profit), producers lose $DEFG$ when supply and demand are S_1 and D_1 and gain $ABCE$ when supply and demand are D_2 and S_2 respectively in Figure[1].

Algebraically, letting G_p the gain to producers, we can write

(7) $G_p = \frac{1}{2}(\mu_p - p)\ [S(p) + S(\mu_p)]$

Taking expectation over x and y after substituting (1), (3) and (5) into (7).

FIGURE 1



(8) $\quad E(G_p) = [(2\alpha + \beta)\sigma_x^2 - \alpha\sigma_y^2]/2(\alpha + \beta)^2$

Similarly, consider the effect of price stabilization on consumer welfare, also measured as the expected value of the change in consumer surplus. Denoting the gain from price stabilization by G_c; we can write

(9) $\quad E(G_c) = [(2\alpha + \beta)\sigma_y^2 - \beta\sigma_x^2]/2(\alpha + \beta)^2$

Furthermore, assuming that total welfare effect can be adequately measured by the sum of the expected value of producers' and consumers' surplus, the total expected gain, $E(G)$ is,

(10) $\quad E(G) = E(G_p) + E(G_c) = (\sigma_y^2 + \sigma_x^2)/2(\alpha+\beta)$

If we substitute (5) into (10)

(11) $\quad E(G) = [(\alpha + \beta)/2]\sigma_p^2$

We can derive principal conclusions of Massell from (8), (9), (10), and (11):

1) Producers lose (gain) from price stabilization if the source of price instability is random shifts in demand (supply).
2) Consumers lose (gain) from price stabilization if the source of price instability is random shifts in supply (demand).
3) Where both demand and supply are random, the gains to each group are indeterminate and depend upon the relative sizes of the variances σ_x^2 and σ_y^2, and upon the slopes of the demand and supply curves.
4) The total gains from stabilization are always positive, with the gainer in principle being able to compensate the losers.
5) The total gains from stabilization are greater the greater the degree ofprice instability.

II. Utility Maximizing Approach

In his model, Massell ignores the effect of price stabilization on the variance of the variable involved by the assumption that individuals are indifferent to risk.

But the producers (consumers) must be assumed to maximize its expected utility from profit (surplus) rather than simply expected profits (surplus). If the decision maker is subjectively risk-averse (risk taker) because of future variable profits, we should consider the cost (benefit) of variability of future income or surplus as he is risk averse or risk taker.

Thus we need to reassess the benefits to producers and consumers from price stabilization in terms of a more general utility function approach. A recent study by Schmitz, Shalit, and Turnovsky has suggested utility maximizing approach in the evaluation of the effects of price stabilization. Focusing on consumers and producers separately, in each case they treat prices exogeneous and does not attempt to integrate them, their models are partial-equilibrium approaches. I will introduce their model for the producers and consumers one after another.

1. In Case of Producers

Consider a firm that maximizes its expected utility from profit $E[U(\pi)]$, where U is a Von Neumann Morgen stern utility function, $\partial^2 U/\partial\pi^2 < 0$, $\partial^2 U/\partial\pi^2 > 0$ and $\partial^2 U/\partial\pi^2 = 0$ depending upon a producer is risk averse or risk preferring and risk neutral. The question to be considered is whether or not producers prefer unstable prices to prices stabilized at their arithmetic means.

The producers' optimization problem is to

$$\text{Max } U(\pi)$$

$$\text{(12)} \qquad \text{subject to } \pi = pf(x) - \sum_{i=1}^{n} w_i x_i$$

where $y = f(x)$ is a concave production function, $x = x_1, \ldots, x_n$ is a vector of inputs, $w = w_1, \ldots, w_n$ is a vector of input prices and p denotes output price.

The first-order conditions for a maximum are

$$\text{(13)} \qquad p f_i(x) - w_i = 0$$

Solving (13), the optimal values of inputs and associated output are

$$\text{(14)} \qquad \begin{aligned} x_i^* &= \phi^i(p, w_1, \ldots, w_n), \; i = 1,2,\ldots,n \\ y^* &= \phi(p, w_1, \ldots, w_n) \end{aligned}$$

Substituting (14) into π, the firm's utility resulting from its optimal decisions are

$$(15) \qquad U(\pi) = U\left[p\phi(p, w_1, \ldots, w_n) - \sum_{i=1}^{n} w_i\phi^i(p, w_1, \ldots, w_n)\right] \equiv V(p, w_1, \ldots, w_n)$$

Suppose that the only variable price is p, with factor prices being non-stochastic and remaining fixed at their arithmetic means. According to Jensen's inequality which asserts that $EV(p, w) \gtrless V(\bar{p}, \bar{w})$ as V is convex or concave in the relevant prices, producers will lose (gain) from having p stabilized at its arithmetic mean as $\partial^2 V/\partial p^2 \gtrless 0$. The second derivative of (15) with respect to p yields[1]

$$(16) \qquad \frac{\partial^2 V}{\partial p^2} = U' \frac{\partial y}{\partial p} + U'' y^2$$

After some arrangement (16) can be rewritten:

$$(17) \qquad \frac{\partial^2 V}{\partial p^2} = \frac{U'y^2}{\pi}\left(\frac{\pi}{py} \cdot \frac{p}{y} \cdot \frac{\partial y}{\partial p} \cdot \frac{-\pi U''}{U'}\right) = \frac{U'y^2}{\pi}(\mu \cdot \epsilon - r)$$

where $\epsilon = \frac{p}{y} \cdot \frac{\partial y}{\partial p}$, price elasticity of supply, which is positive

$\mu = \frac{\pi}{py}$, proportion of profit to the total revenue

$r = \frac{-\pi U''}{U'}$, the degree of relative risk aversion.[2]

The sign of equation (17) which depends upon the sign and size of the parameter μ, ϵ and r is indeterminate. If a producer is risk neutral ($r = 0$), it will ensure that firms prefer price instability $\left(\frac{\partial^2 V}{\partial p^2} > 0\right)$ which was the result of Oi. However if a producer is risk averse ($r > 0$) and further he is highly risk averse the sign of $\frac{\partial^2 V}{\partial p^2}$ may be negative, a producer prefer price stability to instability. The results suggest that price stabilization may be preferable even without considering explicitly the consumer sector and even though the source of instability comes from demand side.

2. In Case of Consumers

Similar analyses can be done for the consumers whether they prefer unstable prices to prices at their arithmetic means. We begin with the formal consumers' maximization problem, that is

[1] $\frac{\partial V}{\partial p} = \frac{\partial U}{\partial \pi}\left[y + p\sum_{i=1}^{n}\frac{\partial y}{\partial x_i}\frac{\partial x_i}{\partial p} - \sum_{i=1}^{n} w_i \frac{\partial x_i}{\partial p}\right] = \frac{\partial U}{\partial \pi} \cdot y$ or $U'y$
$\because \; pf_i(x) - w_i = 0$ by (13).

[2] The degree of relative risk aversion is the elasticity of the marginal utility of income with respect to income, i.e., $r = (dU'/U')/(dy/y)$. The faster marginal utility falls, the more risk aversion.

(18) $$\text{Max } U(c_1, \ldots, c_m)$$

$$\text{s.t.} \sum_{i=1}^{m} p_i c_i = M$$

where $c_1, \ldots, c_m$ are consumer goods, $p_1, \ldots, p_m$ are their prices and y is budget constraint.

The first order conditions are

(19) $$U_i = \lambda p_i \qquad i = 1, \ldots, m$$

$$\sum_{i=k}^{m} p_i c_i = M$$

Solving (19), the optimal quantity of demanded are

(20) $$c_i^* = c_i\,(p_1, \ldots, p_m, M) \quad i = 1, \ldots, m$$

Substituting (20) into (18), the consumers' utility resulting from its optimal decisions are

(21) $$\begin{aligned} U(c_1, \ldots, c_m) &= U\, c_1(p_1, \ldots, p_m, M), \ldots, c_m(p_1, \ldots, p_m, M) \\ &= V(p_1, \ldots, p_m, M) \end{aligned}$$

Supposing that commodity 1 has a random selling price, the effect of stabilizing at its arithmetic mean $\bar{p}_1$ on the welfare of the consumer, once again, depends upon the sign of $\partial^2 V/\partial p_1^2$ just as is the producers' case. It can be shown that the sign of $\partial^2 V/\partial p_1^2$ is determined by[3]

(22) $$\text{sgn}\left(\frac{\partial^2 V}{\partial p_1^2}\right) = \text{sgn}\left[\frac{x_1 \partial U/\partial M}{p_1}\,(s_1(n_1 - r) - e_1)\right]$$

where $r = -\,U''M/U'$ = the degree of relative risk aversion.
$s_1 = p_1c_1/M$ share of consumers' budget allocated to commodity 1.
$e_1 =$ own uncompensated price elasticity of demand for commodity 1.
$n_1 =$ income elasticity of demand for commodity 1.

[3] By the fundamental duality properties the demand functions to be expressed in terms of indirect utility function as follows

(a) $$x_i = -\frac{\partial V/\partial p_i}{\partial v/\partial M} = -\frac{\partial V/\partial p_i}{\lambda}$$

differentiating (a) *w.r.t.Y* yields

(b) $$\frac{\partial^2 V}{\partial Y \partial p_i} = -\frac{\partial^2 V}{\partial M^2} x_i - \frac{\partial V}{\partial M} \cdot \frac{\partial x_i}{\partial M}$$

Differentiate both sides of (a) for $i = 1$, with respect to p_1

(c) $$\frac{\partial^2 V}{\partial p_1^2} = \frac{-\partial^2 V}{\partial M \partial p_i} x_1 - \frac{\partial V}{\partial M} \cdot \frac{\partial x_1}{\partial p_1}$$

Substitute (b) into (c) and make some arrangements,

$$\frac{\partial^2 V}{\partial p_1^2} = \frac{x_1 \partial V/\partial M}{p_1}\,[S_1(n_1 - r) - e_1]$$

It follows that it is certainly possible for $\partial^2 V/\partial p_1^2 < 0$ (in which case the consumer gains from price stabilization contrary to the Waugh proposition). As a consumer become highly risk averse (positive large value of r) for the given value s_1, n_1, and e_1, the sign of $\partial^2 V/\partial p^2$, will be negative, in which case consumer prefer price stability.

III. Mean Variance Analysis

The utility maximizing approach which was analyzed in the last section has several shortcomings. First, since it is such qualitative in its character that we can only predict a consumer or producers' preferences for the price stabilization. Thus we do not know the degree with which a specific stabilization scheme affects on the welfare of consumers and producers. We need to compare several alternative stabilization schemes and to derive optimal policy. Second, since in each case it treats prices as exogeneous—focusing on consumers and producers separately—and does not attempt to integrate them, it is a partial-equilibrium approach. A complete general equilbrium analysis would require us to endogenize prices, explaining their random movements in terms of stochastic shifts in production and preferences. Finally, the preceding models assume that μ_p is known and the authorities stabilize perfectly for any random disturbances. But actually the authorities just reduce the variance of price variability. Thus with such model, we cannot analyze the more general stabilization policies.

I suggest mean variance analysis which will overcome above shortcomings and consider validity of this approach. Next I set up a model for the implication of some price stabilization policies.

It would obviously be convenient if we could describe attitudes to price stabilization just in terms of the mean and variance of the expected profit (surplus), since these characteristics are simple to estimate and manipulate. The mean variance model assumes that a persons expected utility is a function of only the mean and variance of his profit (surplus).

However, for an exact reconcilization of mean variance model with the expected utility hypothesis, the underlying utility function should be quadratic or the distribution of profit (surplus) must be normal.

By the assumption that producers (consumers) only care about the mean and variance of his profits (surplus), we can write the resulted utilities of each from a stabilization policy are

$$U_p = U_p(\mu_p, \sigma_p^2) \tag{23}$$

$$U_c = U_c(\mu_c, \sigma_c^2) \tag{24}$$

where μ_p, μ_c and σ_p^2, σ_c^2 are expected value of profit (surplus) and variance of profit (surplus) of the producers and consumers respectively.

But for the integration of the effects on producers and consumers from a price stabilization, we need further strong assumption. I assume that the mean values and the variances of the profit and surplus are additive based upon assigning equal weights.

Now we can write social utility as,

(25) $$U_s = U_s(\mu_p + \mu_c,\ \sigma_p^2 + \sigma_c^2)$$

The overall desirability of a stabilization policy depends upon

(26) $$dU_s = \frac{\partial U_s}{\partial(\mu_p + \mu_c)} \cdot d(\mu_p + \mu_c) + \frac{\partial U_s}{\partial(\sigma_p^2 + \sigma_c^2)} \cdot d(\sigma_p^2 + \sigma_c^2) \gtrless 0$$

where $\partial U_s/\partial(\mu_p + \mu_c) > 0$ and $\partial U_s/\partial(\sigma_p^2 + \sigma_c^2) \gtrless 0$ as a person is risk taker or risk averse.

A model

Consider an agricultural commodity, with market demand and supply curves written

(2) $$D = -\beta p + y$$

(27) $$S = x$$

where (2) is rewritten and (27) is slightly modified from (1).

Supply is used here in the ex post sence of yeild. Changes in the ex post supply of the product are assumed to result solely from factors that alter yield—mainly weather. We are not concerned with factors that determine the acreage planted; this is determined at planting time and is from then on no longer a stochastic variable.

Now we have two kinds of stabilization policies.

Policy A: Replacing the demand curve (2) by a deterministic demand curve with the same slope and with an intercept equal to $E(y) = \mu_y(D'$ in the Figure 2)

That is

(28) $$D' = -\beta p + \mu_y$$

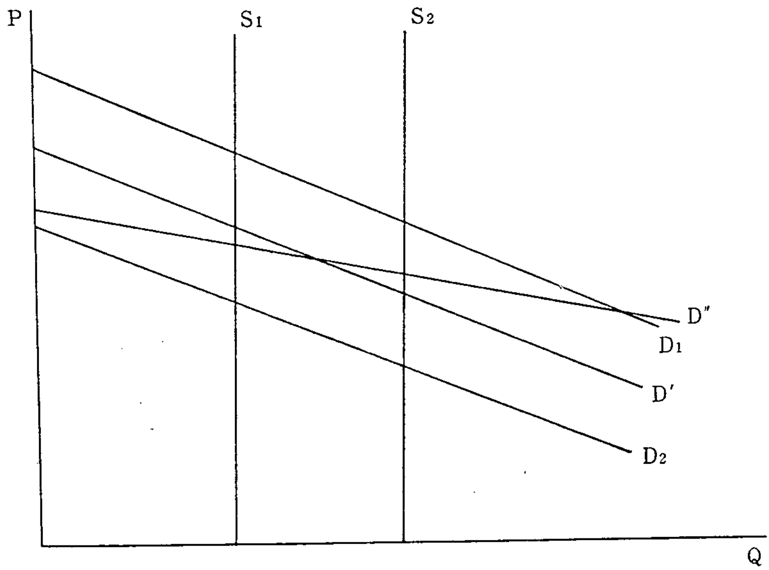
Here the stability comes from demand side by getting rid of the disturbances of the demand curve, while supply disturbances still remain. I think replacing D curves by $D' = -\beta p + \mu_y$ makes more senses. In this case the authority just reduce the variances of price variability by the regulated demand curve D'.

Policy B: Replacing demand curve (2) by a deterministic demand curve D' without altering μ_p and further increase the elasticity of demand curve (increase β)—D'' in Figure 2.

From (2) and (27), the equilibrium price is given by

(29) $$p = (y - x)/\beta$$

FIGURE 2



The expected value and variance of the price μ_p and σ_p^2, are written

(30) $\mu_p = (\mu_y - \mu_x)/\beta$

(31) $\sigma_p^2 = (\sigma_y^2 + \sigma_x^2)/\beta^2$

We can get $\mu_y = \beta\mu_p - \mu_x$ from (30). Substituting μ_y for y in (28), we can get a deterministic demand curve with an intercept equal to $E(y)$

(32) $$\begin{aligned} D' &= -\beta p + \mu_y \\ &= -\beta p + \beta\mu_p - \mu_x \end{aligned}$$

Solving (27) and (32)

(33) $p' = \mu_p + (\mu_x - x)/\beta$

From this

(34) $\mu_p' = \mu_p$

(35) $\sigma_{p'}^2 = \sigma_x^2/\beta^2$

We note that by replacing regulated demand curve, the μ_p does not change but the variance of the price decrease (compare (31) and (35)). We also note that as β increase the variance of the price further decreases.

No we can analyze the effect of a stabilization policy on producers (consumers) welfare in terms of a comparison between the D and D' curves specifically, in terms of how substituting the D' for the D curve effects the expected value and variance of producers (consumers) profits (surplus). Let us first begin with a discussion of producers' profit. Denoting I

profit[4] (income) obtained by the producers. Then

(36) $\quad I = px$

By taking expectation $E(I) = \mu_I = \mu_p\mu_x + \sigma_{px}$ where $\sigma_{px} = (\sigma_{yx} - \sigma_x^2)/\beta$
Thus

(37) $\quad E(I) = \mu_I = \mu_p\mu_x + (\sigma_{yx} - \sigma_x^2)/\beta = \mu_p\mu_x - \sigma_x^2/\beta$

Since the producers' output is influenced by different factors from those determining demand, it is assumed that $\sigma_{yx} = 0$.

And the variance of income, σ_I^2; can be written[5]

$$\sigma_I^2 = E(px - \mu_I)^2 = \mu_p^2\sigma_x^2 + \mu_x^2\sigma_p^2 + 2\mu_p\mu_x\sigma_{px} + \sigma_x^2\sigma_p^2 + (\sigma_{px})^2$$

By substituting (31) into above equation

(38) $$\sigma_I^2 = \mu_p^2\sigma_x^2 + (\mu_x^2 + \sigma_x^2)\frac{\sigma_x^2 + \sigma_y^2}{\beta^2} - 2\mu_p\mu_x\frac{\sigma_x^2}{\beta} + \frac{(\sigma_x^2)^2}{\beta^2}$$

(38)′ $$\sigma_I^{2\prime} = \mu_p^2\sigma_x^2 + (\mu_x^2 + \sigma_x^2)\cdot\frac{\sigma_x^2}{\beta^2} - 2\mu_p\mu_x\frac{\sigma_x^2}{\beta} + \frac{(\sigma_x^2)^2}{\beta^2}$$

Partially differentiating (38) with respect to β

(39) $$\frac{\partial\sigma_I^2}{\partial\beta} = -2\cdot\frac{1}{\beta^3}[(\mu_x^2 + \sigma_x^2)(\sigma_y^2 + \sigma_x^2) - \mu_p\mu_x\sigma_x^2\beta + (\sigma_x^2)^2]$$

Which sign depends upon the inequalities of

(40) $$\frac{(\mu_x^2 + \sigma_x^2)(\sigma_y^2 + \sigma_x^2) + (\sigma_x^2)^2}{\mu_p\mu_x\sigma_x^2} \gtrless \beta$$

By the policy A the expected income (profit) does not change (37) but the variance of income decrease compare (38) and (38)′ as σ_y^2 disappears. Thus producers welfare definitely increased if they are risk averse ($\partial U/\partial\sigma_I^2 < 0$). By the policy B the expected income increase (37) and the variance decrease, constant and increase according to (40), i.e., for the smaller value of β (steeper demand curve) $\partial\sigma_I^2/\partial\beta < 0$ and so on. In this case welfare effects on producers are not unambiguous. If the policy begins with

[4] Because the supply curve is perfectly inelastic, all the surplus income is economic rent.

[5] $\sigma_I^2 = E[(px - \mu_I)]^2 = E(p^2x^2) - \mu_I^2 = E(p^2x^2) - (\mu_p\mu_x + \sigma_{px})^2$
where

(a) $\quad E(p^2x^2) = \int_0^\infty\int_0^\infty p^2x^2 f(p|x)\cdot f(x)dp\,dx$

and

(b) $\quad f(p|x) = (1/\sqrt{2\pi}\sigma_{p|x})\exp[-(p - \mu_{p|x})^2/\sigma_{p|x}^2]$

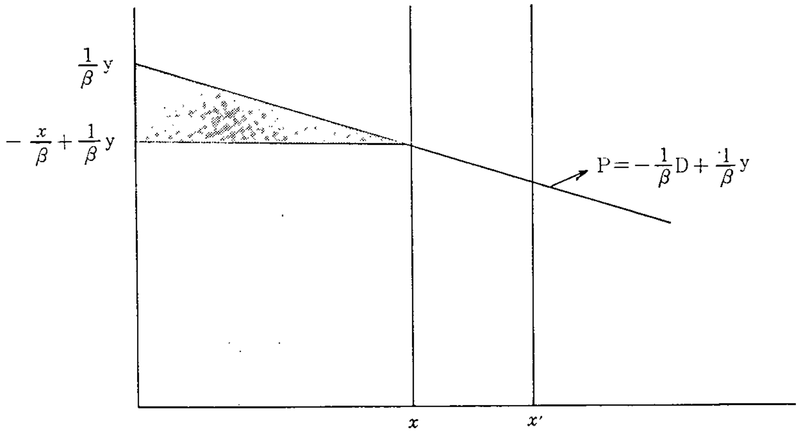
But we know that

(c) $\quad \mu_{p|x} = \mu_p + (\sigma_{px}/\sigma_p\sigma_x)(x - \mu_x)$

(d) $\quad \sigma_{p|x}^2 = \sigma_p^2(1 - \rho^2) = \sigma_p^2(1 - \sigma_{px}^2/\sigma_p^2\sigma_x^2)$

Substituting (c), (d) and (b) into (a) we can find out the value of $E(p^2x^2)$.

FIGURE 3



relatively smaller value of β, producers will gain from the price stabilization.

Now consider the effects on consumers. In this model the consumers surplus (R) for the given disturbances x and y is

$$(41)\qquad R = \frac{1}{2}\cdot x \cdot \left[\frac{1}{\beta}y - \left(-\frac{x}{\beta}+\frac{1}{\beta}y\right)\right] = \frac{1}{2}\cdot\frac{x^2}{\beta}$$

Taking expectation, the expected value of the consumers surplus is

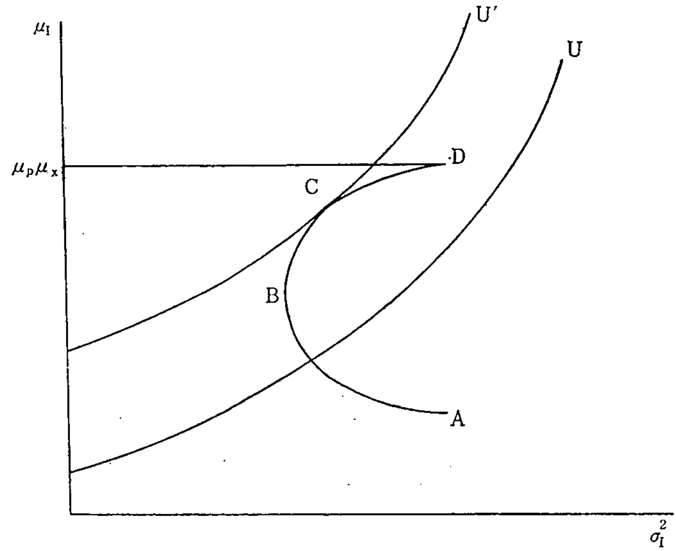
$$(42)\qquad \mu_R = E(R) = \frac{1}{2\beta}(\mu_x^2+\sigma_x^2)$$

$$(43)\qquad \sigma_R^2 = E\left[\left(\frac{x^2}{2\beta}-\mu_R\right)^2\right] = \frac{1}{4\beta^2}\left[E(x^4) - (\mu_x^2+\sigma_x^2)^2\right]$$

Here, the expected value of consumers' surplus (μ_R) and its variance (σ_R^2) are independent from the demand disturbances (y). Thus μ_R and σ_R^2 do not change by replacing regulatory demand curve (D') which implies that consumers are indifferent for the policy A. This is contrast to Massell's model in which, by dropping out σ_y^2, the expected gain from the policy decreases (9). But as β increases (policy B), both of the mean and variance decrease, the effect of the policy on consumers are not clear if consumers are risk averse. It depends on the behavior of the consumers how they trade-off between the mean value and its variance.

Now integrate the effects on producers and consumers for the overall effects of each stabilization policy. First, by the policy A the producers gain if they are risk averse while consumers indifferent from the policy, the social welfare increases. In other words the authority increase the social welfare by dropping out the demand disturbances (supply disturbances still there) without affecting one party adversely in this specific model. But by the policy B, both of the consumers' expected surplus and its variance decrease

FIGURE 4



(42), (43) while the producer expected income increase (37) and its variance decrease or increase according to (40). Thus it is hard to predict the direction of the effects of the stabilization policy.

In the analysis thus far, we consider the effects of the stabilization proposals on both producers and consumers. But since consumers spend a small part of total expenditure on primary products, their expenditure on any one commodity is likely to form only a negligible part of the total. If we could ignore the effects on the consumers from the policy basing upon above reasoning, the results of the policy B become more clear. As the authority increase β for the higher degree of stabilization; producers will gain more as long as they are risk averse and

(40) $$\beta < \frac{(\mu_x^2 + \sigma_x^2)(\sigma_y^2 + \sigma_x^2) + (\sigma_x^2)^2}{\mu_p\mu_x\sigma_x^2} \text{ (move from A to B in Figure 4).}$$

The variance of the producers expected income is minimized when

$$\beta = \frac{(\mu_x^2 + \sigma_x^2)(\sigma_y^2 + \sigma_x^2) + (\sigma_x^2)^2}{\mu_p\mu_x\sigma_x^2} \text{ (at point B in Figure 4)}$$

and the expected income maximized when $\beta = \infty$ (its value is $\mu_p\mu_x$). As long as the sign of the marginal trade-off between mean and variance, $\partial\mu_I/\partial\sigma_I^2 | U = U_0$, is positive, the producers' utility is maximized at point C. Complete price stabilization ($\beta = \infty$) will not be optimal policy for the producers.

Summarizing, the main conclusion of the analysis are

(1) a stabilization policy by dropping out demand disturbances is

desirable in terms of social welfare,

(2) for the producers only, their utility (welfare) is maximized by rather incomplete price stabilization.

IV. Conclusion

This paper has extended the previous work of Waugh, Oi, Massell and others, by changing the welfare criteria from maximization of expected profit (surplus) to maximization of utility.

The main results of the analysis heavily depends on strong assumptions;

(1) the underlying utility functions are quadratic or the distribution of profit (surplus) is normal for the mean variance analysis,

(2) the additivities of the expected values of producers' profit and consumers' surplus.

These assumptions are restrictive and rather unrealistic in some sense. Further, there remain other limitations of the analysis. First, all costs associated with operating the buffer stock have been ignored. Second, all results are based on simple linear models. Finally this has been strictly a partial equilibrium analysis.

The generalization of these limitations will lead to a modification of the present results.

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