Analyzing Market Integration

Introduction

- Market liberalization in LDCs has renewed an interest in the working of agricultural markets as a source of income, employment and food security.
- The success of the reform in promoting and equity and efficiency is constrained by numerous structural deficiencies in local markets.
- One of the main consequences of these structural deficiencies is poor market integration, the difficulty with which information and trade flows among spatially separated markets.

Introduction

- Knowledge about the extent of market integration is important for a number of reasons:
  - By identifying groups of closely integrated markets and by knowing the extent of price transmission across different locations within a country, a government may improve the design of its market liberalization policies.
  - Allows monitoring of price movements.
    - The knowledge of speed of adjustment to shocks arising in different areas of the country is paramount to more effectively managing a price stabilization policy.
  - Integration models can be used to forecast prices all over the country.

Introduction

– By identifying the structural factors responsible for market integration, investment policy in the marketing infrastructure can be improved, because this allows policy makers to understand which kind of marketing infrastructure is more relevant to the development of agricultural markets in a country.

Conceptual Framework

- Performance and integration of markets are the results of the actions of traders and of the operating environment determined by the infrastructure available for trading and policies affecting the price transmission from one market to another.
- The conceptual framework addresses the following issues:
  - Concept and measurement of market integration: what does it mean that markets are integrated? How is market integration measured? Etc.
  - Relationship between market integration and structural factors.

Conceptual Framework

- Three-stage approach is suggested
  - A study of the marketing network
  - Consideration of the measures of integration, and
  - Analysis of the determinants of market integration.

Price correlations

- Measure the co-movements of prices that underlie the intuitive idea of market integration.
- However, these co-movements sometimes can not be separated from long run time trends and seasonality effects.
- More sophisticated methods aim at discovering if there is a stable long-run linear relationship among prices in different localities. **If such relation is found, then these price series are said to be cointegrated.**
- The presence of cointegration between two price series is indicative of interdependence between them.

Conceptual Framework

- Assuming that the markets under consideration are integrated, policy makers are interested in knowing the extent of this integration.
- The degree of integration is then related to the process of price transmission over time.
- Within this dynamic adjustment process, it is possible to distinguish a short-run and a long-run transmission. This process leads to the computation of magnitude and speed (time lapsed in price transmission) of the adjustment.

Conceptual Framework

- Data on prices, transaction costs, and trade flows across spatially separated markets are needed to measure the degree of integration between these markets.
- However, since price data are usually the most readily available and most reliable information on LDCs marketing systems, market integration is often studied using only price data.
- This allows measuring the extent, not the causes of integration.

Conceptual Framework

- In order to understand why (or why not) markets are integrated, we need to consider the factors that affect market integration.
- The most important factors include marketing infrastructure, government policy, dissimilarities in production, and supply shocks.
- Market infrastructure:
  - Includes transportation, communication, credit, and storage facilities that allow a smooth and reliable functioning of the markets.

Conceptual Framework

- Government policy
  - There are numerous public interventions that affect the marketing system in addition to the price stabilization policy, such as trade restrictions, credit regulations, and transportation regulations.
  - On one hand, smoothing seasonal fluctuations enhances the co-movement of prices across markets; on the other, this very stabilizing process may hinder the transmission of price signals.

Conceptual Framework

- Dissimilarities in production
  - Affect market integration by dividing markets into those that generally have a surplus in the commodity under consideration, those that have a deficit, and those that are marginally self-sufficient.
  - If a market *i* is a surplus market and market *j* is a deficit market, then the likelihood that markets *i* and *j* are linked by trade in the examined commodity is higher than if both markets were surplus or deficit.

Conceptual Framework

- Supply shocks
  - Floods, droughts, diseases, and pest attacks affect production directly by creating localized scarcities, whereas other shocks, such as strikes, affect the transportation of goods, making it very difficult for them to reach their final destination.

Analyzing integration

- Three stage approach
  1. **Market network description** – the objective is to collect data on
     - Number and type of participants in each regional market, as well as the volume of their transactions
     - Trade flows among different markets
     - Access to marketing infrastructure such as trucks, railways, river transportation, and telephones
     - Degree of access to price information by market participants
     - Degree of information concerning export promotion programs and structure of marketing costs.
  - Results in a descriptive analysis of the market network and an intuitive notion of the main structural factors affecting market integration.

Analyzing integration

2. Time series analysis
   - There are various measures of integration which are derived from price time-series.
   - Correlation and cointegration coefficients explicitly capture the price co-movement aspect of market integration.
   - Long-term multipliers and composite indices capture the dynamic aspect of price integration.

Correlation coefficients

- Correlation of price series at different markets is related to the idea that integrated markets exhibit prices that move together.
- Due to its simplicity, correlation analysis remains the most common approach to measuring market integration.
- The statistic to test if the correlation coefficient $\mathbf{p_{ij}}$ between prices in markets *i* and *j* is different from zero is given by

$$T = \sqrt{(n-1)}\,\frac{P_{ij}}{\sqrt{(1-P_{ij}^2)}}$$

- Which has a t-distribution with n-2 df, where n is the number of observations on the price series, under the hypothesis that $p_{ij} = 0$.

Correlation coefficients

- Parallel movements in prices can occur for several reasons other than the integration of markets.
  - For instance, they can occur because of the common influence of inflation on both the examined price series, or because the same seasonal influences are present in both markets.
  - This is especially true for agricultural commodities where peak and deficit seasons often take place at the same time.
- In order to eliminate some of these spurious correlations, price differences instead of price levels are sometimes considered in computing correlation coefficients.

Correlation coefficients

- This means
  - Given a price series p_t, instead of using the actual observations we use first difference series

$$\Delta p_t = p_t - p_{t-1}$$

  - But, currently use of the series of logarithmic differences is recommended which is given by

$$\Delta \ln p_t = \ln p_t - \ln p_{t-1}$$

  - Example if price of *tef* changes from 380 in September to 390 in October, we have
  - $\ln(390) - \ln(380) = 5.966 - 5.940 = 0.026$ (equal to the percentage change).

Correlation coefficients

- In addition to the problem of spurious correlation, there are other serious problems related to the often non-stationary nature of the price series involved.
- Stationary series mean a process in which neither the variance of the current disturbance ε_t nor the autocorrelation b/n ε_t and ε_{t-1} depend on t.
- These problems are addressed by the cointegration analysis.

Cointegration Coefficients

- Is an econometric technique that allows the identification of both degree of integration and its direction between two markets.
- Regional prices move over time because of various shocks. If in the long run they exhibit a linear constant relation, then we say that they are cointegrated.
- To use the cointegration procedure, some steps need to be carried out on the price series under examination:
  - First the Augmented Dickey Fuller test
  - Second the Engle Granger Two-Step Procedure.
  - Both procedures are easily accessed from standard statistical packages.

Cointegration Coefficients

- If the ADF tests prove that the two price series are integrated and co-integrated, then price changes in one market are useful to predict price changes in the other market.
- The existence of cointegration therefore implies that there is some market integration and it helps to explain its direction.

Co-integration Coefficients

- Let p_{it} denote the price of the commodity under consideration at time *t* and at location *i*.
- In order to study the interdependence of prices between any pair of markets *i* and *j*, examination has been suggested if there is any relationship among the price series in the two markets, such as the one expressed by a linear relation:

$$P_{it} = \alpha + \beta p_{jt} + u_{jt} \quad (1)$$

- Since the price series are generally non-stationary, this r/ship has interest only if the error term u_{jt} is stationary, implying that price changes in market *i* do not drift far apart in the long run from market *j*.

Cointegration Coefficients

- When u_{it} is stationary, the two series are said to be cointegrated.
- Standard statistical techniques do not allow conducting explicit tests of the significance of parameters α and β.
- Engel and Granger suggested a two-step procedure for evaluating the properties of a pair of non-stationary economic time series.
- **In the first step**, each price series is tested for the order of econometric integration, that is, for the number of times the series needs to be differenced before transforming it into a stationary series.

Cointegration Coefficients

- The test for integration is the Augmented Dickey Fuller (ADF) test:

$$\textbf{(2)} \qquad \Delta p_{it} = \alpha_0 + \alpha_1 p_{1,t-1} + \sum_{k=1}^{k=K} \alpha_{k+1} \Delta p_{i,t-k} + \varepsilon_{i,t}$$

  - Where Δ refers to the difference operator, that is $\Delta p_{i,t-1} = (p_{i,t-1} - p_{it-2})$, $\Delta p_{i,t-2} = (p_{i,t-2} - p_{i,t-3})$, for each variable $p_{i,t}$.
  - The null hypothesis is that the series $p_{i,t}$ is integrated of order 1, and the alternative hypothesis is that the series is of order 0. (H_0 implies stationarity of the original, un-differenced, series.)

Cointegration Coefficients

- If the t statistics for the coefficient α_1, is greater in absolute value than a critical value given by the ADF critical value, then the null hypothesis is rejected, and the alternative hypothesis of stationarity is accepted.
- If the null hypothesis is not rejected, then one must test whether the series is of order of integration higher than just 1, possibly of order 2.

Cointegration Coefficients

- **In the second step**, the residual $U_{i,t}$ of the OLS regression (1) between the two series is again tested for stationarity, with the ADF test.
- If the first step results in two non stationary series, both integrated of order 1, and the second step results in a stationary error term, then the two series are said to be cointegrated of order 1, 1.
- The presence of cointegration is indicative of non-segmentation between the two series.
- Market segmentation refers to the case when the two markets do not exhibit cointegration either in the direction from *i* to *j* or from *j* to *i*.

Cointegration Coefficients

- If markets *i* and *j* are very far away from each other, the lack of cointegration may be due to transportation costs.
- It is more interesting to focus on those markets that, in spite of being separated by less than a critical distance, do not exhibit cointegration.
- A critical distance can be defined as, for example, the maximum distance that could be covered by a one-day trip of a truck loaded with the commodity under consideration.
- Under these assumptions, segmented markets are those markets that are not cointegrated with each other and that are separated by less than a critical distance.

Dynamic adjustments

- In addition to knowing that markets are integrated, we need to know the extent or the degree of integration, which is measured by the magnitude of price transmission.
- The process of price transmission usually takes time and the immediate impact of price shocks should be distinguished from the impact that is building over time.
- The reduced form of a structural model of spatial equilibrium allows one to compute magnitude and speed of the dynamic adjustment process.

Dynamic adjustments

- The price p_{it} depends on variables, θ_t, affecting both supply and demand.
- However, the market equilibrium is efficient only under perfect competition and risk neutrality conditions.
- In reality, imperfect competition, imperfect information, the absence of markets to deal with risk, and many institutional constraints introduce structural rigidities that affect the dynamics of the price transmission process.

Dynamic adjustments

- Moreover, the presence of expectations and storage implies that prices are better described by a dynamic process whereby the current and past values of exogenous variables are taken into account:

(3) $$p_{it} = f(\theta_t, \theta_{t-1}, ..., \theta_0) + \varepsilon_{it}$$

- Information about the structural variables θ is difficult to obtain. Researchers proposed to decompose this dynamic process into a deterministic part, D_t and a stochastic part, S_t as follows:

(4) $$p_{it} = D_t + S_t + \varepsilon_{it}$$

Dynamic adjustments

- The deterministic part includes trend and seasonal dummies, X_{it}.
- The stochastic part is modeled as an autoregressive process, whereby the values of prices are regressed upon their past.
- Whereas cointegration analysis offers a method to understand if there is any long-run relationship, the autoregressive process of price changes allows study of the dynamics of price transmission.
- Price changes, rather than price levels, are the preferred unit of analysis. First differences of logarithm are taken because they offer an immediate interpretation in terms of percentage change.

Dynamic adjustments

- For every pair of market locations *i* and *j*, the following bivariate autoregressive process is estimated:

$$(5) \qquad p_{it} = \sum_{k=1}^{k=m_i} \alpha_{ik} p_{i,t-k} + \sum_{h=0}^{h=n_j} \beta_{ih} p_{j,t-h} + X_{i,t}\gamma_i + \varepsilon_{it}$$

- Where $\varepsilon_{i,t}$ is an error term; $\alpha_{i,k}$, $\beta_{i,h}$, and γ_i are coefficients to be estimated; and m_i and n_j are the number of lags of prices in markets *i* and *j*, respectively.
- In the estimation, problems of simultaneity may be encountered, related to the contemporaneous use of prices in market *i* and in market *j*. Since both prices may respond to the same type of shock, it is expected that the error term $\varepsilon_{i,t}$ will be correlated with the price $p_{j,t}$.

Dynamic adjustments

- To deal this simultaneity, an instrumental variables estimation of $p_{j,t}$ can be used, taking lagged values of the prices of all markets included in the study.
- The three lags, one for prices in market *i*, one for prices in market *j*, and one for the instrumental variables, are determined simultaneously by application of the appropriate model selection criteria.
- The magnitude of price adjustment is estimated with dynamic multipliers. **Dynamic multipliers are interpreted as the effect of a price change due to a random shock or a shift in an exogenous variable.**

Dynamic adjustments

- Following the model specified above, the cumulative effect of a shock to price in market *j* on the price in market *i*, after k periods is

(6) $$\lambda_k^{ij} = \sum_{h=0}^{k} \frac{\partial E_t p_{i,k+h}}{\partial p_{j,k}}$$

where E_t refers to the expectation operator based on information available at time t.

- The full adjustment of the dynamic process described by the model is given by the long-run dynamic multiplier, which corresponds to

(7) $$\lambda_\infty^{i,j} = \lim_{k \to \infty} \lambda_k^{ij}$$

Dynamic adjustments

- The immediate impact of price $p_{i,t}$ and $p_{j,t}$ on the expected value of $p_{i,t}$ is given by $\partial E_t p_{i,t} / \partial p_{i,t} = 1$, and $\partial E_t p_{i,t} / \partial p_{j,t} = \beta_{i0}$. For subsequent periods the following recursive formulae are used:

$$(8) \qquad \frac{\partial E_t p_{i,t+h}}{\partial p_{i,t}} = \sum_{r=1}^{\min(m_i h)} \alpha_{i,r} \frac{\partial E_t p_{i,t+h-r}}{\partial p_{it}}, \quad h = 1, 2, \ldots$$

$$(9) \qquad \frac{\partial E_t p_{i,t+k}}{\partial p_{j,t}} = \sum_{s=0}^{\min(n_t, k)} \beta_{i,s} \frac{\partial E_t p_{i,t+k-s}}{\partial p_{it}}, \quad k = 1, 2, \ldots$$

Composite index involving both magnitude and speed of adjustment

- The analysis of dynamic adjustments allows the study of the speed of price transmission. That is, how much time is needed for price changes to be transmitted from one location to another.
- This is an issue of concern to policy makers for planning food distribution and price stabilization.
- Sometimes, the speed of price transmission is related to the efficiency of the market system.
- However, this assumption is not always valid. Rapid adjustment is just an indication of the flexibility of the mechanism. It does not necessarily imply a well-functioning system.

Composite index

- Here, it is important to consider the speed of adjustment as just another dimension of integration.
- Considering two markets, A and B, with the same value of the magnitude of price adjustment with respect to a third market, C, the shorter the time to complete this adjustment, the better integrated the market.
- This suggests a new indicator of integration which is a combination of the magnitude and speed of adjustment.
- A ratio of the two is an example of such an indicator, after normalization between 0 and 1. This ratio is denoted by μ, with $\mu = \lambda/\tau$, where λ is the long-term multiplier and τ is the time to adjust to the long run.

Composite index

- The closer the number is to one, the more integrated the markets are.
- There are two advantages in the use of this composite index.
  1. It combines the information of two measures into one, and
  2. It can rank market integration across countries.

Price rigidities

- Underlying the intuition of a well-integrated marketing system is the capacity to transmit price changes across different localities.
- One important characteristic of this capacity is its flexibility.
- Flexibility of the price transmission mechanism can be specifically interpreted in terms of the symmetry of price adjustment.
  - It is sometimes claimed that only price increases are transmitted to consumers, whereas traders are the main beneficiaries of price decreases.

Price rigidities

- If the market system were well integrated, then price increases should be transmitted to the same extent as price decreases.

- This is an issue related to the rigidity of price adjustment in the marketing chain.
- In order to explore this issue, the framework of market integration can be extended by incorporating asymmetric price responses.
- Evidence has been presented that price responses are asymmetric, with the common claim that retail prices reflect cost increases more rapidly than cost decreases.

The model

- Some of the ideas of this literature are applied to study horizontal market integration.
- The main issue is whether or not price increases are transmitted across markets with the same intensity of price decreases. Starting with the model of equation (5):

$$(10)\quad p_{i,t} = \sum_{k=1}^{k=m_i} \alpha_{i,k} p_{i,t-k} + \sum_{h=0}^{h=n_i} \beta_{i,h} p_{j,t-h} + X_{i,t}\lambda_i + \varepsilon_{it}$$

- the second term on the right hand side can be decomposed as follows:

$$(11)\quad \sum_{h=0}^{n_i} \beta_{ih} p_{j,t-h} = \sum_{h=0}^{n_i} \beta_{ih} (p_{j0} + p^{+}_{j,t-h} + p^{-}_{j,t-h})$$

The model

- where for any variable x_t, x^+_t is the positive phase, and x^-_t is the negative phase.
- Intuitively, the positive (negative) phase associated to a time-series is the cumulative sum of the positive (negative) changes of that variable. In order to define the positive and negative phase of x_t precisely, let us proceed as follows.
- Let Px_t and Nx_t be the positive and negative increment of variable x_t, namely:

(12) $Px_t = x_t - x_{t-1}$ if $x_t > x_{t-1}$

$= 0$ otherwise

and (13) $Nx_t = x_t - x_{t-1}$ if $x_t < x_{t-1}$

$= 0$ otherwise

The model

- Then, the positive phase is defined recursively as:

(14) $$X_0^+ = 0 \; and \; X_t^+ = X_{t-1}^+ + PX_t$$

- The negative phase is similarly defined as:

(15) $$X_0^- = 0 \; and \; X_t^- = X_{t-1}^- + NX_t$$

- Equation (5) is then generalized, allowing the coefficients of the positive and negative phases to be different:

(16) $$p_{it} = \sum_{k=1}^{n_i} a_{ik} p_{i,t-k} + \sum_{h=0}^{m_i} \left\{ b_{ih}^{'} p_{j,t-h}^{+} + b_{ih}^{''} p_{j,t-h}^{-} \right\} + X_{it} c_i + e_{it}$$

The model

- The symmetry price response hypothesis is then given as

- (17) $$H_0 : \sum_{k=0}^{m_i} b_{ik}^{'} = \sum_{k=0}^{m_i} b_{ik}^{''}$$

Stage 3: Factors of integration

- Market integration, however measured, is the result of the action of traders, as well as the operating environment determined by the infrastructure available for trading and policies affecting the price transmission.
- All the measures of integration considered so far have in common the feature of being computed using only price information available in a specified period of time.
  - Each market link is summarized by just one number.
- However, markets are complex institutions and their performance as well as their integration is the result of numerous factors.

Factors of integration

- Among these factors, marketing infrastructure, price stabilization policies, the degree of dissimilarity in production in different areas, as well as supply shocks, are important explanatory factors of market integration.
- To test hypotheses concerning the effect of structural factors on market integration one needs to specify the explanatory variables mentioned above.

Factors of integration

- Marketing infrastructure includes transportation, communication, and credit. These variables are expected to influence market integration positively.
- Price stabilization policy
  - In order to test these hypotheses, it is necessary to get an index of the degree of price stabilization policy undertaken by a government in various affected areas. One simple way to do this is to consider the correlation between prices and end-of-period public stocks. This correlation is expected to be negative and its absolute value is taken to be indicative of the degree of price stabilization policy.

Factors of integration

- Production affects market integration through the degree of dissimilarity in self-sufficiency of various markets.
  - If market i is a surplus market and market j is a deficit market in the commodity under consideration, then the likelihood that i and j are linked by trade is higher than if both markets were surplus or deficit areas.
  - The degree of dissimilarity is usually measured by the absolute value of the percentage difference in production per capita.

Factors of integration

- Another variable related to production is the number of production shocks affecting various districts.
- The effect of these shocks on market integration is not clear a priori.
- When the production shocks are of a tremendous magnitude, one would expect market integration to be disrupted. In the case of normal production shocks, they may even positively affect market integration, in so far as they add incentives to trade between affected areas and other areas.