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REFORMING AND PROMOTING LOCAL AGRICULTURAL MARKETS: A RESEARCH APPROACH

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ABSTRACT

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 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.

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METHODOLOGICAL APPROACHES TO ANALYSING AGRICULTURAL MARKET REFORM AND PROMOTION

1. INTRODUCTION

The process of economic growth is one of continuous structural transformation channeled through the various linkages between the individual sectors of the domestic economy. Crucial for this process are markets that operate efficiently to coordinate decisions within and across sectors in a way that leads to improved availability and access to new technologies, efficient use of inputs and efficient combination of outputs. In theory, markets are supposed to signal the relative scarcity of resources, guide responses by economic agents and ensure the mobility of goods between regions. In reality, however, in many developing countries a variety of political, structural and institutional factors have prevented markets from performing their basic functions.

Recognizing the considerable economic costs associated with poorly performing domestic markets, an increasing number of developing countries are now launching reform programs aimed at liberalizing markets and freeing them from government control. However, the few evaluations of liberalization efforts that exist indicate that, in many cases, progress has been rather slow, putting domestic marketing systems in an extended and critical transition period, characterized by paralyzed parastatals and a private sector that is unwilling or unable to take over. The most important reasons behind the slow progress are: i) structural and institutional deficiencies, ii) skepticism and lack of commitment on the part of national policy makers, iii) weaknesses in the design and implementation of reforms, and iv) the lack of trust or understanding by private traders with respect to the commitment to market reforms.

The main objective of the projected research work on market reforms is to raise understanding of the factors underlying the deficiencies and strengths of local markets in order to: i) to identify the economic and political impediments to efficient market liberalization; ii) to provide the basis for a more integrated and consistent approach to market liberalization; and iii) to guide the design and implementation of market reforms in the context of substantial institutional and structural deficiencies.

The projected research work under the present program will center around the following four broad research tasks:

1. **Marketing policy environment**: The first task of the project is to study of the prevailing policy and regulatory environment surrounding agricultural marketing and market reform programs. It takes stock of existing policy objectives in the area of agricultural marketing, the policy instruments used to achieve them, and finds out how both are changing or would change under market reforms. A further component of the task is to study the role of the main pressure groups that would be affected by the market reform programs. The third component of the task is to look into policies in the transport and credit areas and their effect on the operation of output markets in the agricultural sector.

2. **Adjustment in costs of marketing**: One of the end objectives of market reforms is to promote low-cost marketing systems. The second task, therefore, seeks to identify the structure and determinants of the costs of operating in local agricultural output markets, and how they would be affected under liberalization. The expected output from this task

will i) provide benchmarks that can be used to monitor the progress of the
reform process and ii) indicate alternative policy changes that are necessary to lower marketing costs in the agricultural sector.

3. **Structure, conduct, and performance of local markets**: Marketing reforms seek to improve the operation of local markets in moving goods and transmitting information. Accordingly, the current task evaluates the degree of integration of and the competition in local agricultural output markets, with the objective of providing monitoring benchmarks and identifying strategies to promote both market integration and competition;

4. **Managing the transition from public to private marketing:** The final task focuses on: i) the response by private traders to changes in the policy environment and, particularly, their investment behavior, in order to anticipate the speed of and potential rigidities in the transfer of marketing activities from parastatals to the private sector; and ii) the facilitating and complementary measures the government can take to accelerate the transition to a private-sector-based marketing system.

The methods that will be used to carry out the tasks described under 1, 2, and 3 above are laid out in chapters 3 to 5 of the methodology paper of MP1 (Input Market Reforms) by Francesco Goletti and Kumaresan Govindan and have already been presented at the methodology seminar for that MP. The questions raised under these tasks are the same in the case of input and output market reforms. Furthermore, the two MPs are normally implemented jointly. Therefore, the same methods will be used for both Mps in addressing these two specific tasks. Consequently, a description of these methods is not offered in the present document. The present paper focuses instead on the methodologies developed to study the questions raised in connection with task 4.

2. INTEGRATION ANALYSIS AND MARKET POLICY RESEARCH[1]

The theories applied in the analysis of agricultural markets can be classified in three main areas: market integration, market failure, and commercialization. Despite the close links between the issues they deal with, these theories have hardly been integrated in applied research. However, the strategic questions raised by the reforms of agricultural marketing and trading policies initiated recently in many developing countries raise methodological challenges that can not be answered by any of these theories separately. Research on agricultural market reforms requires methods that integrate these different approaches in a consistent framework.

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[2]. 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

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

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

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[3]. However, the approach is very useful for analyzing the state of local agricultural markets, which serves as a starting point in the study of domestic marketing reforms.

Most of the work on commercialization, on the other hand, has focused mainly on the relationships between various household characteristics and the decision by subsistence farmers to enter the market process. At the center of the analysis are the determinants of farmer households' production and consumption behavior, which are used to explain the level of marketed surplus as an indicator of the importance of markets in the agricultural sectors[4]. A series of country studies carried out at IFPRI in the 80s covered an important gap in the study of the commercialization process by looking at its impact at the household and local economy levels[5]. However, neither the characteristics of the markets themselves nor their relationship to the broader socio-political environment have hitherto found adequate attention in the analysis. Despite these limitations, the approach is very useful in highlighting potential obstacles to promoting and liberalizing local markets that may originate at the level of farm households. By taking into the analysis the characteristics of local markets, the latter can be extended to identify potential obstacles and incorporate measures that deal with them in the reform programs.

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

[4]) Recent studies in this area include Goetz 1992; Renkow 1990; Bromley and Chavas 1989; and Strauss 1984. For a recent attempt to include the exchange process into the analysis see de Janvry, Fafchamps and Sadoulet 1991.

[5]) See Braun, et al. 1989; 1991; and Bouis and Haddad 1990.

Market failure has been the object of an extensive body of theoretical work. The origins of the concept is related to the phenomenon of externalities, that is interdependencies that are not reflected in the price system, as well as to structural and institutional deficiencies that segment the market process, and therefore distort the process of decentralized maximization[6]. Focus of the empirical work in this area has been on the consequences of market failure in terms of impeding the signaling, response and mobility functions of local markets and the implications for allocative and creative efficiency in individual sectors of the economy[7]. This type of analysis is useful in highlighting the need for reforms and the gains from promoting efficient agricultural output marketing systems. However, its contribution to tackling the research issues raised by the liberalization process could be expanded considerably by giving more attention to the exchange process itself and to the political, structural and institutional factors underlying market failure.[8]

The objective of the present research program is to put together a consistent analytical framework that effectively addresses the various issues raised by the process of market reforms. One of the main challenges to research on market reforms is that, 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

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[6]) For a discussion of the concept see Bator 1988.

[7]) In-depth discussion of the theory and application of market failure can be found in Arndt 1988; Bator 1988; Myint 1985; Stiglitz 1989; Toumanoff 1984; and Wolf 1988.

[8]) For a recent attempt linking market failure and exchange process see de Janvry, Fafchamps and Sadoulet 1991.

agricultural transformation are not part 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 iii) the benefits of doing so.

The methodologies that are proposed in the present paper, while starting from the integration approach, offer an extension of this approach by tying the question of market integration to the more critical one of commercialization and transformation. The methods are designed to analyze the determinants of market integration and the impact of changes in the degree of integration on the level of marketed surplus and income in local agriculture. The approach will include the analysis of the determinants of the cost of trading on agricultural and rural markets, with the objective of identifying and integrating into the reform alternative avenues of reducing such costs.

Furthermore, the proposed methods will allow for the joint analysis of changes in trading and exchange rate regimes, which in almost all cases are implemented parallel with marketing policy reforms. Moreover, 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 market sector. Consequently, research on economic policy reforms requires an integrated approach to analyzing macroeconomic and marketing policy changes.

2.1 Co-integration and the analysis of local markets

The traditional tests of market integration have focused on correlation coefficients of spatial prices[9]. 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[10]. 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[11].

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 reflect 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.

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

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

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

The co-integration techniques proposed in this section allow a detailed study of these co-movements[12]. 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 price 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 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)[13]. 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[14].

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[15]:

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12) See Banerjee, et al. (1993).

13) See Granger (1969).

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

15) See Palaskas and Harris 1991, Goodwin and Scroeder 1991, Ardeni 1989.

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

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 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[16]

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

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:

$$H_0: \quad \gamma_2^i \neq 0, \;\; \phi_h^i = 0, \;\; h = 1,2,\ldots, n_i$$

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 has at least three major weaknesses that need to be compensated for, in order to make it useful for market integration analysis for policy making purposes. In other words, cointegration analysis is not able to say anything about: i) the strength of the relationship between the price series of the considered pair of markets; ii) the length of time it takes for a shock to be transmitted from one

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

market to another; and iii) the symmetry of transmission of upward and downward price changes.

2.2 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 occur 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 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[17].

Autoregressive processes can be applied to prices in individual agricultural markets to obtain indicators for the magnitude and speed of the

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[17]) 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)

price transmission process across these markets. For every pair of market locations i and j, the following bivariate autoregressive process can be estimated:

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

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 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 to quantify the degree of interconnectedness between local prices, but it fails to show the impact of the quality of price interdependence at the local level or its implications for the process of agricultural commercialization. Moreover, it does not capture the role of cost structures in the marketing sector. Consequently, an extension of the approach is proposed in the next section to link market integration to the process of price formation and capture the role of cost of operating in local markets. 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. MARKETING COSTS, PRICE TRANSMISSION, AND 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) $$P_{lt+2} - P_{lt+1} = \mu \ (P_{ct+1} - P_{ct})$$

or equivalently,

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

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

or

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

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) further 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) $$\frac{1}{\mu}P_{lt+2} - \frac{(1 + \mu)}{\mu}P_{lt+1} + P_{lt} = 0$$

A typical solution to problems of the kind of equation (14) is of the following form:[18]

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

$p_{l(t)}$ 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:

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

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

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

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

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

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

which gives the expression for the two roots as:

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

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

the particular integral of equations of the type of equation (13) is usually of the following form[19]:

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

where ϕ is a constant and i equals unity, given that the sum of the parameters in (13) is[20]:

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

and

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

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

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

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

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

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

The final step of solving for P_{lt} in (13) is to calculate the parameters A_1 and A_2, based on the complementary function (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 $A1$ 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 (31) gives the entire solution of problem (13) as:

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

which, after some rearranging becomes:

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

or

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

with

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

Equation (38) express 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 $dP_{lt}/d_t = (\delta P_{lt}/\delta\mu_{lt})(d\mu_{lt}/d_t)$. The first ratio on the right hand side can be obtained from equation (38) as:

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

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

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

Now approximating the time derivative of μ, $(d\mu_{lt}/d_t)$, 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:

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

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 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 correct economic imbalances that are reflected among others in significant levels of balance of payment disequilibrium; and ii) reform-induced adjustment in trade and exchange rate regimes affect in the first place 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 implication of local market conditions for the impact of macro policy reforms is, accordingly, 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)

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

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

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

$P_{c(t=0)}$ 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 $P^w_{(t=1)}$[21].

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

[21]) 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.

In case of ex-ante analysis, the change in the equilibrium exchange rate following changes in macroeconomic and trade policies can be computed using the approach developed by Krueger et al (1998) as[22]:

$$E^e = E^a \frac{B_a + \eta_d [t_m/(1+t_m)] M_d + \varepsilon_s \, [t_x/(1-t_x)] X_s}{\varepsilon_s X_s + \eta_d M_d} + E^a. \tag{48}$$

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. MARKET INTEGRATION, MARKETING COSTS, AND THE EFFECT OF POLICY CHANGES AND PUBLIC INVESTMENT ON COMMERCIALIZATION

The process of commercialization is driven by production and marketing decisions by farm households and trading enterprises. Farmers seek to maximize a profit function such as the one given in equation (49) and traders carry out their marketing activities to maximize profits according to equation (50).

$$\Pi_{f,lt} = \Pi_{f,lt}(P_{lt}, N_{lt}, L_{lt}^* - L_{lt}, z_{f,lt}) \tag{49}$$

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[22]) The derivation of the equation for the real exchange rate and the definition of the variables are explained in Appendix One. In case of ex-post analysis, E^e is equal to the new (post-devaluation) exchange rate.

P_c and P_l stand, respectively, for the vectors of central and local prices, and Π for the profit levels in the production and marketing sectors. In addition to prices, farm profits are determined by the stock of know how and

$$\Pi_{m,lt} = \Pi_{m,lt}(P_{ct},\ P_{lt},\ C_{lt},\ I_{lt},\ c_{lt},\ i_{lt},\ L_{lt}^{*} - L_{lt},\ z_{m,lt}) \quad (50)$$

other exogenous factors in the farming sector, denoted, respectively, by N and z in equation (59). Furthermore, the level of profit is also assumed to be affected by the degree of commercialization, represented by the size of the area under commercialized agriculture (L^*-L), L^* being the total agricultural area and L the share of the area not penetrated by marketing services. In a situation with a highly commercialized crop, but where marketing has been under state monopoly, (L^*-L) can be alternatively interpreted as the area covered by the emerging private trading sector, while L denotes the area still serviced by state marketing institutions. C and I are the available stock of capital and public infrastructure in the marketing sector, and c and i denote capital investment by private traders and infrastructure investment by the government. The remaining variables describe the exogenous factors *(z)* affecting profits in the two sectors.

Following the concept underlying the market integration and price transmission processes of a central market linked to local markets through arbitrage, marketing costs and therefore profits in the trading sector can be modeled as a function of the area to be covered by marketing activities. Accordingly, the area under commercialized agriculture is included as an argument in the profit function of the trading sectors.[23]

[23] On the relationship between area coverage and marketing cost see Bauer and Hummelsheim (1995).

When undertaking investment to promote the marketing sector and accelerate the process of agricultural transformation through commercialization, the government seeks to maximize the stream of discounted pay-off from the farming and marketing sectors, adjusted by the cost of public investment in R&D and infrastructure. Accordingly, the objective function facing the social planner can be expressed as follows:

$$\text{(51)} \qquad Max \int_0^T e^{\varrho t}[\Pi_{f,lt}(...) + \Pi_{m,lt}(...) - w_1 n_{lt} - w_2 i_{lt} - w_3 c_{lt}]dt$$

In maximizing the above objective function, the government faces the following constraints:

a) land allocation:

In addition to increases in the share of marketed surplus, the process of commercialization is also associated with increased penetration of marketing activities into traditional agriculture and the expansion of the area under commercialized agriculture. Following Ehui and Hertel (1989), the annual change in the area under commercialization can be expressed as in equation (52), with the total area yet to be penetrated by the emerging marketing sector defined as in equation (53) below[24]:

$$\text{(52)} \qquad \dot{L}_t = -l_t$$

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[24]) See Ehui S. and T. Hertel. (1989).

With the above definitions, *l* can be used as a proxy for the rate of commercialization, or equivalently, as the speed of transition from public to

$$(53) \qquad L_t = \int_0^T -l_\tau d\tau$$

private sector-based marketing systems, if *l* is defined as the increase in the size of the marketing area from which the public parastatals are withdrawing.

b) technical knowledge:

The rate of augmentation of technical know how in the agricultural sector is assumed to depend on the level of accumulated skills *(N)* and on investments in transfer of know how, e.g. extension, (*n*), and infrastructure (*i*), and is given as:

$$(54) \qquad \dot{N}_t = \pi_{1,1}N_t + \pi_{1,2}n_t + \pi_{1,3}I_t$$

The effectiveness of government expenditure on extension and other farmer training services aimed at raising the level of technical skills in the farming sector can be influenced by the existing stock of knowledge *(N)* in two ways. The most intuitive one is that a higher level of prior knowledge raises the impact of extension outlays, as the recipient farmers are better prepared to process the new information. Alternatively, one could expect the level of added know how per unit of extension outlay to fall with increasing stock of knowledge[25].

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[25]) See Nerlove and Arrow (1962) for a similar treatment of knowledge transmission.

c) Infrastructure and capital constraint:

The next two sets of constraints relate to investments public infrastructure in the marketing system ($\dot{I}$) and of capital formation in by private traders *($\dot{C}$)*.

$$(55) \qquad \dot{I}_t = \pi_{2,1} I_t + \pi_{2,2} C_t + \pi_{2,3} i_t$$

$$(56) \qquad \dot{C}_t = \pi_{3,1} I_t + \pi_{3,2} C_t + \pi_{3,3} c_t$$

The coefficient of I in the infrastructure equation captures the impact of depreciation and is expected to bear a negative sign. Similarly the coefficient before *C* is to capture the impact of changes in the use of infrastructure with varying levels of marketing activities, as reflected in the levels of capital in the marketing sector (*C*). The last variable *(i)* denotes fresh public investment in marketing infrastructure[26].

In the capital equation, the rate of capital formation by private traders is influenced by the level of capital stock *(C)* in the marketing sector (depreciation) and fresh capital investment by private traders (*c*). Furthermore, capital formation is assumed to be influenced by the level of existing infrastructure (*I*) through the impact that improved infrastructure has on the speed of capital depreciation. In both equations above, the coefficients of the last variables should be equal to one.

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[26]) On the treatment of public investment as a constraint in dynamic modeling see Arrow and Kurz, 1970.

d) price constraints:

Modeling the local price system in a way that links it to the changes in the marketing sector requires that the assumption of constant cost of spatial arbitrage (ΔT=constant) made earlier be dropped.[27] Giving up the assumption yields the following complete solution for the second order difference equation given in (12) as[28]:

$$P_{lt} = A_1 + A_2\mu^t + \sum_{j=1}^{t} \mu^{t-j} \,.\, \mu\Delta T_{l,j-1} \tag{57}$$

In contrast to equation (31) the new solution now includes a discounting element for ΔT. Equation (57) is the solution to the difference equations (12) and (13) and can be transformed to obtain the solution for the corresponding differential equation, which yields the following expression after approximating the first difference of T by its time derivative[29]:

$$P_{lt} = A_1 + A_2 e^{(\mu-1)t} + \int_0^t e^{(\mu-1)(t-\tau)} . \mu\, dT(\tau) d\tau \tag{58}$$

The general expression for the local price constraint is given by the original differential equation underlying (58), which has the form:

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[27] The assumption was made when solving for the particular integral of the local price difference equation.

[28]See Tu, P. N. T. 1991. *Introductory optimization dynamics,* 2nd Edition. Springer. p.435

[29]See Tu, P. N. T. 1991. *Introductory optimization dynamics,* 2nd Edition. Springer. p.429

(59) $$\dot{P}_{lt} = (\mu - 1)P_{lt} + \mu T_{lt}$$

T_{lt} is the first difference of arbitrage costs. Equation (59) expresses the local price constraint as a function of the degree of integration and the cost of spatial arbitrage. The subscripts *l* and *t* indicate the time and geographic variability of ΔT.

The price constraint needs to be extended further to capture changes in arbitrage activities. For that purpose, it is assumed that traders involved in arbitrage maximize the profit function given in equation (50) and which, for the sake of simplicity, is rewritten as:

(60) $$\Pi_{m,lt} = \Pi_{m,lt}(P_{ct}, P_{lt}, R_{lt})$$

The *P* are the central and local prices and *R* is a vector of structural and other factors affecting the profit of arbitrage activities, i.e the non price factors in equation (50). Assuming away storage, the supplied quantities in the central markets $(Q_t^{m,s})$ equal the procured quantities in local markets $(Q_t^{m,d})$ at any time t.

(61) $$\frac{\partial \Pi_{m,lt}}{\partial P_{lt}} = Q_t^{m,s} = \beta_0^s + \beta_c^s P_{ct} + \beta_l^s P_{lt} + \beta_l^{r,s} R_{lt}$$

(62) $$\frac{\partial \Pi_{m,lt}}{\partial P_{lt}} = Q_t^{m,d} = \beta_0^d + \beta_c^d P_{ct} + \beta_l^d P_{lt} + \beta_l^{r,d} R_{lt}$$

Setting $Q_t^{m,d} = Q_t^{m,s}$ and solving for P_{ct} yields the following expression for the central market price:

(63)
$$P_{ct} = \frac{\beta_l^d - \beta_l^s}{\beta_c^s - \beta_c^d} P_{lt} + \frac{\beta_0^d - \beta_0^s}{\beta_c^s - \beta_c^d} + \frac{\beta_r^d - \beta_r^s}{\beta_c^s - \beta_c^d} R_{lt}$$

From the definition in equation (8) and equation (63), follows:

(64)
$$P_{lt} + T_t = \frac{\beta_l^d - \beta_l^s}{\beta_c^s - \beta_c^d} P_{lt} + \frac{\beta_0^d - \beta_0^s}{\beta_c^s - \beta_c^d} + \frac{\beta_r^d - \beta_r^s}{\beta_c^s - \beta_c^d} R_{lt}$$

or

(65)
$$T_{lt} = (\frac{\beta_l^d - \beta_l^s}{\beta_c^s - \beta_c^d} - 1) P_{lt} + \frac{\beta_0^d - \beta_0^s}{\beta_c^s - \beta_c^d} + \frac{\beta_r^d - \beta_r^s}{\beta_c^s - \beta_c^d} R_{lt}$$

Defining δ_l as:

(66)
$$\delta_l = \left[\frac{\beta_l^d - \beta_l^s}{\beta_c^s - \beta_c^d} - 1\right] P_{lt} \Big/ \left[\frac{\beta_0^d - \beta_0^s}{\beta_c^s - \beta_c^d} + \frac{\beta_r^d - \beta_r^s}{\beta_c^s - \beta_c^d} R_{lt}\right]$$

yields the following new expression for *T:*

(67)
$$T_{lt} = (1 + \delta)\left[\frac{\beta_0^d - \beta_0^s}{\beta_c^s - \beta_c^d} + \frac{\beta_r^d - \beta_r^s}{\beta_c^s - \beta_c^d}\right] R_{lt}$$

It is noticeable from (67) that the cost of arbitrage is proportional to the last two terms of equation (63). Setting $\omega = 1 + \delta$, the following expression for the cost of arbitrage can therefore be derived from equations (8) and (63):

$$T_{lt} = \omega\frac{\beta_0^d - \beta_0^s}{\beta_c^s - \beta_c^d} + \omega\frac{\beta_r^d - \beta_r^s}{\beta_c^s - \beta_c^d}R_{lt} \tag{68}$$

The coefficient ω is a proportionality factor. expression for the price constraint (equation 59) can now be rewritten as:

$$\dot{P}_{lt} = \alpha(\mu - 1)P_{lt} + \mu\beta_{l0} + \mu\beta_{lr}R_{lt} \tag{69}$$

where $\alpha(\mu\text{-}1)$ is equal to the ratio before P_{lt} in equation (63) and β_{l0} and β_{lr} , respectively to the first and second ratio in equation (68).

So far, μ has been treated as a time invariant coefficient. In reality, however, one would expect the level of market integration to change with time. More importantly, a key objective of market reforms and investments in the marketing system is to improve the operation of local markets, which would raise the level of market integration. It is therefore necessary to treat μ as a time variant coefficient. A time variant μ also offers the possibility to model the impact of government and private trader investments on the degree of market integration. Accordingly, μ is assumed to be determined as follows[30]:

$$\dot{\mu}_{lt} = \xi\mu_{lt} + \gamma_{lt}R_{lt} \tag{70}$$

With a time variant μ, equation (69) and (70) form a non-linear system because of the cross-terms $\mu_{lt}\,P_{lt}$ and $\mu_{lt}\,R_{lt}$. Given the μ is by definition not expected to exceed 1, equation (69) can be linearized using the starting

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[30]) See Goletti et al. (1995).

values of P and R, to yield, together with equation (70), the final expression for the local price constraints:

$$\dot{P}_{lt} = \alpha\mu_{l0}P_{lt} + \alpha\mu_{lt}P_{l0} - \alpha P_{lt} + \mu\beta_{l0} + \mu_{l0}R_{lt} + \mu_{lt}R_{l0} \tag{71}$$

Finally, the constraint for the central market price is derived following the conventional definition which assumes that the latter is determined by world market prices, the exchange rate, and trade policies, that is:

$$\dot{P}_{ct} = \kappa_t + e_t + p_t^w \tag{72}$$

κ, e, and p are, respectively, the exogenously determined changes in trade taxes ($\kappa = 1$ *+/- the tax rate*), the exchange rate, and the world market price.

The system of constraints specified above can now be summarized in matrix form as:

$$\dot{Y}_{lt} = \Theta Y_{lt} + \Psi U_{lt} + \Phi X_{lt} \tag{73}$$

Where

$$\dot{Y}_{lt}^{/} = \left[\dot{L}_{lt}\ \ \dot{N}_{lt}\ \ \dot{I}_{lt}\ \ \dot{C}_{lt}\ \ \dot{\mu}_{lt}\ \ \dot{P}_{lt}\ \ \dot{P}_{ct}\right] \tag{74}$$

$$Y_{lt}^{/} = \left[L_{lt}\ \ N_{lt}\ \ I_{lt}\ \ C_{lt}\ \ \dot{\mu}_{ltP_{lt}}\ \ P_{ct}\right] \tag{75}$$

(76) $$U_{lt}^{/} = \begin{bmatrix} l_{lt} & n_{lt} & i_{lt} & c_{lt} \end{bmatrix}$$

X is a matrix containing the remaining (exogenous) variables, including the trade tax variable, the exchange rate, and the world market price. *Θ, Ψ,* and *Φ* are coefficient matrices estimated from the constraint equations specified above.

Assuming a quadratic form for the profit functions (49) and (50), and using the matrix notation above, the aggregate profit in the farming and marketing sectors in equation (51) can, in any given period *t,* be written as follows:

(77) $$\Pi_t = 0.5Y_t^{/}\Pi_1 Y_t + Y_t^{/}\Pi_2 U_t + 0.5U_t^{/}\Pi_3 U_t + X_t^{/}\Pi_4 U_t + X_t^{/}\Pi_5 Y_t - w_t^{/}U_t$$

The *Π*s are sums of the estimated coefficient matrices of the profit functions to be maximized in equation (51) above and *w* the vector of prices for land and investment capital in the private and public sectors. The *Y, U,* and *X* variables are as explained previously.

The problem facing policy makers in reforming and developing local markets is to maximize the aggregate profit function given in equation (77) over time, subject to the constraints defined in equation (73). This can be expressed as a control problem with the corresponding current value hamiltonian:

$$H_t = e^{\Omega}0.5[Y_t'\Pi_1Y_t + Y_t'\Pi_2U_t + 0.5U_t'\Pi_3U_t + X_t'\Pi_4U_t + X_t'\Pi_5Y_t - w_t'U_t] + \lambda_t'[\Theta Y_{lt} + \Psi U_{lt} + \Phi X_{lt}] \tag{78}$$

In the control problem specified above, the *Y*s are the state variables that policy markers seek to influence over time. These are: *L*, the area to be serviced by the marketing; *N*, the level of know how in the farming sector; *I* the level of marketing infrastructure; *C*, the capital stock in the marketing service; and the local and central market prices, P_l and P_c[31]. The *U*s the control or policy instrument variables that they use to achieve that influence. That is: *n*, public investment in raising know how in the farming sector such as extension services; *i*, public investment in marketing infrastructure; *c*, private trader investment in marketing services; and *l* the change in the area to be covered by the emerging private marketing system, which is determined by the pace and level of government withdrawal from the marketing sector. Finally, the *X*s are exogenous variables determined outside of the model.

The maximization problem expressed in the hamiltonian system above can be solved by applying the maximum principle, that is by computing the following conditions:

$$H_y = -\dot{\lambda}; \quad H_u = 0; \quad H_\lambda = \dot{y} \tag{79}$$

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[31]) While governments aim at influencing local prices through changes in the marketing sector, the change in the central market price is effected exogenously through changes in the trade and exchange rate regimes.

The solution to the system of equations given by the conditions in (79) gives the time path of the state variables (L_t, N_t, I_t, C_t, P_{ct}, P_{lt}) and of the activity variables (l_t, n_t, i_t, c_t) that maximizes the stream of profits in the local farming and marketing sectors. By setting the values for some of these variables, the model can be used to investigate alternative options for reforming and promoting local markets.

6. ANALYZING POLICY OPTIONS FOR MARKET REFORM AND PROMOTION

In order to illustrate the typical options facing the policy maker seeking to reform and promote local markets in the wider context of economic reforms, equation (38) is computed using hypothetical values. For this purpose, a situation is assumed in which the price in the central market jumps from 130 ($=P_{c(t=0)}$) to 166 ($=P_{c(t=1)}$), following changes in the country's trade and exchange rate policies. 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 1. It should be noted that the length of the unit on the time axis in Figure 1 is determined by the speed of price transmission as explained in the section discussing the expression for the long run multiplier (equation 6). In accordance with that definition, the unit on the axis is determined by the amount of time τ that it takes for local multipliers with respect to the central market to converge to their long term values. 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. Alternatively, one could use the same unit if the price adjustment in the different markets is measured at each interval τ, where τ is equal to the speed of the fastest adjusting market.

Figure 1 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 model that is proposed here 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 arising 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.

Given all these concerns that policy makers may have when faced with reforms, it is likely that most among them would like to influence the outcome of reforms at the local level, either to raise their effectiveness or to mitigate their undesirable effects. Figure 1 can be used to illustrate the different options policy makers face in this situation and how they can be analysed using the model developed here. Suppose the objective of the policy maker is to have the highest possible impact of the change in policies on the prices of a given market M, where the degree of integration to the central market is 0.4 at the time of the change in policies. The following are the possible outcomes and options facing the policy maker:

A) If no complementary measures are adopted to promote the marketing activities between M and the central markets, market integration would proceed with its "normal" rate of change along the line going from 0.4 to P_a, with a corresponding level of integration of $\mu_a > 0.4$ 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 . Using equation (70) the level of market integration in the final period, μ_a , can be computed and added as boundary condition when solving the hamiltonian system specified in equation (74). The solution would yield the values for the different variables under the situation where the government does not complement the policy reform programs with measures to promote domestic markets;

B) 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. The level of investments in public infrastructure and marketing services that would be needed to realize the outcome P_b can be estimated by setting the corresponding integration level μ_b as a boundary condition when solving the hamiltonian system;

C) Furthermore, 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 when marketing services were run by the public sector. In the graph, 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 $P_c < P_0 < P_a$. Again here, by using the corresponding level of market integration, μ_c , as a boundary condition, the hamiltonian system can be solved to yield, for instance, the level of profits in the farming and marketing sector that would be associated with such a deterioration of the marketing system;

D) Policy makers may, on the other hand, wish to impact on 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 reform-induced increase in prices due their likely impact on incomes and food security. One option they would have to achieve this 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[32]. The work by

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

Kinsbury (1989) in Southern Africa also shows the impact of administrative barriers on arbitrage costs.

In terms of the graph in Figure 1, cutting arbitrage costs would be equivalent to shifting the surface of the curve instead of moving on it along the μ (market integration) and time axes. Such a movement is illustrated with the help of Figure 2 which shows the impact of changes in arbitrage cost on the time path of local prices. Figure 2 represents a cross section of the graph in Figure 1 along the time axis at $\mu = 0.4$. The P_d curve in Figure 2 shows the impact of cutting the initial arbitrage cost by 0.5 in each period. The options for changes that could be made to bring about the cut in arbitrage costs can be derived from equation (68). Inserting the corresponding changes in the last term of equation (69) and solving the hamiltonian system, yields estimates of the impact of the cut in arbitrage costs;

E) Usually, in the absence of targeted measures to reduce them, arbitrage costs will tend to increase during the economic reforms. This is specially the case when increases in import prices of fuel, spare parts, and vehicles following devaluation of the domestic currency are translated into higher prices for transport services. Arbitrage costs can also increase when the emerging private marketing system works less efficiently than the marketing board in the pre-reform period. The impact of higher arbitrage costs on the long term adjustment of local prices in shown in Figure 2 by the P_e curve. Their implications can be studied by inserting the corresponding change in arbitrage costs in equation (69);

F) In countries with significant structural deficiencies in the marketing system and where public intervention has been extensive, policy makers usually worry about the ability of the private sector to expand rapidly enough to fill the gap that would be left by the elimination of the parastatals. A main reason for the concerns is that private traders may not be able to mobilize the capital necessary to expand their activities. When discussing the model presented earlier, L was defined as the total area that was serviced by the public marketing board and that would need to be covered by the emerging private sector. Accordingly, the demand for capital in the private marketing sector following the withdrawal of the public marketing board can be estimated by setting the corresponding value for l in the final period as a boundary condition when solving the hamiltonian system.

Summing up the discussion above, the model presented here can be used to study: i) the distribution of the impact of reforms across local markets; ii) the likely time path of local market adjustment in the absence of active market promotion; and iii) alternative outcomes associated with different options to improve market integration and reduce the cost of arbitrage in local markets. A summary of the options that can be investigated with the proposed model is contained in table 1. Each one of the cell is a vector, the element of which describe the time path of the corresponding variable on the left-hand side column under each of the options described in the head-row of the table. The darkened cells correspond to the variables that are determined exogenously in the simulated policy experiment.

7. CONCLUSIONS

One of the main methodological challenges to the research program on output market reforms and promotion arises from the fact that, what could be considered frontier-approaches to the study of markets, are primarily statistical in focus with little economic content and very limited policy relevance. Although the techniques that have been used hitherto have become much more sophisticated, recent methodological developments in market research have hardly gone beyond the econometric test of market integration. They do not offer any explanation as to the determinants of market integration, how it could be changed, and what its implications are for the process of commercialization and, thereby, for structural transformation at the local level. Given these limitations, the current focus of available methodological approaches to the analysis of local markets reduces their usefulness in addressing the concerns facing most policy makers who are planning or implementing market reform programs.

The methodologies that are proposed in the present paper, while starting from the integration approach in order to obtain an initial picture of the operation of local markets, provide an extension of this approach by tying the question of market integration to the more critical one of commercialization and transformation. The proposed methods can be used to anticipate the impact at the local level of changes marketing policies or other economic policies which have sectoral implications, such as changes in trading and exchange rate regimes. They can also be used to analyze alternative options to improve market integration and the impact of changes in the degree of integration on marketing activities and incomes in the farming and marketing sectors.

Insert Figure 1

Insert Figure 2

Table 1: Selected policy options that can be studied with the model

	A	B	C	D	E	F
	$\mu_a = \mu^*$	$\mu_b > \mu^*$	$\mu_c < \mu^*$	$\Delta AC = -c$ $\mu_T = \mu^*$	$\Delta AC = +c$ $\mu_a = \mu^*$	$I > I^*$ $\mu_T = \mu^*$
Policy variables						
i						
n						
c						■
State variables						
μ	■	■	■			
P_l						
Π_l						
Π_m						

Notes:

μ^* is the degree of integration of the local market at end period T, in a situation without active market promotion through public investments;

μ_a, μ_b, and μ_c are, respectively, the degree of market integration under the three scenarios described under A, B, and C in the text and corresponding to the endpoints P_a, P_b, and P_c in Figure 1.

μ_T is the degree of market integration at the end period, in a situation with changes in arbitrage costs;

I and I^* are, respectively, the change in the rate of commercialization with and without active market promotion by the government. Note that the rate of commercialization is defined as the increase in the area serviced by private traders;

ΔAC denote the changes in arbitrage costs; and c is a constant giving the simulated level of these changes.

APPENDIX ONE

ESTIMATION OF THE EQUILIBRIUM EXCHANGE RATE

The idea behind equation (48) in the main text is that restrictive trade regimes and imbalances in overall economic policies are typically reflected in a sustained appreciation of the real exchange rate and a deterioration of country trade balances. Macroeconomic 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)*.[33] 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:

(a1) $$\varepsilon_s = (dX_s/X_s)\ /(dE/E),\ and$$

(a2) $$\eta_d = (dM_d/M_d)/(dE/E).$$

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

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[33]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.

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:

$$\text{(a3)} \qquad \varepsilon_s = [(Q^t - X_a) / X_a] / [(E^t - E^a) / E^a], \textit{ and}$$

$$\text{(a4)} \qquad \eta_d = [(M_a - Q^t) / M_a] / (E^t - E^a) / E^a].$$

Furthermore, if the unsustainable part of the balance of trade (B_a) is defined as $B_a = M_a - X_a$, equations (a3) and (a 4) can be solved to yield:[34]

$$\text{(a5)} \qquad B_a = [(E^t - E^a) / E^a] (\varepsilon_s X_s + \eta_d M_d) , \textit{ and}$$

$$\text{(a6)} \qquad (E^t - E^a) / E^a = B_d/(\varepsilon_s X_s + \eta_d M_d),$$

Equation (a6) 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 (a6) 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

[34]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.

paid by importers (E_d^t) 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 (a7) and (a8):

(a7) $$E_s^t = (1 - t_x)\, E^t, \text{ and}$$

(a8) $$E_d^t = (1 + t_m) E^t.$$

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

(a9) $$B_t = \eta_d\, [(E_d^t - E^t) / E^t]\, M_d - \varepsilon_s\, [(E_s^t - E^t) / E^t] X_s,$$

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

(a10) $$(E_d^t - E^t) / E^t = t_m/(1 + t_m), \text{ and}$$

(a11) $$(E_s^t - E^t) / E^t = t_x / (1 - t_x).$$

Inserting equations (a10) and (a11) into equation (a9) yields a new expression for the impact of trade restrictions on the balance of trade:

(a12) $$B_t = \eta_d\, [t_m / (1 + t_m)]\, M_d - \varepsilon_s\, [t_x / (1 - t_x)] X_s.$$

adding B_t as defined in equation (a12) to B_a in equation (a6) 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:

(a13) $$(E^e - E^a) / E^a = (B_a + B_t) / (\varepsilon_s X_s + \eta_d M_d).$$

Equation (a13) 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:

(a14) $$E^e = [(B_a + B_t) / \varepsilon_s X_s + \eta_d M_d) + 1]E^a.$$

Or, using the expression for B_t, in equation (a12),

(a15) $$E^e = E^a \frac{B_a + \eta_d[t_m/(1+t_m)]M_d + \varepsilon_s\ [t_x/(1-t_x)]X_s}{\varepsilon_s X_s + \mu_d M_d} + E^a.$$

APPENDIX TWO

MARKET PENETRATION AND THE COST OF SPATIAL ARBITRAGE DURING REFORMS

The general process of market development (or the transition from public to private marketing systems) is normally characterized by the expansion of trading activities by private traders from the center and into the markets of the periphery. As markets grow and traders expand their areas of procurement, total cost of arbitrage will increase. Using the theory developed by Thuenen, Bauer and Hummelsheim show arbitrage costs (AC) to increase as a cubic function of the distance (r) between the central and local markets[35].

(a16) $$AC_{lt} = \frac{2}{3}\pi k_{lt} q_{lt} r_{lt}^{3}$$

AC is the total cost of arbitrage between the central and procurement market, i.e,(P_c - P_l); *k* is the cost of arbitrate per unit of quantity and per unit of distance; and *q* is the average level of procured quantities per unit of area. Treating the overall procurement area as a circle around the central market and using *F* and *Q* to denote that area and the procured quantities, equation (a16) can be rewritten as:

(a17) $$AC_{lt} = \frac{2}{3} k_{lt} F_{lt} q_{lt} r_{lt}$$

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[35]) Bauer, S. und S. Hummelsheim. (1995).

Expressing arbitrage costs as a linear function of the distance r, that is

(a19) $$k_{lt} = a_l r_{lt},$$

(a18) $$AC_{lt} = \frac{2}{3} k_{lt} Q_{lt} r_{lt}$$

equation (a18) becomes:

(a20) $$AC_{lt} = \frac{2}{3} a_l Q_{lt} r_{lt}^2$$

Using the formula for the area of circle, the costs of arbitrage per unit of quantity ($T = AC/Q$) can now be expressed as:

(a21) $$T_{lt} = \frac{2}{3\pi} a_l F_{lt}$$

Equation (a21) shows that the cost of arbitrage can be expressed as a function of the area to be serviced by the marketing sector, which provides the argument for including the area variable in the estimated profit function for the marketing sector.

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