The economics of storing a non-storable commodity

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Abstract. Commodity stabilization under a buffer stock and under a buffer fund are compared. In the case where a good cannot be physically stored, stability brought about by a buffer fund scheme cannot result in a net welfare improvement for society. When instability is due only to demand variability, there are no gainers or losers; when instability is due to supply variability, a buffer fund does not result in a welfare loss to society, but there is a transfer of income from taxpayers to producers. Hence, producer arguments for a buffer fund are a desire for a redistribution of income in their favour.

L'analyse économique de l'entreposage d'une denrée non-entreposable. Les auteurs comparent la stabilisation du prix des denrées à l'aide d'un stock de denrées et d'un fond de stabilisation. Dans le cas où la denrée n'est pas entreposable physiquement, la stabilité engendrée par un fond de stabilisation ne peut pas engendrer une amélioration nette du bien-être de la société. Quand l'instabilité est attribuable seulement à la variabilité de la demande, il n'y a ni gagnants ni perdants; quand l'instabilité vient du côté de l'offre, un fond de stabilisation n'engendre pas de pertes pour la société mais il y a transfert de revenu des contribuables vers les producteurs. Donc les arguments des producteurs en faveur d'un fond de stabilisation trahissent simplement le désir de redistribuer le revenu dans leur direction.

As a result of fluctuating prices, governments have intervened in agricultural markets to provide producer price stability. This has been the case for both storable and non-storable goods. However, to date, the economic analysis of price stabilization has considered only the case of a storable commodity (see Schmitz, 1984). In this paper, we deal with the economics of creating producer price stability for goods that cannot be stored, namely, for perishable agricultural commodities. In this case, price stabilization can be accomplished through a buffer fund type of arrangement, whereas in the standard literature

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price stabilization is achieved through physical storage. Analyses by Waugh (1944), Oi (1961), and Massell (1969) have shown that producers gain from stabilization using a buffer stock (i.e., storage) when supply instability is the main driving force and consumers lose, while the opposite result holds if the source of instability is demand led. If compensation is allowed in Massell's analysis, society gains from stabilization, regardless of the source of instability (supply or demand variability). Van Kooten and Schmitz (1985) prove an even stronger result: in the case of uncertainty caused by demand fluctuations, a storage program is Pareto optimal. This paper shows the strong result that there is no net gain to society by introducing price stabilization schemes for non-storable goods. Thus, it follows that, if a commodity can be stored, price stabilization brought about via storage is socially preferred to achieving stabilization through a buffer fund. We also show that in certain cases buffer fund schemes involve a transfer of income from taxpayers to producers. These results are supported by an empirical example.

VARIABILITY IN DEMAND FOR A NON-STORABLE COMMODITY

We begin by considering the case where instability is caused by demand variability. In figure 1, D_E represents the expected demand, while D_0 and D_1 represent the actual demands, each of which occurs with a probability of one-half. Since the planning supply curve S remains invariant and producers expect D_E to be the demand for their product, an amount $\hat{Q}$ is produced in each period. Hence, supply can be treated as completely inelastic, that is, as S'. In order to stabilize price at P^e and clear the market for the perishable good, the government would allow P_1 to prevail when demand is D_1 and collect area P_1abP^e as revenue for the buffer fund. Producers would receive a price of P^e rather than P_1. Then, when demand fell to D_0 with price falling to P_0, the government would disburse an amount equal to area P^ebcP_0 to producers. Since the probability of either demand scenario is 0.5, and ignoring administrative costs, the stabilizing mechanism is actuarially sound; the expected revenue accruing to the buffer fund is equal to expected payments.

This model can be described mathematically as follows. We assume that suppliers are competitive and risk neutral. The two demand scenarios facing producers are indexed by $j = 0, 1$, so that demand is given by $D(P, j)$, and each scenario has an equal chance of occurring. The demand function is assumed to be downward sloping. Suppliers must produce before the realization of j is known and, hence, their behaviour is completely specified by the supply function $S(P^e)$, where P^e is the expected price. Thus, a rational expectations equilibrium in such a market is characterized by the triple $(P_0, P_1, \hat{Q})$, such that

$$\hat{Q} = S[1/2(P_0 + P_1)] \text{ and}$$

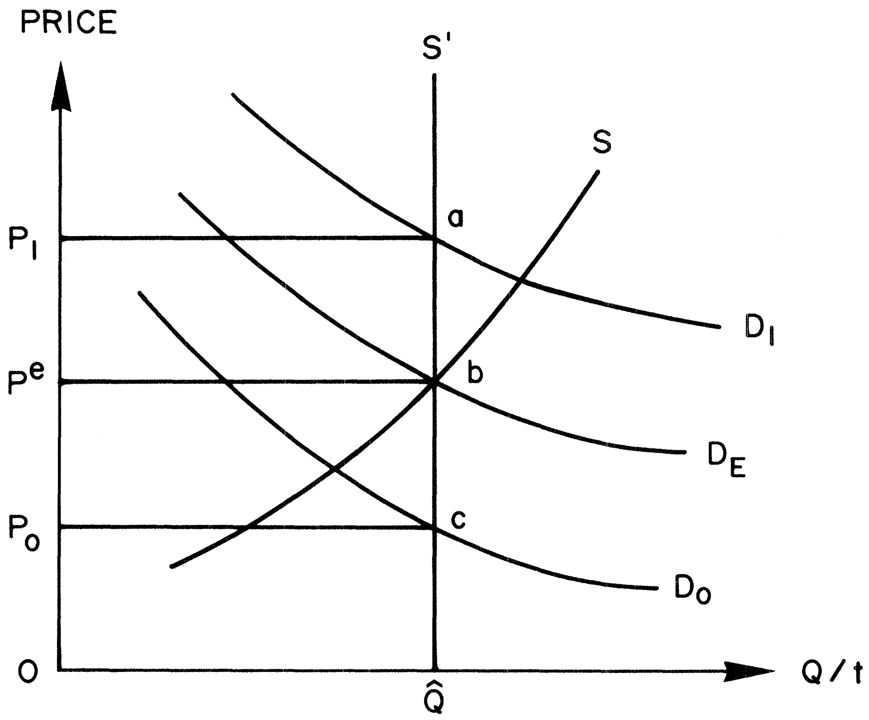

FIGURE 1 Demand variability case

$$\hat{Q} = D(P_0, 0) = D(P_1, 1).$$

A buffer fund program that sets the producers' price at $1/2(P_0 + P_1) = P^e$ clearly induces suppliers to produce the same $\hat{Q}$ as above. Hence, the ex post prices in each state must also be P_0, P_1. Given that producers are risk neutral, it follows that no one is affected by the buffer fund, including taxpayers. The expected tax revenues are given by

$$1/2\hat{Q}(P^e - P_1) + 1/2\hat{Q}(P^e - P_0) = 0.$$

With a buffer fund mechanism used for stabilizing the price to producers but not to consumers (with physical storage consumer prices would also be stabilized), neither producers nor consumers are better off than they would be without stabilization. This is opposite to the case of the storable good (Van Kooten and Schmitz). In the case of demand instability, if the good could be stored, stabilization via a buffer stock is preferred to stabilization brought about by means of a buffer fund. For the non-storable commodity, or where a storable good is stabilized by means of a buffer fund, the consumer does not benefit from stabilization as was the case for physical storage; indeed, the consumer is indifferent as to whether or not stabilization of a perishable commodity occurs. For the case of a buffer stock, the consumer gains as Van Kooten and Schmitz show. Thus, the average benefit to the consumer is greater under physical storage than it is under a buffer fund.

VARIABILITY IN THE SUPPLY OF A NON-STORABLE COMMODITY

Now consider the case where price instability is due to supply variability. $D(P)$ is now non-stochastic demand. The quantity supplied varies from one period to the next, taking values Q_0 and Q_1 with equal probability.[1] Then the expected price is $P^e = 1/2(P_0 + P_1)$ and the ex post market supply is a realization of the random variable $S(P^e, j)$. A rational expectations equilibrium is now characterized by the prices (P_0, P_1), such that

$$S[1/2(P_0 + P_1), 0] = D(P_0) \text{ and}$$
$$S[1/2(P_0 + P_1), 1] = D(P_1),$$

and corresponding quantities (Q_0, Q_1).

If the producer price is stabilized at the expected price P^e determined implicitly by this system, producers make the same ex ante decisions as previously, given the assumptions of (expected) price-taking behaviour and risk-neutrality. That is, producers effectively plan production according to $Sp(P) = 1/2[S(P, 0) + S(P, 1)]$. Thus, prices and supply are unaltered. However, expected producer revenues without the buffer fund are given by

$$1/2[D(P_0)P_0 + D(P_1)P_1],$$

while the buffer fund policy alters this to

$$1/2[D(P_0)P^e + D(P_1)P^e] =$$
$$1/2\{D(P_0)P_0 + D(P_1)P_1 + 1/2[D(P_0) - D(P_1)](P_1 - P_0)\}.$$

Therefore, with downward sloping demand, these revenues must be greater than they would be without the buffer fund. Independently of the shape of the demand and supply curves, a buffer fund represents a pure (expected) transfer from taxpayers to producers. As before, there is no net gain or loss to society, but, unlike the previous case, there is now a transfer from taxpayers to producers. The model is illustrated in figure 2. Since the demand curve is considered fixed in each period, the government agency expects to collect area (P_1abP^e) in one period and pays out area (P^edfP_0) to producers in the next period.

Unlike the case discussed by Van Kooten and Schmitz where society as a whole gains from storage, there is no net gain or loss to society with the buffer fund.[2] There is only a transfer from taxpayers to producers.

1 In beef production, the supply curve can shift back and forth over time, since the error terms are correlated over time. As an example, calving rates may be correlated over time.

2 It is assumed that the required taxes are collected in such a fashion that their allocative effect is neutral.

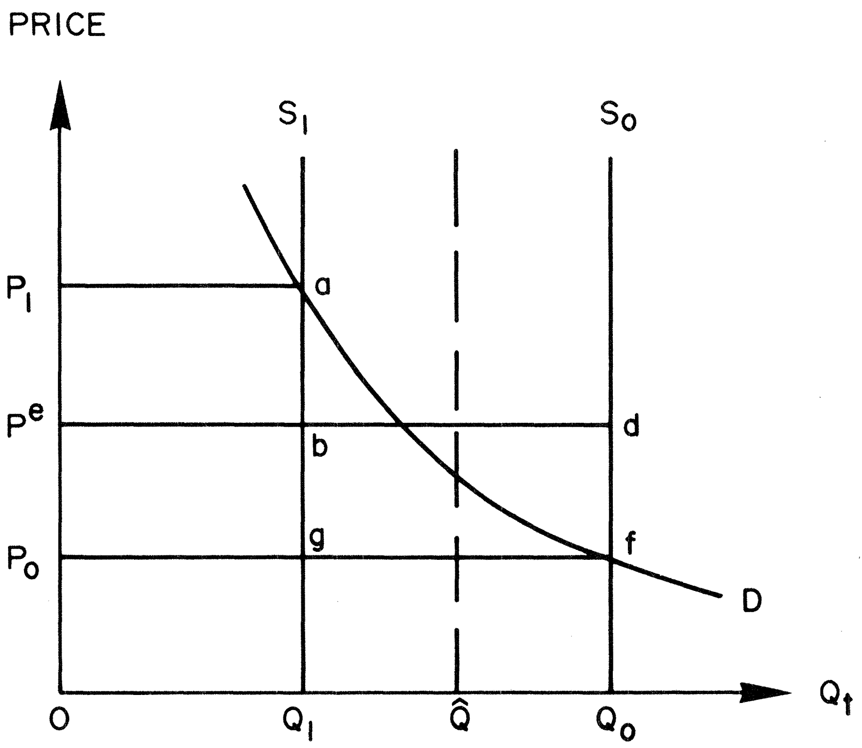

FIGURE 2 Supply variability case

It is important to note that the price expected by producers, P^e, is not equal to their average revenue (AR). Therefore, stabilization via a buffer fund at price P^e is not actuarially sound, since it requires a transfer from the treasury. For a program to be actuarially sound one must cover the rents to fixed factors. Since variable inputs do not change from one period to the next, it can be argued that the transfer is a rent to some fixed factor. The reason for this is that when prices fall, the return to fixed factors must be reduced as cost of production falls. For actuarial soundness of the buffer fund program, it would be desirable to set price equal to average revenue. It is possible to find the average revenue price P_a required for an actuarially sound program simply by equating the expected revenues into the buffer fund with the expected pay-outs; that is, by solving the following system of equations:

$$(P_a - P_0)D(P_0) + (P_a - P_1)D(P_1) = 0,$$

$$S(P_a, 0) = D(P_0), \text{ and } S(P_a, 1) = D(P_1).$$

However, any attempt to stabilize the producer price at a value different from the expected price P^e will result in an output response, since producers' ex ante decisions will change.

An important issue raised by the analysis and of concern to policy makers is that, even though a buffer fund can bring about price stability, it can also bring about an increase in producer income variability. This can clearly be seen from figure 2. Under a buffer fund, period 1 income is reduced by P_1abP^e, whereas in period 0 producer income is increased by P^edfP_0. With a buffer fund, income in period 0 exceeds that in period 1 by Q_1bdQ_0, which is larger than $0P_1aQ_1$ minus $0P_0fQ_0$. That is, the difference in income between the two periods under a buffer fund as opposed to no stabilization is given by area *bdfg*. Therefore, if income variability is of concern, policy makers have to choose some optimal combination of both income and price stabilization within a buffer fund context.

EMPIRICAL EXAMPLE

In the past several years, the federal government has attempted to stabilize Canadian beef prices. Price instability is due to supply variability, but no consensus regarding the type of program to be implemented currently exists. Some provinces have implemented their own programs, of which the Saskatchewan Beef Stabilization Program is an example. The Saskatchewan program was started in 1982 and is a buffer fund scheme; at the end of the third quarter of 1986, it had a deficit of approximately $50 million (Miketinac et al., 1986), indicating that the program is not actuarially sound. Here we consider what the annual burden to Canadian taxpayers might be if a national buffer fund program were put in place.

Between the beginning of 1980 and the end of 1985, an average of 211.5 million kg of beef was supplied to the domestic market in each quarter; the variance of supply is about 43.2 million kg.[3] Therefore, we assume that supply in each quarter is either 254.7 million kg with probability 1/2 or 168.3 million kg with probability 1/2. We further assume that a price of $4.167/kg, which is the average 1981 price of beef (Van Kooten, 1987, 114), represents the price where the demand and planned supply functions intersect (i.e., $\hat{P}$). In the analysis, we assume three demand elasticities for beef, namely, -1.5, -1.0, and -0.5, and two different functional forms for demand – a linear and a double logarithmic functional form.

Our results are presented in table 1. The linear demand curve is constructed by assuming that the price elasticity is estimated for the expected price and quantity – $4.167/kg and 211.5 million kg, respectively. Similarly, the double logarithmic demand function is assumed to pass through this point. Both the expected price P^e and the average revenue price P_a are provided in the table, as are the expected revenues, pay-outs, and transfers under price stabilization at P^e. For the double logarithmic demand function, the price elasticity is constant

3 These data are for cold dressed meat and are obtained from Statistics Canada Catalogue #23-203, *Livestock and Animal Product Statistics*, 1984 and 1985, tables 5 and 7.

TABLE 1
Expected annual buffer fund revenue, pay-out and transfer, various demand and elasticity scenarios, possible Canadian beef stabilization program

Demand elasticity	Expected price P^e	Average revenue price	Expected annual		
			Revenue	Pay-out	Transfer
	($/kg)			($ million)	
Linear demand					
−1.5	4.167	4.051	190.99	289.04	98.05
−1.0	4.167	3.993	286.49	433.57	147.08
−0.5	4.167	3.819	572.98	867.13	294.15
Double logarithmic demand					
−1.5	4.267	4.147	197.12	298.31	101.19
−1.0	4.348	4.167	298.96	452.44	153.48
−0.5	4.727	4.348	623.96	944.28	320.32

throughout. As can be seen from the last column in the table, a buffer fund program will never be actuarially sound if the stabilizing price is P^e.

The results indicate that the cost of a buffer fund could be quite large. From table 1, it appears as if producers were to favour a buffer fund scheme, and one is put in place, the transfer would amount to about $100–300 million annually. This constitutes a substantial transfer from taxpayers to beef producers.

CONCLUSIONS

In the case where a good cannot be physically stored, stability brought about by a buffer fund scheme cannot result in a net welfare improvement for society. When instability is due only to demand variability, there are no gainers or losers; when instability is due to supply variability, a buffer fund does not result in a deadweight loss to society, because allocative inefficiency is absent. However, there is generally a transfer of income from taxpayers to producers. Therefore, such a stabilization scheme can be adopted only if there is a desire by decision makers to make such transfers, and producer arguments for stabilization should be recognized as a desire for a redistribution of income in their favour.

Even though, from a societal point of view, a buffer stock scheme is preferred to a buffer fund where a commodity can be physically stored, there may be cases where producers prefer a buffer fund for stabilizing the price of a storable commodity. This arises when there are opportunities for rent seeking, particularly if producers can obtain a significant transfer from government. As is true of most agricultural stabilization programs (e.g., the beef case above), producers are generally in control of the program, and, in particular, they determine the cost of production formula which is used to determine the stabilizing support price. One objective of producers is to increase the cost elements of the production formula and, thereby, the amount of the government transfer; hence, producers are rent seeking. The formula is generally based on the production costs of high-cost producers or, in some cases, on an average of the production costs of all producers, including high-cost producers. Economies of scale or size effects are ignored. Therefore, while storage programs are size neutral, regardless of whether storage is a private or a public activity, the buffer fund is size distorting if economies of scale are present. That is, if the cost of production is geared towards the small operator, the more efficient, generally larger operators will benefit from the price stabilizing program to a larger extent than small operators will. Hence, such a program has adverse distributional impacts. The costs are an average calculated over all producers regardless of size. Therefore, low-cost producers who also tend to be larger operators benefit more than high-cost or smaller operators.

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