Foundations of Agricultural Market Analysis and Agricultural Policy

Koester

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Vahlen

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typical price differences in the course of the year, e.g. from week to week or from month to month, one speaks of a seasonal price movement. From year to year there can be price differences in equilibrium for individual products if the harvest in individual years is different, but the demand is almost constant. For example, when Josef had the dream of the seven fat years and the seven lean years to realize, the problem arose for him as to what pricing he would have to take over the course of time. Such problems can be solved if the laws of intertemporal price differences are known.

Intertemporal market equilibrium with seasonal production

In order to illustrate the problem, we first want to explain the phenomenon of seasonal price movements using a simple model-theoretical approach. We assume the following:

The perishable product under consideration is harvested in one period but is demanded during two periods. Storage is only possible including the second period. It should also be noted that space is limited, and demand can only be satisfied by regional production. In this case, the problem can be illustrated by *Figure 4.17.*

Figure 4.17 assumes that total production is equal to q^P. It is also assumed that producers have the alternative of offering either production in period 1 or in period 2. The quantity offered in period 2 must therefore be stocked by the producers in period 1. For reasons of simplification we neglect the trade and processing sector. The quantity stocked by the producers can also be called the producers' **reverse demand**. From this it follows that the market supply in period 1 results from the total production quantity minus the producers' reverse demand. The producers' reverse demand for alternative prices in period 1 depends on the expected price in period 2 and the storage costs. It is to be expected that the market supply in period 1 can react relatively elastically, since

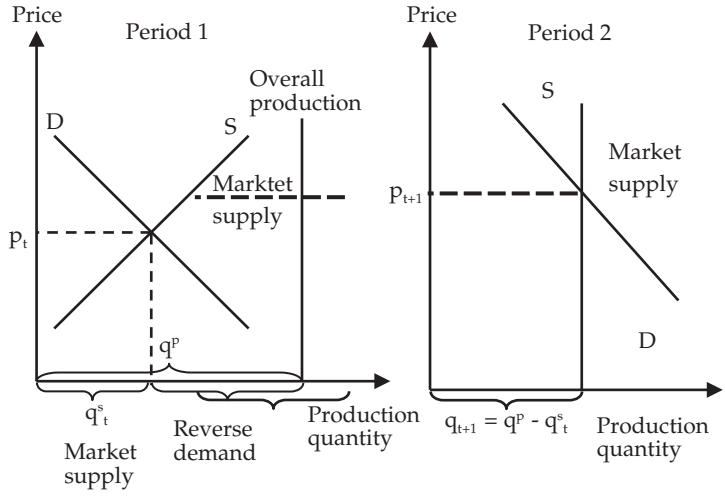

Figure 4.17: Intertemporal pricing

the producers have an alternative: they can offer in period 1 or in period 2. The situation in period 2, on the other hand, is different. It is assumed that this is a perishable product that can no longer be stored beyond period 2, as the new crop will then already be on the market and will be of higher quality. In period 2, therefore, the market supply will be completely inelastic. According to Figure 4.17, in period 1 there is a market supply in the amount q_t^S and thus a price of p_t. At this price p_t, the supply in period 2 is identical to the total production (q^P) minus the market supply in period 1 (q_t^S). For this supply of q_{t+1}, the price of p_{t+1} is obtained in period 2 according to Figure 4.17.

If the prices p_t and p_{t+1} characterize an equilibrium situation, the expectations of the producers are confirmed. In such a case the price difference $p_{t+1} - p_t$ must cover the storage costs of the products.

In detail, the following cost elements are to be paid:

- Stocking up costs
- Storage costs (interest on borrowed capital, insurance, rent, shrinkage),
- Selling costs
- Profit elements for return on equity, entrepreneurial activity and risk.

In the case of seasonal production, the price trend will be similar to that shown in *Figure 4.18*.

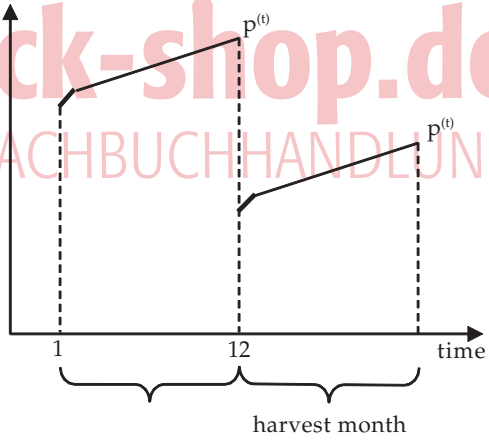

Figure 4.18: Seasonal figure of price development at harvest time at a certain point in time – schematic presentation

Figure 4.18 shows the seasonal price trend for several periods (12 months) under the above conditions. In this case, the price difference between the first and second month will be slightly greater than between the second, third and all subsequent months, because one-off costs, such as stocking up costs, arise between the first and second month, which do not occur additionally if storage is continued.

In reality, such a typical price movement will usually not occur. The main reason for this is as follows: the harvest does not occur in just one month. If we think of the potato harvest, for example, we have regions in the Federal Republic of Germany or the EU that grow early potatoes and bring their harvest to market much earlier than regions where late potatoes are grown. The potato harvest within the EU lasts several months. We will therefore have months in the course of the year in which demand can only be met from stock, and other months in which demand can be met both from stock and from current production, and finally months in which monthly production exceeds monthly demand. In such a case, with complete information, the seasonal figure could have a characteristic as shown in *Figure 4.19*.

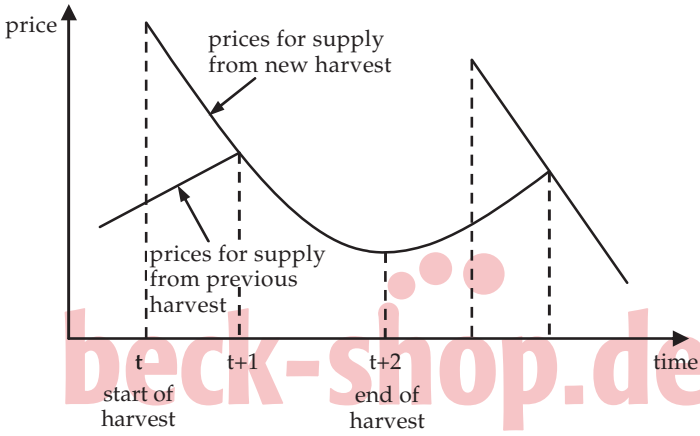

Figure 4.19: Seasonal price development for temporal extended harvest – schematic presentation

At the beginning of the harvest t products from old and new harvest are offered. It is assumed that the situation is the same as on the potato market and that the new potatoes are considered to be of higher quality than alternative potatoes from the point of view of demanders. However, since new potatoes are not yet produced in sufficient quantities, a higher price is paid on the market for new potatoes than for old potatoes. From the time t+1 only new potatoes are offered. Warehouse keepers have cleared their warehouses with complete information; the storage costs are fully covered by the development of market prices. Prices are falling until the end of harvest t+2. From this point on, demand can only be met from storage. In the period after t+2, demanders must therefore tend to pay rising prices in equilibrium. This will apply until time t+1.

The reader should note that the seasonal figure described will only be obtained with complete information. In reality, such a development will therefore rarely occur. Further details are given in chapter 4.7.

So far, we have only explained the seasonal figure for periodically occurring production. Of course, a seasonal price development can also occur during ongoing production. If, for example, the production costs vary in the course of the

year, then the production quantity will usually also vary depending on the season (typical example: milk production). A seasonal price development can also occur, however, if the production volume remains the same throughout the year as a result of seasonally varying demand (e. g. Christmas poultry, Easter eggs).

Reasons for changing the seasonal figure over time

In the case of free market price formation, the seasonal figure can change, for example, for the following reasons:

(1) Extension of the region

An extension of the region will, above all, lead to a change in the seasonal pattern if the seasonal development of production in the regions is different. If, for example, only late potatoes can be grown in a region, then the seasonal price movement on the potato market would change if the region were to be expanded to include an early potato growing area. In principle, it is true that, for example, the establishment and expansion of the EU has changed the seasonal figures in Germany (especially for plant products), since the climatic conditions in the individual regions of the EU are different.

(2) Adjustment of production costs

If the production costs are adjusted by new production processes in the course of the year, the seasonally different production quantities will be equalized, and production will be kept at a constant level throughout the year.

(3) Changes in storage costs due to the emergence of new products and new storage techniques

In particular, in the fruit and vegetable market, but also in the meat market, the emergence of new refrigeration techniques and products has contributed to the seasonal nature of these markets. If in a given period, e. g. in the harvest months or months with above-average production, the quantity produced is greater than the quantity to be consumed in that period at unchanged prices, part of the raw product quantity may be stored in frozen form. This also influences price formation in the periods in which the product enters the market in fresh form.

Shrinkage as a component of storage costs should not be underestimated. In some developing countries, for example, grain storage losses of up to 30 % can occur in some years (particularly by rats, e. g. in India). Changing the shrinkage through improved storage techniques means at the same time that storage costs and thus seasonal price differentiation are reduced.

(4) Change in transport and information costs

Falling transport costs are leading to greater market integration. Falling information costs are also having an effect in the same direction. For example, the Internet has helped to make information available more quickly and to reduce the importance of distance. Flowers can be cut one day in Kenya, sold the next morning at auction in Amsterdam and transported the same day to other European or Asian markets. Cutting the flowers in Kenya can respond immediately to changing demand in Amsterdam because of the cheap information provided by the Internet. Demand in Amsterdam in turn includes changes in demand

on Asian flower markets. The seasonal figure for flowers that was common in Europe in earlier times has therefore changed fundamentally.

Intertemporal market equilibrium with annual harvest fluctuations

To illustrate the problem, the example of the seven fat years and the seven lean years quoted above shall be used[23]. It is assumed that there is a complete temporal market transparency and therefore the production quantity in the individual years is known in advance. Furthermore, the produced quantity within the seven-year periods is the same; the production level is only higher in the fat years than in the lean years. In the following, the price, consumption and inventory developments that would occur in the intertemporal market equilibrium will be shown. If the price development is of equal weight, the price in each period must be equal to the marginal costs of supply (from current production and from warehousing).

During the seven fat years the stocks are replenished and during the seven lean years they are reduced (see *Figure 4.20*). Since storage is only profitable if the price difference from year to year at least covers the storage costs, prices must rise over the entire 14 years. While the annual price differences in the first seven years correspond to the storage costs, the price difference between the seventh and eighth years will additionally include the costs of removal (selling costs). After the eighth year, prices will continue to rise. This price movement (see *Figure 4.21*) ensures that the price difference between the year of selling from storage and the year of entry into storage covers the total storage costs in terms of stocking up costs and storage and selling costs.

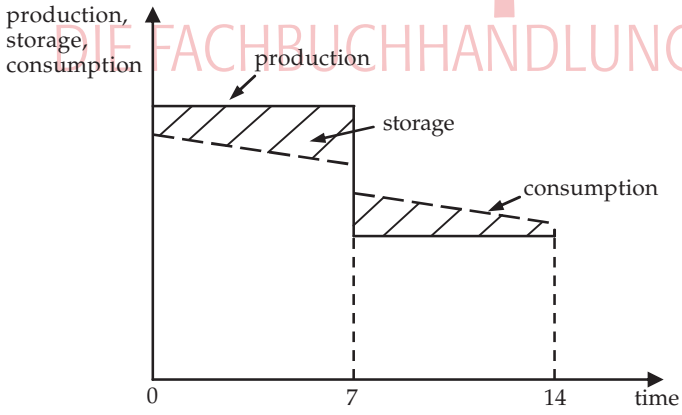

Figure 4.20: Production, storage and consumption development during seven fat and seven lean years

[23] Cf. in particular *Bressler, R.G., Jr.* und *R.A. King*, Markets, Prices and Interregional Trade. New York, London, Sydney, Toronto 1978, p. 219 ff..

The production, storage and consumption developments shown in *Figure 4.20* correspond to such a price development. Consumption decreases over time due to rising prices.

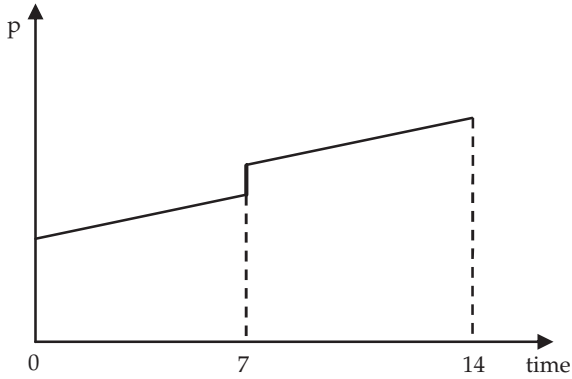

Figure 4.21: Equilibrium price development during seven fat and seven lean years

This simple example should have demonstrated that constant prices over time with annual crop fluctuations are not compatible with market equilibrium.

4.5 Fluctuations in agricultural prices

So far, we have primarily focused on the development of equilibrium prices over time between products and between individual regions. In the following we will analyze some reasons for uneven price developments for agricultural products over time.

Imbalanced price changes over time for agricultural products can be either cyclical or random.

4.5.1 Cyclical fluctuations in agricultural prices

Cyclical price movements are periodically recurring price movements with a cycle length of more than one year. Cyclical fluctuations in the agricultural sector can basically be caused by the following three factors:

(1) The echo principle

(2) Price-induced supply fluctuations and

(3) Business cycle induced fluctuations in the agricultural sector.

For didactic reasons, the analysis is based firstly on a closed national economy.

The echo principle

The **echo principle** means that investments that were increasingly made in a certain time period t lead to an increased replacement investment after n periods. If due to exogenous influences, such as war, a sudden investment activity sets in, then this will lead to an increased need for replacement after the normal wear and tear of the investments. The same phenomenon can also be observed in the labor market. In the agricultural sector, this phenomenon plays a role not only in investments in machinery and buildings, but also in permanent crops. If, for example, the profitability of a permanent crop has increased significantly due to exogenous influences, this can lead to a sudden increase in planting. After the normal lifetime of the permanent plants, new planting will then be necessary. Since the yields are usually below average in the first years after new planting, a reduced supply will be brought onto the market after each new planting, causing supply and price fluctuations.

Price induced supply fluctuations

The prerequisites for price-induced supply fluctuations are:

- the disturbance of the equilibrium by exogenous influences,
- price expectations of producers who are oriented towards current prices,
- an existing difference between the immediate and the medium to long-term supply reaction.

The situation can be illustrated in Figure 4.22.

Figure 4.22 assumes that an equilibrium originally existed for the quantity q_0 and the price p_0. This equilibrium is disturbed by an exogenous influence; it is assumed that the demand curve shifts from N_0 to N_1. If we assume that supply is completely inelastic in the short term, a price of p_1 will occur in period 1. If the producers assume that this price p_1 will also apply in the future, they will align production with this price. According to the assumed long-term supply curve A_L, this will lead to an offer of q_1. With supply q_1, however, the market can only be cleared at price p_2.

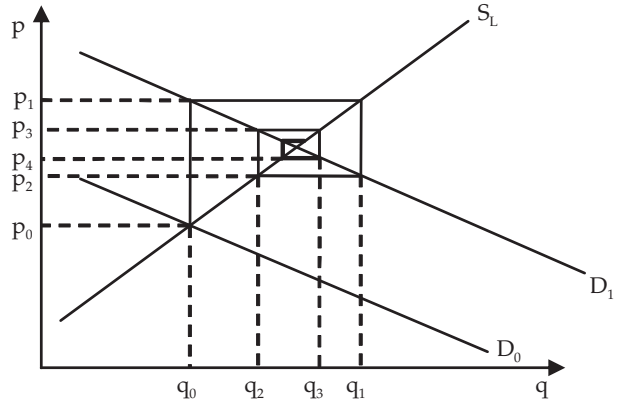

Figure 4.22: Price induced cyclical price movements

If the producers again assume that this price p_2 will also apply in the future, they will bring the supply quantity q_2 to the market. For q_2, however, the price p_3 will appear on the market. *Figure 4.22* shows that the market price is gradually moving towards the new equilibrium price. After disturbance of the equilibrium, however, the new equilibrium price is not found by a continuous approximation, but the market prices fluctuate temporarily with decreasing amplitude around the new equilibrium price. In the literature, this fact is also referred to as the ***Cobweb* theorem**, according to the graphic picture. The facts on which the *Cobweb* theorem is based are presented in *Overview 4.3*.

Period	Price of supply p^S	Price of demand p^D	Supplied quantity = demanded quantity	Relation between price of supply and price of demand
t_0	p_0^S	p_0^D	q_0	$p_0^S = p_0^D$
t_1	p_0^S	p_1^D	q_0	$p_0^S < p_1^D$
t_2	p_1^S	p_2^D	q_1	$p_1^S > p_2^D$
t_3	p_2^S	p_3^D	q_2	$p_2^S < p_3^D$
. . .	. . .			
t_n	p_{n-1}^S	p_n^D	q_{n-1}	$p_{n-1}^S = p_n^D$

Overview 4.3: Sequence analysis of cyclical price movements

In the period t_0 an equilibrium exists on the market under consideration. The supply price, i. e. the expected price, is equal to the demand price, i. e. the market price. The expectations of both producers and consumers are met. It is now assumed that the demand curve in t_1 shifts due to exogenous influences, with the result that the demand price (= market price) rises from p_0^D to p_1^D. The demand price (= market price) is then determined by the market price. However, since suppliers expect the price p_0^D, they continue to offer the quantity q_0. This means that the expected price of the suppliers p_0^S is lower than the market price p_1^D. If the suppliers expect that the price p_1^D can actually be realized on the market in period 2, they will offer the quantity q_1 on the basis of this assumption. However, it turns out that the quantity q_1 can only be sold at the price p_2^D. It follows from this that the expected price of the producers p_1^S is greater than the price p_2^D actually realized on the market. In period 3 the producers will therefore offer the quantity q_2. For the quantity q_2, however, they will not realize the expected price p_2^S, but the price p_3^D, which is larger than the expected price p_2^S, so that the producers will again adjust their production in the next period. This process continues until the expected price of the suppliers and the actual market price p_n^D match again in period n. In this period there is then again an equilibrium.