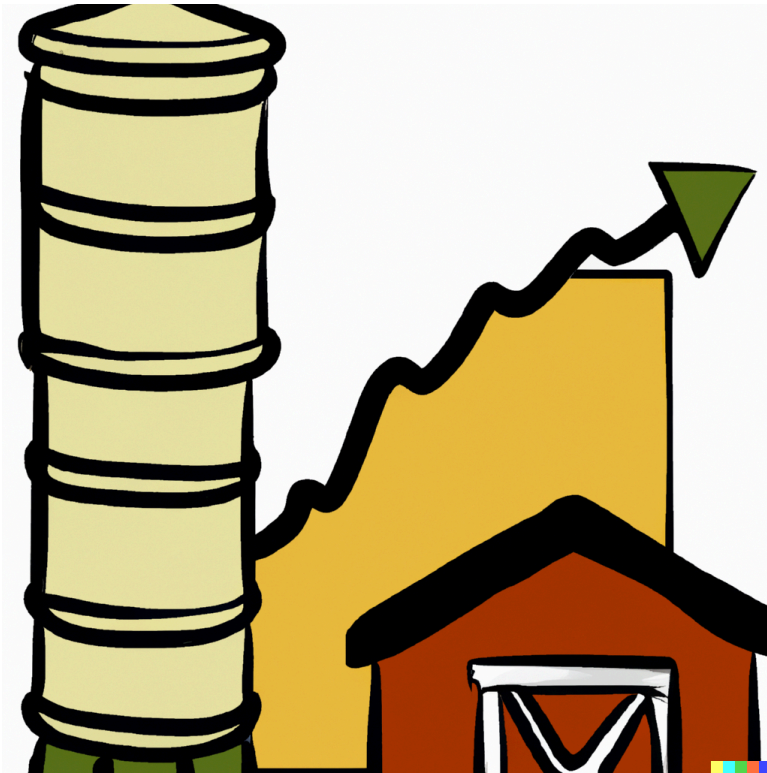


Agricultural Markets

Lecture 7: Storage and Price Dynamics

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Prices change over time



- Thus far we have considered agricultural markets in a 'static world,' where underlying factors of the demand and supply are fixed.
- Over time, these factors change. For example:
 - demand for meat may shift over time due to changes in dietary preferences;
 - supply of maize may shift each year due to weather shocks, or it may gradually shift due to technological advancement.
- The dynamic behavior of commodity prices is a consequence of such changes.

Price changes can have a specific pattern

- Changes in the underlying factors of a commodity price behavior may result in shifts and switches of the commodity price trends, or altered seasonal or cyclical patterns.
 - e.g., previously perishable products—such as meat, eggs, butter—became 'storable' with the invention of refrigeration, which also impacted their price dynamics.



The patterns are trends, cycles, and seasonality

- These changes may result in trends, cycles, and seasonal behavior of the commodity price series.
- Commodity price series may exhibit one or more of these features
 - e.g., seasonality is a likely feature of annually harvested agricultural commodity prices;
 - prices of meat typically follow a cyclical pattern, etc.

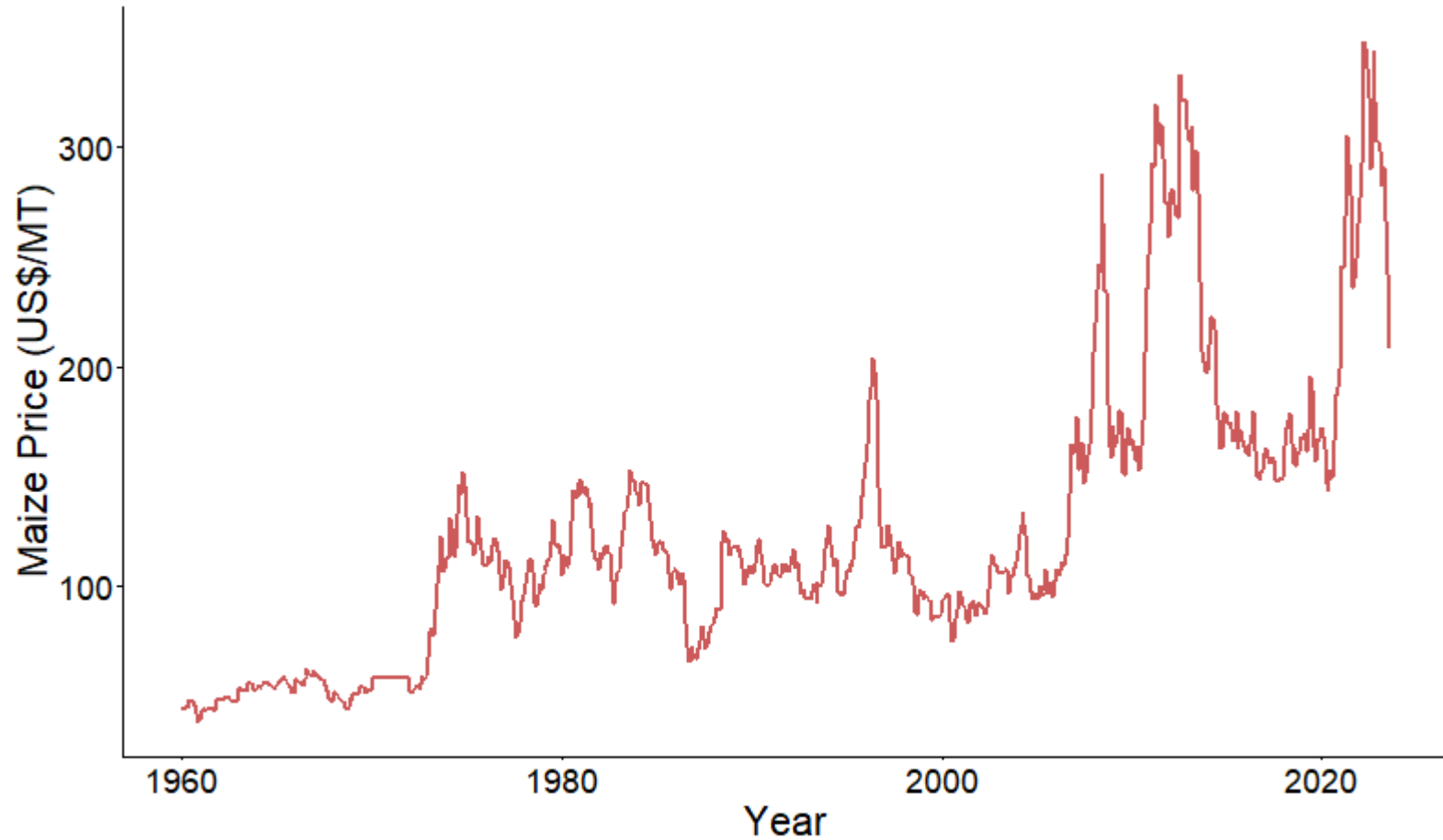


Trends and shifts in prices

- Commodity prices may exhibit time-specific shifts in price levels.
- A continuum of such shifts result in price trends.
- Trends usually are presented by persistent upward (or downward) movements in prices over a reasonably long period of time.



U.S. maize price dynamics



retrieved from the World Bank 'Pink Sheet' Data
<https://www.worldbank.org/en/research/commodity-markets>



What results in price trends?

- Recall that observed prices are equilibrium market prices, governed by supply and demand schedules.
- For an observable trend in a commodity price series, continuous relative shifts in supply and demand must occur.
 - For example, a continuous stream of new production technology may cause the supply function to steadily shift rightward, resulting in a downward trend in observed prices.



Some examples for agricultural price trends

- For agricultural commodities, a major factor in year-to-year price variability is change in annual supply.
- Crops have swings in annual production, because of changing expectations about returns as well as climatic and biological factors of production.
- Inventories and imports may mitigate the effects of a small crop in a particular region, unless the effect has worldwide manifestation.



Some examples for agricultural price shifts

- In contrast to somewhat stable year-to-year changes, there are occasions when price levels shift to (and remain at) a new level.
- This may happen as a result of an abrupt (or, possibly, gradual within a relatively short period of time) structural change in commodity markets.
 - For example, the entry of the Soviet Union into the world market for grains in 1973 created a new source of demand that persisted, which resulted in a substantially high nominal prices.
 - More recently, the so-called 'ethanol boom' in the U.S. has shifted the prices of corn to a new, higher level.



Agricultural commodity price cycles

- A cycle is a pattern that repeats itself over a time period that is longer than one year. The simplest variant of a price cycle has a fixed period, but such cycles are rare.
- Cycle-like behavior of prices is typically initiated by an external event (say, a drought). Such events manifest irregularly and with varying intensity, which play role in patterns of price cycles.
- Moreover, due to the very nature of production process, the cycles may be asymmetric - i.e., a positive shock of a given magnitude may result in dynamics that is different from dynamics due to a negative shock of the same magnitude.



What results in price cycles?

- Two factors facilitate cyclical behavior in commodity prices:
 - the way expectations are formed, and
 - the costs associated with responding to changed expectations.
- Due to the production lag, profit-maximizing decisions rely on expected (rather than actual) prices.



Price cycles and the cobweb Mmodel

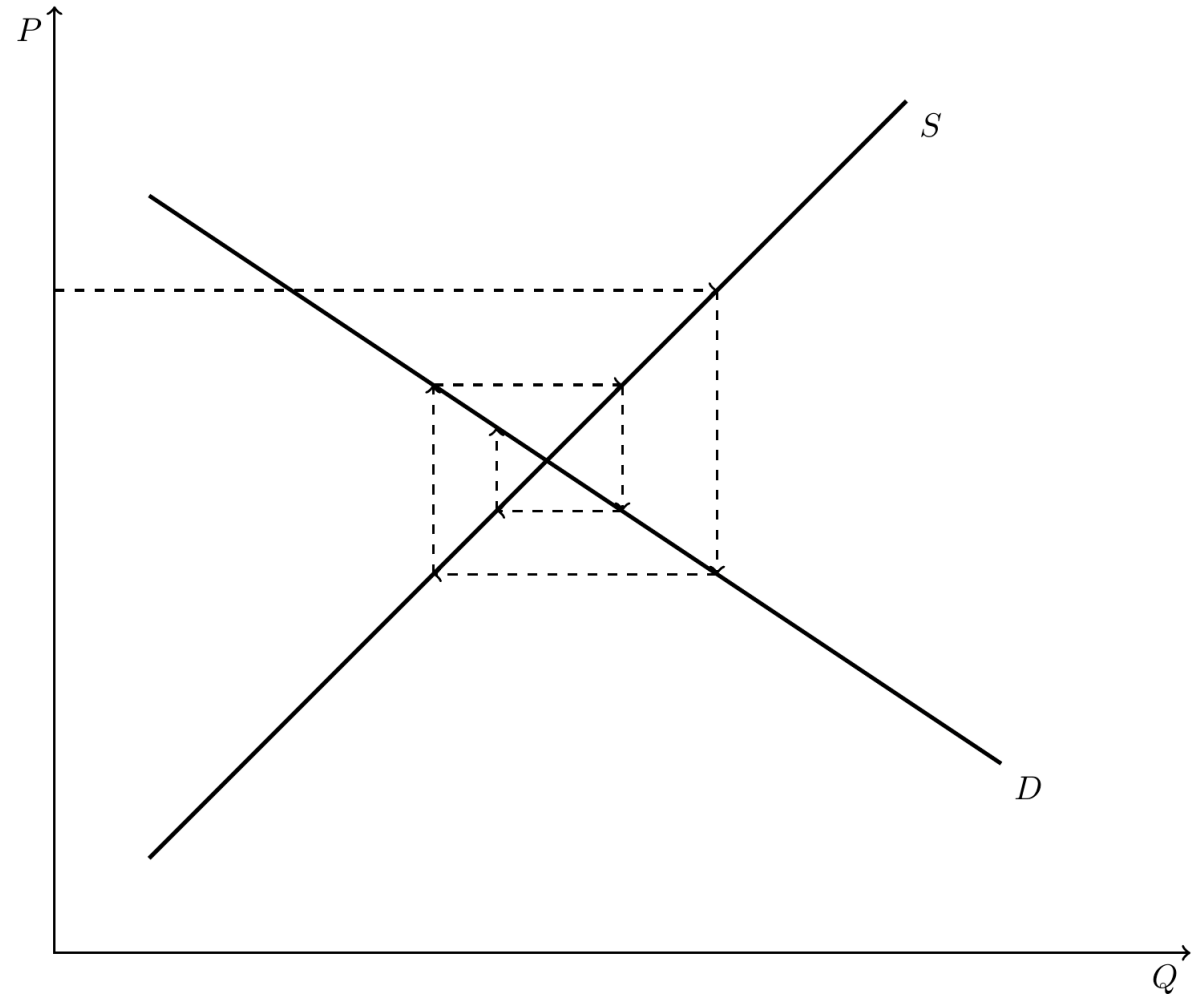
- To illustrate the point, consider a case of *naive expectations*:

$$p_{t+1}^* = p_t,$$

where p_{t+1}^* denotes the expected price for period $t + 1$, which is equal to an observed price in period t . In addition, assume a competitive market (producers are price-takers), a market clearing price adjustment, and a static supply and demand.

The cobweb model: An illustration

- Under the foregoing assumptions, a (one-off) shock to the market will result in a price (and quantity) cycles that will gradually dissolve.



Adaptive expectations and lag dependence

- Somewhat more 'sophisticated' models assume some form of *adaptive expectations*. Such models incorporate multiple lags of prices (i.e., p_{t-1}, p_{t-2}, \dots) in forming the expected price of a commodity.
- The expected price then can be a weighted average of current and past prices, e.g., a prediction from an autoregressive process. To that end, the naive expectations is a special case of the adaptive expectations.



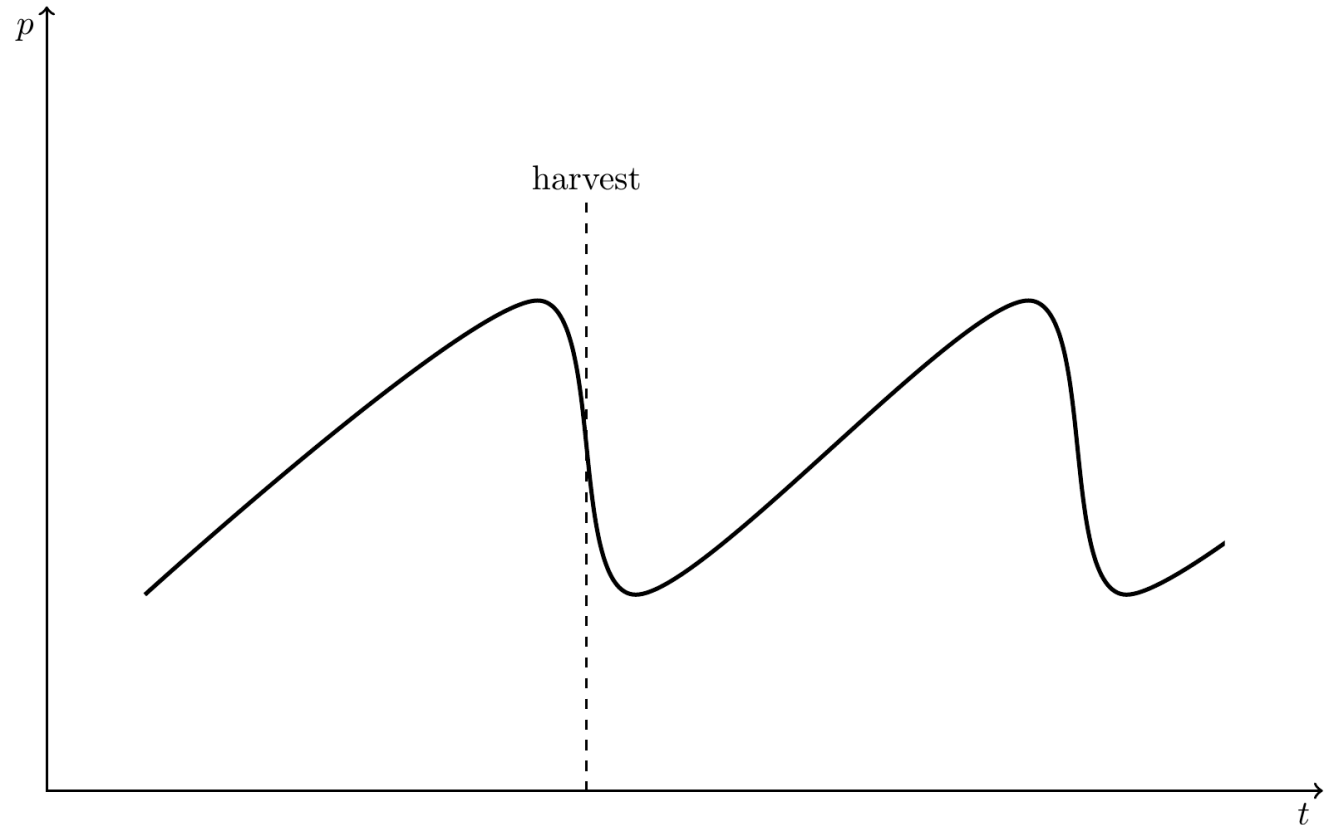
Seasonality of food and agricultural prices

- Seasonal price behavior is a systematic pattern that occurs within a year, and repeats across the years.
- For food and agricultural commodities, the main source of seasonality is the supply-side effects. Although, demand-side effects are also occasionally evident
 - For example, high demand for turkey meat in the U.S. around the Thanksgiving period in November.



Seasonality of annually harvested crop prices

- Assuming an annually produced storable commodity, and a perfectly competitive market, prices will be lowest just after the harvest, and rise at the rate of *cost of storage* per unit of time.



Different seasons – different seasonalities

- The typical seasonal price pattern does not prevail each year. Prices may rise by more than the cost of storage, or they may even decline over the season.
- People act upon information related to expected production, available stocks, and expected changes in demand for a commodity. But the information is subject to change throughout the season. And prices will reflect those changes.



Cost of storage

- The storage costs within a year—implicitly depicted in the seasonal pattern of prices—can be divided into the four components:
 - The costs of inputs;
 - The opportunity costs (which depends on the price of the commodity and interest rates);
 - The convenience yield (of holding stocks);
 - The risk associated with the expected future price of a commodity.



Seasonality of price fluctuation

- As the storage season (or the marketing year) progresses, not only prices increase, but they also become more volatile. That is, the price volatility immediately after harvest is smaller than the price volatility during the months later in the marketing year.
- Within a marketing year, inventories are declining, and when inventories are small late in the season, changes in expectations can have a large price effects (spikes).



Commodity prices, costs, and seasonality

- For an annually produced storable commodity (e.g., grains), supply is given by the production in the current period, plus the beginning inventory (i.e., the leftover stocks from previous marketing year), and minus the ending inventory.
- The decision about the inventory storage depends on the relationship of the expected price of the commodity relative to its current price.
- The driving force in the relationship between current and expected prices is *intertemporal arbitrage*.



Intertemporal arbitrage

- Mathematically, intertemporal arbitrage is given by the following equilibrium condition:

$$E(p_{t+1}|\Omega_t) - p_t = s_t,$$

where s_t is the marginal cost of storage between periods t and $t + 1$. That is, for any fixed period of storage, difference between the expected future price and the current price of a commodity must equal the marginal cost of storage for that time interval.

The law of one price (over time)

- This equilibrium condition is referred to as the law of one price in a temporal context.
- If, for example, the expected price exceeds the current price by more than the cost of storage, an incentive exists to store a larger amount of inventory for future use. This, in turn, will have the effect of raising the current price and reducing the expected price. The process will continue until the equilibrium condition is met.



The lack of the seasonality in developing countries

- While typically well-featured in developed countries, the expected seasonal pattern for annually harvested crops appears to be largely absent in developing countries.
- The lean season price fails to rise above the harvest season price 16.3% of the time on average (Cardell & Michelson, 2023).
- Aversion to the potential negative returns may tempt farmers to opt for the harvest-time sale of their crop.



Readings



Tomek & Kaiser, Chapter 9

Cardell & Michelson (2023). Price risk and small farmer maize storage in Sub-Saharan Africa: New insights into a long-standing puzzle. *American Journal of Agricultural Economics*, 105(3): 737-759.