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MARKET INTEGRATION AND THE LONG RUN ADJUSTMENT OF LOCAL MARKETS TO CHANGES IN TRADE AND EXCHANGE RATE REGIMES: OPTIONS FOR MARKET REFORM AND PROMOTION POLICIES

by
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ABSTRACT

A major limitation of the conventional market integration analysis is its neglect of the factors that underlie the cost associated with moving commodities across local markets. For instance, the existence of integrated markets implied by interdependently determined prices and stable spatial and temporal price spreads does not say much about the competitiveness and efficiency of local markets, or about the nature and determinants of the costs of market intermediation. Furthermore, while more efficient methods are being proposed to analyze price interdependence, the implications at the farm level and for agricultural transformation are not part of the analysis. One would, however, expect reforming governments to be more interested in issues such as i) the implications of market integration for the operation of local markets, ii) its impact on the process of domestic market reforms, iii) strategies to improve the degree of integration, and iv) the benefits of doing so.

Market integration analysis may be helpful in providing a photograpy of the operation of local markets at a given point in time. However, the process of market reform in the context of structural and institutional deficiencies, rather than being a one-shot issue, involves a lengthy transition process from a state-run to a private-sector-based distribution system. Unless it is extended to examine, among others, how market integration affects the process of adjustment in local markets, integration analysis will be of limited help as a tool for market policy research. The approach outlined in the present paper proposes an extension that is based on two premises.
First, that the impact of the shock in the central market prices does not only affect the short term level of the local prices, but also their time path. That second, long term impact is determined by the degree of integration μ and is affected by any accompanying changes in local arbitrage costs.

1. INTRODUCTION

The analysis of domestic agricultural markets has been traditionally based on the following three concepts: 1) *market integration*, defined as the prevalence of stable price spreads among markets; 2) *market competition*, which assumes that inter-market price differentials reflect the costs of transferring commodities between markets; and 3) *market efficiency*, which entails the requirement of minimum transfer costs[1]. One major limitation of this traditional approach is its neglect of the factors that underlie the cost associated with moving commodities on local markets. For instance, the existence of integrated markets implied by interdependently determined prices and stable spatial and temporal price spreads does not say much about the competitiveness and efficiency of local markets, or about the nature and determinants of the costs of market intermediation[2].

Although the techniques that are being used have become much more sophisticated, recent methodological developments in market research have hardly gone beyond the econometric test of market integration. While more efficient methods are being proposed to analyze price interdependence, the implications at the farm level and for agricultural transformation are not part

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[1]) See discussion in Harris 1979; Heytens 1986; Ravaillion 1986; Delgado 1986.

[2]) See examples given in Faminow and Benson 1990; Ravallion 1986; Harris 1979.

of the analysis. However, one would expect reforming governments to be more interested in issues such as i) the implications of market integration for the operation of local markets, ii) its impact on the process of domestic market reforms, iii) strategies to improve the degree of integration, and iv) the benefits of doing so.

It is well known that the ultimate impact at the local level of changes in macroeconomic policies depend to a large extent on the adjustment at the meso-level, meaning the marketing sector. Consequently, understanding the impact of economic policy reforms at the local level requires an integrated approach to analyzing macroeconomic and marketing policy changes. The present paper develops a model which, while starting from the integration approach, offers an extension of the latter to show the implication of market integration for the adjustment of local markets to policy reforms. Approaches to dealing with options to improve market integration are presented in Badiane and Nuppenau (1996).

2. MARKET INTEGRATION ANALYSIS[3]

The traditional tests of market integration have focused on correlation coefficients of spatial prices[4]. However, correlation coefficients mask the presence of other synchronous factors, such as general price inflation, seasonality, population growth, procurement policy, etc. Early criticism of this approach has been advanced by Blyn (1973), Harriss (1979), and Timmer (1974). More recently, contributions by Boyd and Brorsen (1986), Delgado (1986), Ravallion (1986), and Totter (1992) have introduced time series methods in the study of market integration. A parallel line of research has introduced cointegration techniques to study long term relations between non-stationary price series[5]. Further extensions of the time series methods, using ARCH methods (Engle 1982) have been studied by Mendoza and Rosegrant (1995). More recently, the analysis of market integration has moved from a purely time series approach to an attempt to understand the underlying structural factors responsible for market integration[6].

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[3]) This section draws on Goletti, Badiane, and Sil. 1994.

[4]) See for instance Lele (1971); Farruk (1970); Jones (1972).

[5]) See Engle and Granger (1987), Ardeni (1989), Palaskas and Harris (1991), Wyeth (1992), Goodwin and Schroeder (1991), Goletti and Babu (1993).

[6]) See Goletti, Ahmed, Naser (1993).

Co-integration and the analysis of local markets

One would expect individual prices in interrelated markets to depend on their own past values and the values of other prices in previous periods. Past changes in one set of prices are consequently reflected in present or future changes in another set of prices. Based on economic theories of supply and demand, these co-movements in prices can be expected to bear some persistent and long-term relationship. Consequently, a measure of the long term co-movement of prices gives a good indication of the degree of interconnectedness between local markets.

The co-integration techniques allow a detailed study of these co-movements[7]. These techniques are used to test whether a constant linear relationship can be established over time between local prices. The level of cointegration between the prices series reflect the extent to which the considered markets are integrated with each other.

The main interest of studying price integration among local agricultural markets is to be able to identify sets of markets that lead other markets in the price transmission process. If two markets, A and B, are cointegrated, then there must be some sort of "causality" running from one market to the other. The concept of causality here is to be interpreted with the limited

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[7]) See Banerjee, et al. (1993).

meaning of past movements in the prices in one (set of) market(s) contributing to the predictability of prices in other markets. If the causation is unidirectional, then, technically, past prices in one market can be used to forecast the prices in the other market (the principle of Granger causality)[8]. If the analysis can identify a market, whose prices can be used to systematically predict prices in the remaining markets, then that specific market is considered a *central* market[9].

As indicated earlier, examining the degree of market integration between any pair of markets i and j, is to test whether or not there is any systematic relationship between the price series of the two markets. This can be done by estimating a linear relationship of the following type[10]:

$$(1) \qquad P_{it}=\alpha+\beta.P_{jt}+u_t$$

where P_{it} denotes the price at time t and at location i of a given agricultural product. The coefficients α and β are parameters to be estimated, and u_t is the usual error term. Since the price series are generally nonstationary, this relation has interest only if the error term u_t is stationary, implying a stable

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[8]) See Granger (1969).

[9]) See Ravallion (1987) for the implication of cases where there is only one central market that affects prices in other markets, leading to a radial model of price transmission.

[10]) See Palaskas and Harris 1991, Goodwin and Scroeder 1991, Ardeni 1989.

pattern in the relationship between changes in the price of market *i* and changes in the price of market *j*. When this occurs, then a long term and stable relationship exist between the two price series and they are said to be cointegrated.

The two-step estimation procedure proposed by Engle and Granger (1987) can be applied to evaluate the stability of the patterns of price relationships among local markets. In the first step, price series in individual markets are tested separately for the order of econometric integration, that is for the number of times each series needs to be differenced before transforming it into a stationary series. For that purpose, the Augmented Dickey Fuller test (Dickey and Fuller 1979) can be used. In the second step, the residual u_t of the OLS regression in equation (1) between a given pair of local foodgrain price series is in turn tested for stationarity, using the same Augmented Dickey Fuller test method, but this time to establish the stability of the patterns of the relationship between the two series. The presence of cointegration between two price series is indicative of interdependence between their respective markets.

Once the presence of cointegration between two foodgrain price series is established, then the relationship between the two series can be represented as an Error Correction Mechanism (ECM), as follows[11]

(2)
$$\Delta p_{i,t} = \gamma_0^i + \gamma_1^i p_{i,t-1} + \gamma_2^i p_{j,t-1} + \sum_{k=1}^{k=m_i} \delta_k^i \Delta p_{i,t-k} + \sum_{h=0}^{h=n_i} \varphi_h^i \Delta p_{j,t-h}$$

where Δ is the difference operator; m_i and n_i are the number of lags; and γ, δ, and ϕ are parameters to be estimated. Causality from market *j* to market *i* can then be tested as follows:

$$H_0: \quad \gamma^i_2 \neq 0, \ \ \phi^i_h = 0, \ \ h = 1,2,\ldots, n_i$$

The above test can be used to establish the existence of a *central market*, defined as a market whose prices have a one-way influence on prices in other markets. A weaker version of centrality would involve causation within a certain region, so that a *regional center* can be defined, consisting of a market whose prices affect prices in all markets within that region without being affected by them.

Cointegration analysis helps answer the existence or not of a systematic relationship between two economic time series. However, it is not able to say anything about: i) the strength of the relationship between

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[11]) See Engle and Granger (1987).

the price series of the considered pair of markets; ii) the length of time it takes for a shock to be transmitted from one market to another; and iii) the symmetry of transmission of upward and downward price changes.

Dynamic adjustment of local prices

Besides the mere existence of long term market interdependence and knowledge of the poles of market influence, it is of importance for marketing policy purposes to have an idea of the *magnitude* of the interdependence and the *speed* with which changes in the price system are transmitted across individual markets. This additional information allows a better interpretation of changes in central markets in terms of their implications for price behavior in distant markets. Having exact information on the nature of intermarket relationship also contributes to improving the design and implementation of future foodgrain market related programs, such as market stabilization policies, floor pricing, market information systems, planning of food security reserves, etc.

Perfect market integration would be indicated if the price in one market is an exact translation of the price in another market, implying that price changes are fully transmitted between the two markets. Market segmentation, on the other hand, would be reflected in the absence of cointegration. In reality, however, perfect integration or segmentation are only extreme cases, with intermediate degrees of integration being the normal situation. The main issue becomes then the measurement of the *magnitude* of intermarket price transmission. This can be done by applying autoregressive techniques to local foodgrain price series to yield dynamic multipliers which are used to measure the transmission of price changes.

In the process of intermarket price transmission, the impact of immediate shocks are to be distinguished from their cumulative impact, which builds up over time. This is because the process of price transmission usually takes time, involving complex dynamic adjustments among individual markets. The analysis of the price adjustment process over time using the convergence of dynamic multipliers allows one to study the *speed* of price transmission, that is the number of days, weeks, or months it takes, for changes in prices in one subset of domestic foodgrain markets to be transmitted fully or partially to another subset of markets. Together with the information on the magnitude of price transmission, this information is key to understanding the operation of local markets and can be useful in the design of stabilization programs or market monitoring and information systems.

Normally, the speed of cross-market price responses is determined by the efficiency of the distribution system and of the structural characteristics of local markets. Rapid adjustments would reflect sufficient flexibility and responsiveness of the domestic market mechanism. Furthermore, given the magnitude of price adjustment between two markets, then the better integrated a given pair of markets, the lower the amount of time it takes for the two markets to complete the adjustment to induced price shocks. Accordingly, an indicator of the actual extent of market integration can be used, which combines both the magnitude and speed dimensions of the adjustment process[12].

Autoregressive processes can be applied to prices in individual agricultural markets to obtain indicators for the magnitude and speed of the price transmission process across these markets. For every pair of market locations i and j, the following bivariate autoregressive process can be estimated:

$$\textbf{(3)} \qquad p_{i,t} = \sum_{k=1}^{k=m_i} \alpha_{i,k}\, p_{i,t-k} + \sum_{h=0}^{h=n_i} \beta_{i,h}\, p_{j,t-h} + \gamma_i\, X_{i,t} + \varepsilon_{i,t}$$

where $P_{i,t}$ is the percentage change of the price of a given foodgrain in market *i* at time *t*, and $P_{j,t}$ the percentage change of the price for the same product in market *j* at time *t*. X_{it} denotes exogenous variables such as

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12) For that purpose the ratio between the estimated coefficients for the magnitude and speed of transmission can be computed and normalized between 0 and 1. The values 0 and 1 designate, respectively, the extreme cases of total segmentation and full market integration (see Goletti et al. 1994a)

seasonal dummies and time trend, and m_i and n_i are the number of lags in the estimation. The $\alpha_{i,k}$, $\beta_{i,h}$, and γ_i are the coefficients to be estimated, and $\epsilon_{i,t}$ the usual error term.

Technically, problems of simultaneity may be encountered in the estimation, related to the use of contemporaneous prices in markets *i* and *j*. Since prices in any given pair of markets may be affected by the same type of shocks concomitantly, the error term $\epsilon_{i,t}$ is expected to be correlated with the percentage price change variable $P_{j,t}$. To overcome this problem, 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 Akaike information criterion (see Akaike 1969). Following Mendoza and Farris (1992), the error term of equation (3) can be modeled as an autoregressive conditional heteroskedasticity (ARCH) process (see Engle 1982). The ARCH model specifies the contemporaneous conditional variance as a function of past squared residuals. This specification captures the volatility clustering characteristics of price time series, i.e. the tendency of large residuals to be followed by large residuals and small residuals by small ones. In this case, the error term $\epsilon_{i,t}$ is shown to be normally distributed with zero mean and variance h_t, where h_t is given by

(4) $$h_t = a_0 + \sum_{k=1}^{p} a_k \varepsilon_{i,t-k}^2, \quad a_k \geq 0, \quad k=0,1,...,p$$

The *magnitude* of price adjustment is estimated using average dynamic multipliers based on (3). The dynamics of the adjustment process involves a series of interim multipliers, as initial shocks fluctuate to converge and bring the system to a steady state. In the context of the model introduced in (3), the cumulative effect of a shock to the price of a given foodgrain in market *j* on the price of the same foodgrain in market *i*, after *k* periods can be computed as:

(5) $$\mu_k^{i,j} = \sum_{h=0}^{k} \frac{\partial E[p_i(t+h)]}{\partial p_j(t)}$$

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

(6) $$\mu = \lim_{k \to \infty} \mu_k$$

Accordingly, the *speed* of price transmission can be calculated by computing the time T that it takes for the intermediate multipliers to convergence within a certain range of the long run multiplier given by (6). The convergence rule is to find T such that $|\mu_T/\mu - 1| < \epsilon$ and $|\mu_K/\mu - 1| < \epsilon$ for every $K > T$, where ϵ is an assumed tolerance limit and μ_K is the estimated multiplier after K periods.

The techniques presented above allows one to quantify the degree of interconnectedness between local prices. In the next section, an extension of the approach is proposed to link market integration to the process of price formation and model the adjustment of local markets to shocks in central market prices that arise from changes in trade and exchange rate regimes. It is clear from the preceding discussion that the methods to analyze the operation of local markets should be dynamic in their approach. From the point of view of market reforms, the dynamic approach is necessary, as measures to promote markets have long term orientation and the impact of improvements in the marketing system takes time to materialize.

3. MARKET INTEGRATION AND THE PROCESS OF PRICE FORMATION IN LOCAL MARKETS

At any given point in time, the contemporaneous relationship between local and central market prices, P_l and P_c , respectively, can be written as:

(7) $$P_{lt} = P_{ct} - T_t$$

or equivalently

(8) $$P_{ct} = P_{lt} + T_t$$

Equation (5), on the other hand, can be used to define the (dynamic) long run equilibrium relationship between the price in a given local market (P_l) and the price in the central market (P_c). It expresses the cumulative adjustment of the local prices to changes in the central market price in the previous periods. Defining the *h* units of time that it takes for the long run multiplier to converge to its long run value as one period, equation (5) can be rewritten, using first differences as:

(9) $$\Delta P_{lt+1} = \mu \Delta P_{ct}$$

Writing out equation (9) and inserting the values for $P_{c.}$ from equation (8) yields:

$$(10) \qquad P_{lt+2} - P_{lt+1} = \mu\ (P_{ct+1} - P_{ct})$$

or equivalently,

$$(11) \qquad P_{lt+2} = \mu(P_{lt+1} + T_{t+1}) - \mu(P_{lt} + T_{t}) + P_{lt+1}$$

Rearranged slightly, equation (11) yields a second order linear difference equation that can be solved to obtain local prices P_{lt} as a function of the long run multiplier μ and local marketing costs T_{l}, as given by equations (12) and (13) below:

$$(12) \qquad P_{lt+2} = (1 + \mu)P_{lt+1} - \mu P_{lt} + \mu \Delta T$$

or

$$(13) \qquad \frac{1}{\mu}P_{lt+2} - \frac{(1 + \mu)}{\mu}P_{lt+1} + P_{lt} = \Delta T$$

Equation (13) can be solved for P_l in two steps (See Tu 1994; p. 46-50). The first step is to find the solution to its homogeneous part or reduced form given in (eq. 14) below in order to obtain the complementary function. The second step is to compute the particular integral given in equation (25) below. The complete solution is then obtained by adding the solutions of the reduced form and the particular integral.

The reduced form of equation (13) is:

(14) $$\frac{1}{\mu}P_{l,t+2} - \frac{(1 + \mu)}{\mu}P_{l,t+1} + P_{l,t} = 0$$

typical solution to problems of the kind of equation (14) is of the following form:[13]

(15) $$p_{l,t} = A\alpha^t$$

$p_{l(t)}$ is the solution to the reduced form, A is some arbitrary constant, and α represent constant(s) to be calculated. Substitution of (15) into (14) yields:

[13] See Tu (1994); p. 46-47

$$(16) \qquad A\left(\frac{1}{\mu}\alpha^{t+2} - \frac{(1+\mu)}{\mu}\alpha^{t+1} + \alpha^{t}\right) = A\alpha^{t}\left[\frac{1}{\mu}\alpha^{2} - \frac{(1+\mu)}{\mu}\alpha + 1\right] = 0$$

Given that $A\alpha^{t} \neq 0$, equation (16) requires the characteristic equation to vanish. That is:

$$(17) \qquad \frac{1}{\mu}\alpha^{2} - \frac{(1 + \mu)}{\mu}\alpha + 1 = 0$$

Equation (17) can now be solved for the two roots $\alpha = \{\alpha_1, \alpha_2\}$:

$$(18) \qquad \alpha = \frac{\mu}{2}\left[\frac{(1 + \mu)}{\mu} \pm \sqrt{(1 - \mu)^{2}/\mu^{2}}\right] = \frac{1}{2}[(1 + \mu) \pm (1 - \mu)]$$

which gives the expression for the two roots as:

$$(19) \qquad \alpha_1 = \frac{1}{2}(1 + \mu + 1 - \mu) = 1$$

(20) $$\alpha_2 = \frac{1}{2}(1 + \mu - 1 + \mu) = \mu$$

In order to write the solution for the complementary function its form needs to be determined by looking at the sign of the determinant:

(21) $$\left(\frac{(1 + \mu)}{\mu}\right)^2 - \frac{4}{\mu} = \left(\frac{1-\mu}{\mu}\right)^2 \geq 0$$

The determinant of the characteristic function given by equation (21) is positive, indicating that the solution to equation (14) is of the form:

(22) $$p_{l(t)} = A_1\alpha_1^t + A_2\alpha_2^t \ ,$$

Substituting equations (19) and (20) into equation (22), the complementary solution can now be written as:

(23) $$p_{l(t)} = A_1 + A_2\mu^t$$

It can be seen from equation (18) that the long run multiplier, μ, determines the two roots and therefore the stability of the time path of P_{lt}.

The next step in solving equation (13) is to compute its particular integral or equilibrium value. In the equilibrium state defined as:

(24) $$P_{lt+2} = P_{lt+1} = P_{lt} = \overline{P} \text{ ,}$$

the particular integral of equations of the type of equation (13) is usually of the following form[14]:

(25) $$\overline{P} = \varphi t^{\,i}$$

where ϕ is a constant and i equals unity, given that the sum of the parameters in equation (13) is[15]:

(26) $$\frac{1}{\mu} - \frac{1}{\mu} - 1 + 1 = 0$$

and

(27) $$-\frac{(1 + \mu)}{\mu} + \frac{2}{\mu} = 1 - \mu \neq 0$$

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[14] See Tu (1994); p. 46 and 47.

[15] See Tu (1994); p. 46 - 47 for the conditions determining the value of i.

Equation (27) holds for the typical case of markets that are less than completely integrated, i.e. μ less than 1. Given the value of $i = 1$, the solution of the particular integral can be obtained by setting $P = \phi t$ and substituting into equation (13) to yield:

(28) $$\frac{1}{\mu}\varphi(t + 2) - \frac{(1 + \mu)}{\mu}\varphi(t + 1) + \varphi t = \Delta T$$

Solving equation (28) for ϕ yield its value as:

(29) $$\varphi = \frac{\mu}{1 - \mu}\Delta T$$

Inserting ϕ from equation(29) back into equation (25), with i set to 1 gives the equilibrium value or particular integral:

(30) $$\overline{P} = \varphi t = (\frac{\mu}{1 - \mu})t\Delta T$$

Putting equations (23) and (30) gives the complete solution of problem (13), which is as follows:

(31) $$P_{lt} = A_1 + A_2\mu^t + (\frac{\mu}{1 - \mu})t\Delta T$$

The final step of solving for P_{lt} in equation (13) is to calculate the parameters A_1 and A_2, based on the complementary function of equation (23) and using the initial values $P_{l(t=0)}$ and $P_{l(t=1)}$. The value for $P_{l(t=0)}$ is given by:

(32) $$P_{l(t=0)} = A_1 + A_2\mu^0 = A_1 + A_2 \Rightarrow A_1 = P_{l(t=0)} - A_2$$

Similarly, the value of $P_{l(t=1)}$ is obtained as:

(33) $$P_{l(t=1)} = A_1 + A_2\mu^1 = P_{l(t=0)} - A_2 + A_2\mu = P_{l(t=0)} + (\mu - 1)A_2,$$

This yields the value for A_2 as:

(34) $$A_2 = \frac{1}{\mu - 1}[P_{l(t=1)} - P_{l(t=0)}]$$

The values for A_1 can now be computed as:

(35) $$A_1 = P_{l(t=0)} - \frac{1}{\mu - 1}[P_{l(t=1)} - P_{l(t=0)}]$$

or, equivalently, after rearranging:

(36) $$A_1 = \frac{1}{\mu - 1}[\mu P_{l(t=0)} - P_{l(t=1)}]$$

Substitution of equations (34) and (36) for A_2 and A_1 back in equation

$$\textbf{(37)} \qquad P_{lt}=\frac{1}{\mu-1}[\mu(P_{l(t=0)}-P_{l(t=1)})]+\frac{1}{\mu-1}[P_{l(t=1)}-P_{l(t=0)}]\mu^{t}+(\frac{\mu}{1-\mu})t\Delta T_{t}$$

(31) gives the entire solution of problem (13) as:

which, after some rearranging becomes:

$$\textbf{(38)} \qquad P_{lt} = \frac{\mu - \mu^{t}}{\mu - 1} P_{l(t=0)} + \frac{\mu^{t} - 1}{\mu - 1} P_{l(t=1)} + (\frac{\mu}{1 - \mu}) t\Delta T$$

or

$$\textbf{(39)} \qquad P_{lt} = \zeta_{lt} P_{l(t=0)} + \varrho_{lt} P_{l(t=1)} + \varphi_{lt}\Delta T$$

with

(40)
$$\zeta_{lt} = \frac{\mu - \mu^t}{\mu - 1};$$
$$\varrho_{lt} = \frac{\mu^t - 1}{\mu - 1};$$
$$\varphi_{lt} = \left(\frac{\mu}{\mu - 1}\right)t$$

Equation (38) expresses local market prices as a function of: i) their past values; ii) the long run multiplier, μ, which measures the degree of integration of local markets and which is determined by the performance of the price transmission mechanism between these markets; and iii) the change in arbitrage costs ΔT, which reflects the efficiency of the local trading sector. Thus the equation does not only portray the price level in any time t as the outcome of its distant past, but also shows that the degree of market interconnectedness and the cost of spatial arbitrage do influence that outcome. In other words, changes in the degree of market interdependence or the level of marketing costs appear to have not only contemporaneous or one time effects on local prices, but also affect the evolution of these prices over time.

Using equation (38) one can calculate, for instance, the impact of improvements in the degree of market integration on the time path of local prices, as $dP_{lt}/dt=(\delta P_{lt}/\delta\mu_{lt})(d\mu_{lt}/dt)$. The first ratio on the right hand side can be obtained from equation (38) as:

(41) $$\frac{\partial P_{lt}}{\partial \mu_{lt}}=\frac{[(1-t\mu^{t-1})(\mu-1)-(\mu-\mu^{t})]}{(\mu-1)^2}P_{l(t=0)}+\frac{[t\mu^{t-1}(\mu-1)-(\mu^{t}-1)]}{(\mu-1)^2}P_{l(t=1)}+\frac{1}{(1-\mu)^2}t\Delta T$$

(42) $$\frac{\partial P_{lt}}{\partial \mu_{lt}}=\frac{[(1-t)\mu^{t}+t\mu^{t-1}-1]}{(\mu-1)^2}P_{l(t=0)}+\frac{[(t-1)\mu^{t}-t\mu^{t-1}+1]}{(\mu-1)^2}P_{l(t=1)}+\frac{1}{(\mu-1)^2}t\Delta T$$

(43) $$\frac{\partial P_{lt}}{\partial \mu_{lt}}=\frac{1}{(\mu-1)^2}[((t-1)\mu^{t}-t\mu^{t-1}+1)(P_{l(t=1)}-P_{l(t=0)})+t\Delta T]$$

Now approximating the time derivative of $\mu,(d\mu_{lt}/dt)$, through its first difference $\Delta\mu_t$, and multiplying with equation (43) yields the change in the time path of local prices induced by changes in the degree of market integration:

$$\text{(44)} \qquad \frac{dP_{lt}}{dt} = \frac{\Delta\mu_t}{(\mu-1)^2}[((t-1)\mu^t - t\mu^{t-1} + 1)(P_{l(t=1)} - P_{l(t=0)}) + t\Delta T_t]$$

The model for the time path of local prices developed in this section allows one to tie the concept and analysis of market integration to the more fundamental question of domestic market development and its impact on local incentives. It also offers an opening to bring into the analysis the link between marketing reforms and macroeconomic policy changes. A model is developed in the following section to look into these relationships.

4. MARKET INTEGRATION AND THE IMPACT OF CHANGES IN TRADE AND EXCHANGE RATE REGIMES.

Market reforms usually are implemented in association with changes in country trade and exchange rate regimes. Moreover, the degree to which changes in these regimes achieve the expected objectives with respect to the agricultural and rural economy depends to a large extent on the transmission of these changes through the market mechanism to the local level. It is therefore necessary to extend the analysis to the process of transmission of these changes. In extending the analysis to cover the role of the marketing system in the transmission of the effect of macroeconomic policy changes, the following assumptions are made: i) countries undertake macroeconomic policy reforms to restore economic imbalances such as balance of payment disequilibrium; and ii) reform-induced adjustment in trade and exchange rate regimes affect prices in the central markets which are more closely linked to the external economy. Depending on the degree of integration between the central and local markets, that effect is then passed on to the latter markets. The first step in modeling the impact of macro policy reforms on local market conditions is to model the effect of these reforms on the central market price.

The way this part of the model relates to the previous part is the following: while $P_{l(t=0)}$ in equation (38) can be computed as in equation (45) below, $P_{l(t=1)}$ is to be modeled to reflect the effect of changes in macroeconomic policies and their transmission to local markets following adjustments in the central market(s) (equations 46 and 47)

(45) $$P_{l(t=0)} = P_{c(t=0)} - T_{(t=0)}$$

Assuming a one time macro-economic reform induced shock in the central market and that local markets have finished adjusting, and setting as one period the time it takes for the long run multiplier to converge to its equilibrium value, the price in a given local market after change has ceased ($P_{l(t=1)}$) can be defined as:

(46) $$P_{l(t=1)} = \mu[(P_{c(t=1)} - P_{c(t=0)})] + P_{l(t=0)},$$

$P_{c(t=0)}$ and $P_{l(t=0)}$ are the actual (pre-reform) price levels in the central and local markets before changes in macro policies. The price in the central market after policy changes, $P_{c(t=1)}$, captures changes in macro policies reflected in the equilibrium exchange rate *(E^e)* and in foreign trade policies *(T^e)*. The remaining variable in equation (47) is the world market price in the post reform period $P^w_{(t=1)}$.[16]

(47) $$P_{c(t=1)} = E^e P^w_{(t=1)} - T^e_{(t=1)}$$

The reasoning behind equation (46) and (47) is explained in Figure 1. For the sake of illustrative convenience, horizontal price lines are assumed, except during the period of long term adjustment by the local market price. Changes in macroeconomic policies are assumed to take place at t_a, leading to an upward jump in the central market price. Depending on μ_{lt}, the degree of local market integration, the shock at time t_a is transmitted to the local

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[16]The model is based on Krueger, Schiff, and Valdes, 1988. For other applications, see Stryker 1990; Intal and Power 1990; Jansen 1988; Jenkins and Lai 1989; Moon and Kang 1989; Garcia and Llamas 1989.The law of one price underlying the present model is adopted for expositional purposes only. In empirical applications, it may be more realistic to replace it with an Armington type specification.

market at time t_{a+1}. The jump in the local price at t_{a+1} is what the traditional market integration analysis captures. As the present shows, however, the impact of the shock in the central market prices does not only affect the short term level of the local prices, but also their time path. That second, long term impact is determined by the degree of integration μ and is affected by any accompanying changes in local arbitrage costs.

As it is known from macroeconomic and trade theories, it is through the change in the real exchange rate that macroeconomic policy reforms affect the central market price. Imbalances in macroeconomic policies are typically reflected in a sustained appreciation of the real exchange rate and a deterioration of the trade balance. Policy reforms seek to remove these imbalances in order to eliminate the appreciation of the exchange rate and restore equilibrium in the trade balances. Accordingly, a model linking the exchange rate to trade restrictions and the current account deficit is used to estimate the equilibrium exchange rate (E^e). It is assumed that individual country supply (X_s) and demand (M_d) for foreign exchange react to changes in the real exchange rate (E) with elasticities ϵ_s and η_d, which are respectively defined as:

(48) $$\varepsilon_s = (dX_s/X_s)\ /(dE/E),\ and$$

(49) $$\eta_d = (dM_d/M_d)/(dE/E).$$

First, defining E^a as the actual official exchange rate and X_a and M_a as the actual levels of aggregate country exports and imports; second, defining Q^t as the equilibrium level of exports and imports in the absence of trade restrictions; and third, defining E^t as the value of the balanced-account exchange rate, ϵ_S and η_d can be rewritten as:

(50) $$\varepsilon_s = [(Q^t - X_a) / X_a] / [(E^t - E^a) / E^a], \textit{ and}$$

(51) $$\eta_d = [(M_a - Q^t) / M_a] / (E^t - E^a) / E^a].$$

Furthermore, if the unsustainable part of the balance of trade (B_a) is defined as $B_a = M_a - X_a$, equations (50) and (51) can be solved to yield:[17]

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[17]Specifications of the sustainable level of country current account balance rests on assumptions about the normal level of financial flows. Given the difficulty this presents in identifying the sustainable share of actual country account imbalance, the calculations carried out in the study are based on sustainable levels of zero current account balance.

(52) $$B_a = [(E^t - E^a) / E^a] (\varepsilon_s X_s + \eta_d M_d), \textit{ and}$$

(53) $$(E^t - E^a) / E^a = B_a / (\varepsilon_s X_s + \eta_d M_d),$$

Equation (53) gives the change in the exchange rate that is required to eliminate the unsustainable part of country current account deficits. Since country exchange rates are equally affected by the imposition of trade restrictions, equation (53) needs to be modified to include the change in the exchange rate that would arise from the removal of trade restrictions. In the presence of restrictions, the true exchange rates received by exporters (E^t_s) or paid by importers (E^t_d) differ from E^t, the corresponding country's equilibrium exchange rate. The former are determined by the actual equivalent rates of taxation of the exports (t_x) and imports (t_m) in each country, as presented in expressions (54) and (55):

(54) $$E^t_s = (1 - t_x) E^t, \textit{ and}$$

(55) $$E^t_d = (1 + t_m) E^t.$$

The effect of trade restrictions on the current account can thus be calculated as:

(56) $$B_t = \eta_d\,[(E_d^t - E^t) / E^t]\,M_d - \varepsilon_s\,[(E_s^t - E^t) / E^t]X_s,$$

with the effect of removing trade restrictions on country import and export prices given by:

(57) $$(E_d^t - E^t) / E^t = t_m/(1 + t_m),\ and$$

(58) $$(E_s^t - E^t) / E^t = t_x / (1 - t_x).$$

Inserting equations (57) and (58) into equation (56) yields a new expression for the impact of trade restrictions on the balance of trade:

(59) $$B_t = \eta_d\,[t_m / (1 + t_m)]\,M_d - \varepsilon_s\,[t_x / (1 - t_x)]X_s.$$

Adding B_t as defined in equation (59) to B_a in equation (52) yields the change in exchange rates that would prevail in a situation without trade restrictions and with balanced country current accounts. The new expression is:

$$(E^{e} - E^{a}) \;/\; E^{a} = (B_{a} + B_{t}) \;/\; (\varepsilon_{s}X_{s} + \eta_{d}M_{d}). \tag{60}$$

Equation (60) can now be solved for the equilibrium exchange rate E^e which would prevail in the absence of trade restrictions and other domestic policies that cause country exchange rates to appreciate. The expression for E^e, is:

$$E^{e} = [(B_{a} + B_{t}) \;/\; \varepsilon_{s}X_{s} + \eta_{d}M_{d}) + 1]E^{a}. \tag{61}$$

Or, using the expression for B_t, in equation (56),

$$E^{e} = E^{a}\frac{B_{a}+\eta_{d}[t_{m}/(1+t_{m})]M_{d}+\varepsilon_{s}\,[t_{x}/(1-t_{x})]X_{s}}{\varepsilon_{s}X_{s}+\mu_{d}M_{d}} + E^{a}. \tag{62}$$

Inserting the value of E^e given above into equation (47) yields the price level in the central market, which together with equations (45) and (46) give the two initial values of the local price that are used in equation (38) to model these prices over time. Equation (38) thus allows to estimate the time path of local prices following shocks in central market prices caused by changes in trade and exchange rate policies.

5. THE ADJUSTMENT OF LOCAL PRICES TO CHANGES IN TRADE AND EXCHANGE RATE REGIMES

The model laid out in the preceding chapters can be used to study the long term adjustment of local prices following changes in country macroeconomic policies and their effect on border (central) market prices. For that purpose, let us assume that a change in macro policies, working through equations (62) and (47), causes prices in the central market to jump from initially 130 ($=P_{ct=0}$) to 166 (($=P_{ct=1}$). The change in the central market price is transmitted to individual local markets, with varying degrees of integration to the central market ranging from $\mu=0$ to $\mu=1$. For the sake of simplicity, the local price in each of these markets before the change in policies is assumed to be 100. Computing (38) with these values and for 20 periods yields the results presented in Figure 2. It should be noted that the length of the unit on the time axis in Figure 2 is determined by the speed of price transmission τ, as explained previously in the section discussing the expression for the long run multiplier (equation 6). Each unit of time is, accordingly, equivalent to the distance between t_a and t_{a+1} in Figure 1. In accordance with that definition, the unit on the axis is given by the amount of time T that it takes for the prices in local markets to adjust to the shock in the central market and the multiplier μ to converge to its long term value. By using the same unit for the different values of μ, it is assumed in the hypothetical case that prices in the different markets take the same amount of time to adjust to the shock, but they do so with varying degrees as reflected by the different values of μ.

Figure 2 shows along the front axis the distribution of the impact of policy changes across local markets, classified by level of market integration. Along the right-hand side axis, it shows the time path of adjustment in individual markets. The information in Figure 1 illustrates some of the additional information the proposed model is adding to the traditional analysis of market integration. It shows the cost of market segmentation and the benefits of improving market integration in terms of the potential impact at the local level from the reform process. It does not only show how the level of market integration affect the short term geographic distribution of the impact of policy changes, but it also shows how the impact evolves over time in individual markets. This is the type of information most policy makers undertaking or planning marketing and other economic policy reforms with sectoral implications would be interested in. The interest would arise from the need to anticipate the impact of reforms on incentives at the local level. It could also come from the concerns about the effects changes in prices might have on incomes and food security and the need to develop measures to mitigate them. Furthermore, the political economy of reforms is such that policy makers often worry about the regional equity aspects of the effects of reforms.

Following the changes in macroeconomic policies, if no complementary measures are adopted to promote the marketing activities between a given market M and the central market, market integration can be expected to proceed with its "normal" rate of change along a line such as the one depicted by the two points M and P_a. In this case, the level of integration the considered market would rise to $\mu_a > 0.4$ in the end period. The improvement in market integration raises the price level in M in the final period from P_o to P_a . If the objective of the policy maker is to have a stronger price response, then one option would be to put in place measures to improve market integration to $\mu_b > \mu_a$, with the corresponding price level of P_b . One way of doing this would be to invest in developing the local marketing infrastructure and encourage private traders to expand arbitrage activities.

A frequently reported problem that is encountered during the reform of marketing systems is a situation in which public marketing boards have been dismantled but private traders' response to reforms have not been sufficient enough to fill the gap. Consequently, a situation develops which is characterized by a lengthy period of transition during which the marketing system is likely to deteriorate. Local markets in such cases tend to be more segmented than during the pre-reform period of public-sector run marketing. In the graphic, this is reflected in $\mu_c < 0.4$. In the present example, prices in M evolve along a path similar to MP_c, with a corresponding price level in the end period of $P_c < P_0 < P_a$.

Furthermore, policy makers may wish to impact the local adjustment process in a much shorter term than would be possible through long run investments. For instance, they may want to contain the increase in prices due their likely impact on incomes and food security. One option would be to cut arbitrage costs, which often are inflated by taxes on fuel, vehicles, and inter-market commodity flows, as well as a host of administrative barriers that can be changed in the short run. Case studies of the cereal sector in West Africa show for instance that these taxes can reach up to 100 CFA per km, compared to marketing costs ranging between 70 and 100 CFA per ton and km, respectively[18]. The work by Kinsbury (1989) in Southern Africa also shows the impact of administrative barriers on arbitrage costs.

In terms of the graph in Figure 2, cutting the financial costs of arbitrage costs would be equivalent to shifting the surface of the curve instead of moving on it along the μ (market integration) and time axises. Such a movement is illustrated with the help of Figure 3 which shows the impact of changes in arbitrage cost on the time path of local prices. Figure 3 represents a cross section of the graph in Figure 2 along the time axis at $\mu = 0.4$. The P_d curve in Figure 3 shows the impact of cutting the initial arbitrage cost of initially 30 [the difference between $P_{ct=0} = 130$ and $P_{lt=0} = 100$] by 0.5 in each period. Arbitrage costs tend to increase during economic reforms including liberalization and devaluation, in cases where increases in import prices of fuel, spare parts, and vehicles are translated into higher prices for transport services. Financial costs of arbitrage may also increase when the transition to a private marketing system is accompanied with the elimination of marketing (primarily transport) cost subsidies that lowered the distribution costs of the marketing parastatals in the pre-reform period. The impact of higher arbitrage costs on the long term adjustment of local prices in shown in Figure 3 by the P_e curve.

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[18]) See Gaye (1991); Gabre-Madhin (1991); Camara (1992).

The preceding discussion indicates that policy makers have two avenues to affect the response of local markets to changes in a country's macroeconomic and marketing policies. They can do so in the medium to long term by investing in raising the degree of integration among local markets. In the short term, they may target the reduction of arbitrage costs. In most situations, however, there is need for both options, as the initial level of integration among local markets tends to be low and cost of spatial arbitrage relatively high.

Figure 4 gives an idea of the impact of government actions to raise the degree of local market integration over time. It is based on computation of equation (44) for different values of the initial level of market integration, assuming constant absolute increases of 0.025 in the degree of integration in each period. The highest value of μ for which the computations were carried out is 0.5, since the cumulated periodic increases would total 0.5 at the end of the 20 periods, yield a final μ of 1.0, the maximum possible per definition. It is observable from the graphs that changes in the degree of integration affect the adjustment of local prices much stronger and much faster, the higher the initial level of integration. Furthermore, the impact seems to last longer the more integrated the markets are already.

The impact of changes in arbitrage costs on the path of local price adjustment is showed in Figures 5. The four figures represent cross-section of the curve in Figure 2 along the market integration axis and at different points along the time axis. Changes in arbitrage costs would move the surface of the curve up or down. The three lines in each of the graphs in Figure 5 reflect these up and down movements. The top (bottom) line show the cumulative impact of changes in arbitrage cost of 0.5 (-0.5) per period. As in the case of improvements in market integration, the response to changes in arbitrage costs also increases over time and with the level of market integration.

The preceding discussion indicates that: i) low initial levels of integration among local markets reduce the rate of adjustment of local prices to changes in macroeconomic and marketing policies; and ii) the possibility of affecting the level of price responsiveness through government programs to improve integration and cut arbitrage costs decreases with low levels of integration. This may explain the difficulties faced by market reform programs in cases of considerable institutional and infrastructural deficiencies. However, the empirical evidence gathered in Africa and Asia so far indicate levels of market integration averaging 0.4 to 0.6[19]. Based on that evidence and the results presented in Figures 4 and 5, policy makers should expectedly be able to raise the impact at the local level of economic and market reform programs by adopting additional measures to improve market integration and cut arbitrage costs.

Although the options policy makers will chose to implement will depend on their concerns, there seems to be some obvious choices. In a situation with already well integrated local markets and responsive prices, the primary concerns of policy makers may be to contain the rise in local prices. The best option in this case would be to adopt measures to reduce arbitrage costs. In a situation with significant deficiencies in market infrastructure and institutions, the main concern becomes one of raising the responsiveness of local prices. Hence, in addition to cutting arbitrage costs, policy makers will need to set up programs to raise the level of integration across local markets. In order to be helpful to policy makers in making these choices, market policy research will need to be extended further and beyond

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[19]) See Goletti (1994); Goletti et al (1994b); Goletti and Babu (1994a); Goletti et al (1993); Mendoza and Rosegrant (1995); Clemens et al (1995)

what has been proposed in this paper. The research should include the analysis of options to improve market integration and cut arbitrage costs[20].

6. CONCLUSIONS

The objective of the present paper was to expand the traditional analysis of local markets to effectively addresses the various issues raised by the process of local adjustment to market reforms. Although the techniques that are being used have become much more sophisticated, recent methodological developments in market research have hardly gone beyond the econometric test of market integration. The methods proposed in the present paper offer an extension of this approach which allows the study of the implications of market integration for the spatial and long term distribution of the adjustment of local prices to shocks in the marketing system.

Although based on hypothetical data, the results obtained in this paper do not only show how the level of market integration affect the short term geographic distribution of the impact of policy changes, but it also shows how the impact evolves over time in individual markets. This is the type of information most policy makers undertaking or planning marketing and other

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[20]) See Badiane and Nuppenau (1996).

economic policy reforms with sectoral implications would be interested in. The interest would arise from the need to anticipate the impact of reforms on incentives at the local level. It could also come from the concerns about the effects changes in prices might have on incomes and food security and the need to develop measures to mitigate them. Furthermore, the political economy of reforms is such that policy makers often worry about the regional equity aspects of the effects of reforms.

Two major conclusions can be drawn from the results presented in this paper. The first one, which is no surprise, is that low levels of integration among local markets reduce the rate of adjustment of local prices to changes in macroeconomic and marketing policies. The second and more important conclusion is that the possibility to influence the level of price responsiveness through government programs to improve integration and cut arbitrage costs decreases with low levels of integration (<0.4). The latter finding may explain the difficulties faced by market reform programs in cases of considerable institutional and infrastructural deficiencies. However, the empirical evidence on market integration in Africa and Asia so far indicates that levels of market integration are high enough to allow market-promoting and cost-cutting measures to raise the impact at the local level of economic and market reform programs. Furthermore, they indicate that in a situation with already well integrated local markets and responsive prices, the best way to do so would be to adopt measures to reduce arbitrage costs. On the other hand, in a situation with significant deficiencies in market infrastructure and institutions, policy makers will need to set up programs to raise the level of integration across local markets, in addition to cutting arbitrage costs.

In order to be helpful to policy makers in making these choices, market policy research will need to be extended further and beyond what has been proposed in this paper. The research should include the analysis of options to improve market integration and cut arbitrage costs, and their impact at the local level of the economy[21].

[21]) See Badiane and Nuppenau (1996).

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