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# AREC2002: Commodity Market and Price Analysis

## Lecture 1: Economics of Commodity Prices

### Causes and Consequences of Commodity Prices

- Agricultural commodity prices strongly influence level of farm incomes and are thus important determinant of consumer welfare
- Changes in levels of commodity prices = changes in internal/external balance with respect to MP/FP
- Bellemare 2015: high levels of food prices = social and political unrest

### Commodity Price Dynamics

- Typical time series of commodity prices shows random and systematic behaviour with occasional spikes
- Consensus about commodity price movements are that:
  1. Prices are persistent (Groshay 2013) → price today is derived from yesterday's price
  2. Process may occasionally exhibit shifts in trends (Enders and Holt 2012)
  3. Prices tend to follow asymmetric cycles (Cashin 2002) → asymmetric meaning that slumps last longer than booms
  4. Prices of different commodity groups tend to co-move (Byrne 2013) → commodities even when unrelated tend to co-move
- Price analysts are often concerned with primarily *causation and consequence* of price behaviour, but also *variance, skewness and kurtosis*

### Supply Side Effect

Agricultural commodity price behaviour largely depends on nature of the industry:

- Significant **time lags** exist between decision to produce and realisation of output
- **Yields vary** from year to year due to *weather* (random variable)/ disease/ infestation etc.
- supply is **inelastic** due to inability to adjust land and equipment
- farmer's production decisions are partially based on **expectations** about future
- yields and prices of the alternative commodities they could be producing (valuation of opportunity cost)

### Demand-Side Effect

- Farm level demand is derived from an array of uses to manufacture a broad range of end products
- Demand for most agricultural commodities are *price inelastic* since consumer preferences change gradually
- **Thus, a change in price of commodity is generally caused by supply side factors rather than demand economics**
- Exception is demand shocks like food scare e.g. Avian Influenza

### Indices

- Consumer Price Index (CPI): measure of the average rate of change in prices paid by consumers
- Producer Price Index (PPI): measure of the average rate of change in prices received by producers for their output
- Price indices are the weighted average of a basket of commodity prices

**Lowe Index** → the second formula expressed price of goods in terms of shares rather than quantity and is often a better measure than the former

Lowe Index

- ▶ For a basket of  $n$  goods and services:

$$P_t^* = \frac{\sum_{i=1}^n P_{it} Q_{ib}}{\sum_{i=1}^n P_{i0} Q_{ib}} \quad (1)$$

where  $b$  is the quantity base period, 0 is the price base period.  $P_{ij}$ , is the price of item  $i$  at period  $j$ , and  $Q_{ib}$  is the quantity of item  $i$  at period  $b$ .

Lowe Index

- ▶ Alternatively, the index can be expressed in terms of revenue/expenditure shares:

$$P_t^* = \sum_{i=1}^n \frac{P_{it}}{P_{i0}} s_{ib} \quad (2)$$

where

$$s_{ib} = \frac{P_{i0} Q_{ib}}{\sum_{i=1}^n P_{i0} Q_{ib}}$$

Two variants of the Lowe Index:

1. Laspeyres Index → gives good indication of what a base period basket of goods and services would have cost at current period prices by the way of nullifying base period quantity (b=0)

Laspeyres Index

- ▶ Impose  $b = 0$  in Lowe index to obtain Laspeyres index:

$$P_t^L = \frac{\sum_{i=1}^n P_{it} Q_{i0}}{\sum_{i=1}^n P_{i0} Q_{i0}} \quad (3)$$

where  $P_{ij}$  is the price of item  $i$  at period  $j$ , and  $Q_{i0}$  is the quantity consumed of item  $i$  at base period.

Laspeyres Index

- ▶ It is more practical to express the Laspeyres index using revenue/expenditure shares instead of quantities:

$$P_t^L = \sum_{i=1}^n \left( \frac{P_{it}}{P_{i0}} \right) s_{i0} \quad (4)$$

where  $s_{i0}$  is the relative weight of item  $i$  at base period.

2. Paasche Index → in a sense opposite to Laspeyres as  $b=t$  in Lowe

Paasche Index

- ▶ Set  $b = t$  in Lowe index to obtain Paasche index:

$$P_t^P = \frac{\sum_{i=1}^n P_{it} Q_{it}}{\sum_{i=1}^n P_{i0} Q_{it}} \quad (5)$$

where  $P_{ij}$  is the price of item  $i$  at period  $j$ , and  $Q_{it}$  is the quantity consumed of item  $i$  at period  $t$ .

Paasche Index

- ▶ As in the Laspeyres index, the Paasche index can be expressed using revenue/expenditure shares:

$$P_t^P = \left[ \sum_{i=1}^n \left( \frac{P_{it}}{P_{i0}} \right)^{-1} s_{it} \right]^{-1} \quad (6)$$

Fisher Index → the CPI measure obtained as a geometric average of Laspeyres and Paasche Indices

Fisher (Ideal Price) Index

- ▶ The Fisher index, is the CPI measure obtained as a geometric average of Laspeyres and Paasche indices.

$$P_t^F = \sqrt{P_t^L \times P_t^P} \quad (7)$$

where  $P_t^L$  and  $P_t^P$  are price measures calculated via Laspeyres and Paasche indices.

Use of Indices

Consumer and producer price indices are useful as:

- economic indicator
- deflator of other series
- agents make decisions in relative terms → they use time series comparison/ expectations which are internalised in the discussed measures

Real vs Nominal Prices

Real prices are nominal prices normalised to present a particular period in time

$$P_t^R = P_t^N \times \frac{P_b^*}{P_t^*} \quad (8)$$

Or can use  $[P^N / (P_t^* / P_b^*)]$

where  $P_t^*$  represents a price index (i.e., a deflator) in period  $t$ ; and  $b$  is the base period of choice.

## Lecture 3: Firms Objective and Producer Surplus

### Producer Objective Function

Firm's profit function:  $\pi = pq(x_1, x_2) - w_1x_1 - w_2x_2$

Optimal level of factor use: where  $MP_x = w_x/p \rightarrow$  relationship implied that increase in  $w$  will lead to reduced use of that input and therefore lower output

### Supply

Market Supply: Horizontal summation of individual supply curves

Law of Supply: higher the price received for the good, the more of the same product will be supplied

### Elasticity of Supply

- Price elasticity of supply: measure of responsiveness to quantity supplied to changes in price of a commodity:

$$\epsilon^s = \frac{\partial Q^s}{Q^s} / \frac{\partial P}{P} \equiv \frac{\partial Q^s}{\partial P} \frac{P}{Q^s}$$

- Assuming linear supply curve, as Q and P increase (so movement up and along the curve), the price elasticity of supply converges to 1  $\rightarrow$  meaning 1% increase in price = 1% increase in quantity.
- If supply curve intersects with the origin, the elasticity of supply is always 1

### Determinants of Supply

Movement along curve: Factors affecting the quantity supplied (such as the own price of commodity)

Shift of curve: factors affecting actual supply

- Prices of inputs
- Value of opportunity cost (supply curve will shift to the left if alternative commodities become more profitable to produce.
- Prices of related commodities
  - Substitute commodities and joint products
- Factors affecting costs (technology)
- Factors affecting output (weather)

## Lecture 7: Price Behaviour over Time

### Dynamic Behaviour of Commodity Prices

- The dynamic behaviour of prices of a commodity is a consequence of changes in demand and supply, and can result in Trends (T), cycles (C), Seasonality (S) as well as random fluctuation (e)

$$P = T + C + S + e$$

In addition, the year-to-year variation in prices is likely due to annual production changes and other related supply shocks. Abrupt/ unexpected shifts in levels or trends in prices can also be the result of structural changes but not as common as cyclical.

- In general, the driving force behind dynamic price behaviour of commodities is *inter-temporal arbitrage* by economic agents
- *The equilibrium condition is that, for any fixed period of storage, the difference between expected future price and current price is equal to the marginal cost of storage (or marginal benefit) for that time  $\rightarrow$  law of one price*
  - E.g. if future price is expected to increase, there would be incentive to store large amounts of the commodity, which would effectively raise the current price (when including cost to store during time period) and reducing expected future price until equilibrium is met again.

### SEASONAL Price Behaviour

- Seasonal price behaviour is an observed systematic pattern that occurs within a year and repeats across the years.
  - Thus, time series data should be at least quarterly to observe seasonality as they occur within a year.
- Changes in price reflect changes in information about expected production/ available stocks and expected changes in demand (and thus price) for that commodity

Main source of seasonality for:

- Agricultural commodities = supply side effects
- Energy commodity prices = demand side factors drive price changes

Storage costs can be divided into four components:

1. The conventional costs of inputs
2. Opportunity cost
3. The convenience yield of holding the stock
4. Risk associated with expected future price of commodity

Storage Cost

- *Generally, inventories mitigate price fluctuation so higher storage cost = lower inventories = amplified seasonal pattern.*
- Non storable commodity prices are likely to have greater seasonal pattern. Technology innovation can lower storage costs and moderate seasonality price fluctuations
- A 'non-storable commodity scenario' refers to the situation where the cost to store the commodity exceeds the price differential such that agents are better off not maintaining any inventory. In this case, production of the commodity is subject to extreme seasonality price fluctuations.

*Because inventory mitigates price fluctuations, price becomes more variable as the season progresses (and inventories are declining. Price will be lowest at harvest time (when price variability is low and inventories are high) and will rise consistent with the marginal cost of storage per unit of time. During the later months of marketing, inventories are declining and changes in expectations have large price spikes.*

### SHIFTS/TRENDS in Price Behaviour

- In contrast to year-to-year changes, there are occasions when prices shift and remain at a new level. This may happen as a result of an abrupt or gradual structural change in international commodity markets.
- Trends represent persistent and systematic upward/downward movement in prices
- For an observable trend in a commodity price series, continuous relative shifts in supply/demand must occur.
- For example: a steady stream of new production technology causing supply to steadily shift to the right
- *Can think of trends as a continuum of small demand/supply shifts. An observable trend will affect the real price (adjusted for inflation) of a commodity.*

### CYCLICAL Price Behaviour

- Cycle: pattern that repeats itself over a time period that is *longer than one year*.
- Cycle-like behaviour of prices is typically initiated by an external event (e.g. drought) which manifest irregularly and the reason why cycles are generally irregular
- Cycles are also asymmetric: positive shock consequence on dynamic behaviour won't be proportional to the consequence of a negative shock of the same magnitude.

Two factors that facilitate cyclical behaviour in commodity prices:

1. Way expectations about prices are formed (four leading models)
2. The costs associated with responding to changed expectations (how costly is it for economic agents to update expectations when new information is disseminated). Notion of neutral band is applicable here – price fluctuations within the neutral band would not activate arbitrage activities. However, prices beyond neutral band would trigger price equalising arbitrage activities as expected profit from arbitrage > associated cost of updating preferences.

## Lecture 12: Role of Government in Price Discovery

### [extended response practice]

In regulating commodity markets, governments can aid producers by setting price floors or making direct payments, and can aid consumers by setting a price ceiling.

#### 1. PRICE SUPPORT PROGRAMS

- a. What is it
  - i. Governments can maintain commodity prices above equilibrium if it provides the demand for the surplus production generated by support prices
  - ii. Cost of regime depends on the slopes of the demand and supply where steeper slopes imply smaller cost (only small amounts of additional output demanded is needed to influence price to support level)
  - iii. Governments can only maintain continued stock accumulation if they recover costs of price support – this can only happen if demand grows faster than supply
- b. Positive Implications
  - iv. Establishes a price floor
  - v. *Price Stabilisation (assuming storable commodities)*. By purchasing stock in periods of excessive supply, gives governments a price stabilisation mechanism by the way of option to release inventories when prices exceed price floor level or times of commodity shortage. This will mitigate seasonality fluctuation and reduce the uncertainty faced by economic agents in making the most optimal decision.
  - vi. Producers extract larger profits
- c. Negative Implication
  - vii. Storage cost increases cost of program in burden of maintaining physical stock accumulation
  - viii. High support prices have the potential to stimulate the development of their lower cost substitutes which can decrease the demand (relative to supply) of the commodity that is being supported = further accumulation of inventories
  - ix. Basically, lower cost substitutes are introduced to the market due to excessively high prices relative to equilibrium market demand
  - x. Ways to deal with negative implications (excessive amounts of inventories):
    - Limiting production to match consumers demand at support price
    - Subsidizing exports

#### 2. DIRECT PAYMENTS

- a. What is it
  - xi. Governments make direct payments to farmers, effectively *subsidizing the cost of production* to the natural market equilibrium
  - xii. Under scheme, price received by farmers is *market price + deficiency payment* where market price is below prevailing equilibrium price that would have existed without the program
  - xiii. Similarly, to price supports, the composition of the demand/supply schedules determine the cost of the scheme
- b. Positive Implications
  - xiv. Simple payment to producers, don't have to maintain physical inventories
  - xv. Consumers are better off, extracting greater profits from lower prices
- c. Negative Implications
  - xvi. Governments lose mechanism of price stabilisation as they don't have inventory leverage to do so.

Which program is costlier for the government?

Price Supports are generally costlier due to storage costs associated with maintaining accumulated stock. However, there are additional benefits under the price supports program from price stabilisation which reduces certainty in the market.