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A THEORETICAL DISCUSSION OF THE ECONOMIC EFFECTS OF BUFFER STOCKS AND BUFFER FUNDS

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It has been established that the absence of risk markets justifies market intervention in principle. The form of intervention that has been discussed most widely in the literature is the buffer stock. This paper points out that other forms of intervention, specifically buffer funds, are likely to perform better. The analysis shows that buffer funds are likely to outperform buffer stocks because they address market failure more directly. A sub-theme developed in this paper is that since buffer funds are enforced saving, it follows that policies that address capital market failure are likely to dominate buffer funds and buffer stocks in welfare terms.

The use of stabilisation policies by governments has resulted in a large literature on the subject of price stabilisation. Most of this work has focused on the gains from buffer stocks, to producers and consumers and to society at large. The literature on buffer stocks may be divided broadly into two generations. The first generation, building on the theoretical contributions of Waugh (1944) and Oi (1964), attempted to show that the operation of a stockpile that was increased when prices were depressed and reduced when prices were high would redistribute income between producers and consumers, in a manner that depends on the sources of price variation in the market, and that social gains were generally positive.[1] Underlying these studies, and driving most of their results, were the implicit assumptions that buffer stocks could be operated without cost and that there were no private markets for stocks.

It was pointed out as early as 1958 by Gustafson that the socially optimal price rule for administering a buffer stock would correspond to the rule that would be adopted by traders in a competitive market and hence that buffer stocks would not be expected to increase welfare in Paretian terms in the absence of market failure. However, it was not until Newbery and Stiglitz's (1981) publication that the role of market failure gained preeminence in the stabilisation literature. The second generation work in stabilisation was based on Hart's results for missing markets (Hart 1975). Hart showed that if markets for risk were missing or incomplete there was a role for governments in market intervention.

A further development by the second generation of stabilisation theorists has been the recognition of the importance of the role of private stocks in determining the effects of a buffer stock on market stability. Since buffer stocks and speculative stocks operate in very similar ways, with purchases occurring when prices are low and sales when prices are high, albeit for different reasons, it seemed reasonable to assume that the former had the capacity to displace the latter. This theme has been developed in the work

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[1] The result that social gains were generally positive reflected a hidden 'missing market' argument. That is, the authors left out the private stocks markets, then provided a policy that involved trading stocks, then identified a welfare gain as the policy moved the new equilibrium closer to the complete markets outcome.

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of Helmberger and Weaver (1977), Wright (1979) and Wright and Williams (1984).

These theoretical developments have led to a clearer understanding of the roles and purposes of buffer stocks and of price stabilisation more generally. The emphasis, in the consideration of stabilisation issues, is now on the effects on producers rather than on consumers. Increasingly, stabilisation is seen as a way of offsetting the aversion of producers to the price risks entailed in fixed investment decisions rather than as a means to price and quantity stability as such. This change in emphasis has been facilitated by the role that producers have played historically in the establishment of such schemes (either through lobbying or by direct action).

Given that stabilisation schemes in agriculture are often viewed as a form of producer co-operation for dealing with price risk, the aim in this paper is to determine whether the objectives of stabilisation policy may be better met through a buffer stock or through some type of deficiency payments scheme such as a buffer fund. Using a model of a simple commodity market that takes price risk and private storage explicitly into account, changes in producer and consumer surplus associated with the two policies, namely buffer stocks and deficiency payments, are compared for a specific price stabilisation rule. The implications of both policies for the private stockholding market are explored and some observations are made on the differences in operating costs associated with the policy options. The study builds on work by Longmire, Kaine-Jones and Musgrave (1986), with the aim of extending the theoretical basis of the discussion by making explicit assumptions about private stockholding, the formation of expectations and producers' attitudes toward price risk. A comparison is made between two alternative forms of stabilisation: the buffer stock and the buffer fund. The buffer stock operates by transferring the physical good between low price states and high price states while the buffer fund operates by transferring cash in a similar fashion. By choosing a price rule that results in the same degree of price stability from each policy it is possible to focus on the transfer effects of the two policies and hence the differences in financial sacrifice that must be made to obtain a given level of price and income stability under the different regimes.

While it is clear from theory that risk-averse producers benefit from more stable incomes it is not clear that they will always benefit from price stabilisation. For example, with unitary elastic demand and all the shocks coming from the supply side, income would be perfectly stable and price stabilisation would destabilise income. However, actual policy invariably only considers price objectives even though it is not the appropriate objective if welfare of producers is the issue. Nevertheless, the impact of choosing an inappropriate objective remains of interest given the second best nature of the policies.

The Model

A simple commodity market with market clearing is proposed and modelled by three stochastic equations representing, respectively, supply, demand and stockholding. The supply equation is linear and incorporates a production lag of one period and two risk terms (a term for price risk and a term for production risk). Thus, it is assumed that producers are concerned about uncertainties arising from future period price fluctuations and about uncertainties on the production side such as weather.

Together, the two terms represent concern about fluctuations in income. However, their separation in the analysis is used because the policy instruments being examined, buffer stocks and buffer funds, are concerned with price risk and hence the policy analysis is to be conducted within this second best context. The approach taken to incorporating price risk was initially developed by Just (1974) for the adaptive expectations case and developed further by Fisher and Hanslow (1984) for rational expectations models. The same approach has been extended to incorporate production risk. All the coefficients are positive and supply in period t is denoted by S_t:

$$S_t = a_0 + a_1\hat{P}_{t-1,t} - a_2E_{t-1}(P_t - \hat{P}_{t-1,t})^2 - a_3E_{t-1}(S_t - \hat{S}_{t-1,t})^2 + X_t \tag{1}$$

The hats denote producers' expectations: $\hat{P}_{i,j}$ is the expectation of price in period j conditional on information available in period i. The first quadratic term denotes the squared producer price forecast error, E_{t-1} is the conditional expectations operator and a_2 is a coefficient of absolute risk aversion. The second quadratic term denotes the squared producer supply forecast error where E_{t-1} is again the conditional expectations operator and a_3 is a coefficient of risk aversion. The X_t term is a vector of exogenous variables that have been scaled to have unit coefficients; X_t has the form

$$X_t = \bar{X} + u_{1t} \tag{2}$$

where the bar denotes the mean and u_{1t} is a vector of random variables with zero means and finite variances. It is assumed to be homoscedastic and to follow an AR(1) process:

$$u_{1t} = r_1u_{1(t-1)} + e_{1t} \tag{3}$$

in which the error term, e_{1t}, is 'well behaved'. Subsuming the $\bar{X}$ term into the intercept the supply equation is rewritten as

$$S_t = a_0 + a_1\hat{P}_{t-1,t} - a_2E_{t-1}(P_t - \hat{P}_{t-1,t})^2 - a_3E_{t-1}(S_t - \hat{S}_{t-1,t})^2 + u_{1t} \tag{4}$$

A further simplification can be made. Since $S_t = \hat{S}_{t-1,t} + e_{1t}$ it follows that the second quadratic term, $(S_t - \hat{S}_{t-1,t})^2$, simplifies to (e_{1t}^2). Assuming that e_{1t} is homoscedastic, the supply equation may be rewritten as

$$S_t = a_0 + a_1\hat{P}_{t-1,t} - a_2E_{t-1}(P_t - \hat{P}_{t-1,t})^2 - a_3\sigma_1^2 + u_{1t} \tag{5}$$

where σ_1^2 equals $E_{t-1}(e_{1t})^2$. Since the production risk term is a constant it is possible to subsume it into the intercept entirely. Thus, the equation may be rewritten as

$$S_t = a_0 + a_1\hat{P}_{t-1,t} - a_2E_{t-1}(P_t - \hat{P}_{t-1,t})^2 + u_{1t} \tag{6}$$

In the consumer equation it is assumed that consumption occurs instantaneously:

$$D_t = b_0 - b_1P_t + u_{2t} \tag{7}$$

The disturbance term has the same properties as u_{1t} and is derived in a similar way. Again, it is an AR(1) process with a 'well behaved' error term.

The competitive stockholding model is based on Samuelson's first order conditions for speculative stockholding which embody the principle that inventory holders will acquire stock until the expected marginal cost of holding an extra unit of stock is equal to the expected speculative gain (Samuelson 1971). The equation for private stockholding adopted in this study comes from work undertaken by Kawai (1983) and others and is based on a quadratic cost function. It is written as

$$M_t = m_1(\hat{P}_{t,t+1} - P_t) \tag{8}$$

where M_t is the change in stocks following a small change in the expected speculative return.
Market clearing requires that

$$S_t = D_t + M_t \tag{9}$$

The model was solved using a conjectural coefficients approach described in Bers and Karal (1976). This approach introduces a linearity assumption into the solution of the expectations terms and hence can be viewed as only an approximation to the true forward solution. It has been used widely in macroeconomic applications by Sargent (1979), Lucas (1973) and others in the solution of models for which the exact forward solutions are computationally intractable.

Using R to denote the quadratic price risk term, the supply, demand and stock equations (6), (7) and (8) are substituted into the market clearing identity and rearranged to give

$$P_t = \frac{b_0 - a_0 + u_{2t} - u_{1t} + a_2 R + m_1 \hat{P}_{t,t+1} - a_1 \hat{P}_{t-1,t}}{b_1 + m_1} \tag{10}$$

A solution for price is conjectured:

$$P_t = S_0 + S_1 u_{1t} + S_2 u_{1(t-1)} + S_3 u_{2t} + S_4 u_{2(t-1)} + S_5 R \tag{10a}$$

and using the algebra of expectations:

$$\hat{P}_{t-1,t} = S_0 + S_1 r_1 u_{1(t-1)} + S_2 u_{1(t-1)} + S_3 r_2 u_{2(t-1)} + S_4 u_{2(t-1)} + S_5 R \tag{10b}$$

$$\hat{P}_{t,t+1} = S_0 + S_1 r_1 u_{1t} + S_2 u_{1t} + S_3 r_2 u_{2t} + S_4 u_{2t} + S_5 R \tag{10c}$$

where $$R = E_{t-1}(P_t - \hat{P}_{t-1,t})^2$$

It is simplest to solve first for the risk term R, substituting for P_t and $\hat{P}_{t-1,t}$ from (10a) and (10b), respectively, and noting that

$$u_{it} = r_i u_{i(t-1)} + e_{it} \qquad (i = 1,2)$$

$$R = E_{t-1}(S_1 e_{1t} - S_2 e_{2t})^2 \tag{11}$$

which, given the independence of the two error terms, yields

$$R = S_1^2 \mathrm{var}(e_{1t}) + S_2^2 \mathrm{var}(e_{2t})$$

Since e_i $(i = 1,2)$ is assumed to be homoscedastic, the risk term is invariant over time and perfectly co-linear with the intercept. To solve for the conjectural coefficients, substitute (10b) and (10c) into (10):

$$\begin{aligned} P_t = [&(b_0 - a_0 + u_{2t} - u_{1t} + a_2 R) \\ &- a_1(S_0 + S_1 r_1 u_{1(t-1)} + S_2 u_{1(t-1)} + S_3 r_2 u_{2(t-1)} + S_4 u_{2(t-1)} + S_5 R) \\ &+ m_1(S_0 + S_1 r_1 u_{1t} + S_2 u_{1t} + S_3 r_2 u_{2t} + S_4 u_{2t} + S_5 R)]/(b_1 + m_1) \end{aligned} \tag{12}$$

Using equations (10a) and (12):

$$S_0 = \frac{b_0 - a_0}{b_1 + a_1}$$

$$S_1 = \frac{-(a_1 + b_1 + m_1)}{(b_1 + m_1)(b_1 + a_1 + (1 - r_1)m_1)}$$

$$S_2 = \frac{a_1 r_1}{(b_1 + m_1)(b_1 + a_1 + (1 - r_1)m_1)}$$

$$S_3 = \frac{a_1 + b_1 + m_1}{(b_1 + m_1)(b_1 + a_1 + (1 - r_2)m_1)}$$

$$S_4 = \frac{-a_1 r_1}{(b_1 + m_1)(b_1 + a_1 + (1 - r_2)m_1)}$$

$$S_5 = \frac{a_2}{b_1 + m_1}$$

Hence, substituting into equation (12), the equilibrium price is

$$\begin{aligned} P_t = \frac{b_0 - a_0 + a_2 R}{b_1 + a_1} &+ \frac{(a_1 + b_1 + m_1)u_{1t} - a_1 r_1 u_{1(t-1)}}{(b_1 + m_1)(a_1 + b_1 + (1 - r_1)m_1)} \\ &+ \frac{(b_1 + a_1 + m_1)u_{2t} - a_1 r_1 u_{2(t-1)}}{(b_1 + m_1)(b_1 + a_1 + (1 - r_2)m_1)} \end{aligned} \tag{13}$$

and equilibrium supply and demand are

$$\begin{aligned} S_t = \frac{b_0 a_1 + b_1 a_0 - a_2 b_1 R}{b_1 + a_1} &+ \frac{a_1 r_2 u_{2(t-1)}}{b_1 + a_1 + (1 - r_2)m_1} \\ &- \frac{a_1 r_1 u_{1(t-1)}}{b_1 + a_1 + (1 - r_1)m_1} + u_{1t} \end{aligned} \tag{14}$$

$$(15)\qquad D_t = \frac{b_0a_1 + b_1a_0 - a_2b_1R}{b_1 + a_1} + \frac{b_1(b_1 + a_1 + m_1)u_1 - a_1b_1u_{1(t-1)}}{(b_1 + m_1)(b_1 + a_1 + (1 - r_1)m_1)}$$

$$- \frac{b_1(b_1 + m_1 + a_1)u_{2t} - a_1b_1r_2u_{2(t-1)}}{(b_1 + m_1)(b_1 + a_1 + (1 - r_2)m_1)}$$

Incorporating Price Stabilisation

To adjust the model to include a price stabilisation element, it is necessary to choose a price rule. Many different price rules have been considered in the literature with 'optimal price rules' attracting some attention. However, the concept of an optimal price rule is not clear. Given that stabilisation schemes are more often than not financed by producers, does a stabilisation authority choose a rule that maximises social gains or producer gains? Newbery and Stiglitz (1981) maximise social gains which include both consumer and producer welfare while Hinchy and Simmons (1983) viewed stabilisation as a purely producer initiative and maximised only producer welfare. In the broader context of maximising social welfare, consideration must be given to the type and degree of market failure motivating the policy. In the Newbery and Stiglitz (1981) study, markets for risk are assumed to be incomplete and the objective of stabilisation is to provide optimal insurance against unanticipated downward price movements. However, given that risk markets are incomplete rather than non-existent (inasmuch as income smoothing can be partially achieved through devices such as portfolio diversification or saving), while complete contingent markets will generally be absent, it is not clear what would constitute optimal intervention. From a practical standpoint the best price rules are probably the most simple. Simple rules are easily understood, and can be anticipated by producers without confusion.

For these reasons, a fairly simple price rule is adopted for the evaluative purposes of this study. It is assumed that prices are stabilised at the levels that, at the production planning stage in the previous period, were expected to prevail in the current period. That is, price is constrained to be equal to the production planning price: $P_t = \hat{P}_{t-1,t}$. Under this rule, the level of market intervention by the stabilisation authority that will occur in period t, expected in period $t-1$, is zero. This is because the price rule ensures that only unanticipated shocks in period t are eliminated. The authority promises to maintain prices at the level that it expects (at period $t-1$) would be necessary to clear the market in period t if it made no intervening sales. This effectively drives the risk component, R, to zero.

This price rule has a number of advantages. First, it strikes at the heart of the problem by removing price risk from investment decisions. Second, it ensures that stock levels will be statistically stationary over time; hence, there is no tendency in the model toward infinite stock levels. [Turnovsky (1974) refers to this as the 'self-liquidating' condition.] Third, such a price rule will allow prices to evolve over time, smoothing the impact of market shocks rather than eliminating them. The aim is to allow producers to adjust in a non-risky environment, not suppress market forces as occurs with rigid 'band width' rules such as those used by Turnovsky (1978). Thus, the rule addresses the problems raised by Salant (1983) and Townshend (1977). Salant observed that, historically, buffer stocks have generally broken down and hence are likely to be subject to speculative attack. His conclusions are supported by Townshend's theoretical result that, because prices are a random walk, price fixing systems will inevitably result in costs that are unbearable for stabilisation authorities in the long run. By using a price rule in this analysis that 'evolves' with market conditions these risks are greatly reduced.

To incorporate a buffer stock into the model using this price rule, three changes are made. The market clearing equation (5) is modified to

$$S_t = D_t + M_t - A_t \tag{16}$$

where A_t is the change in the level of stocks held by the stabilising authority in period t. Thus, A_t is a flow of stocks like M_t. The price rule is imposed in the form of a behavioural constraint on the stabilisation authority which becomes the fifth equation of the model. [The market is fully described by equations (6), (7), (8), (16) and (17).] The authority purchases the difference between expected and actual demands and supply:

$$A_t = (S_t - \hat{S}_{t-1,t}) - (D_t - \hat{D}_{t-1,t}) - (M_t - \hat{M}_{t-1,t}) \tag{17}$$

Finally, since price risk is eliminated, the risk term, R, becomes zero. The modified model is solved using the same technique as before. Equations (16) and (17) simplify to

$$\hat{S}_{t-1,t} = \hat{D}_{t-1,t} + \hat{M}_{t-1,t}$$

and the solution is obtained by substituting into this equation, after taking the relevant conditional expectations and then using the conjectural coefficients approach as before. In the expressions that follow, the superscripts s, d and f refer to the buffer stock, buffer fund and free market situations, respectively. Using a buffer stock, the equilibrium price (and the production planning price) is

$$p_t^s = \frac{b_0 - a_0}{a_1 + b_1} - \frac{r_1 u_{1(t-1)}}{a_1 + b_1 + (1 - r_1)m_1} + \frac{r_2 u_{2(t-1)}}{a_1 + b_1 + m_1(1 - r_2)} \tag{18}$$

If a buffer stock is used, the equilibrium supply and demand equations are

$$S_t^s = \frac{a_0 b_1 + a_1 b_0}{a_1 + b_1} - \frac{a_1 r_1 u_{1(t-1)}}{a_1 + b_1 + m_1(1 - r_1)} + \frac{a_1 r_2 u_{2(t-1)}}{a_1 + b_1 + m_1(1 - r_2)} + u_{1t} \tag{19}$$

$$D_t^s = \frac{a_0 b_1 + a_1 b_0}{a_1 + b_1} + \frac{b_1 r_1 u_{1(t-1)}}{a_1 + b_1 + m_1(1 - r_1)} - \frac{b_1 r_2 u_{2(t-1)}}{a_1 + b_1 + m_1(1 - r_2)} + u_{2t} \tag{20}$$

The imposition of a buffer fund on the model is considerably simpler. The buffer fund operates by making compensating payments to producers when prices are low and taxing their revenues when prices are high, so that effectively they receive the stabilisation price. Hence, the spot market price is not directly influenced, and the equilibrium price, supply and demand equations are the same as equations (13), (14) and (15) where the risk term, R, is set to zero. While this seems counter-intuitive, since one would expect the payment from the buffer fund to be 'coupled' to supply and hence to influence prices and quantities more directly, it is important to remember that payments to producers will be unanticipated under the price rule chosen and hence will not influence the producer's decision problem except through his attitude to risk.

Producer Rents

In this section, the changes in producer rent, as measured by producer surplus, likely to result from the adoption of the alternative policy options are considered. Change in producer surplus, ΔPS^s, is calculated by integrating the two supply curves, S^f for the free market and S^s for the market after the introduction of a buffer stock. These measures can be found through direct integration:

$$\begin{aligned} \Delta PS^s &= \int_0^{P_t^s} S^s dP - \int_0^{P_t^f} S^f dP \\ &= \tfrac{1}{2}(P_t^s - P_t^f)(S^s + S^f) + a_2 P_t^f R \end{aligned} \tag{21}$$

To obtain the expected change in producer surplus from the adoption of the buffer stock policy, the equilibrium values of the model from equations (13), (14), (18) and (19) are substituted for the elements of equation (21) and unconditional expectations are calculated. Let

$$\begin{aligned} X &= a_1 + b_1 + m_1 \\ Y_1 &= (b_1 + m_1)(a_1 + b_1 + m_1(1 - r_1)) \\ Y_2 &= (b_1 + m_1)(a_1 + b_1 + m_1(1 - r_2)) \end{aligned}$$

$$E(\Delta PS^s) = \tfrac{1}{2}\left[\frac{-2(b_0 a_1 + b_1 a_0 - a_2 b_1 R) a_2 R}{(a_1 + b_1)^2} + \frac{a_2 R(b_0 - a_0 + a_2 R)}{(a_1 + b_1)} + \frac{2(1 - r_1^2) X \sigma_1^2}{Y_1} \right] \tag{22}$$

The term σ_1^2 is the variance of u_{1t}. The first element in the long brackets is the price effect ($Q\Delta P$), which is negative, since supply is greater under stabilisation because risk-averse suppliers supply more. The second term is the quantity effect ($P\Delta Q$), which is always positive. Whether the price or the quantity effect is dominant will depend on the elasticities of demand and supply. The third term in the long brackets is unambiguously positive and is consistent with the Massel (1969) result that producers gain from stabilisation of prices when the source of variation in prices is supply-side shocks. The zero effect of demand-side shocks is consistent with Turnovsky's (1974, 1978) results and reflects the assumption that supply is fixed in the short run. These three terms are the transfer effects of stabilisation.

With the buffer fund, all of the effects of introducing the policy are felt through the risk term, R, which becomes zero after the introduction of the stabilisation policy. The expected change in producer surplus based on prices received exclusive of the deficiency payment is the same as the first two terms in the long brackets in equation (22):

$$(23)\quad E(\Delta PS^{d}) = \tfrac{1}{2}\left[\frac{-2(b_0a_1+b_1a_0-a_2b_1R)a_2R}{(a_1+b_1)^2}+\frac{a_2R(b_0-a_0+a_2R)}{(a_1+b_1)}\right]$$

The producer also receives the deficiency payment which, under the price rule chosen, has a positive expected value. This is because under the buffer fund revenue collected by the authority is greater than revenue disbursed. The value of the payment will be equal to the difference between the stabilisation price and the realised market price multiplied by the quantity that is produced:

$$\text{Payment} = (\hat{P}^{d}_{t-1,t}-P^{d}_{t})Q^{d}_{t}$$

where the superscript *d* denotes prices and quantities under the buffer fund. Substituting from equations (10a), (10b) and (13), and setting *R* to zero:

$$(24)\qquad E(\text{Payment}) = \frac{X(1-r_1^2)\sigma_1^2}{Y_1}$$

From comparison of this equation with equations (22) and (23) it is apparent that the effects of the buffer stock and buffer fund on producer rents are identical when the value of the deficiency payment is taken into account. Thus, although the two policies work in different ways and affect market prices and quantities differently, their transfer effects will be the same and producers will experience the same level of income under each when storage costs associated with the buffer stock and the costs of the deficiency payment are ignored.

Gains to Consumers

To calculate expected changes in consumer surplus resulting from the imposition of a buffer stock on a free market, the same approach is used:

$$(25)\qquad \Delta CS^{s} = \int_{P^{f}_{t}}^{P^{s}_{t}} D_t d\mathrm{P} = \tfrac{1}{2}(P^{f}_{t}-P^{s}_{t})(D_t+D^{s}_{t})$$

Substituting for the elements of equation (25) from equations (13), (15), (18) and (20) and taking unconditional expectations:

$$(26)\quad E(\Delta CS^{s}) = \left[\frac{(a_1b_0+b_1a_0-a_2b_1R)a_2R}{(b_1+a_1)^2}-\frac{(1-r_1^2)b_1X^2\sigma_1^2}{Y_1^2}\right.$$
$$\left.+\frac{(1-r_2^2)(-b_1X+2(b_1+m_1)(X-m_1r_2))X\sigma_2^2}{Y_2^2}\right]$$

The signs of the first and third expressions in the long brackets are positive and consistent with theory. The positive first term indicates that consumers benefit from the increase in supply with its consequent downward effect on prices. The positive third term is consistent with Massel's (1969) result that consumers gain from price stabilisation when the source of price variability is demand-side shocks. The negative second expression is consistent with the argument of Waugh (1944) that consumers benefit from increased supply-side variability and hence will lose from stabilisation when fluctuations in supply are an important source of price variation.

The shift from a free market to the buffer fund regime results in an expected change in consumer surplus equal to the first term in long brackets in equation (26). That is, supply is increased, prices are therefore lower and hence consumers are unambiguously better off. (This assumes the stabilised good is not an important component of the consumer's budget and hence consumer risk attitudes do not matter.)

$$(27) \qquad (\Delta CS^d) = \left[\frac{(a_1 b_0 + b_1 a_0 - a_2 b_1 R) a_2 R}{(b_1 + a_1)^2} \right]$$

Thus, in a move from a buffer stock regime to a buffer fund regime consumers may gain or lose depending on the sources of price variability and the magnitude of the elasticities of demand and supply.

The Private Stockholding Function

The level of stock acquisition and disbursement that will occur in the absence of a stabilisation policy is calculated by solving equations (10a) and (10c) for the conjectural coefficients and substituting into equation (8); the superscript f denotes free market or the absence of either policy:

$$(28) \qquad M_t^f = \frac{(1 - r_1)(b_1 + m_1) m_1 (u_{1t} + a_1 e_{1t})}{Y_1} - \frac{(1 - r_2)(b_1 + m_1) m_1 (u_{2t} + a_1 e_{2t})}{Y_2}$$

The change in stocks held privately with the buffer stock operating is found through similar substitution:

$$(29) \qquad M_t^s = - \frac{m_1 r_1 (u_{1t} - u_{1(t-1)})}{a_1 + b_1 + (1 - r_1) m_1} + \frac{m_1 r_2 (u_{2t} - u_{2(t-1)})}{a_1 + b_1 + (1 - r_2) m_1}$$

Subtraction of equation (29) from equation (28) gives the change in the level of private stock acquisition associated with a shift from a free market to a market stabilised with a buffer stock:

$$(30) \qquad M_t^f - M_t^s = \frac{m_1 (b_1 + a_1 + m_1) e_{1t}}{Y_1} - \frac{m_1 (b_1 + a_1 + m_1) e_{2t}}{Y_2}$$

Note that from the assumption of independence of the residuals it follows that

$$E(M_t^f - M_t^s \mid M_t^f, M_t^s > 0) > 0$$

and hence the private stocks industry will trade more stock in the absence of the buffer stock. Solving equation (16) after substituting for the appropriate equilibrium values, the level of buffer stock purchases and sales (A_t) can be calculated as

$$A_t = \frac{(a_1 + b_1 + m_1)e_{1t}}{a_1 + b_1 + (1 - r_1)m_1} - \frac{(a_1 + b_1 + m_1)e_{2t}}{a_1 + b_1 + (1 - r_2)m_1} \tag{31}$$

Thus, comparing equation (31) with equation (30), it is apparent that the buffer stock purchases and sales will displace private purchases and sales in the proportion of $m_1/(b_1 + m_1)$. That is, the displacement effect increases as the value of the elasticity of consumer demand declines and as the elasticity of private stocks demand increases and the amount of stocks displaced from the private stocks industry will be equal to the buffer stock quantity when the consumer demand elasticity approaches zero. At this point the aggregate changes in stocks (both private and buffer) will be equal to the changes in stocks that would occur in the free market situation. This implies that, for non-zero demand elasticities, the aggregate level of stock activity in the market will increase with the introduction of the buffer stock if agents are rational and the price is stabilised so as to remove price risk from the production decision.

The operation of a buffer fund, in contrast to a buffer stock, will not influence the expected level of stock acquisition or sales by the private sector but will have identical effects to a buffer stock from the standpoint of risk reduction.

Costs

Under both stabilisation schemes producers face administrative costs and interest costs. It seems reasonable to assume that the administrative costs for the buffer stock and for the buffer fund will be similar and henceforth they will be assumed to be zero. For the interest charge, the simplifying assumptions are made that the administration of the buffer fund can invest excess funds and can borrow when funds are deficit and that the borrowing and lending rates are the same. The true direct costs of the buffer fund are two: the administrative cost and the difference between borrowing and lending rates. The indirect costs associated with the buffer fund were noted in the section entitled 'Producer Rents'. The expected level of payments to producers from the buffer fund surplus is non-zero since if the agency stabilised the price at its equilibrium value, or, as in this analysis, around the conditional equilibrium value, the average level of payouts to producers is not equal to the average level of pay-ins by producers. The expected value of the payouts (from before) is

$$\frac{X(1 - r_1^2)\sigma_1^2}{Y_1} > 0$$

and hence the buffer fund will run at a loss. With a buffer stock where the stabilisation authority is constrained to use the price rule, $P_t = \hat{P}_{t-1,t}$, there will on average be a zero trading surplus. Thus, the storage costs incurred by the buffer stock authority for handling, transport and warehousing represent additional costs for producers that will be incurred with the buffer stock and not the buffer fund. It follows that when unanticipated supply shocks are not large and stockholding is costly the buffer fund is likely to be the least costly option. This ultimately reflects the fact that its store of wealth, cash, rather than the physical good, can be lent to obtain a return.

Summary and Conclusions

The paper addresses the proposition that buffer funds will be a superior policy option to buffer stocks for eliminating price risk faced by producers at the production planning stage. There were five principal assumptions in the model: that demand and supply are linear, additive and stochastic, expectations are rational in the Muth sense, a private stock industry arbitrages price, production is lagged one period, and that futures markets and equities markets are missing.

Four further assumptions were made about policy: that public stocks are costly to hold, administration costs are the same for the buffer stock as the buffer fund, the buffer fund and buffer stock have an identical objective function (the elimination of price risk from the producer's decision problem) and that the buffer fund can borrow and lend at the same rate.

The major conclusion of the analysis is that the buffer fund will be a less costly option than the buffer stock for stabilising prices at their production planning levels when unanticipated supply variability is not high and stockholding is costly. Since the buffer fund is simply a form of 'enforced saving' it is easily dominated in welfare terms by policies that address the failure in capital markets that are necessary to justify its existence.

The analysis reinforces the Newbery and Stiglitz (1981) view that if markets for risk are missing the buffer stock may be welfare improving over a free market situation and this result continues to hold even if the buffer stock is dominated in welfare terms by the buffer fund option. However, the analysis raises important questions about the strength of the missing markets assumption in the Newbery and Stiglitz work. This is because a buffer fund is simply a form of enforced saving. That is, under the buffer fund, producers are forced to put aside cash in good years to meet their needs in bad years. If capital markets are perfect, then producers will be able to do this voluntarily by using credit markets, and, thus, the voluntary saving option with perfect capital markets will dominate the buffer fund option.

Even if capital markets are not perfect due to moral hazard or because of economies to size in borrowing and lending enjoyed by the stabilisation authority, the first best option is still not a buffer fund, but, rather, some type of producer credit union or farmers' bank. Thus, it emerges that the buffer stock is likely to be less cost effective than a buffer fund for shifting risk and that the buffer fund is likely to be inferior to policies more directly related to correcting the capital market failure that is needed to justify the buffer fund.

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