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BUFFER FUND PRICE STABILIZATION UNDER RATIONAL EXPECTATIONS

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Agricultural price and income stabilization programs play an important role in the policy fabric of many countries. A major shortcoming of early studies of the effects of commodity stabilization (Waugh; Oi; Massell) is the omission of any explicit consideration of producer expectations. Hence, one of the major contributions of the recent literature on commodity price and income stabilization has been the explicit incorporation of producer price expectations (Newbery and Stiglitz). However, there is another deficiency in the literature that has received inadequate attention, namely, the policy instrument of stabilization itself. The literature generally assumes that stabilization is to be brought about through buffer stock programs, but in many situations buffer fund programs are used instead. This is particularly the case for perishable commodities, although there are some countries that have elected to use buffer fund schemes even for non-perishable commodities.

A recent study focusing on the economic effects of buffer fund stabilization is by Van Kooten, Schmitz and Furtan (VSF). In this study, the authors compare a buffer fund scheme with a buffer stock scheme as a method for stabilizing commodity prices. Their main conclusions are that, (A) while a buffer stock scheme results in a net welfare gain to society, a buffer fund scheme is neutral in its impact on social welfare; (B) a buffer fund scheme will increase producer income variability; and (C) a buffer fund scheme will lead to a transfer of income from general taxpayers to producers. While we agree with the general thrust of that study, we find it deficient in at least three respects: (i) it only examines a simple static stabilization rule; (ii) it assumes away the possible effects of price expectations on supply; and (iii) it assumes an autarkic model of demand. The purpose of the present paper is to re-examine the economic effects of buffer fund price stabilization by addressing these deficiencies. We show that there are situations where none of the three major conclusions of VSF hold.

Assuming rational expectations behavior on the part of agricultural producers (Muth; Goodwin and Sheffrin; Huntzinger), it is important to distinguish two measures of price: average price and the (action) certainty equivalent (CE) price. The average price ($\bar{p}$) is the expected price or mean of the probability distribution of price, while the CE price (p) is that "price which, if it prevailed on the market, and if there were no risk, would yield exactly the same supply response as does the random price" (Newbery and Stiglitz, p. 64). In the case of symmetrical supply uncertainty and a linear demand curve (not shown), the price distribution will be normal and $\bar{p}$ will equal the rationally expected price p. However, if the demand function is convex, the price distribution will be skewed toward higher prices, and the average price will exceed p (Fig 1). If producers use average price as their expected price, this would not be rational since they would then not be using all the information at their disposal. In particular, using such a price would imply a planned output that is greater than $\bar{q}$, namely, $\bar{q}'$. Rational producers would take this information into account and use it to revise their expectations. The rationally expected price is the one price which rational producers would not have an incentive to revise since it uses all the information at their disposal. This is the one which simultaneously satisfies the demand and the planned supply fuctions. If the government stabilizes price at the average level, there will be a supply response and, to clear the market, consumer price would tend to fall below the stabilized producer price, with a consequent net payout to producers.

One of the main features of the early literature on the effects of

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stabilization programs is its reliance on static stabilization rules which do not bear much resemblance to the rules used in real-world stabilization programs. The rule used in the papers by Waugh, Oi, Massell and VSF is a fixed price rule. In this paper, in addition to this fixed price (FP) rule, we want to examine the effects of two dynamic stabilization rules. They are a moving average price (MA) rule and a price underwriting (UW) rule. MA operates in a similar way to FP as producers receive the stabilization program price, except that this price is no longer fixed. It is now a moving average of past market prices. UW uses the moving average stabilization price as a price floor. Producers receive the stabilization price only if market prices fall below this level, else they receive the market price.

Stochastic Simulation Exercise

We employ dynamic stochastic simulation of a simple commodity market that is subject to supply uncertainty, namely, the Canadian hog market. The methodology is analagous to that used by Miranda and Helmberger. The purpose is to show that the specification of stabilization rules and market structure matter when assessing the results of stabilization. In particular, we show that the principal conclusions of VSF do not hold in certain situations.

The impact of price stabilization is investigated under (i) a closed economy (autarky) and (ii) a small open economy. For each, we explore the effects of the three alternative stabilization rules discussed above. Under the FP rule, the producer price is set at the arithmetic average of the market price that would maintain in a competitive market; it is determined by setting it equal to the average price determined from the competitive market simulation over 100 replicates of 30 years each. Under the MA rule, the producer price is set at the five-year moving average of the competitive market price. Under the UW rule, producers receive the moving average price only if it exceeds the current market price, but, if the market price exceeds the moving average price, producers receive the market price. Since the MA and UW rules involve the use of 5-year moving averages, we set the stabilization price at the average price as determined from the competitive market simulation for the first five years of the simulation. After the fifth year, the stabilization price is calculated according to our two dynamic stabilization rules.

Autarky Model

The model of the Canadian hog market under autarky is illustrated in Figure 1. On the basis of historical data, the CE equilibrium price and quantity are chosen to be \$3.75/kg and 700 million kilograms, respectively, with the standard deviation of quantity determined to be approximately 70 million kgs. The planned supply curve is assumed to be linear with the price elasticity taking on values 0.5, 1.0 and 1.5 at the CE equilibrium. This range of elasticities is not unreasonable in light of earlier empirical estimates (Chin, Pando and West; Martin and Zwart). The demand for hogs is simulated by a linear and a double-logarithmic functional form, with an assumed elasticity of -1.0 (Hassan and Johnson's estimate is -0.955).

The basic simulation model is as follows:

<u>Supply</u> $$Q^{*}_{it} = 700(1-\varepsilon_s) + (700\ \varepsilon_s/3.75)\ \hat{P}_{i}t$$

$$Q_{it} = Q^{*}_{it} + u_{it}$$

<u>Demand</u> Linear: $$QD_{it} = 1400 - 186.67\ P_{it}$$

Nonlinear: $QD_{it} = 0.000381\ P_{it}^{-1.00}$

Expected producer price

Competitive market: $\hat{P}_{it} = 3.75$

Fixed price rule: $\hat{P}_{it} = \sum_{t=1}^{T} (\sum_{i=1}^{r} P_{it} / r) / T$

Moving average price rule: $\hat{P}_{it} = [\sum_{k=1}^{5} (P_{i(t-k)}]/5$

Underwriting price rule: $\hat{P}_{it} = \mathrm{Max}\{ 3.75, [\sum_{k=1}^{5} (P_{i(t-k)}]/5\}$

Net income transfer from the government to producers

Fixed price rule: $PAY_{it} = \{[\sum_{t=1}^{T} (\sum_{i=1}^{r} P_{it}/r)/T] - P_{it}\} Q_{it}$

Moving average price rule: $PAY_{it} = \{[\sum_{k=1}^{5} (P_{i(t-k)}]/5 - P_{it}\} Q_{it}$

Underwriting price rule: $PAY_{it} = \mathrm{Max}\{ 0, [\sum_{k=1}^{5} (P_{i(t-k)}]/5] - P_{it}\} Q_{it}$

Producer revenue $REV_{it} = P_{it}\ Q_{it} + PAY_{it}$

In the model, Q^{*}_{it} = planned output; ε_s = elasticity of supply; $\hat{P}_{it}$ = rationally expected price; Q_{it} = actual quantity produced; u_{it} = random shock to quantity produced; P_{it} = actual price; PAY_{it} = income transfer to producers (+) or to the government (-); REV_{it} = producer revenue including income transfers; t = 1,...,T, and i = 1,...,r, where T is the total number of years simulated and r is the number of replicates. Under the no-program simulation, the rationally expected producer price is constant at the intersection of the demand and planned supply curves ($3.75/kg); under stabilization, it is a function of the particular stabilization rule simulated.

A summary of the simulation results for the no-trade or autarky case is provided in Table 1. Several conclusions can be derived from these results.

(1) Under the 'no rule' scenario, average price is higher when the demand curve is nonlinear and convex toward the origin (i.e., double-logarithmic functional form). This follows the logic of Figure 1.

(2) Under the fixed price rule and a nonlinear demand curve, the producer price is set at the average competitive price which is higher than the certainty equivalent equilibrium price. On average, this results in an increase in quantity produced and a decrease in consumer price. This result is contrary to the results of VSF who found no production and price effects (and hence no welfare effects). The production and price effects are less the lower is the assumed elasticity of supply. The VSF result corresponds to an elasticity of supply of zero.

(3) All three price stabilization rules lead to a reduction in the variability of producer price as measured by the standard deviation, but all also lead to an increase in the variability of producer revenue. This result agrees with VSF who demonstrate theoretically that producer revenues are more variable under a price support program than under perfect competition. This was also demonstrated via a simulation model by Miranda

and Helmberger. This result may be an argument against price stabilization since producers are generally thought to be more concerned with income stability than price stability.
(4) On average, all stabilization rules provide for an income transfer from the government to producers. This is particularly the case for underwriting.
(5) Underwriting tends to result in an increase in average production and a decrease in average producer and consumer prices. This applies both in the case of the linear and nonlinear demand curves. The depressing effect on producer price is interesting since it is precisely opposite to the basic objective of the rule which is to support (underwrite) producer price.

Small Open Economy Model

The situation for trade is illustrated using Figure 2. As output price is not determined within the domestic economy, we assume that it is a normally distributed random variable with known mean ($\bar{p}$) and variance (σ^2). Rational producers correctly anticipate the distribution of (exogenous) output price and, in the competitive model, plan to produce that level of output (as determined by the planned supply curve) associated with the mean price, namely, q^*. However, the planned output is not realized as actual output is normally distributed with mean given by the planned level and standard deviation determined by random shocks as explained previously. Any output not sold in the domestic economy at the random, exogenously-determined price is sold abroad at that price; if there is excess demand, it is satisfied by imports. Hence, in Figure 2, q^D is consumed domestically while the difference between realized output (q^R) and domestic consumption is exported. While the simulation model is basically the same as for the closed economy, there are three changes or additions:

Consumer Price	$P_{it} = 3.75 + v_{it}$,
Expected Producer Price: Competitive Model	$\hat{P}_{it} = 3.75 + v_{it}$, and
Net Exports	$QX_{it} = Q_{it} - QD_{it}$,

where v_{it} is the random shock to price in period t, replicate i, and QX_{it} is the quantity exported (imported) in period t, replicate i. Externally-determined price is assumed to be a normal random variable with standard deviation of $0.90 per kg. The simulation results are given in Table 2.

The following conclusions are based on these simulation results.
(1) The average quantity produced is not affected by the FP and MA stabilization rules, but it does tend to increase under the UW rule. The distortion in production increases the more elastic the planned supply. Distortions in production imply welfare effects. Thus, while the FP and MA rules appear to lead to conclusion 1 of VSF, the UW rule does not. The variability of output is increased under the MA and UW rules but not under FP. MA results in the largest distortion in the variability of output.
(2) The average producer price is unaffected by any of the stabilization rules. The variability of producer price is reduced under all three rules.
(3) The average producer revenue is increased under the MA and UW rules, but not under the FP rule. Variability in producer revenue tends to be lower under all three rules compared with a competitive market. This is in contrast to the autarky case where the variability in producer revenue increased under all three rules. This suggests that price stabilization may

assist producers in reducing their income variability provided they are producing a commodity whose price is determined in world markets. This result does not agree with conclusion 2 of VSF.

(4) There appears to be an average net income transfer from the government to producers under the MA and UW rules, but not under the fixed-price rule. The result for the FP rule is in contrast to what was found for the autarky case and is in contrast to conclusion 3 of VSF. VSF argue that a fixed price rule would lead to a net transfer of income from the government to producers. However, their model represented a closed economy. We find this is true for the autarky/large open economy model (which is what VSF implicitly assumed), but not for the small, open economy model.

(5) There is an increase in net exports under an underwriting scheme but not under the other schmes. This can be traced back to the positive output effect generated by the UW rule. The FP and MA rules tend to lead to a modest increase in the variability of net exports.

Conclusions

Our results provide evidence that price stabilization may not provide unequivocal benefits to producers or consumers. It depends on the structure of the model and the particular stabilization rule used. For example, the variability in producer revenue may increase or decrease as a result of price stabilization depending on whether we assume an autarky/large open economy model or a small open economy model. The average level of producer revenue depends on the choice of stabilization rule. Thus, the UW rule, which has an extra built-in subsidy component through the underwriting mechanism, results in a higher average level of producer revenue than the other two rules. Under autarky, average consumer prices tend to be higher when a nonlinear as opposed to linear demand curve is assumed.

Methodologically, this simulation exercise does three things. Firstly, it suggests that the effects of introducing a stabilization program depend critically on the particular stabilization rules employed. Thus, results obtained using the simplistic rules described in the early literature may be very different from those obtained with an alternative, more realistic stabilization rule. Secondly, it suggests that these rules should be incorporated into an analysis of price stabilization via the producer expectations variable. If one assumes that producers have rational expectations then, when a stabilization rule is introduced or modified, this should form part of the information set available to the producer to generate his price expectations and, hence, affect his supply decisions. Thirdly, this exercise suggests that dynamic stochastic simulation is a very useful tool for analyzing the effects of different stabilization rules. Simulation allows one to model a particular commodity market with particular stabilization rules. Stochastic simulation allows for the fact that (price or production) uncertainty is required before a stabilization rule is triggered. Dynamic stochastic simulation allows for the analysis of stabilization rules that are dynamically determined (e.g., moving average rules) or that have dynamic effects (i.e., lagged effects resulting from a lack of information or from adjustment costs).

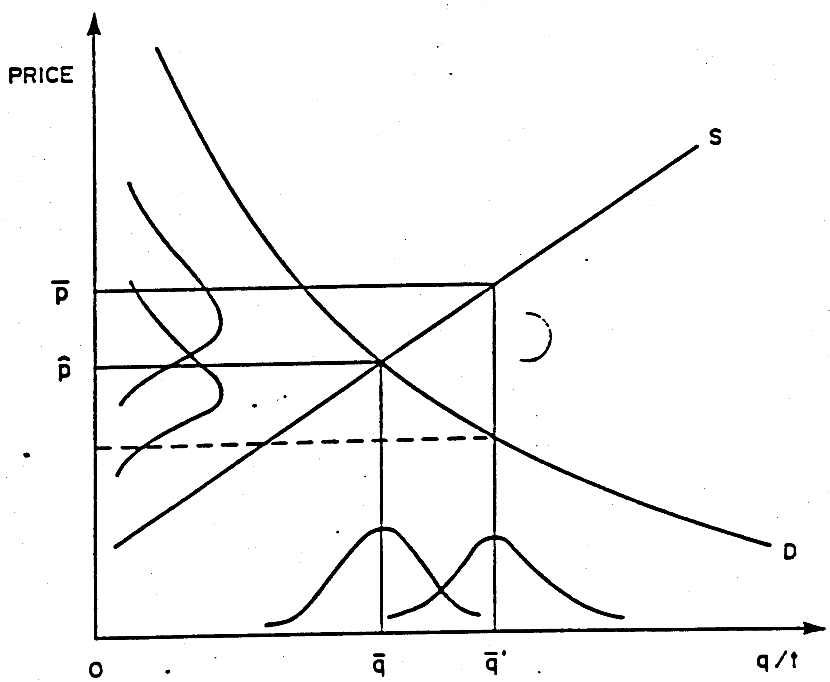

FIGURE 1 COMMODITY MARKET MODEL GIVEN NORMALLY DISTRIBUTED STOCHASTIC OUTPUT AND AUTARKY

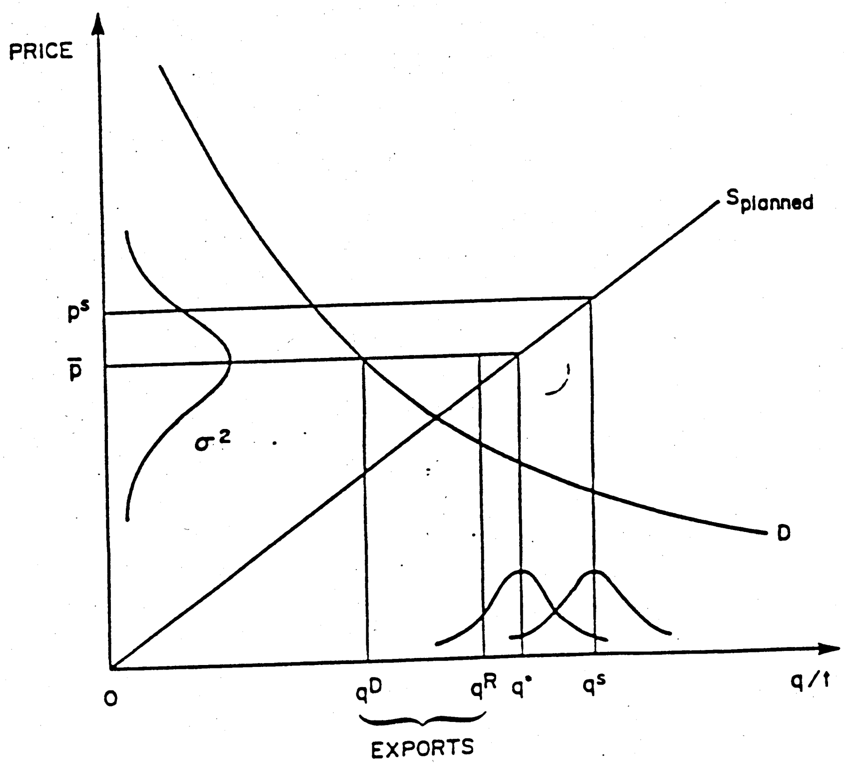

FIGURE 2 COMMODITY MARKET MODEL GIVEN NORMALLY DISTRIBUTED STOCHASTIC OUTPUT AND PRICE IN A SMALL OPEN ECONOMY

Table 1: Simulation Results Under Alternative Price Stabilization Rules and Autarky[a]

Stabilizn. Rule[b]	Quantity Produced	Consumer Price	Producer Price	Producer Revenue[c]	Income Transfer
A. LINEAR DEMAND					
(elasticity of supply = 0.5)					
no rule	699 (69)	3.76 (.37)	3.76 (.37)	2599 (36)	-
FP	699 (69)	3.75 (.37)	3.76 (.00)	2627 (260)	28 (259)
MA	700 (70)	3.75 (.38)	3.76 (.15)	2630 (298)	32 (297)
UW	704 (70)	3.73 (.37)	3.74 (.16)	2732 (184)	133 (197)
(elasticity of supply = 1.0)					
no rule	699 (69)	3.76 (.37)	3.76 (.37)	2599 (36)	-
FP	700 (69)	3.75 (.37)	3.76 (.00)	2629 (260)	30 (259)
MA	700 (73)	3.75 (.39)	3.76 (.13)	2631 (316)	35 (316)
UW	708 (71)	3.71 (.38)	3.72 (.15)	2736 (189)	138 (206)
(elasticity of supply = 1.5)					
no rule	699 (69)	3.76 (.37)	3.76 (.37)	2599 (36)	-
FP	701 (69)	3.75 (.37)	3.76 (.00)	2632 (260)	39 (260)
MA	700 (77)	3.75 (.41)	3.75 (.13)	2632 (338)	39 (338)
UW	710 (72)	3.70 (.38)	3.71 (.15)	2739 (195)	142 (214)
B. NONLINEAR DEMAND					
(elasticity of supply = 0.5)					
no rule	699 (69)	3.80 (.39)	3.80 (.39)	2625 (00)	-
FP	703 (69)	3.77 (.37)	3.80 (.00)	2668 (263)	43 (263)
MA	702 (70)	3.78 (.40)	3.78 (.15)	2657 (305)	32 (305)
UW	706 (70)	3.76 (.39)	3.77 (.16)	2760 (187)	135 (187)
(elasticity of supply = 1.0)					
no rule	699 (69)	3.80 (.39)	3.80 (.39)	2625 (00)	-
FP	707 (69)	3.75 (.38)	3.80 (.00)	2684 (263)	59 (263)
MA	704 (73)	3.77 (.41)	3.78 (.14)	2660 (325)	35 (325)
UW	710 (71)	3.74 (.39)	3.74 (.15)	2764 (194)	139 (194)
(elasticity of supply = 1.5)					
no rule	699 (69)	3.80 (.39)	3.80 (.39)	2625 (00)	-
FP	711 (69)	3.73 (.38)	3.80 (.00)	2700 (263)	75 (263)
MA	705 (78)	3.77 (.44)	3.77 (.14)	2664 (349)	39 (349)
UW	713 (72)	3.72 (.40)	3.73 (.15)	2767 (201)	142 (201)

[a] Mean values with standard deviations in parentheses
[b] FP = fixed price; MA = moving average price; UW = underwriting.
[c] Includes government payments and levies

Table 2: Simulation Results Under Alternative Price Stabilization Rules and an Open Economy[a]

Stabilizn. Rule[b]	Quantity Produced	Producer Price	Producer Revenue[c]	Income Transfer	Net Exports
A. LINEAR DEMAND					
		(elasticity of supply = 0.5)			
no rule	779 (69)	3.74 (.89)	2912 (740)	-	77 (178)
FP	778 (69)	3.74 (.00)	2910 (259)	2 (700)	76 (178)
MA	778 (80)	3.74 (.39)	2928 (520)	19 (767)	76 (182)
UW	795 (73)	3.74 (.39)	3290 (571)	319 (460)	93 (179)
		(elasticity of supply = 1.0)			
no rule	779 (69)	3.74 (.89)	2912 (740)	-	77 (178)
FP	777 (69)	3.74 (.00)	2907 (259)	2 (699)	75 (178)
MA	777 (105)	3.74 (.39)	2941 (656)	35 (769)	76 (194)
UW	810 (83)	3.74 (.39)	3359 (627)	330 (479)	109 (184)
		(elasticity of supply = 1.5)			
no rule	779 (69)	3.74 (.89)	2912 (740)	-	77 (178)
FP	776 (69)	3.74 (.00)	2904 (259)	2 (698)	74 (178)
MA	777 (138)	3.74 (.39)	2954 (798)	52 (773)	75 (213)
UW	826 (98)	3.74 (.39)	3428 (696)	341 (500)	124 (191)
B. NONLINEAR DEMAND					
		(elasticity of supply = 0.5)			
no rule	779 (69)	3.74 (.89)	2912 (740)	-	29 (230)
FP	778 (69)	3.74 (.00)	2910 (259)	2 (700)	28 (230)
MA	778 (80)	3.74 (.39)	2928 (520)	19 (767)	28 (233)
UW	794 (73)	3.74 (.39)	3290 (571)	319 (460)	44 (231)
		(elasticity of supply = 1.0)			
no rule	779 (69)	3.74 (.89)	2912 (740)	-	29 (230)
FP	777 (69)	3.74 (.00)	2907 (259)	2 (699)	27 (230)
MA	777 (105)	3.74 (.39)	2941 (656)	35 (769)	27 (244)
UW	810 (83)	3.74 (.39)	3359 (627)	330 (479)	60 (235)
		(elasticity of supply = 1.5)			
no rule	779 (69)	3.74 (.89)	2912 (740)	-	29 (230)
FP	776 (69)	3.74 (.00)	2904 (259)	2 (698)	26 (230)
MA	777 (138)	3.74 (.39)	2954 (798)	52 (773)	26 (260)
UW	826 (98)	3.74 (.39)	3428 (696)	341 (500)	76 (241)

[a] Mean values with standard deviations in parentheses
[b] FP = fixed price; MA = moving average price; UW = underwriting
[c] Includes government payments and levies

REFERENCES

Chin, S. B., J. L. Pando and D. A. West. National and Regional Hog Supply Functions. Economics Branch Publication No. 74/15, Agriculture Canada, Ottawa, 1974.

Goodwin, Thomas and Steven M. Sheffrin. "Testing the Rational Expectations Hypothesis in an Agricultural Market", Review of Economics and Statistics 64(November 1982): 658-667.

Hassan, Zuhair A. and S. R. Johnson. Consumer Demand for Major Foods in Canada. Ottawa: Agriculture Canada, Economics Branch Publication 76/2, 1976.

Huntzinger, R. LaVar. "Market Analysis with Rational Expectations", Journal of Econometrics 10(June 1979): 127-145.

Martin, Larry and Anthony C. Zwart. "A Spatial and Temporal Model of the North American Pork Sector for the Evaluation of Policy Alternatives", American Journal of Agricultural Economics 57(February 1975): 55-66.

Massell, Benton F. "Price Stabilization and Welfare," Quarterly Journal of Economics 83(May 1969): 284-298.

Miranda, Mario J. and Peter G. Helmberger. "The Effects of Commodity Price Stabilization Programs", American Economic Review 78(March 1988): 46-58.

Muth, John F. "Rational Expectations and the Theory of Price Movements", Econometric 29(1961): 315-335.

Newbery, David M. G. and Joseph E. Stiglitz. The Theory of Commodity Price Stabilization. Oxford: Clarendon Press, 1981.

Oi, Walter Y. "The Desirability of Price Instability Under Perfect Competition," Econometrica 29(January 1961): 58-64.

Van Kooten, G.C., Andrew Schmitz and W. Hartley Furtan. "The Economics of Storing a Non-Storable Commodity", Canadian Journal of Economics 21(August 1988):

Waugh, Fredrick W. "Does the Consumer Benefit from Price Instability?" Quarterly Journal of Economics 58(August 1944): 602-14.