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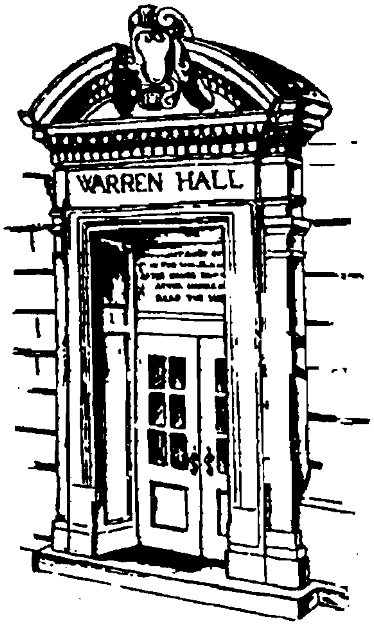

Staff Paper

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HORTICULTURAL MARKETING IN ZIMBABWE: Margins, Price Transmission and Spatial Market Integration

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I. Introduction

Findings from different studies on smallholder horticultural production have led to the general impression that it has tremendous potential for development. This recognition has led in a rather natural way to efforts that are aimed at improving the productivity of horticultural crops on-farm, as well as investing in post-harvest handling facilities. A number of organizations are currently working on improving the adoption of modern production techniques and improved crop cultivars. This research contends that, alongside these absolutely important farm-level efforts to improve technical efficiency in horticultural production, concurrent emphasis should be placed on understanding the performance of the smallholder horticultural marketing system.

This paper is a culmination of two closely related studies on smallholder horticultural marketing in Zimbabwe, jointly sponsored by the Cornell International Institute for Food and Agricultural Development (CIIFAD) and the Rockefeller Foundation. Gibson Guvheya's masters thesis study appraised the performance of the domestic smallholder horticultural market by evaluating the degree of spatial market integration, while Edward Mabaya investigated the links among market structure, margins earned, direction of price flow and symmetry in price transmission (Guvheya, 1988; Mabaya, 1988). Data used in these studies was collected through field surveys in Zimbabwe in the summer and fall of 1996.

The broad objective of this study is to gather information on the functioning of domestic horticultural markets to provide a basis for improving the performance of the smallholder horticultural marketing system. The following three specific objectives will be addressed in this paper:

1. To determine the marketing margins earned by participants in the various marketing channels used by smallholder farmers.

2. To examine price causality and transmission along the marketing channels.

3. To appraise the performance of the domestic horticultural market by evaluating the degree of spatial market integration.

II. Marketing Margins

Marketing margins are differences between prices at different levels in the marketing channel. They capture the proportion of the final selling price that a particular agent in the marketing chain adds, thus providing linkages between prices at various levels in the distribution system. Even though the magnitude of a margin is not indicative of operational efficiency, their variance across participants is usually suggestive of areas for consideration in improving efficiency. Margins that vary widely among participants at the same level often reflect price inefficiency at that level. Response of marketing margins to price changes (at any level of the channel) is also indicative of the efficiency of the channel. Where middlemen are few and market information is not available at farm level, increases in consumer prices often take long to be transmitted to the farmer. This phenomenon leads to the calculation of price transmission and stability of margins.

Data

Average weekly tomato wholesale prices were used to calculate margins between successive levels along the major marketing channels used by smallholder farmers. The weekly prices only reflect a five-day week because data was usually not collected over the weekend. Farm-gate prices are represented by price paid to farmers at Murewa Growth Point, while wholesale price is the price received by farmers and rural merchants at Mbare Musika.

The Model

Marketing margins were calculated using the *concurrent method*[1], whereby prices at consecutive levels of the marketing channel are compared at the same point in time. Hence, a marketing margin is specified as:

$$M^{l}_{t} = P^{L}_{t} - P^{(L-1)}_{t}$$

where,

M^{l}_{t} = Marketing margin between market level (L) and its preceding level (L-1)

P^{l}_{t} = Price at market level (L)

$P^{(L-1)}_{t}$ = Price at market level (L-1).

Where marketing margins at different levels of the marketing chain are to be compared, it is common to use the consumer price as the common denominator for all margins. The following are some commonly used indicators that will be used in the analysis:

Total Gross Marketing Margin (TGMM)

$$TGMM = \frac{Consumer\ Price - Farmer's\ Price}{Consumer\ Price} * 100$$

Farmer's Portion or Producer's Gross Marketing Margin (PGMM)

$$PGMM = \frac{Consumer\ Price\ -\ Marketing\ Gross\ Margin}{Consumer\ Price} * 100$$

[1] In the 'Concurrent Method', prices prevailing at successive stages of the marketing channel are compared at the same point in time. For a discussion of the relative merits of this method see (Market Research and Planning Cell, 1985).

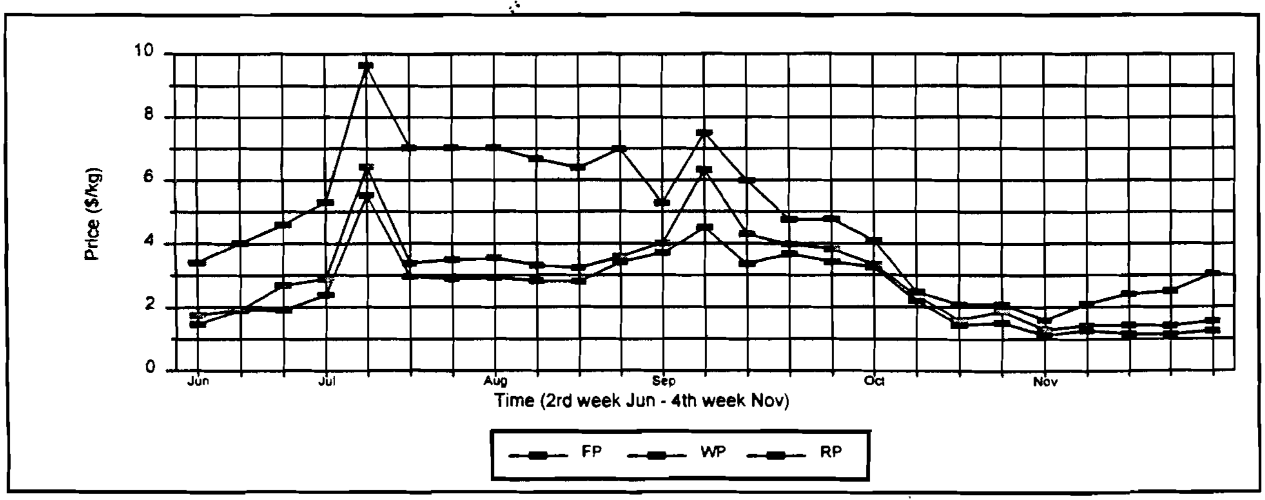
Results and Discussion

Absolute prices at the different levels are illustrated in Figure 1, where the different margins are depicted by the vertical distance between the relevant price series.

The magnitude of the margins is now considered. The average farm-wholesale gross margin (FWGM) of $0.44/kg is much lower than the wholesale-retail gross margin (WRGM) of $1.76/kg. The two add up to an average total gross marketing margin (TGMM) of $2.19/kg. Considering the average retail price of $4.75/kg, the total marketing margins are significantly high, accounting for 43 percent of the total price paid by the consumer. This finding supports the hypothesis that marketing costs account for a large portion of the consumers' dollar. Improving efficiency in the marketing channel could go a long way in increasing income for rural farmers and/or ensuring affordable prices to the urban consumer.

A word of caution is in order before we attempt to explain the individual margins. Kolhs and Uhl (1980) clarify four of the widely held misconceptions about the food marketing margin.

Figure 1. Average Daily Prices (July 1996)



First, the magnitude of a margin is not indicative of marketing margins for horticultural crops. Though inefficiencies prevail in food marketing functions, "efficiency cannot be judged solely by the size of a marketing margin". Second, the size of a margin does not depend on the number of middlemen, but instead on the number and cost of marketing services. Third, an inverse relationship between the size of margins and farm prices is not always the case (i.e., "large margin do not cause low farm prices"). For example, some marketing services such as advertising and merchandising will increase margin but ultimately increase demand for thereby increasing producer prices. Lastly, the size of margins are not a measure of additional profits that can be gained by farmers and consumers by assuming the role of middlemen. "There is no guarantee that farmers or consumers will perform marketing functions as efficiently as middlemen and thus capture food marketing profits" (Kolhs and Uhl, p213).

To comment on profitability at the different levels, we need information on costs so as to calculate net margins. The farm-wholesale margin of $0.44/kg is relatively low. Much of this margin goes to covering transport costs, the major value adding activity at this level. The Mashonaland East Fruit and Vegetable Program (MEFVP), a major transporter in the study area, charges about $3.00 per 15kg box of tomatoes that reduces to about $0.20/kg. Other forms of transport are relatively more expensive. Murewa (the study area) is considerably close to Harare (80km of tarred road) and well serviced with good transport infrastructure. The close proximity to a major urban wholesale market and the large concentration of horticultural farmers attracts more wholesalers and other agent middlemen to this area, facilitating more competitive behavior. Thus, when compared to other rural areas, the low farm- wholesale margins should be taken as an exception rather than the rule. Further, margins vary widely with distance from urban markets and the time of the year (seasonality). In distant and/or remote rural areas, prices can be extremely low since wholesale prices remain the same while the farm-wholesale margin increases. The relatively low farm retail margin can also be accredited to the high economies of scale earned by middlemen at this level that reduce marketing costs per kilogram.

The average wholesale retail gross margin (WRGM) of $1.76/kg is relatively high, accounting for 34.69% of the consumer's dollar. Since our wholesale price reflects mainly the price paid to farmers and other rural merchants at Mbare Musika wholesale market, the other wholesaling expenses and profits are accommodated in the wholesale-retail margin in addition to costs incurred by retailers. Costs contained in this margin include labor, transportation, packaging material and marketing fees. Most retailers are micro-enterprises (which are much smaller than the average wholesaler) resulting in relatively lower economies of scale. The high level of fixed marketing overheads (labor, marketing fees, stall rental) are spread over a lower volume of produce.

With the aid of Figure 1 and some correlations, the movement of margins across time can be analyzed further. The farm-wholesale margin is relatively stable in absolute terms with a standard deviation of 0.38 and positively correlated with both farm and wholesale prices. The stability of the farm wholesale margin could be indicative of a mark-up pricing structure. According to this model, short-run price movements at different levels are simply a reflection of the costs of marketing services between the two levels. This pricing structure could be unique to Murewa where competition among rural middlemen is substantial.

Supply and demand for marketing services, as well as demand for horticultural produce, are relatively stable in the short-run. Therefore, it can be inferred that most of the price changes for horticultural products are supply induced. Gardner's static equilibrium framework holds that, in a free market, ". . . events that increase (decrease) the supply of farm products will increase (decrease) the retail-farm price ratio (RFPR)". From laws of supply and demand, events that increase (decrease) supply would decrease (increase) equilibrium prices, *ceteris paribus* (holding demand constant). Putting the two together, it is expected that a negative correlation between the retail-farm price ratio and market prices exists. The correlation between the farm-retail price ratio and the market prices are as follows: -0.11 with farm prices, -0.05 with wholesale prices and 0.40 with retail prices. Though the first two correlations are negative, they are very low. The positive correlation with retail prices cannot be explained using this model. The poor explanatory power of this model to horticultural markets lies in the assumption made by Gardner. Two of the basic assumptions are violated in this case; perfect competition and constant returns to scale. Thus the results indicate some level of market imperfections and high economies of scale (due to high marketing overheads). This conclusion suggests possible ways of improving marketing efficiency to benefit farmers and consumers.

III. Price Causality and Transmission

The second objective consists of two related parts: examining price causality and transmission along the marketing channel. To gain an insight into the dynamic relationship among prices at different levels of the marketing channel causality and price transmission tests are built upon the static analysis of marketing margins. Causality tests will be used to test the direction of the price flow between the farmgate and wholesale level, and between the wholesale level and the retail level. This information will be used to identify points of price determination along the marketing chain. Having established the direction of causality, the analysis will proceed to test the hypothesis of asymmetric price transmission in the market.

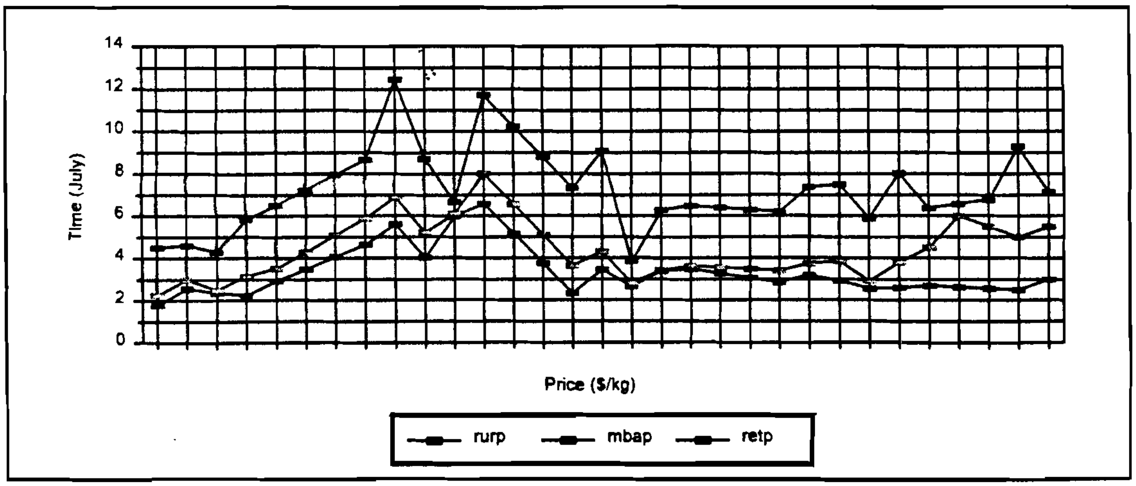
Data

For both temporal and spatial analysis, a daily time series data-set, compiled for the main marketing channel and covering the month of July (1996) will be used. Data was collected at three levels of the marketing channel, namely, the farm-gate, wholesale and retail levels. Figure 2 below shows daily tomato prices.

A. Price Causality

Implicit from Figure 2 is the existence of high positive correlations between prices at different levels of the marketing channel. As discussed in the previous section, a high positive correlation between prices at different levels of the marketing channel exists. Though such correlations reflect a degree of integration of markets at different levels, they do not tell us

Figure 2: Average Daily Prices (July 1996)



anything about the direction of price causality. The direction of price flow can be estimated statistically through causality tests. Although the direction of price flow *per se* is better described by *a priori* or theoretical information, analysts have resorted to statistical tests to ascertain causality where theory is reticent.

The Model

Granger (1969) developed and applied the first widely used statistical test for causality. Presuming that the future cannot cause the past, past information of one variable is used to predict or forecast the other. If past and present price information at one level of the marketing channel is used to improve the forecast future prices at another level, then the former level is said to Granger-cause the later level. The test is based on the following model.

$$FP_t = \sum_{i=1}^{n} a_i \, WP_{t-i} + \sum_{i=1}^{n} b_i \, FP_{t-i} + u_{1t} \qquad (1)$$

$$WP_t = \sum_{i=1}^{n} c_i \, WP_{t-i} + \sum_{i=1}^{n} d_i \, FP_{t-i} + u_{2t} \qquad (2)$$

where FP, WP and RP are as defined before.

In words, the first equation postulates that current farm prices (FP_t) are dependant on past farm prices (FP_{t-i}) and past and present wholesale prices (WP_{t-i}). The second equation postulates the same for wholesale prices (WP_t). The upper limit (n) is set at the optimal lag length and the error terms (u_{1t} and u_{2t}) are assumed to be uncorrelated. Any one of the following causality relationships can be tested by placing the appropriate restrictions on the model and using the F-test to confirm statistical significance.

1) *Unidirectional causality from WP_t to FP_t* if the estimated coefficients on the lagged WP_t in the first equation are as a group, statistically different from zero ($\Sigma a_i \neq 0$) and the estimated coefficients on the FP_t in the second equation are, as a group, statistically not different from zero ($\Sigma d_i = 0$).

2) *Unidirectional causality from FP_t to WP_t* is suggested when estimated coefficients on the FP_{t-i} in the second equation are as a group, statistically different from zero ($\Sigma d_i \neq 0$) and the estimated coefficients on the WP_{t-i} in the first equation are jointly statistically not different from zero ($\Sigma a_i = 0$).

3) *Independence* is suggested when both sets of the lagged exogenous variables are not statistically different from zero ($\Sigma a_i = 0$ and $\Sigma d_i = 0$). This implies that no causal relationship exists between the variables.

4) *Bilateral causality or feedback* exists when both sets of the lagged exogenous variables are, as a group, statistically significantly different from zero in both equations ($\Sigma a_i \neq 0$ and $\Sigma d_i \neq 0$)

Results and Discussion

From an *a priori* understanding of the market information system and an inspection of cross correlograms (correlation between lagged prices at different levels), the optimal lag length was set at five days (n=5) between farm and wholesale prices and two days (n=2) between wholesale and retail prices. This price relationship reflects the higher market information efficiency between wholesale and retail levels that between wholesale and farm-gate level. In one command, Econometric Views (E-views) software automatically runs four OLS equations consistent with Granger-causality theory. The hypothesis tested is that one variable does not Granger cause another. Results from these tests are given in Table 1.

Table 1. Pairwise Granger Causality Test Results

1. Farm-wholesale (Sample: 7/02/1996 7/31/1996 Lags: 5)			
Null Hypothesis:	Obs.	F-Statistic	Probability
WP does not Granger Cause FP	26	1.23615	0.34072
FP does not Granger Cause WP	26	0.84905	0.53639
2. Wholesale-retail (Sample: 7/02/1996 7/31/1996 Lags: 2)			
Null Hypothesis:	Obs	F-Statistic	Probability
RP does not Granger Cause WP	29	3.82284	0.03620
WP does not Granger Cause RP	29	5.74810	0.00913

Farm-wholesale price causality

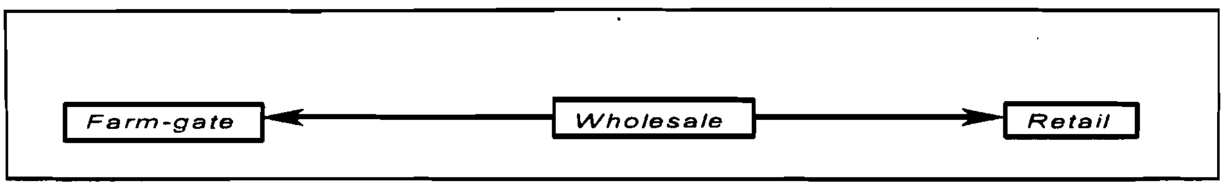
Results on Granger-causality between farm and wholesale prices indicate little predictive power of one variable on the other. Using a decision rule of α=0.05, we fail to reject both hypotheses (WP does not Granger Cause FP, and FP does not Granger Cause WP) and conclude with 95% confidence that there is no causal relationship between the two price series (i.e., the price series are independent in the Granger sense). However an evaluation of the F-statistic probabilities indicates that the hypothesis of WP not Granger causing FP is more likely to be accepted at a higher alpha level than the opposite hypothesis. This result suggests that prices are more likely to flow from wholesale to farm level than from farm level to wholesale. Our understanding of the market structure and conduct supports this premise.

Wholesale-Retail Price Causality

Results for Granger-causality tests between wholesale and retail prices presented in Table 1 indicate a strong predictive power of RP on WP and similarly for WP on RP. Using a decision rule of α=0.05, we reject both hypotheses (WP does not Granger Cause RP, and RP does not Granger Cause WP) and conclude with 95% confidence that bilateral causality or feedback exists between wholesale and retail prices. However, a look at the F-statistic probabilities suggests stronger causality from wholesale to retail than the opposite. This result is again supported by our understanding of the market structure and information systems.

Causality tests are highly sensitive to the sampling frame and period of analysis chosen and, consequently, need to be supported by the underlying basic conditions of the market and information systems. Both farmers in rural areas and retailers in urban areas use wholesale price as a benchmark in their market transactions. We therefore expect prices to flow from wholesale level in both directions to farmers and retailers. Though uni-direction causality was not detected using the Granger tests, results from these tests hint toward such a price flow system. This direction of price flow is illustrated in figure 3 below.

Figure 3. Direction of Price Flow



B. Asymmetry in Price Transmission

The test for asymmetry aims to establish if increases and decreases in wholesale prices are transmitted symmetrically to farmers and retailers, given that prices are determined at the wholesale level. The presence of asymmetric price transmission is an indicator of an ill-performing market, as Tomek and Robinson (1990) argue, that asymmetric or sticky price behavior suggests imperfectly competitive markets.

This price behavior occurs as players with market power (i.e wholesalers in our case) transmit more slowly price changes that benefit them while transmitting faster price changes that are a cost to them. Farm level prices are often more responsive to a drop in wholesale prices than they are to a rise. This pattern is often a result of collusive behavior at middlemen level. In addition, imperfect information might avail a temporal advantage to some market players resulting in some inter-stage price stickiness (Kohls and Uhl, 1980).

The Model

To run the relevant model and perform the tests, the data used in price flow tests was transformed to generate the following new variables:

CFP_t = Change in Farm Price = $Fp_t - Fp_{t-1}$

WPI_t = Wholesale Price Increase = $Wp_t - WP_{t-1}$ if $WP_t > WP_{t-1}$ and = 0, otherwise

WPD_t = Wholesale Price Decrease = $Wp_t - WP_{t-1}$ if $WP_t < WP_{t-1}$ and = 0, otherwise

CRP_t = Change in Retail Price = $Rp_t - Rp_{t-1}$

Rudolf (1971) developed an approach to detecting nonreversible functions. Houck (1977) applied this technique to detect asymmetric price transmission in what has come to be known as the 'Houck procedure'. Assuming that our results from the causality tests indicate unidirectional causation from wholesale prices (WP_t) to farm prices (FP_t), Houck tests the hypothesis that a unit increase in wholesale prices will have a different absolute effect on farm prices from a unit decrease in wholesale prices. The Houck procedure consists of estimating the following equation in first differences by ordinary least squares (OLS):

$$\Delta FP_t = a_0 + a_1 \, WPi_t + a_2 \, \Delta WPd_t \qquad (3)$$

Where, $\Delta FP_t = FP_t - Fp_{t-1}$

$\Delta WPi_t = WP_t - WP_{t-1}$ if $WP_t > WP_{t-1}$ and

$= 0$ otherwise (price increase)

$\Delta WPd_t = WP_t - WP_{t-1}$ if $WP_t < WP_{t-1}$ and

$= 0$ otherwise (price decrease),

with FP and WP as defined before.

A non-reversibility or asymmetry occurs in ΔFP_t if the coefficient for a price increase is different from that of a price decrease ($a_1 \neq a_2$). A t-test is used to test for the statistical differences between the two coefficients. Houck notes two main problems with this method: First is the loss of explanatory power of the first row of observations due to differencing. And second, is the likely correlation between the two explanatory variables that might lead to statistical problems if not corrected.

Estimation, Results and Discussion

Asymmetry in price transmission was tested at two points in the market channel, namely, the farm-wholesale and wholesale-retail levels.

Wholesale-Farm Price transmission

To test for asymmetric price transmission from wholesale to rural farmers, the following OLS regression was run:

$$CFP_t = a_0 + a_1 WPI_t + a_2 WPD_t + u_t \tag{4}$$

Where a_0 is an intercept term, a_1 is the effect of wholesale prices on farm prices when wholesale prices are increasing, and a_2 is the effect of wholesale prices on farm prices when wholesale prices are decreasing. The regression results are given in Table 2.

Table 2. **Houck procedure for Wholesale-Farm Price transmission**
LS // Dependent Variable is CFP N=30

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant	0.215184	0.159560	1.348607	0.1887
WPI	0.353271	0.206575	1.710131	0.0987
WPD	0.979772	0.177723	5.512911	0.0000

R-squared	0.699431	F-statistic	31.41480
Adjusted R-squared	0.677167	Prob.(F-statistic)	0.000000
Durbin-Watson stat	2.021107	Cov $((a_1, a_2)$	-0.020249

To detect asymmetry in price transmission, we test equality in the coefficients a_1 and a_2 (H_0: $a_1 = a_2$, H_1: a_1 not equal to a_2). A non-reversibility or asymmetric transmission occurs when the coefficient for price increases (a_1) is statistically different from the coefficient for price decreases (a_2). Under classical assumptions, this two tail test follows a t-distribution with n-k degree of freedom (where n is the number of observations and k is the number of parameters estimated including the intercept). Our test statistic is as follows;

$$\frac{a_1 - a_2}{\sqrt{Var(a_1) + Var(a_2) - 2Cov(a_1, a}} \qquad (5)$$

Using the formula above, our calculated t is 1.8503. For 27 degrees of freedom (30-3), the calculated t-value exceeds the critical t-value at 10% level of significance but not at 5% (two tail test). Hence we reject the null hypothesis that the coefficients a_1 and a_2 are equal and conclude with 90% confidence that the effect of increasing wholesale prices is statistically different from that of decreasing prices. Price transmission from wholesale to farm level is asymmetric.

According to the regression results, only $0.35 of a $1 increase in wholesale prices are immediately transmitted to the farm level whereas $0.97 of a $1 price decrease at wholesale level would be immediately transferred to the farm level or rural markets. Middlemen between wholesale and farm level transmit slowly price changes that benefit them, but transmit rapidly price changes that would otherwise disadvantage them. As Tomek and Robinson (1991) confer, such symmetric or sticky price behavior suggests perfectly competitive market structures that allow some degree of collusive behavior among middlemen.

These results are consistent with the market structure along the channel, whereby wholesalers, by virtue of them being the smallest number of channel participants, are apt to wield greater market power than either farmers or retailers. Another contributing factor to such behavior is the relatively poor market information at farm level that avails a temporal advantage to middlemen when wholesale prices increase.

Wholesale-Retail Price Transmission

Similarly, asymmetric price transmission from wholesale to retail was tested by running the following OLS regression

$$CRP_t = a_0 + a_1 WPI_t + a_2 WPD_t + u_t \qquad (6)$$

The regression results are given in Table 3. Interpretation of the coefficients and subsequent hypothesis testing procedure are similar to those discussed in the previous section.

Table 3. Houck procedure for Wholesale-Retail Price transmission LS // Dependent Variable is CRP

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant	0.106312	0.561920	0.189194	0.8514
WPI	1.233366	0.727491	1.695369	0.1015
WPD	1.677356	0.625884	2.679978	0.0124

R-squared	0.445090	F-statistic	10.82828
Adjusted R-squared	0.403986	Prob.(F-statistic)	0.000352
Durbin-Watson stat	2.358594	Cov $((a_1, a_2)$	-0.251134

For 27 degrees of freedom (30-3), the observed t-value is less than the critical t-value even up to a 50% level of significance (two-tail test). Therefore, we fail to reject the hypothesis that the coefficients, a_1 and a_2, are equal and conclude that the coefficients for increasing wholesale prices and decreasing prices are not statistically different. Price transmission from wholesale to retail is symmetric. This result is indicative of some level of market efficiency between wholesale and retail levels. Higher market efficiency at this level is facilitated by better price information efficiency between these levels, a lesson that could be applied to improve efficiency between wholesale and farm levels.

IV. Spatial Market Integration

An important aspect of horticultural marketing in Zimbabwe is the movement of commodities from surplus markets to deficit markets during given times of the year. The efficiency of such inter-market exchange is predicated on the perfect transmission of price signals between the source market and the sink market. The transmission of price signals between markets is captured by market price integration. *Price integration* can be defined as the co-movement of prices between markets (Jones, 1984).

An empirical tool for testing the existence, or not, of spatial arbitrage is *market integration analysis*. Markets are said to be spatially integrated if they exhibit a co-movement of prices between the corresponding price series (Jones, 1984; Goletti and Babu, 1994). Put differently, a market is spatially integrated to other markets if prices in the market do not only respond to local supply and demand conditions, but also to the aggregate supply and demand of all the other markets to which it is connected.

Clearly, spatial market integration is an aspect of market performance. By shipping a product from areas of abundance and low prices to areas of scarcity and high prices, spatial arbitrage is less prejudicial to producers in the source market and consumers in the sink market. This welfare benefit is accentuated in settings where marked dissimilarities in production between regional markets exist, and this scenario is characteristic of the smallholder horticultural marketing system in Zimbabwe during the dry season. In the long run, market integration may foster horticultural production according to patterns of comparative advantage (Mendoza and Rosegrant, 1995).

Knowledge of the structure of market integration enables policy makers to forecast the price effect of a shock in one regional market on other regional markets to which it is connected. By identifying the factors inimical to market integration, remedial policy interventions can be designed (Mendoza and Rosegrant, 1995). Efforts to assess market integration in the smallholder domestic horticultural markets, and suggestions for improvements thereof, are therefore consistent with the government objective of improving the welfare (or income) positions of both smallholder farmers and the low income section of urban dwellers.

Data

The data used in this analysis was collected in Zimbabwe from August to December, 1996 (Guvheya, 1998). With the aid of a team of six enumerators, daily tomato wholesale prices were collected in the seven urban horticultural marketplaces namely, Harare, Bulawayo, Mutare, Chitungwiza, Chinhoyi, Marondera and Bindura. The data to be analyzed is a set of seven series of contemporaneous daily wholesale prices for tomatoes. The series for Harare, Bulawayo and Mutare are the longest, with five month's worth of daily (excluding weekends) data, from August to December of 1996. The remaining four series are a month shorter, running from September to December of the same year.

The Model

The analysis on spatial market integration seeks to address three questions about the nature of the price transmission process between pairs of regional markets. First, are markets integrated or not? Second, how long does it take for a price shock in one market to be transmitted to the other market to which it is connected? and third, how much of a price change in one market is transmitted to the other market? Cointegration analysis is used to find out if markets are integrated or not. However, cointegration analysis is only concerned with the existence of a long-run equilibrium between markets, and cannot answer questions pertaining to the price adjustment process over time. Recourse is therefore made to dynamic analysis, using autoregressive models to establish whether or not markets are integrated in the short-run, and how long it takes for a price change in one market to be transmitted to another. In addition, the dynamic analysis is used to quantify the total impact of a price change in one market on another market.

Cointegration between two contemporaneous price series will indicate that the corresponding markets are spatially integrated. The notion of cointegration can be explained in the following way. Although the individual variables are random walk, a linear combination of these variables might be stationary, in which case the two variables are said to be cointegrated. The mechanics for inspecting if the two variables are cointegrated requires that we set up a *cointegrating regression*, i.e,

$$Y_t=\beta_1+\beta_2X_t+\varepsilon_t \qquad (7)$$

$$\varepsilon_t=Y_t-\beta_1-\beta_2X_t \qquad (8)$$

Using the ADF procedure, if ε_t is stationary, i.e if $\varepsilon_t \sim I(0)$, then Y_t and X_t are cointegrated. In this case, the procedure is called the *augmented Engle-Granger* (AEG) *test* (Engle and Granger, 1987). In general, if $Y_t \sim I(d)$ and $X_t \sim I(d)$, with the d-value the same in both cases, Y_t and X_t can be cointegrated. Although individually nonstationary, regressing the variables in levels is statistically valid if cointegration holds.

Cointegration analysis is concerned only with the judgement as to whether a long-run relationship between markets exists or not. Yet the knowledge that markets are integrated or not, alone, may be quite limiting for policy analysis. In addition, need exists to know also the *degree* or *extent* of market integration, which naturally leads to measuring the *magnitude* of the price transmission process (Goletti and Babu, 1994). In such an analysis, a distinction should be made between the immediate impact of price shocks and the impact that builds over time. The notion of dynamic multipliers is used to compute the short-run and long-run magnitudes. Also, the analysis of dynamic adjustments allows study of a related concept - the *speed* of price transmission - how long it takes for a price shock in one market to be transmitted to another market's price.

Two modeling approaches will be taken, depending on the way markets are organized across space. Evidence gathered during primary data collection suggests two forms of spatial market organization. First, a radial market configuration exists among Harare and the surrounding urban markets, namely, Bindura, Chinhoyi, Chitungwiza and Marondera. Harare is expected to dominate price formation because of the large volume of trade that it handles compared to the volume of transactions in each of the smaller urban markets. In addition, the level of intra satellite market trade is quite negligible relative to trade between each of the satellite markets and Harare. Such an organization fits the *radial market configuration* in the literature (Ravallion, 1986). In that breadth, Harare becomes the central market, and the smaller markets the satellite markets. On the other hand, it is assumed that less primacy exists in price formation among Bulawayo, Harare and Mutare, principally owing to the large distances spanning the markets, and the relatively less variation in market sizes.

Harare, Bulawayo and Mutare

Modeling these three markets takes the form of investigating if relationships between price series for pairs of markets exist. Three such pairs of markets will be considered, namely, (Bulawayo, Harare), (Bulawayo, Mutare) and (Harare, Mutare). For every pair of markets *i* and *j*, consider the following bivariate autoregressive model (Goletti and Babu, 1994):

$$P_{i,t} = \sum_{k=1}^{k=mi} \alpha_{i,k} P_{i,t-k} + \sum_{h=o}^{h=ni} \beta_{i,h} P_{j,t-h} + X_{i,t}\gamma_{i} + \epsilon_{i,t} \qquad (9)$$

The dependent variable is the price in market *i* at time *t*, and $P_{j,t}$ is the price in market *j* at time *t*. Exogenous variables such as frost periods in the case of tomato production that will have an impact on the way market prices relate to each other are captured by $X_{i,t}$.

The *extent* of market integration will be assessed by measuring both the *magnitude* of price transmission and the *time needed to adjust*. The magnitude of the price transmission process is estimated by *long-run* or *total* dynamic multipliers. From (9), the cumulative effect of a shock to price in market *j* on the price in market *i*, after a maximum *k* periods is given by:

$$\mu_{k}^{i,j} = \sum_{h=0}^{k} \frac{\partial E(P_{i,t})}{\partial P_{j,t-h}} \qquad (10)$$

The time needed to adjust is given by the length of the lag, *h=ni* in (9). The smaller the length of lag, for the same magnitude of price transmission, the better the integration between the markets concerned.

Harare, Chitungwiza, Chinhoyi, Marondera and Bindura

As has been discussed before, the spatial organization of these markets approximates the radial market configuration. In this case, Harare is the central market, and each of the remaining the satellite markets. Trade with the central market dominates price formation in the local markets, although there might be some trade among the local markets. The dynamic model has the analytical advantage that alternative hypotheses of market integration and market segmentation can be nested within a more general model and tested as restricted forms. Following the classic work of Ravallion (1986), consider the following model.

$$P_1 = f_1(P_2, P_3, \ldots\ldots, P_N, X_1) \quad \text{(central market price)} \tag{11}$$

$$P_i = f_i(P_1, X_i),\ i = 2, \ldots\ldots, N \quad \text{(local market prices)} \tag{12}$$

where, $X_i\,(i=2,\ldots\ldots,N)$ is a vector of other (non-price) influences on local markets and N is the number of spatial markets in the analysis. Equations (11) and (12) constitute a static representation of the data-generating process for a simple radial configuration of markets, in which each satellite market trades directly with the central market.

Assuming a linear form for the f_i functions ($i=2,\ldots\ldots,N$), and allowing for a suitable dynamic structure , the econometric versions of (11) and (12) for a T-period series of prices for N-regions follow:

$$P_{it} = \sum_{j=1}^{n} a_{ij} P_{it-j} + \sum_{j=0}^{n} b_{ij} P_{1t-j} + ciXi_{1t} + e_{it} \tag{13}$$

$$P_{1t} = \sum_{j=1}^{n} a_{1j} P_{1t-j} + \sum_{k=2}^{N} \sum_{j=0}^{n} b_{1j}^{k} P_{kt-j} + c_1 X_{1t} + e_{1t} \tag{14}$$

where $i = 2,\ldots\ldots,N$, the *e's* are the appropriate error terms and the *a's*, *b's* and *c's* are the true but unknown population parameters.

In words, equations (13) and (14) represent a data-generating process in which the current price for each local market is a function of its own past prices as well as present and past prices in a trading region. Usually, only (13) is identified (Ravallion, 1986), and (14) is often inflicted with the problem of simultaneity. However, in this analysis emphasis will be placed on (13); hence, the endogeneity of the explanatory variables in (14) will not concern us. As stated before, alternative hypotheses about market integration are nested within equations (13) and (14) and can be tested as the appropriate restricted forms.

Observe that for the purposes of estimation, equation (13) is just a special form of (9), where the second summation term is always made up of present and past values of prices in the central market. Since the hypotheses of concern in this analysis are all nested within (13), the modeling approaches for the two sets of markets converge to the same autoregressive model. Hence, the same hypotheses and testing procedures will be adopted in analyzing whether pairs between Harare and the satellite markets are cointegrated or not, and in investigating the price transmission process. This harmonization offers the advantage that the same hypotheses are tested for the two sets of markets, allowing comparisons across the different pairs of markets.

Empirical Results and Discussion

Tables 4 and 5 below present a summary description of the data that characterize the apparent relationships among the urban horticultural markets being studied. Simple correlations

Table 4. Summary Data for the Urban Horticultural Markets, 24 September - 27 December, 1996.

Type of Data	Chitungwiza	Chinhoyi	Marondera	Bindura	Mutare	Byo*
Distance to Harare (km)	30	115	74	88	263	439
Mean daily price differential ($/kg)	.45	1.17	2.40	.97	.75	3.26
Standard deviation of price differential	.67	.66	1.28	.61	.73	2.12
Simple correlation of price with Harare	.7339	.4969	.4762	.5366	.2204	.7506
Population**	274,912	43,054	39,384	21,167	131,367	621,742

For the descriptive statistics, $n = 67$. The price differentials are in absolute values, and they are calculated as the difference in price between each market and Harare. *Byo is short for Bulawayo. **Harare's population is 1,189,103.
Source: Field Survey data, 1996; CSO (1994).

are used to show a preliminary picture of the relationship among horticultural markets across space. While suffering from many analytical deficiencies (Harris-White, 1979), simple correlations are a suitable starting point.

Cointegration Tests

Cointegration analysis is the tool that has been used to establish whether markets have a tendency towards a long-run equilibrium or not. A technical note is in order. Cointegration between a pair of price series denotes a long-run equilibrium, and does not guarantee a short-run equilibrium. Stated in other words, cointegration is a necessary but not sufficient condition for short-run market integration. If markets are cointegrated, any short-term disequilibria (segmentation) is conceived as part of an adjustment process towards a long-run equilibrium.

Recall the following model:

$$y_t = \beta_1 + \beta_2 x_t + \varepsilon_t \tag{15}$$

where y_t and x_t are the price series for the pairs of markets being investigated. Using the Augmented Dickey-Fuller procedure we can perform a unit-root stationarity test on the error term from (15), given as:

$$\varepsilon_t = y_t - \beta_1 - \beta_2 x_t \tag{16}$$

If the series ε_t is stationary, then the two price series are said to be cointegrated.

When contemporaneous prices between two markets are cointegrated, we say that the two markets are spatially integrated. Let us now investigate if pairs of markets are cointegrated. Table 5 below shows results of cointegration analysis between the pairs of markets that were established during data collection as having significant direct trade with each other.

Table 5. Augmented Dickey-Fuller Tests for Unit Root on Residuals from Cointegrating Regressions

		ADF Critical Value				
Market Pair	T-Statistic	5%	10%	Decision	DW	N
Chitungwiza, Harare	-5.170977	-3.4713	-3.1624	Ho rejected	2.13	73
Chinhoyi, Harare	-3.655647	-3.4801	-3.1675	Ho rejected	2.05	64
Marondera, Harare	-4.314482	-3.4673	-3.1601	Ho rejected	1.98	78
Bindura, Harare	-3.738261	-3.4673	-3.1601	Ho rejected	1.9	78
Mutare, Harare	-4.932610	-3.4713	-3.1624	Ho rejected	1.98	73
Bulawayo, Harare	-2.703850	-3.4561	-3.1536	Ho not rejected	2.02	97
Bulawayo, Mutare	-2.183912	-3.4713	-3.1624	Ho not rejected	2.03	73
Marondera, Chit.*	-3.635499	-3.4713	-3.1624	Ho rejected	2.09	73

Source: Field Survey data, 1996

From the table it can be seen that the following pairs of markets are cointegrated: (Chitungwiza, Harare), (Chinhoyi, Harare), (Bindura, Harare), (Mutare, Harare) and (Marondera, Chitungwiza). However, (Bulawayo, Harare) and (Bulawayo, Mutare) are not cointegrated. These results conform to our intuition in that markets that are closer to each other and connected by well developed infrastructure are integrated and markets that are far-flung are not. This result is also corroborated by the patterns of intermarket trade flows as they were observed during the data collection period, that more significant trade in tomatoes exists among Harare and the Statellite markets than among Harare, Mutare and Bulawayo. Also, the inter-market distance between Harare and Mutare is about half the distance between Bulawayo and Harare. In general, markets in geographical proximity are more likely to trade with each other, thereby raising the possibility of spatial market integration.

Dynamic adjustment

Having established which markets are integrated through the cointegration analysis, the next task is to analyze the dynamics of the price transmission process. The dynamic analysis will shed light on three questions. First, what is the magnitude of the price transmission process? In other words, if there is a price shock in one market, how much of it is transmitted to the other market after the full adjustment process? Second, how long does it take for a shock in one market to be transmitted to another market? Put differently, what is the duration or speed of the adjustment process? Third, are markets integrated in the short-term? As has been reiterated earlier on, cointegration is a necessary but not sufficient condition for short-term integration.

It should be stated that dynamic analysis makes sense for markets that are cointegrated, or, more technically, when the necessary condition for market integration is met. Recall from the cointegration analysis that the following pairs of markets have been established as being integrated in the long run: Harare and Mutare, Harare and each of Chitungwiza, Chinhoyi, Marondera and Bindura, as well as Chitungwiza and Marondera.

For the sake of estimation and hypothesis testing, one basic autoregressive model will be used. In view of the nonstationarity in the levels of the price series, the following transformation to the data has been made:

$$Y_{i,t}^* = 100\ln(Y_{i,t}/Y_{i,t-1}) = 100[\ln(Y_{i,t}) - \ln(Y_{i,t-1})] \qquad (17)$$

where $Y_{i,t}^*$ is now interpreted as the percentage change of price in market i at time t. This transformation has been usual practice in the literature (Palaskas and Harris-White, 1994; Golleti and Babu, 1993), and it has two principal advantages. First, inter-correlations between the transformed series are sufficiently low thereby allaying the problem of multicollinearity that is common in estimating autoregressive and distributed lag models. Second, the transformed series are stationary.

Let us now invoke the autoregressive model from equation (17):

$$P_{i,t} = \sum_{k=1}^{k=mi} \alpha_{i,k} P_{i,t-k} + \sum_{h=o}^{h=ni} \beta_{i,h} P_{j,t-h} + X_{i,t}\gamma_i + \epsilon_{i,t}$$

where $P_{i,t}$ and $P_{j,t}$ are in percentage changes. Notice that equation (13) is a special case of (17), in which the second summation is made up of present and lagged values of the price series in the central market. The estimation proceeds as follows. A generous lag structure is estimated, which is then pared down by significance testing. Table 6 below presents results of the dynamic analysis.

Table 6 Dynamic Adjustments: Cross Long-run Multipliers (CRLM) and Speed of Adjustment

	CLRM	Speed of Adjustment*	
		First effects	Last effects
Harare, Chitungwiza	0.787	T_1	T_2
Harare, Chinhoyi	0.062	T_{13}	-
Harare, Marondera	0.599	T_{13}	T_{16}
Harare, Bindura	-	-	-
Harare, Mutare	0.245	T_{14}	T_{19}
Chitungwiza, Marondera	-	-	-

(-) indicates that the corresponding could not be calculated. T_i,T_j, $i \leq j$, is the duration between the first and last days when the effects of a price change in one market were felt in the other market.
Source: Field Survey, 1996.

Recall that the cross long-rum multiplier was defined as the total impact of a price change in one market on another market's price if the change is sustained. This concept is intimately related to cointegration. Having established that markets are integrated in the long run, the second logical step is to find out how much of a price change in one market is transmitted to another market if the adjustment process proceeds uninterrupted. Unfortunately, the analysis was indeterminate for (Harare, Bindura) and (Harare, Mutare). The same problem applies to (Harare, Chinhoyi), for which the last effects of the adjustment could not be established, and the CLRM was calculated for only one time period; the figure 0.062 should be viewed with caution. These problems arise if the markets are individually unstable.

A few comments on the market pairs (Harare, Chtitungwiza), (Harare, Marondera) and (Harare, Mutare) follow. The price transmission process between Harare and Chtitungwiza is the greatest. Also, this pair of markets has the smallest *time needed to adjust*, hence the greatest *speed of adjustment*. Given that the CLRM and Speed of Adjustment are the highest, we can say that Chitungwiza is the most integrated of the three pairs of markets. This is the kind of analysis that should ideally be done; however, it depends critically on whether the data is well-behaved, and we are not so blessed here.

An interesting feature in Table 6 is the one-to-one correspondence between CLRM and inter-market distances. The closer the markets are together, the greater the size of the transmission process. This pattern most probably results from the greater information flows, lower transportation costs and greater possibilities of arbitrage in general. Based on the strong relationship between the CLRM and inter-market distances, we can infer the statistics for (Harare, Bindura) and (Chitungwiza, Marondera). For example, the CLRM for (Harare, Bindura) would be expected to be between 0.599 and 0.245.

Conclusions and Policy Recommendations

The purpose of this research was to characterize the operation of the smallholder horticultural marketing system in Zimbabwe that have adverse effects on market performance and make suggestions for improving the welfare of farmers and consumers. Three inter-related aspects of market performance were investigated, namely, distributive marketing margins, the determination and symmetry of prices along the main marketing channels, and the degree of spatial market integration. The ultimate aim of the study was to identify key areas that could form the basis for improving the performance of the horticultural marketing system. In the sequel, the main conclusions are presented and the implications of the study for both public and private policy discussed.

Margins, Price Flow and Price Transmission

Correlation coefficients reveal a high degree of linear association between prices at different levels; 0.97 between farm and wholesale prices, 0.85 between wholesale and retail prices, and 0.84 between farm and retail prices. The average farm-wholesale gross margin (FWGM) of $0.44/kg is much lower than the wholesale-retail gross margin (WRGM) of $1.76/kg. The dynamics of margins in relations to prices at different levels hints at inefficiencies in the channel and high economies of scale in marketing hints at inefficiencies in the channel and high economies of scale in marketing.

Price causality was tested between pairs of adjacent levels (farm-wholesale and wholesale retail). Through Granger causality test and our knowledge on market structure and conduct, it was determined that prices flow from wholesale to farm level and from wholesale to retail. The Houck procedure results indicate asymmetric transmission of prices between wholesale and farm level which is indicative of inefficiencies in the channel between these points. Transmission of prices between wholesale and retail was symmetric. Though margins are lower between farm-gate and wholesale, there are greater inefficiencies between these level which can be largely attributed to poor market information system and limited transportation.

Spatial Market Integration

Information obtained from inter-market correlations dismisses the possibility of strong market integration among the spatial markets of concern in this study. This conclusion comes in the wake of the result that inter-market correlations are at most 0.7506, a moderate relationship by the standards of the theory of statistics. Three comments arise from examining the patterns of inter-market correlations in price levels.

First, Bulawayo is apparently significantly related to the other markets, particularly Harare, Chitungwiza, Marondera, Bindura and Chinhoyi, contrary to the evidence from the pattern of the physical flow of commodities across space, wherein Bulawayo is revealed as disconnected from virtually all the other markets for the period of the analysis. The second comment is that the correlations among Harare and the satellite markets are greater than the inter-relations among the major urban centers net of Bulawayo. Third, the significant relationship between Mutare and Harare, and indeed with the other markets is a derived relationship in the sense that the two cities do not directly trade with each other in tomatoes; rather, they are related via a common source region, that is, the irrigation schemes in the south-eastern lowveld.

Correlations of differenced data show markedly lower levels of inter-market connections, raising some suspicion that part of the static correlations in price levels is due to spurious reasons. This possibility could very well be the case with Bulawayo, a case of significant correlation between markets when in actual fact they are physically disconnected. A probable reason for the existence of spurious regressions is non-stationarity of the data, quite inherent in agricultural time series. Expectedly, all the price series were nonstationary in levels.

Hence, the patterns of inter-market relationships arising from static correlation analysis should be augmented with finer analysis. Cointegration tests on transformed data indicated that the following pairs of markets are cointegrated: (Harare, Chitungwiza), (Harare, Chinhoyi), (Harare, Bindura), (Harare, Marondera) and (Harare, Mutare). Markets that are integrated indicate that over the long haul, the respective prices move in conformity with each other, through the arbitraging actions of traders. Note the fallout of Bulawayo!

Two reasons exist for the segmentation between Bulawayo and all the other markets. First, Bulawayo is over 400 kilometers from Harare and about 700 kilometers from Mutare. These long inter-market distances imply huge transport costs that are prohibitive for inter-market trade. Second, the long distances between markets imply that it is nigh impossible to obtain information pertaining to regional prices and supply conditions - requirements for spatial arbitrage hence market integration.

Of a pair of integrated markets, how much of a price change in one market is transmitted to the other market? Alternatively, what is the size of the price transmission process? Unfortunately, the data is such that results for some market pairs were indeterminate. Fortunately, though, results for some 'strategic' pairs of markets were obtained. Of the valid results, the price transmission process between Harare and Chitungwiza is the largest (0.787), followed by the one between Harare and Marondera (0.599). The transmission process between Harare and Mutare is the least (0.245). This gradation mirrors rather closely the respective inter-market distances. In other words, the greater the inter-market distance the larger the size of the price transmission process.

Also, the price adjustment process between Harare and Chitungwiza takes place in the shortest time, in two days, compared to Harare and Marondera (3 days) and Harare and Mutare (5 days). Information from the size and speed of the price transmission process enables us to say in a composite way that (Chitungwiza, Harare) is the most integrated market pair.

The markets for which valid results were obtained has been termed strategic in the sense that they are spatially positioned such that they enable us to impute the nature of the price transmission process of the markets for which results were indeterminate. For example, the sizes of the price transmission process for (Harare, Chinhoyi) and (Harare, Bindura) are expected to be between those for (Harare, Chitungwiza) and (Harare, Mutare) and close to (Harare, Marondera), going by the strong relationship between market integration and inter-market distances.

Policy Implications

In spite of the interest in smallholder horticulture, public policy involvement in smallholder horticultural production has been passive at best. As a result, smallholder horticultural marketing has been, and is, taking place in an environment that lacks infrastructure and is hampered by lack of accessible and reliable market information. In addition, farm-level constraints have led to low and inferior quality production, rendering smallholder farmers unable to take full advantage of any existent market windows.

Given the backdrop of the ongoing economic policy reforms and the accessory liberalization of agricultural marketing, government can adopt facilitative, functional, and regulatory policies to improve market performance and societal welfare in the informal horticultural sector.

Most of the present extension efforts are production centered, resulting in most farmers producing in the same period of time according to the dictates of agro-climatic conditions. This state of affairs results in most farmers following the same cropping schedule and husbandry practices, leading to a highly seasonal supply pattern. Instead, extension efforts need to include market-centered approaches to assist farmers develop better marketing strategies. Information on long-term trends and seasonality of prices for the major crops should be disseminated to farmers to farmers so that they take advantage of market windows. Better access to market intelligence would reduce risk and uncertainty, thereby increasing the social pie. Smallholder farmers benefit by exploiting market windows while the urban consumers benefit from the stable and lower prices.

The high seasonality in prices reveals an opportunity for time arbitrage. Although perishability of horticultural produce makes direct storage expensive and non-profitable, opportunities for arbitrage exist through processing. Most vegetables can be sun dried in periods of glut and marketed in times of market shortages. Currently, some farmers sun dry tomatoes and leafy vegetables. It is a challenge for research and extension to improve sun drying techniques and expand their use to more crops. Processing companies could take advantage of the seasonality by canning fruits and vegetables in times of peak supply and selling them at a profit in times of shortage.

Evidence suggests that marketing agents are engaged in collusive behavior, indicative of imperfect marketing conditions. In times of peak supply, bottlenecks in transport facilities worsen the bargaining position of farmers. As a temporal measure, the government could supplement the services of transporters especially in remote areas. It is imperative to run such operations on profitable bases so as not to distort marketing forces or crowd out other middlemen. Success stories such as the Mashonaland East Fruit and Vegetable Program could be duplicated in other areas of high production.

Three factors have stuck out prominently as impediments to greater market integration among the urban horticultural markets, namely the lack of access to quality market information by farmers and traders, lack of a credit facility to finance informal horticultural trade and the rudimentary nature of the transport system in inter-market trade.

Market information plays a facilitative role in the marketing process. The access by all market participants to timely, accurate and comprehensive market information is important in two fundamental ways. First, it has been established in this study that market information can act as an entry barrier at the wholesale level, sheltering experienced incumbents from competition by potential and new entrants. Second, symmetrical access to market information improves the bargaining process during price discovery between transacting agents, hence pricing efficiency. Third, freely available information on regional product availabilities and prices is simply a necessary condition for market integration through its facilitation of inter-market arbitrage. In general, market information is essential for the competitiveness of the marketing system through its effect on long-term resource allocation and short-term marketing strategy. The public good nature of market information necessitates government provision. A public market information system should distinguish between 'market information' regarding current supplies and prices and market intelligence or outlook data.

The lack of formal credit tailored to the circumstances of informal horticultural traders has real costs in terms of greater market concentration at the wholesale level and the attendant problems of loss in pricing efficiency and inequity. Also, lack of access to credit to participate in spatial arbitrage during the scarcity months has a direct stifling effect on market integration. Government can facilitate the smallholder horticultural marketing process by enhancing traders' access to formal credit. The state can do this in two ways. First, in a macroeconomic sense, government needs to rescind the tight monetary policy, itself a result of the large budget deficit (over 10 percent of GDP) to lower interest rates and make it easier for investors to borrow money. Traders who have the requisite collateral can then borrow more easily.

Although the design of this study did not explicitly consider transport variables, it is clear that transport issues are a real determinant of how well markets are integrated across space. One reason why inter-market distance is such a major explainer of the pattern of market integration is that it determines transport costs. Transport creates place utility, as well as playing a role in market development, expansion and fostering regional competition. Also, the unreliability of transport in inter-market trade is a source of risk. Government can improve the transport situation in two ways. The state can play a facilitative role by improving the quality and enhancing the density of roads connecting trading regions. In addition, the state can play a facilitative role in improving the transport situation by making it easier for private entrepreneurs to purchase and operate faster refrigerated trucks that minimize damage of the produce in transit and the time needed to move produce between regional markets.

The smallholder horticultural marketing system is conspicuously lacking in a system of grades and standards, which are typically established and enforced by government to facilitate the marketing process. Grades and standards simplify marketing and reduce marketing costs, can lower search and transaction costs and foster a more efficient price discovery process. In relation to spatial arbitrage, grading may decrease transport costs and reduce spoilage.

Lack of on-farm storage gives rise to the 'distress' sales that farmers make either when they sale their produce at the farm-gate or in the central market. The highly perishable nature of tomatoes lowers farmers bargaining power during price discovery, often forcing farmers to accept prices that do not bear any relation to costs. Also, on-farm storage enables farmers to hold onto the produce until such a time when returns could be highest as the market outlook suggests. On-farm storage is a huge investment, requiring spacious facilities that are refrigerated and minimize both decay and pest damage. Since we are talking of small, geographically diffused farmers, the storage facilities should be well cited to achieve the required threshold holding for profitability. These huge investments make a case for government investment in on-farm storage. However, needs exists to assess the economic returns relative to the costs both in a static and dynamic sense.

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