Testing the Performance of Fresh Tomato Markets Following Import Trade Liberalization in Ghana

A Price Transmission Approach

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Abstract

A chronic issue of policy concern in Ghana is the implication of trade liberalization for the performance of agricultural markets. Much public opinion in Ghana blames the perennially volatile, highly dispersed and uncompetitive prices of tomato on the importation of cheap tomato products into Ghana. There is however insufficient empirical evidence to confirm this opinion. To the best of our knowledge, no empirical research on the performance of tomato markets in the post-liberalization period in Ghana has ever been conducted. This paper therefore seeks to provide evidence on the performance of Ghana's tomato markets following trade liberalization.

Such evidence is useful in assessing the implication of liberalization for the performance of Ghana's food commodity markets. We used the threshold autoregressive model to analyse wholesale prices of fresh tomato gathered from four major markets in Ghana. The findings reveal that price transmission and adjustments parameters, key indicators of market performance, declined following the actual liberalization of Ghana's agricultural markets. It appears that the underlying factors responsible for the performance of the tomato markets deteriorated over the period of the study. This may be evidence of liberalization being partly responsible for the marketing problem of tomato in Ghana.

Key Words/Descriptors: Trade Liberalization, Price Transmission, Market Integration, Tomato, Commodities Market.

Introduction

One of the most contentious debates in the last two decades has been whether or not the implementation of liberalized market reforms improved price transmission between agricultural commodity markets in developing countries. Spatial price transmission or market integration measures the degree to which markets at geographically separated locations share common long-run price or trade information on a homogenous commodity. The purported ability of trade liberalization to integrate markets and offer farmers reasonable prices was a major economic need that led Ghana and most developing countries to subscribe to liberalization policy in the 1980s.

Trade liberalization, as part of Ghana's economic reform and structural adjustment programme comprised the gradual abolition of state interventions in agricultural markets. The notion was that by eliminating state interventions, import trade quotas and tariffs, Ghana's agricultural markets would become well integrated and efficient. Ghana's import trade liberalization can be classified under two sub-periods – a high tariffs period when the import protection of agricultural markets was about 20%, and a reduced tariffs period with rationalized import tariffs rates of 0%, 5% and 10% after 2000 (FAO, 2006). For tomato, the commodity of interest in this study, tariffs reduction increased the importation of tomato products beyond the trigger volume after 2000, causing local tomato producers to lose their market share by 35% (ibid).

Two decades after the implementation of trade liberalization policy, the few empirical studies (Alderman, 1992; Badiane and Shively, 1998; Abdulai, 2000) on price transmission in agricultural markets in Ghana report either weak or mixed results. Whereas studies involving commodities with no import substitutes tend to report strong patterns of price transmission and widening marketing opportunities for such commodities, studies involving import substitutes such as rice and tomato report declining market opportunities for local farmers and traders.

Anecdotal evidence shows that locally produced tomato is one of the commodities gravely affected by trade liberalization policy in Ghana. The effects, namely, volatile and dispersed prices, seasonal gluts and uncompetitive markets, imply risks for tomato farmers, traders and other stakeholders in Ghana's tomato industry. The purported cause of this problem is the import dumping of cheap tomato products from the EU on Ghana. Opponents of the import dumping view however blame government inability to strengthen market institutions and improve infrastructure for private sector to effectively replace state interventions after liberalization as the cause of the problem.

The contrasting views of the implication of trade liberalization for Ghana's fresh tomato markets and the perennial policy conflicts in marketing locally produced tomato are empirically baseless. To the best of our knowledge, no empirical proof of the performance of fresh tomato markets since the advent of trade liberalization policy in Ghana exists. The scanty literature available is from advocacy studies. This study has been motivated by the policy need for evidence on the performance of tomato markets, and by extension food commodity markets following trade liberalization in Ghana.

The study seeks to determine whether the performance of fresh tomato markets in Ghana improved over the post liberalization period by examining the rate of price transmission between four tomato markets across two sub-periods following trade liberalization. The first sub-period (hereafter called the high tariffs period) is from January 1992 to December 2000, while the second sub-period (the reduced tariffs period) is from January 2001 to April 2009. The dichotomy between the periods is consistent with Ghana's agricultural trade policy of maintaining import protection using import bans and tariff rates of about 20% or more in agricultural markets till 2000, followed by a reduction in tariffs to rates of about 13% alongside the complete removal of import quotas and bans after 2001(FAO, 2006).

The study covers four major tomato market centres in Ghana. These include two net producer markets, Navrongo and Techiman[1], and two net consumer markets, Tamale and Kumasi. The net producer markets are the largest markets in terms of tomato production in Ghana, while the net consumer markets are big urban markets with considerable consumption levels of tomato but deficit in fresh tomato production. The net producer markets therefore export large volumes of tomato to meet demand in net consumer markets. Even though Accra is the largest tomato consumer market in Ghana, it was dropped from the main analysis due to insufficient data.

The findings of the study show some evidence to support the claim that trade liberalization reduced the transmission and integration of prices between fresh tomato markets in Ghana. Impediments arising from oligopolistic behaviour of traders, seasonal production of the commodity and poor connectivity of surplus producer markets to consumer markets off the West African highway, and the availability of cheap tomato paste in the market may be setbacks to the ability of improved quality of roads, transport

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1   Techiman and Navrongo are market centres for tomato produced in areas around them.

infrastructure and market information flow via mobile phones in eliminating the supply gluts, volatile and uncompetitive prices and other signals of market failure in Ghana's tomato marketing system.

In the following section, we describe the study setting and the data used in the study. Then we specify, in section three, the Johansen's cointegration and the TAR model, then present and discuss the results of the analysis in section four. The final section concludes the paper and outlines suggestions for policy and further research.

The Study Setting and Datasets

The study covers four major, spatially separated fresh tomato markets located along the West African highway in Ghana. They are two net producer markets, Navrongo and Techiman, and two net consumer markets namely Tamale and Kumasi. Navrongo and Techiman, the two major net producing tomato marketing centres in Ghana, are located in different ecological zones, and have different production and harvesting periods. Navrongo is located in the northern, savannah zone and supplies tomato between December and May, while Techiman is located in the southern, transitional zone and supplies tomato between June and early December[2]. Ghana therefore has a tomato marketing system where only one of two major, net-producer markets (areas) supplies many other markets at a time.

The commonness in the source of supply of tomato per season for all tomato markets across Ghana is theoretically a necessary condition for price transmission and integration between the markets. The spatial separation of the two major net producing centres also signals reversal in the direction of trade flow of tomato seasonally. Fresh tomato flows northwards to Navrongo and Tamale, and southwards to Kumasi and Accra between June and December when Techiman is the prevailing supply source. Between January and May when Navrongo is supplying, the trade flow of fresh tomatoes reverses, flowing southwards to the other markets under study, as well as to Accra and Sekondi-Takoradi.

The seasonal reversal in the sources and levels of production implies not only seasonal variations in the price of tomato, but also variable inter-market transfer costs, which constitutes the main component of transaction costs in Ghana's tomato markets. Our survey of the markets under study revealed that transaction costs also vary with changes in international crude oil prices, which exhibited erratic patterns over much of the study period.

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2   Techiman produces more tomato and has a longer supply period than Navrongo. In addition, much of the fresh tomato in Ghana's markets between March and May comprises imports from Burkina-Faso

The above characteristics of the tomato marketing system; namely, the seasonal switching in trade flow, and non-stationarity in commodity prices and transactions costs provides an ideal case for employing the TAR model in analysing price transmission and market integration between the markets under study. The TAR model is capable of capturing non-linearities in the price series due to reversals in the direction of trade flow and non-constant transactions costs. It should be noted that transactions costs and trade flow reversals have the potential to modify arbitrage conditions and thus the nature of price transmission and market integration.

The dataset for the analysis comprises a low-frequency (monthly) wholesale level price series of fresh tomato collected by Ghana's ministry of food and agriculture (MoFA) in the target markets from 1992 to 2009. The Johansen's cointegration approach and a threshold autoregressive (TAR) model are applied in analyzing the data. The behaviour of the price series over the period covered is illustrated in Figures 1.
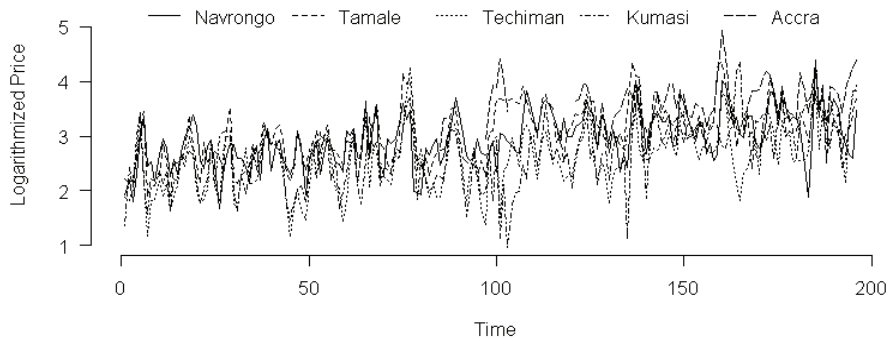
Figure 1: Monthly Fresh Tomato Prices from 1.1992 to 4.2009 (constant March 2007 Ghana Cedi)
Source: Plotted from Dataset

Although the available wholesale prices used for the analysis date back to the 1980s, we used only the series collected in the post trade liberalization period, specifically from January 1992 to April 2009. To capture the dynamics in price adjustment parameters and transaction costs over the period, we divide the dataset into two. Price series from January 1992 to December 2000 were gathered in a high import tariffs period, while the series from January 2001 to April 2009 represent tomato prices collected after import tariffs rates were reduced.

Using the Johansen's cointegration approach, we check for the presence of a cointegrating vector, which signifies a long run equilibrium relationship between pairs of producer and consumer tomato markets, and then compute the cointegration coefficient ($\hat{b}_1$) using OLS. With the TAR model, we estimate speeds of price transmission, price adjustment

thresholds and associated half-lives between market pairs separately for each period, and examine changes in the estimated parameters across the two periods.

Since Ghana experienced high rates of inflation during the 1990s and first half of the 2000s, we deflated the entire dataset using consumer price indices (CPIs) published by the Ghana Statistical Services[3] for food commodities. All prices are expressed in the new Ghana Cedi and the analysis is done with logarithmic transformation of the prices. The estimation is symmetric and pair-wise, examining changes in price adjustment parameters, thresholds and half-lives between producer/consumer market pairs.

Methodology

To ascertain the time series properties of the prices, preliminary tests of unit roots in the individual series using the augmented Dickey Fuller (ADF) test[4], and test for cointegration between producer/consumer market pairs with the Johansen's maximum likelihood approach, were conducted. The cointegration analysis plays an additional role of checking whether the market pairs are integrated in the long run. In the prior analysis using the cointegration test, we evaluate the equilibrium parity condition implied by the relation:

$$(1)\ P_t^c - a - b_1 P_t^s = e_t$$

Where P_t^c is the price of tomato in the net consumer market c and P_t^s is the price in the net source (producer) markets, a is a constant, b is the long run cointegration coefficient and e_t is the error term. In our analysis using the Johansen approach of cointegration, we estimate the equation:

$$(2)\ \Delta p_t = \Pi p_{t-1} + \sum_{j=1}^{n-1} \Gamma_j \Delta p_{t-j} + e_t$$

Where p_t is vector of time-ordered price series (i.e. the consumer/producer market prices in our case), Δ is the first difference operator, Γ is a p-dimensional vector of short run coefficients, while e_t is a vector of random errors.

The parameter matrix Π is the value of interest to be estimated from (2). Following the Johansen's approach, we evaluate the rank of Π, denoted r, which determines the number of cointegrating vectors between a pair of producer and consumer markets or between all the markets in the system as a group, and thus whether or not the markets are integrated in the long run. There are two types of Johansen's test statistics, the maximal Eigen value and the trace test statistics. For convenience in estimation and interpretation, we employ the latter in this study.

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3   We used March 2007 as the base month in deflating the price series.

4   For a description of the theoretical framework of the ADF, see Said E. and David A. Dickey (1984)

As noted in section one, the TAR model is employed to determine whether or not price transmission between tomato markets in Ghana improved over the post liberalization period. In estimating the TAR model, we divide the price series into two periods; January 1992 – December 2000 constitutes a period of high import tariffs, while series from January 2001 – December 2009 represent a reduced import tariffs period. The division is consistent with the pattern of Ghana's agricultural import protection as outlined in section one.

According to the theoretical framework of the TAR model following van Campenhout (2006):

if the price difference between a net consumer market, c, and a net source market, s is given by $d^{cs} = P_t^c \square I$, a simple TAR framework following the symmetric self-exciting TAR model, allows the price adjustment process to vary according to whether $d_{t\square1}^{cs}$ the price difference at time t-1, is below or above a threshold, t^{cs} (a proportional measure of the transaction costs between markets) as follows:

$$(3) \ \square d_t^{cs} = \begin{cases} r^{out} d_{t\square1}^{cs} + e_t, & \text{if } d_{t\square1}^{cs} > t^{cs} \\ r^{in} d_{t\square1}^{cs} + e_t, & \text{if } -t^{cs} \square d_{t\square1}^{cs} \square t^{cs} \\ r^{out} d_{t\square1}^{cs} + e_t, & \text{if } d_{t\square1}^{cs} < \square t^{cs} \end{cases}$$

Where r^{in} is the speed of price adjustment when the price difference is below t^{cs} and r^{out} is the speed of price adjustment when the absolute value of the price difference exceeds t^{cs}. Theory assumes that there is no adjustment when the price difference is below t^{cs} i.e. $r^{in} = 0$. With this assumption, the TAR model we actually estimate is:

$$(4) \ \square d_t^{cs} = \begin{cases} r^{out} d_{t\square1}^{cs} + e_t, & \text{if } d_{t\square1}^{cs} > t^{cs} \\ e_t & \text{if } -t^{cs} \square d_{t\square1}^{cs} \square t^{cs} \\ r^{out} d_{t\square1}^{cs} + e_t, & \text{if } d_{t\square1}^{cs} < \square t^{cs} \end{cases}$$

The estimation process involves identifying the t^{cs} through a grid search for the threshold that maximizes the sum of squared residuals. The J-Multi software is used in running the analysis.

Results and Discussion

Results of Cointegration Analysis

This subsection presents the results of the cointegration tests. Visually examining the graphical plots (Figures 1) suggests that we specify only a constant but omit a time trend in testing for cointegration between tomato producer/consumer market pairs. The preliminary augmented Dickey-Fuller (ADF) unit root test used to check the stationary property of the prices series shows that the series are unit root non-stationary), i.e. I(1), in their levels but stationary, i.e. I(0), in their first differences. This means we can proceed to test for cointegration between the market pairs with the Johansen's approach.

The Johansen's cointegration test results are presented in Table 1 below. We first determine the rank of cointegration (r) between the market pairs and then use OLS to estimate the magnitude ($\hat{b}_i$) of the cointegration relation between pairs of producer and consumer markets.

Table 1: Johansen's Cointegration Trace Test Statistics and Cointegration Relations

Market Pair	Distance (Km)	Cointegration Vector (Trace Stat.)		Cointegration Relation ($\hat{b}_i$)
		r = 0	r = 1	
Navrongo – Kumasi	610	50.48**	8.65	0.40+
Navrongo – Techiman	460	46.94**	12.33	0.50+
Navrongo – Tamale	190	47.00**	19.41**	0.60+
Techiman –Kumasi	150	29.97**	4.37	0.54+
Techiman – Tamale	270	64.83**	15.42**	0.84+
Techiman - Navrongo	460	46.94**	12.33	0.73+ -
All Market Pairs	-	124.30**	12.12*	-

Source: Authors' Own Estimations from Dataset

The asterisks * and ** denote rejection of the null hypothesis of no cointegration relation at the 5% and 1% levels respectively, while + indicates significance of $\hat{b}_i$ at the 5% level.

It can be seen from Table 1 that the null hypothesis of r = 0, implying an absence of a cointegrating vector between producer/consumer market pairs is rejected in all cases at both the 1% and 5% significance levels. We cannot however reject the null hypothesis of one cointegrating vector, i.e. r = 1 for four out of the six market pairs under study at the 1% and 5% levels. The significant trace statistics for the Navrongo-Tamale and Techiman-Tamale market pairs, signifying two cointegration vectors between these markets pairs is statistically not interpretable and may be due to data limitations – i.e. unidentified correlation between the price series of Tamale and Navrongo and Tamale and Techiman that is not due to long run effects.

Having no reason to suspect an absence of cointegration between the target tomato market pairs, which we observed via our market surveys to be well connected through a good quality road, information flow and trader network, we perform a multivariate form of the Johansen's test to check for cointegration in the system comprising the four markets as a group. The findings of the multivariate cointegration analysis prove that the marketing system is cointegrated at the 5% level, with the system of markets having the expected r = N-1 = 3 cointegrating vectors; where N is the number of markets in the system[5].

The findings imply that similar supply-demand processes, possibly induced by the efficient flow of market information, means of transportation and trader networks between markets, drive the behaviour of prices in the tomato marketing system in Ghana. For this reason, tomato prices in the producer and consumer markets do not drift apart in the long run (Motamed, Foster and Tyner, 2008). In this case, price changes resulting from random market shocks on any producer market will be expected to reflect as changes in the prices of the commodity in all other markets, assuming unchanged transaction costs. In the long run, the results are evidence for a common domestic tomato market in Ghana, where inter-market prices adjust to achieve long-run, market equilibrium.

Perhaps the seasonal nature of tomato production, with either the Navrongo or Techiman market being a major source of supply of tomato to the other markets in the system per season, and recent improvements in roads, means of transportation and information flow via mobile phones, explains this outcome. Since good quality trunk roads connect the system of markets under study, concluding that a common domestic tomato marketing system exists in Ghana as a whole may be hyperbolic. It is likely that cointegration may be lacking between net producer and consumer markets poorly connected by road, especially those markets off the West African highway. Nevertheless, the evidence provides an ideal setting for us to use the TAR model to explore the nature of price transmission and market integration between the markets under study.

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5   The test statistics presented are those testing the null hypotheses r = 0, and r = 3; the latter cannot be rejected at the 5% significance level.

Market Integration over the period of Trade Liberalization in Ghana

The results of the TAR model used to verify whether there have been changes in the transmission of price signals between pairs of fresh tomato markets following trade liberalization policy in Ghana are presented in Table 2 below. The focus is on the differences between estimated speeds of price adjustment, half-lives and thresholds across the high- and reduced tariffs periods following liberalization.

It can be seen from the Table that the estimated thresholds (t^{σ}) – proportional measures of the amount (in Ghana Cedi) that inter-market price differentials must exceed before provoking price adjustment – are only higher for the market pairs Tamale-Navrongo (0.21) and Techiman-Navrongo (0.45) in the reduced- than in the high tariffs period, otherwise t^{σ} for the Kumasi-Navrongo (0.31), Tamale-Techiman (0.54) and Kumasi-Techiman (0.19) market pairs declined following the reduction in import tariffs in 2001.

Table 2: Adjustment Speeds, Thresholds and Half-lives of the TAR Model

Market Pair	High Tariffs (1992-2000)			Reduced Tariffs (2001-2009)		
	t^{σ}	r^{out}	$\hat{l}$	t^{σ}	r^{out}	$\hat{l}$
Tamale-Navrongo	0.13	-0.491** (-5.87)	1.03	0.21	-0.663** (-6.80)	0.64
Techiman-Navrongo	0.30	-0.394** (-5.09)	1.39	0.45	-0.295** (-4.28)	1.98
Kumasi-Navrongo	0.37	-0.500** (-5.71)	0.99	0.31	-0.488** (-5.45)	1.04
Tamale-Techiman	0.70	-0.378** (-4.88)	1.46	0.54	-0.384** (-5.09)	1.43
Kumasi-Techiman	0.32	-0.778** (-7.73)	0.46	0.19	-0.548** (-6.06)	0.87
Navrongo-Techiman	0.30	-0.394** (-5.09)	1.39	0.45	-0.295** (-4.28)	1.98
Average Value	0.35	-0.489	1.12	.36	-0.446	1.32

Source: Authors' Own Estimations from Data

The asterisks * and ** denote significance of the price adjustment speeds at the 5% and 1% levels respectively. r^{out} is the estimated adjustment speed in the outer regimes; the negative values of this coefficient shows price adjustment form market disequilibrium towards equilibrium. The half-lives ($\hat{l}$) are measured in months. Average values are computed arithmetic means of all estimated thresholds, and of only significant speeds of adjustment.

On average, thresholds between market pairs have to be at least 0.35(35%) above the inter-market price margin under high tariffs and 0.36 (36%) above the price margin under reduced tariffs to trigger price adjustment processes between markets. That is, whereas both negative and positive inter-market price variation of up to 35% from their equilibrium values was acceptable to arbitragers in the first period, price divergence up to 36% from equilibrium was permitted by arbitragers following tariffs reductions. The proportional "trigger" threshold, therefore, increased by about 1% from the high- to the low tariffs period.

There is evidence of rapid speeds of price adjustment in both periods, with all estimated speeds of adjustment (r_{out}) being significantly different from zero. Nevertheless, the speed of price adjustment between the pairs of markets improved fairly by about 0.172 (17.2%), only for Tamale-Navrongo, after tariffs were reduced in 2001. Price adjustment between all other markets pairs worsened or remained fairly stable (such as between Tamale and Techiman) across the two periods.

Overall, fresh tomato prices adjusted faster to market shocks in the period of high tariffs where the mean value of the speed of adjustment is about 0.489 (49%), than in the reduced tariffs period with an average adjustment speed of 0.446(45%). This signifies a 4% worsening in the rate of price transmission and extent of integration of the tomato markets over the two periods.

The estimated half-lives6 of price adjustment show that market disequilibrium and unexploited arbitrage opportunities persisted a little longer under the reduced tariffs period than under the high tariffs period. The half-lives indicate that prices need, on average, about 1.3 months (over 5 weeks) under the reduced tariffs period to correct half of the deviations from equilibrium following market shocks as against about one month in the high tariffs period. Individually however, the results are mixed.

Altogether, our findings seem to reveal that despite substantial efforts by government and non-governmental institutions to improve the performance of tomato markets in Ghana in the past decade, price transmission and the extent of market integration in fresh tomato markets declined following the reduction of agricultural import tariffs due to trade liberalization. It appears the underlying factors responsible for the efficient transmission of tomato price signals between producer and consumer markets over the

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6   Half-lives measure the time required (in months) for half of the price deviations from market equilibrium to be eliminated.

period of liberalization in Ghana deteriorated, and have offset any market improvement strategy implemented within the last decade. Therefore, the claim that trade liberalization is, at least, partly responsible for reduced marketing opportunities for locally produced fresh tomato markets in Ghana is empirically confirmed.

Conclusion and Recommendations

We examined the extent of price transmission and market integration between net producer and consumer pairs of tomato markets in a high tariffs period (1992-2000) and a low tariffs period (2001-2009) to determine whether price transmission and hence the underlying factors responsible for market integration sufficiently improved over the two periods. The findings reveal that the fresh tomato markets under study are cointegrated, with producer and consumer market prices tending to co-move together in the long run. This is expected since the markets are strongly linked by the West African highway, relatively standard means of transportation, trader networks and rapid information flow through the use of mobile phones.

The results of the standard TAR model show swift but mixed patterns in the inter-market speeds of price adjustment, adjustment half-lives and levels of transaction costs across the two periods. Nevertheless, estimated average price transmission speeds declined, while estimated thresholds, which proxy proportional transaction costs, increased following tariffs reductions. This implies that the degree of market integration deteriorated whereas the transaction costs incurred in moving tomato from producer to consumer markets rose, following trade liberalization in Ghana. There is therefore compelling evidence to suggest that trade liberalization is partly responsible for the perennial marketing problem of fresh tomato in Ghana. Trade may not however be the sole determinant of market performance (Stephens, Mabaya, von Cramon-Taubadel and Barrette, 2008). This is because the rate of price transmission remains high despite declining following the reduction of tariffs.

It appears that even though obvious, increased investments in road, transport and market infrastructure in the last decade of trade liberalization policy in Ghana managed to keep tomato markets integrated, these investments failed to ensure increased rates of price transmission and reduce marketing costs between tomato producing and consuming areas as would be expected. Recalling the observations made earlier, we suspect the import surge of cheap tomato products into Ghana, the near-oligopolistic behaviour of wholesalers, seasonality, physical and institutional road barriers from the police and customs services, as well as the high risks involved in trading in a perishable commodity like tomato may jointly undermine the potential of improved infrastructure, transportation and market information flow via mobile phones in boosting the price competitiveness of locally produced tomato and improving the integration of Ghana's tomato markets.

The challenge to future research in price transmission and market integration in Ghana's fresh tomato markets should be to determine exactly the linkage between prices of imported tomato products and those of locally produced tomato. In addition, since transfer costs in the markets under study are non-constant, estimating the TAR model with the speeds of adjustments and thresholds specified as time-varying parameters may also yield more economically interpretable results than those of the standard TAR model used here. In the meantime, policy options aimed at reducing costs of tomato production, curtailing imports of cheap tomato products, minimizing the use of traders' market power, encouraging local storage and processing, and improving road linkages between isolated, fresh tomato-deficit markets and net producer markets, will reduce price volatility and boost the competitive urge of fresh tomato in Ghana.

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