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Search for Stability under Price Risk

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Abstract

Society's preference for commodity price stability brought about by storage is supported by many researchers. However, most of the models assume that both prices and quantities are known with certainty. Also, the models' price instability comes about from supply shocks where the variation in supply is due to shifting supply curves. These assumptions have been criticized. To relax these assumptions, we introduce a price risk model that distinguishes between ex ante decisions and ex post outcomes, and supply shocks are generated not from a shift in the planning supply curve, but rather, from production deviations from it. Even when a price risk model is used, society prefers price stability to instability—the result common in the literature. Also, private competitive storage leads to optimal price stability and, therefore, there is no need for government storage.

Keywords

Commodity Stocks, Price Risk, Stabilization

1. Introduction

Society's preference for commodity price stability is supported by many researchers where price stability is generated through storage (Massell, 1969, 1970; Just et al., 1978, 2004; Konandreas & Schmitz, 1978; Turnovsky, 1978; Gardner, 1979; Wright & Williams, 1982; Tangermann, 2011; Schmitz & Kennedy, 2016; Schmitz, 2018a, 2018b; Kennedy et al., 2019, 2020; McLintock, 2020; Schmitz & Chegini, 2020; van Kooten et al., 2020; Schmitz et al., 2021). However, most of the models used to arrive at this conclusion assume that prices are known with certainty, and instability is generated by supply shocks where the variation in supply is due to shifting supply curves. These assumptions have been criticized (e.g., Tisdell, 1972; Just et al., 2004). To relax these assumptions, this paper introduces a price risk model that distinguishes between ex ante decisions and ex post outcomes. Producers are assumed to make production decisions using a planned supply curve. Supply shocks are generated from production deviations from the planned supply curve rather than from the shift in supply curves.

2. Risk Framework

In the risk models discussed below, it is made clear that price instability brought about by production shocks are not generated from shifts in supply curves, rather the instability is due to production variation from a producer's planned supply curve.

2.1. No Price Instability

Consider the following model framework that deals with price risk in later models. The framework is very different than used in standard stability models. Here, we separate ex ante decisions on the part of producers from ex post outcomes. In standard models, both price and quantities are known with certainty. As shown in **Figure 1**, demand is given by D_d, and S_p is the producers' supply curve. The latter is an ex ante planning curve, where producers at planting time expect to receive price p_e for their crop and expect to produce q_e. The area $(p_e bc)$ is the cost of the fixed factor of production, while area $(bq_e c)$ is the total variable cost. Therefore, the producers' expected total cost equals $(p_e bq_e c)$. The expected total revenue is $(p_e q_e)$.

2.2. Price Instability under Zero Storage

For simplicity, many conventional models use two time periods, where production in period 1 is very different from production in period 2. However, the outcomes (both prices and quantities) are known with certainty.

2.2.1. Period 1

Suppose in period 1 that due to abundant rainfall, output is q_1 that exceeds expected production q_e. The price falls from p_e to p_1. In this case, total revenue (TR) is $(p_1 bq_1 d)$, while the total cost (TC) is $(p_e bq_e c)$. The effect on

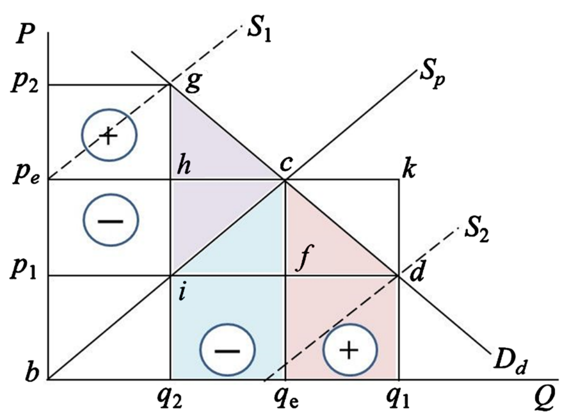

Figure 1. Price instability: Ex ante versus ex post outcomes.

producers is negative $\{(p_e p_1 fc)-(fq_e q_1 d)\}$. The gain to consumers is $(p_e p_1 dc)$. The net societal gain is $(cq_e q_1 d)$.

2.2.2. Period 2

In period 2, due to drought, output falls to q_2 which is less than the expected output q_e. The price increases to p_2 which is above the expected price p_e. As a result, total revenue (TR) is $(p_2 bq_2 g)$, while TC remains at $(p_e bq_e c)$. The negative effect on producers is $\{(p_2 p_e hg)-(hq_2 q_e c)\}$. The loss to consumers totals $(p_2 p_e cg)$. The net societal loss is $(gq_2 q_e c)$.

2.2.3. Periods 1 and 2 (Net Producer Loss)

Over the two periods, there is a net loss to producers from a price variability of $2(hifc)$ or $\{(hifc)+(p_e p_1 ih)\}$. There is a consumer gain of (cid).

The relative losses to producers from price risk depend on price demand elasticities. The more elastic the demand, the greater will be the loss in period 2 relative to period 1, but there remains a loss in each period. Also, under elastic demand, the producer loss is greater; therefore, it is in the interest of producers to use storage to create price stability.

2.2.4. Periods 1 and 2 (Net Consumer Gains)

In this model, consumers lose from price stability while producers gain. In period 1, consumers gain $(p_e p_1 dc)$ while, in period 2, they lose $(p_2 p_e cg)$. On net, consumers lose (cid).

2.2.5. Combined Effects of Price Instability

In the absence of storage in period 1, the net effect of price instability is $(cq_e q_1 d)$ and for period 2 $(gq_2 q_e c)$. The combined effect is (gic).

2.3. Price Instability with Storage

We now consider the effect of storage that is used to bring about price stability. Earlier models were incorrect in arguing that storage brings about complete price stability. In this framework, storage can only bring about partial price stability (Schmitz, 2018a). Under achievable storage, the price is completely stabilized.

When $(q_e q_1)$ is stored in the abundant supply period and released in the short supply period, price is stabilized at p_e. The effects are as follows:

$$\text{Producer gain from stabilization} = (hifc)+(cfdk) \tag{1}$$

$$\text{Consumer loss from stabilization} = -(p_2 p_e cg)+(p_e p_1 dk) \tag{2}$$

where $(p_2 p_e cg)=(hifc)$ and $(p_e p_1 dk)=(cfdk)$.

$$\text{Net gain from stabilization } (gic) \text{ is positive.} \tag{3}$$

3. Producer Gains from Storage: Different Demand Price Elasticities

The incentive for producers to engage in storage depends on the nature of the product produced. Consider **Figure 2**, where demand D^* is more price elastic than demand D. The producers' planned supply curve is S_p. The stable price and quantity are p_s and q_s, respectively. Consider the effect in period 1 of a production shock of $(q_s q_1)$. For demand D, the price falls to p_4, but for D^*, the price falls to p_1 and the net loss in total revenue is $\{(p_s e q_s f)-(p_4 e q_1 c)\}$. Under demand D^*, the total revenue falls from $\{(p_3 e q_s f)-(p_1 e q_1 d)\}$. Thus, for the more inelastic demand, the greater is the loss in total revenue from a supply shock.

Consider period 2. For demand D, a production shock of $(q_2 q_s)$ causes price to increase to p_3, but for D^*, the price increases to p_2. Hence, under inelastic demand D^* relative to D, total revenue increases by $(p_2 p_3 ba)$ for a production change of $(q_2 q_s)$. Hence, the gain in total revenue for demand D is smaller than for D^*. However, compared to period 1, the size of the loss in period 1 is far greater than the gain in period 2 under demand D^* versus D as measured by $\{(p_4 p_1 dc)-(p_2 p_3 ba)\}$. This adds to the incentive for producers to store when the commodity produced is relatively price inelastic.

4. Conclusions and Limitations

The major conclusion from our risk model supports the use of storage to improve society's welfare. This conclusion further supports that reached by other researchers who largely use models where production and price under different time periods are known with certainty.

Within our model, there is no need for government storage. To maximize profits, producers carry out storage. The incentive for producers to store increases when the price elasticity of demand for the commodity is highly inelastic.

The conclusion supporting private storage does not take into account the support for government storage to improve food security in food-deficit less-developed countries. If a government's objective is to use stocks to promote

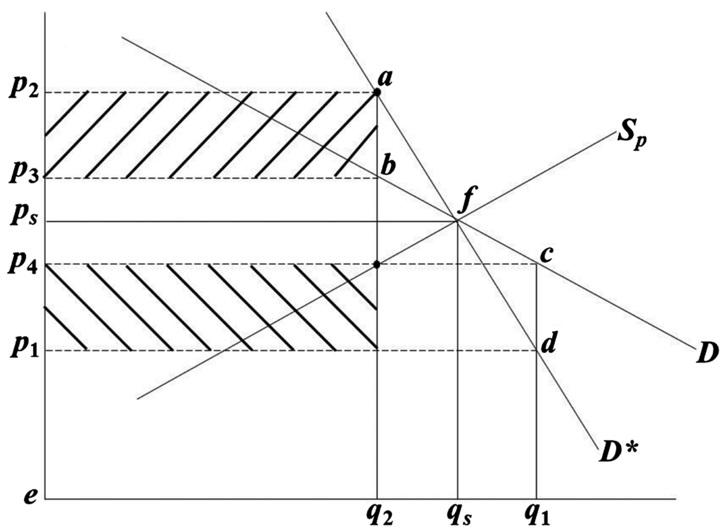

Figure 2. Producer storage under different demand price elasticities.

food security, this may lead to a different outcome than producer profit maximization (Kennedy et al., 2019, 2020; van Kooten et al., 2020).

It is important to keep in mind that our model, like those of many other researchers, is based on classic welfare economics. Within this framework, the role of government to promote food security should be given explicit treatment. In addition, our model should be extended to include more than two time periods. For example, in a four-time period model, the results could be derived when probabilities attached to higher output periods are greater than those attached to lower output periods. Also, we do not consider producer supply response under rational expectations, a topic dealt with by Wright and Williams (1982). Under these conditions, the planning supply curve in our model could take different forms.

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Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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