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Cartels and Rent Sharing at the Farmer-Trader Interface

An Example from Ghana's Tomato Sector

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ABSTRACT

Ghana's "market queens," itinerant traders who purchase tomatoes from rural farms and bring them to the large urban markets, are accused of acting as a cartel, both driving down the price farmers receive and driving up the price urban consumers pay through restricting the volume of tomatoes entering key markets. Our paper provides the first detailed exploration of the interface between farmers and traders, combining a theoretical model with novel empirical data on daily prices and tomato quality that we collected from Ghana's Upper East region. We find evidence that the traders do operate a cartel but that farmers who sell to them receive higher prices than if they sell to the local market, even though there is little difference in quality compared with tomatoes sold to the local market. This suggests that traders share cartel rents with these farmers, resulting in lower prices in rural areas, higher prices in the cities, and a greater constriction of total market volume. Our paper suggests that policymakers would do better to focus on the full value chain and on opening up the urban markets rather than on strengthening farmers' bargaining power with the traders, which restricts market volumes and harms farmers unable to sell to traders.

Keywords: arbitrage, agricultural value chains, trader cartels, Ghana

JEL codes: D43, N57, Q13

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1. INTRODUCTION

A key feature of the tomato sector in Ghana is the strength of the itinerant traders, the "market queens" who purchase tomatoes from rural farms and bring them to the large urban markets. Ghana's tomato market queens have a poor reputation. Working closely with the transport unions, these traders control distribution networks and the number of trucks of tomatoes that can enter a particular urban market on any particular day. In the press and the gray literature, these traders are variously portrayed as a cartel that is detrimental to both consumers, who pay inflated prices, and producers, who receive lower prices or get no market at all; or as the only group in the tomato value chain that is disciplined and organized, reducing risk, uncertainty, and spoilage of a highly perishable fruit.

Farmers in Ghana's Upper East region in particular complain that they have insufficient access to the traders and must often sell to the nearby rural markets or agro-processors, where prices are much lower than in the urban centers to which they cannot take their tomatoes directly because access is restricted by the trader cartels.[1] The traders in turn retort that they play a valuable role in the tomato value chain, taking on considerable risk in traveling the length of the country, buying tomatoes directly from the farmer, transporting the tomatoes long distances to markets, and risking dangerous roads and robberies en route, with no guarantee of selling once they get to the market.

In reality, the impact of Ghana's tomato traders on the sector is not understood. To date there has been little detailed exploration of the relationship between traders and farmers and in particular the extent to which the so-called trader cartel affects farmgate and consumer prices and volume of tomatoes in the rural and urban markets. In part this is because there is a general dearth of information concerning production and market prices of vegetables in Ghana. Our paper partially fills this gap with both a theoretical model of the trader–farmer interface and an empirical investigation based on data collected for one season in Ghana's Upper East region. First, based on our observations of the tomato market in Ghana's Upper East region, we develop a theoretical model in which a farmer can sell to a trader if she comes to his farm, else the farmer must take his produce to a nearby rural market. The tomato traders take these purchased tomatoes to the urban markets, which they control by restricting who can bring tomatoes into the market, on what days, and in what quantities (Robinson and Kolavalli 2010a). The traders therefore have an important if indirect impact on wholesale tomato prices. In contrast, access to the rural markets in the production areas is unrestricted. Our discussions with farmers in the Upper East region and elsewhere suggest that farmers prefer to sell to the traders, even though they complain that the prices they are offered are too low, because the traders take on the associated risks of transportation and selling. On the other hand, if a farmer sells to the nearby rural market he must find and pay up front for transportation, and he risks not selling all his produce after incurring the cost of taking it to the market.

We use our model to show how equilibrium prices and quantities at the urban and rural markets and prices paid to the farmers depend on whether or not traders are operating a cartel and whether farmers have any influence on prices when bargaining with the traders—that is, whether farmers share in any cartel rents. Then, using a new and very detailed dataset we collected in early 2010 (including the dates and prices of tomato sales, quantities sold, whether the sale was to a trader or to the local market, and information on the average quality of each farmer's tomatoes using multiple quality indicators), we test whether farmers received different prices depending on whom they sold to—specifically whether a trader or the rural market—and whether these differences are due to differences in quality.

Our theoretical model suggests that with the market structure we find in practice, namely a trader cartel controlling access to the urban markets plus free access for farmers to rural markets, traders should be able to pay farmers their reserve price, which is set by the rural markets, and extract all the cartel rents. Yet in practice we find that farmers in the Upper East who sell to the traders get on average statistically higher prices than those farmers who sell directly to the nearby rural markets. We posit two possible reasons for this. First, this difference could be because the traders demand and purchase higher-quality

[1] Ghana has tomato processing capacity but for various reasons processing has only been an option intermittently (Robinson and Kolavalli, 2010b).

tomatoes. Second, it could be that the traders are in fact sharing the cartel rents with those farmers with whom they trade. To determine which is indeed most likely to be the cause of these price differences, we look at the quality of tomatoes being grown by each farmer.

The remainder of our paper is structured in the following way. In the next section we situate our paper within the literature, focusing on lessons from labor economics on monopsony and collective bargaining as well as literature on cartels and competitive fringes. Then in Section 3 we develop a theoretical model that explores equilibrium tomato prices and quantities depending on whether traders do indeed act as a cartel and the extent to which farmers share in the cartel rents. In Section 4 we show empirically that farmers who sell to traders receive higher prices than those who sell to the market, even though the quality of their fruits appears to differ little. Finally in Section 5 we consider the policy implications of our paper, in particular addressing where governments might more effectively intervene to enhance Ghana's tomato sector.

2. LITERATURE

In Ghana the relationship between farmers and traders has been tumultuous. Often farmers think negatively of traders and accuse them of exploitation, particularly because they appear to be organized as a domestic cartel. Farmers habitually state that if they could just get rid of the traders, their profits would improve. Traders, in contrast, state that they fulfill a vital role in the value chain by bearing the risks of moving tomatoes from rural areas to urban centers, where they may or may not sell the tomatoes. They argue that the farmers are better off with an organized group of traders, not worse off.

Most of the literature that addresses Africa's domestic agricultural trader cartels describes them as detrimental to the sector with which they are involved (such as Lenné and Ward 2010), though a key exception is a study by KIT and IIRR (2008), which focuses on the benefits for farmers of being able to sell to traders. A number of reasons are given to justify the existence of these trader associations. Focusing on the tomato trade in the city of Kumasi in Ghana, Lyon (2003) identifies information dissemination as an important activity of the associations. Membership provides access to information about farmers or retailers who are credit risks, and the association also holds members accountable to pay off debts in order to protect the reputation of all members. Shepherd (2005) points out that for tomato traders in Accra, traders' associations typically have important welfare and dispute resolution functions. Although they can influence markets by limiting access to members, apparently with the collusion of the market authorities, Lyon (2003) concludes that direct price manipulation is very limited, being constrained by the knowledge that new supplies will be arriving the following day (though this argument is less relevant for more perishable goods such as tomato). Concerning the wool market in South Africa, D'Haese and colleagues (2003) suggest that traders offer farmers a relatively low price because the traders take on risks associated with grading, sorting, packaging, and transport, implying that the traders get a risk premium.

Growers, on the other hand, suspect that they are not being paid a fair price, and they therefore seek opportunities to empower themselves through producer associations. These associations are often weak, with limited bargaining power. In some cases, however, they have led to success stories. For instance, in Kumasi, Akumadan, and Mampong, farmers have strong associations for marketing their produce (Boateng et al. 2007). On a larger scale, formal institutions like the Onion Producers Association of Niger also increase the likelihood that farmers get what they consider to be a good deal. The Onion Producers determine minimum prices to be paid for onions for each month of the year and even oblige buyers to pay a levy to fund association activities. The Onion Producers also run a market intelligence service in the major terminal points where their goods are sold. As a result, onion growers are the most prosperous farmers in the country (Dar 2007).

Although our paper focuses on the interface between highly organized trader cartels and less-organized tomato farmers, our work sits less within the standard cartel literature and more within that of monopsony and collective bargaining for a number of reasons. In Ghana we find a proven stable cartel of tomato traders, and so determining stability is not an issue for us (as it was, for example, in studies by Selten 1973, D'Aspremont et al. 1983, and Ellison 1994). Moreover, there is not a competitive fringe of traders per se, as we find in papers such as those by Pindyck (1979) and Cellini, Lambertini, and Mantovani (2008). In our model, domestic trader cartels are spatially differentiated: Different cartels operate pretty much independently in the key markets in the key urban centers, notably in Kumasi's main market and in the Agbogbloshie and Makola markets in Accra, controlling the volume of tomatoes that enter these markets. Outside of the larger, urban markets are smaller, rural markets to which access is not restricted; that is, traders and farmers are both free to bring their tomatoes there to sell. For a particular harvest, then, farmers may either sell to the trader cartel for transport to the controlled urban markets (assuming a trader has approached the farmer with an offer to buy) or sell, either directly or through local traders, to the fringe (the unrestricted rural markets) (Robinson and Kolavalli 2010a). Although some farmers sell only to traders throughout the season and others only to the local market, there are some who vary their selling practices within a given season (Robinson and Kolavalli 2010a). Importantly, ours is an

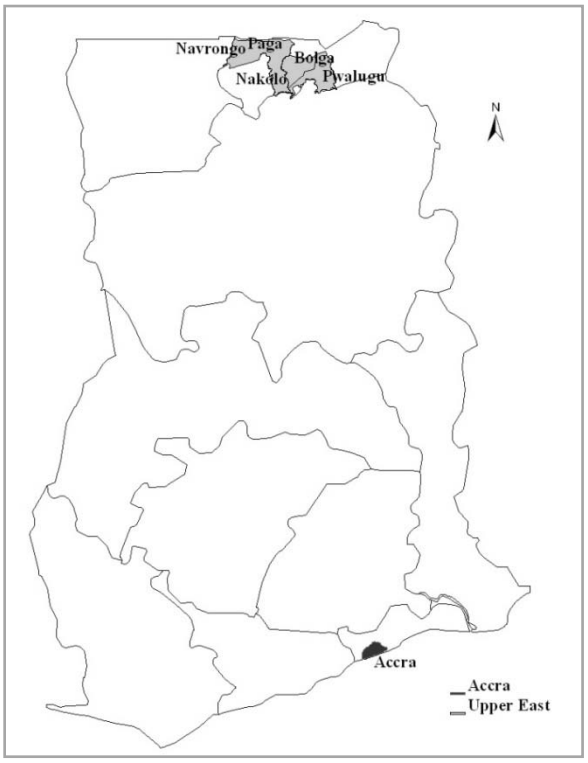
explicitly spatial model—the markets farmers sell to (indirectly through traders or directly) are spatially separated: The tomatoes of farmers who sell to the traders go to the distant, urban markets; those of farmers who cannot sell to the traders go to the nearer, rural markets.

Finally, because we focus on the interface and therefore the relationships between farmers and traders, not simply on prices and quantities, our paper is more closely related to the labor economics literature on monopsony and collective bargaining than to the cartel literature (see, for example, Katz and Summers 1989; and Blair and Harrison 2010, whose Chapter 8 provides a useful analysis of monopsony in agricultural markets). A key emphasis in some of this literature is the need for better organization of workers or suppliers to counter the strength of the monopsonist. For example, Key and Runsten (1999) highlight the problems of monopsony and oligopsony with food processors and marketers and emphasize the need for small-scale farmers to be organized to increase their bargaining power (see also Coulter et al., 1999). In our paper the monopsonist is the market trader cartel that buys from farmers and sells to a restricted urban market (the monopsony is therefore due to a spatially segregated market).

3. THE MODEL

We develop a model centered around the market trader–farmer interface. In our model there are three actors: farmers, traders, and consumers.[2] We let there be two markets, the large urban market, designated as "Accra," and the smaller market located in the production area, designated as "Navrongo" (see Figure 1 for a map of Ghana showing production areas and key markets relevant to this paper).[3] In our model the traders are initially the only group able to exert any market power, which takes the form of restricting access to the urban market, Accra, which is distant from the production area. In contrast, farmers can take their produce to the nearby Navrongo market. We determine the long run equilibrium volumes and prices in each of the markets and so the total quantity of tomato produced is determined endogenously.

Figure 1. Production areas studied (Upper East) and key Ghana tomato market (Accra)



Source: Produced by authors using Arc-GIS data.

In any one year the total tomato production in the region equals Q, of which traders choose a quantity Q_A to purchase from farmers and take to the urban markets while the remainder, Q_N, is sold directly by the farmers at Navrongo, such that $\overline{Q} = Q_N + Q_A$. We let the price at each market be p_i, where $p_i = B - \alpha Q_i$ (inverse demand function): $i = N$ for the Navrongo market and $i = A$ for the Accra market.[4]

[2] In this season some farmers did sell to tomato processors. However, at the time of the survey and as has been typical over the past decade and longer, the local processor has been working only intermittently. Moreover, farmers who sell to domestic processors typically contract with a processor before they plant. Therefore, although the option of farmers selling to processors is an interesting one, in this model we focus on the spot market which is dominated by traders and the local markets

[3] In Ghana, the key urban markets are those in Accra or Kumasi; the smaller markets Paga, Bolgatanga, and Navrongo are in the Upper East region close to the production area.

[4] Our theoretical model assumes the same demand function for both markets, Accra and Navrongo, but naturally in practice

No Trader Cartel

If we assume competitive markets (no trader market power), then the arbitrage condition holds:[5]

$$p_A = p_N + T \quad , \tag{1}$$

where T is the cost of transporting tomatoes from the production area to the Accra market (we assume zero cost for taking tomatoes to the nearby Navrongo market).

We let the costs of tomato production be *C* per unit. As long as the price farmers receive (for which p_N is a reasonable proxy) at least covers their cost of production, farmers will continue to grow tomatoes (long-run zero-profit condition). In the long-run equilibrium, therefore, $p_N = C$, and if the arbitrage condition holds, the price in Accra is simply $p_A = C + T$. We use the inverse demand functions to determine the quantity sold in each market, recognizing that the total quantity *Q* is endogenous and depends on the cost of production:

$$Q_N = \frac{B - C}{\alpha} \text{ and } Q_A = \frac{B - C - T}{\alpha} \; ; \; p_N = C \text{ and } p_A = C + T. \tag{2}$$

Trader Cartel

Next we assume that the traders, acting as a cartel, choose Q_A to maximize their joint expected net profits. When the traders control access to the Accra market, the condition $p_N = C$ still holds. Traders maximize their joint profits period by period:

$$\max_{Q_A} \{ p_A Q_A - T Q_A - p_N Q_A \} \quad , \tag{3}$$

which can be rewritten as

$$\max_{Q_A} \{ Q_A (B - \alpha Q_A - T - C) \} \quad , \tag{4}$$

which gives us the result

$$Q_N = \frac{B - C}{\alpha} \; ; \; Q_A = \frac{B - C - T}{2\alpha} \; ; \; p_N = C \; ; \; p_A = \frac{B + C + T}{2} \quad . \tag{5}$$

In this case, where we have a trader cartel, the price and quantity sold at Navrongo is the same

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the demand functions will be different, with the Accra market being larger and selling greater volumes year-round whereas the smaller local markets in the Upper East region tend to sell tomatoes from the nearby farmers for a few months of the year.

[5] This relationship would hold as long as knowledge was perfect and information was symmetric, or the product could be stored without additional cost. These conditions, however, are rarely met in real markets and therefore the price in two places will rarely differ by exactly the transportation cost (Stigler and Sherwin 1985). This is so for a number of reasons: (1) seasonal and stochastic shocks to supply and demand that create divergent price movements in parts of a market in the absence of perfect foresight; (2) absence of unique transportation costs because transportation cost is influenced by exogenous factors such as cost of fuel, size of shipment, and so on; (3) impediments to efficient arbitrage, such as trade barriers, imperfect information, or risk aversion (Ravallion 1986; Buccola 1985); and (4) imperfect competition in one or more of the markets (Stigler and Sherwin 1985; Faminow and Benson 1990). This latter point is relevant because most studies have come to the conclusion that for equation (1) to hold there must competitive arbitrage forces. However, as noted by Faminow and Benson (1990), it may be difficult to discern the specific cause(s) for failure of equation (1) to hold (see also Sexton, Kling, and Carman 1991).

whether there is a cartel or not because in the long-run total tomato quantities adjust such that the zero-profit condition holds. In the Accra market, as expected, the quantity of tomatoes traded is halved when the cartel is acting as a monopoly.

Farmers Have Some Market Power

It is possible that some farmer groups, knowing that the traders are making excess profits, are able to negotiate a higher price with the traders, thereby sharing some of the trader cartel rents. Here we investigate how greater negotiating power by the farmer affects farmer and trader rents, consumer prices, and the total volume of tomatoes in the system. To explore farmer market power, we parametrically vary some δ, which we define as the price that the traders give farmers over and above the endogenously determined price in Navrongo. Assuming for the moment risk-neutral farmers and traders, in the long-run equilibrium, expected profits from farming tomatoes must continue to equal zero because there is free entry and exit into the tomato sector as a whole for farmers. Therefore we can write

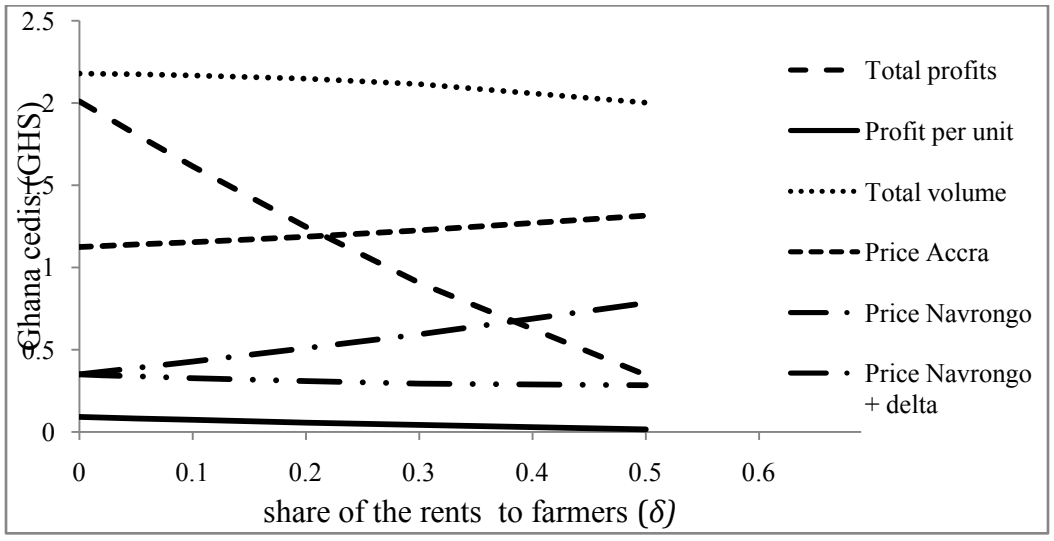
$$p_N Q_N + (p_N + \delta) Q_A - c(Q_N + Q_A) = 0 \quad (6)$$

The cartel now maximizes $p_A Q_A - TQ_A - (p_N + \delta) Q_A$, which can be written

$$\max_{Q_A} \{ Q_A (P_A - T - (P_N + \delta)) \} \quad (7)$$

Conceptually, we take equations (6) and (7), replace prices using the inverse demand function, and solve out. Since we cannot get an explicit solution, Figure 2 shows graphically the impact of parametrically varying δ on revenues, volumes, and profits in the two markets.

Figure 2. Impact of share of rents to farmers on volumes and prices in the markets



Source: Author calculations.

Intuitively, because of the long-run zero-profit condition for farmers (via entry and exit of tomato farmers) and an assumption of risk neutrality for both traders and farmers, when farmers who sell to traders share in the cartel profits, farmers who sell to the Navrongo market must make negative profits. That is, the price in Navrongo is below cost. From Figure 2 we can see that the greater the share of the rents that traders give to farmers they trade with, the lower the total profits for traders in the system and

the smaller the profit per unit of tomato. Trader profits fall relatively rapidly as the share of cartel rents that farmers get increases. The overall volume of tomatoes in the system also falls (a larger fall in the Accra market is somewhat but not fully offset by an increase in sales at the Navrongo market that reflects the lower prices in this rural market).

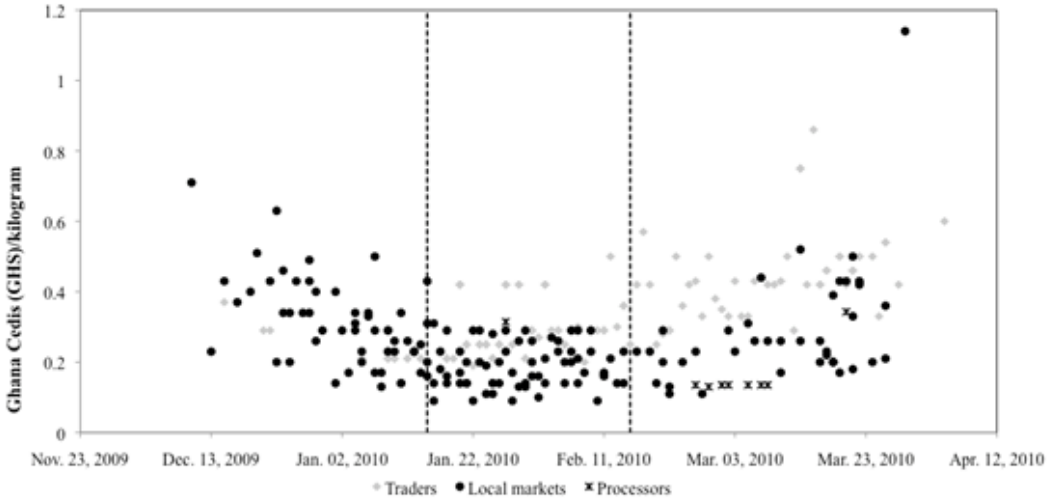
Overall, when farmers share in some of the cartel rents, the Accra market is more restricted and so the price increases further, implying that the greater the share of cartel profits going to farmers, the worse off consumers are in Accra. Prices in Navrongo fall (but only a small amount), implying that consumers there are slightly better off. Not surprisingly, farmers who sell to traders do better than farmers who sell to the Navrongo market, and the greater the share of the rents that farmers who sell to traders get, the greater the differentials between these two types of farmers—those who have access to traders and those who do not.

4. DO FARMERS IN PRACTICE SHARE IN THE CARTEL RENTS? AN EMPIRICAL EXAMPLE

For the 2009/10 dry-season irrigated tomato crop in Ghana's Upper East region, we collected data for a random sample of 100 tomato farmers from 10 different villages (10 farmers per village). In addition to production data, each time a farmer made a sale we recorded the quantity sold, whom the farmer sold to, and the price. For each farmer, once during the season, we also collected a sample of tomatoes, which we tested for a number of quality attributes.

Here we consider whether the prices that farmers in the Upper East region received during the 2009/10 season depended on the group to which the buyer belonged (trader, local market, or processor). We undertake an ANOVA test for the three distinct marketing routes: traders, local markets, and processors. We match sales on specific days to take account of price trends over the season (see Figure 3). We therefore take into account both the date when a particular farmer sold his crop and to whom the farmer sold.

Figure 3. Farmgate tomato price per kilogram



Source: Author survey data.

The ANOVA test is a general robustness test that allows us to investigate the three groups simultaneously to see if there is any difference in their means, though it does not enable us to say which group is different or the magnitude of that difference, only that at least one is. Based on Table 1, we can see that the group to which the tomato buyer belonged was indeed a significant factor affecting the price received by the farmer. Because the p-value is below 0.05, the null hypothesis of equality of mean prices is rejected, indicating that prices paid to farmers are different in at least one of the three groups analyzed.

Table 1. Analysis of variance

Source	Partial SS	Df	MS	F	Prob > F
Model	0.580	2.000	0.290	17.750	0.000
Buyer category	0.580	2.000	0.290	17.750	0.000
Residual	4.800	294.000	0.016		
Total	5.380	296.000	0.018		

Source: Author calculations.

To determine which pair of buyer groups exhibited statistical differences and what the magnitudes of those differences are, we conduct pairwise t-tests on alternative pairs (traders versus buyers from local markets, traders versus agroprocessors, and buyers from local markets versus agroprocessors). As for the ANOVA test, for these pairs we compare prices only when we have a sale on the same day. We investigate in particular whether traders ("market queens") were paying different prices to the tomato growers in the Upper East compared to the prices farmers received from the nearby local markets and agroprocessors. On average, we find that over the season, traders offered about GHS 0.10 more per kilogram than did buyers from nearby markets. Similarly, traders paid GHS 0.19 more per kilogram than agroprocessors paid.[6] These results are significant at the 1% level (see Table 2).

Table 2. Price equality test, December 2009 to April 2010

	Traders	Local market
Traders ("market queens")		
Buyers from local markets	0.100***	
	(0.011)	
	[107]	
Processors	0.194***	0.104***
	(0.029)	(0.042)
	[12]	[8]

Source: Author calculations.
Notes: *** significance at 10% level. Standard errors in parentheses and number of observations in brackets.

A casual look at Figure 2 reveals that the price received by Upper East farmers for a kilogram of tomatoes changed over the 2009/10 season. Prices typically were high in December 2009, at the start of the Upper East season, when tomatoes are typically fairly scarce; decreased through early February 2010 as supply increased; and increased again between mid-February and April, when production decreased and supply again became scarce (Ihle et al. 2010; Robinson and Kolavalli 2010c). To compare prices offered by different buyers at different stages of the Upper East season, we therefore divided the sample into three periods corresponding to the three major sub-seasonal phases that can be seen in Figure 2. The first phase is between December 10, 2009, and January 15, 2010, with low to moderate production, buyers from Navrongo and other local markets dominating the market, and prices falling over time, reflecting a gradual increase in the volume of tomatoes in the system. The second phase is from January 16 to February 15, 2010, with relatively high tomato production, relatively low and stable prices, and most local markets in operation. The third phase is between February 16 and April 10, 2010, when declines in tomato production led to price increases over time and when traders and some local markets, such as the one at Bolgatanga, dominated.

During the first period, our statistical test reveals that the average price in the local markets was GHS 0.046 more than the price paid to farmers by the traders. In the second period, a paired statistical t-test shows that traders paid GHS 0.098 and GHS 0.11 more than the prices of the local markets and agroprocessors respectively. In the third period, when traders were the most active buyers of tomatoes in the Upper East, they paid GHS 0.16 and GHS 0.224 more than nearby markets and agroprocessors respectively.

[6] When data were collected, one Ghanaian cedi (GHS) was equivalent to US$0.71.

Table 3. Price equality test, December 2009 to April 2010, divided into three periods

	Dec. 10, 2009, to Jan. 15, 2010		Jan. 16, 2010, to Feb. 15, 2010		Feb. 16, 2010, to April 10, 2010	
	Traders	Local markets	Traders	Local markets	Traders	Local markets
Traders ("market queens")						
Buyers from local markets	-0.046**		0.098***		0.165***	
	(0.014)		(0.012)		(.019)	
	[14]		[58]		[35]	
Processors	---	---	0.106***	0.054	0.224***	0.157**
	---	---	(0.000)	(0.030)	(0.034)	(0.033)
	---	---	[3]	[3]	[9]	[6]

Source: Author calculations.
Notes: *** significance at 10% level, ** significance at 5% level. Standard errors in parentheses and number of observations in brackets.

These results again suggest that when traders are active in the Upper East tomato production area—mainly in the second and third periods—they offer higher prices to farmers compared to other marketing routes (see Table 3). In the first period, between December and January, only a few traders bought tomatoes from the Upper East, most likely because supply, though increasing, was still low. At this time traders had to search harder throughout the region to find sufficient tomatoes to fill a truck, causing concern that they might not fill their trucks in a timely fashion so as to bring the tomatoes to the urban markets while they were still fresh. During this period little competition is observed among traders. Further, the nearby agroprocessor was not yet up and running for the season.

It is not obvious why traders offer higher prices than the two alternative markets. It is possible that the different prices tomato farmers receive from different buyers are due to quality differences in the tomato fruits themselves. To test this hypothesis, we conducted statistical tests to determine whether or not there are significant differences in quality between tomatoes bought by traders versus those bought by other buyers. We considered seven typical measures of tomato quality: shelf life, fruit weight, fruit diameter, acidity, total soluble solids, fruit color, and total titratable acidity (see Hong and Gross 2000; Artés et al. 1999; Gil, Conesa, and Artés 2002; Abbott and Buta 2002). We collected and tested a sample of tomatoes from one harvest per participating farmer; therefore we cannot identify changes in quality over the season. However, our tests showed that for all but two of the quality measures, there were no statistically significant differences in quality between tomatoes sold to traders and those sold to local markets and agroprocessors (see Table 4).

Table 4. Differences in fruit quality between tomatoes sold by farmers to traders and through other marketing routes

	No. of	Shelf	Fruit	Fruit	pH	TSS (%	Color	TTA
Local markets	*71*	-2.724	3.145	0.015	0.008	-0.472***	-0.313	-0.012***
		(1.968)	(2.671)	(0.076)	(0.051)	(0.167)	(0.299)	(0.005)
Agroprocessors	*13*	-0.893	-2.284	-0.066	0.084	0.647***	-0.213	0.013*
		(3.382)	(3.701)	(0.104)	(0.092)	(0.272)	(0.567)	(0.009)

Source: Author calculations.
Notes: *** significance at 10% level, * significance at 1% level. Standard errors in parentheses and number of observations in brackets.

Our informal discussions with the market traders revealed shelf life to be an important quality for these women who transport fresh tomatoes over long distances on poor-quality trucks and roads between the Upper East and the southern markets in Accra and Kumasi (Robinson and Kolavalli 2010a). Yet we found no significant differences between the shelf life of tomatoes bought by traders and those sold locally. The two quality measures for which we did find significant differences were total soluble solids (TSS) and total titratable acidity (TTA). Our results show, for example, that the TSS for tomatoes purchased by traders were 0.4 percent lower than for those sold to local markets. When compared to tomatoes sold to agroprocessors, however, we found the TSS of tomatoes bought by traders to be 0.6 percent higher. This may be explained by the fact that agroprocessors are more interested in striking the right balance between TSS, pH, and TTA than in having the highest level of sweetness. Our price and quality data therefore suggest that the higher average prices that farmers receive from traders over the nearby markets and agroprocessors are more likely to be due to farmers' sharing in the cartel rents than due to quality differences.

5. CONCLUSIONS AND POLICY IMPLICATIONS

The theoretical model that we develop in this paper (which assumes risk neutrality and free entry into and exit from tomato farming) suggests that if the traders took all the rents from the system, (1) farmers would be indifferent (excluding issues of risk) as to whether they sold to the market traders or to the local markets and agroprocessors; (2) rural consumers would pay the long-run equilibrium competitive price; (3) consumers in urban areas would pay a higher price because of the restricted supply to urban markets; and (4) the overall volume of tomatoes produced in the country would be lower than with free access to all markets.

However, although farmers complain that the prices they are paid by traders are too low, the findings of our model and empirical analysis suggest that farmers who sell to traders—Ghana's "market queens"—are in fact better off than if there were no trader cartel; it is farmers unable to sell to the traders and thereby to urban consumers who are harmed by the current market structure. Our tests on the quality of individual farmers' tomatoes, along seven dimensions, suggest that these higher prices are not because farmers are supplying traders with overall higher-quality tomatoes. In particular, the shelf life of tomatoes sold through each of these three marketing routes does not appear to differ significantly despite the fact that this characteristic appears most important for traders. Therefore we conclude that farmers who sell to the urban traders in any particular year share some of the trader cartel rents, implying that farmers do have some power when it comes to bargaining over prices.

Our research raises a number of issues for policymakers. First, any market power that the traders have distorts the tomato market in terms of the volume traded and the prices that the urban consumer must pay. However, in rural areas, if there are free entry and exit of farmers and free access to nearby rural markets, and if farmers have no market power in the price they get from traders, then our model predicts that farmers who continue to be involved in tomatoes are not harmed by the current market structure, nor are rural consumers. Those likely to be harmed are urban consumers and farmers who exit out of tomato farming. But in practice, farmers in Ghana's Upper East region are likely to be risk-averse, and entry into and exit from tomato farming are not without cost. It is not easy for farmers to switch from one crop to another. Farming a particular crop requires a certain amount of management knowledge that is typically accumulated over time.

Second, the findings from our analysis of price data are in line with our observations in the Upper East, where farmer groups have evolved specifically to negotiate with the traders to improve market access and to increase the price that they obtain. Such activities are advocated by, among others, Key and Runsten (1999). Our model suggests that the benefits that these organized farmers gain come at a cost to urban consumers as well as to farmers unable to sell to the traders. Encouraging farmers to increase their bargaining power with traders has the effect of increasing price uncertainty for farmers because they do not know whether they will sell to the traders (at a higher price) or have to sell to the local market (at a lower price). Further, greater farmer bargaining power shrinks the overall tomato market in the country, resulting in higher prices in the Accra market than if farmers did not share in the cartel rents. It is also likely to result in rural market prices lower than the cost of production for farmers unable to sell to the traders. These findings suggest that policymakers would do better to focus on removing access restrictions to the urban markets and reducing the potential for losses incurred by the traders, rather than on strengthening farmer organizations and bargaining power.

The relationship between farmers in the Upper East and the market queens has become increasingly strained because of the perception by farmers that the traders are passing them by, sometimes to purchase from Burkina Faso instead, and that traders, when they do come to Upper East region farming communities, offer prices that are too low (though our data in this paper suggest otherwise). Farmers in the Upper East region, traders, and transporters have recently had a set of negotiations designed to improve relations and increase cooperation between the groups (Robinson and Kolavalli 2010a). One initiative was that producers would send traders "requests" concerning the number of trucks needed to collect local produce and that traders, based on these requests, would allocate trucks either to the Upper

East or to Burkina Faso. Whether this helps the Upper East farmers is yet to be seen.

A questions remains as to why the market traders would choose to share their monopoly rents with the farmers. Traders could be willing to share the cartel rents to improve the likelihood that they have access to "higher-quality" tomatoes—though the latter does not appear to be the case, as shown by our quality tests. The traders have also been under pressure from politicians and NGOs to offer more favorable terms to farmers and so may be responding to that pressure.

If farmers had strong and regular arrangements with particular traders, then the current system might not be so problematic. Indeed, as Springer-Heinze writes, "contrary to traditional food markets, the partners in global value chains collaborate intensively" and typically successfully (2005, 2). Yet we find that although some individual tomato farmers have strong links with traders with whom they have been trading for many years and with whom there are often reciprocal credit arrangements, most farmers do not. So in practice, although farmers do typically get better prices if they can sell to a trader, a farmer cannot be guaranteed from one year to the next that he will be able to sell to a trader rather than the local market. This results in increasing uncertainty over the prices that farmers will receive, over and above general price uncertainty. Indeed it also increases uncertainty over whether in practice a particular farmer will be able to sell his tomatoes at all before they rot.

Whether or not the traders' restrictive practices with respect to access to the urban markets is justified due to the risks that they take on along the value chain is a question left to a separate piece of research that we are currently undertaking. What this paper has shown is that there is what might be termed a two-tiered system for farmers—those who manage to sell to traders get good prices and lower risk; those unable to sell to traders face lower prices in the nearby rural markets and a chance that they will not be able to sell all of their tomatoes (exacerbated by the high perishability of tomatoes and the limit to the total quantity of tomatoes that the rural markets can absorb). Naturally for a farmer, selling to the traders becomes very important.

Finally, if Ghana wants a thriving tomato sector and viable domestic processing, it needs to see production and productivity increasing, such that decreases in equilibrium price, increases in volume, and tomato production are profitable and carry lower risk (Robinson and Kolavalli 2010c). This is likely to occur only if farmers are willing to invest in yield- and productivity-enhancing technologies, which is more likely to occur if their uncertainty decreases. Typically economists focus on production uncertainties. But for tomato farmers the greater uncertainty is arguably over whether they can sell their harvest and where. Certainly in the Upper East there appears little incentive to invest in the sector while access to markets is so uncertain.

Although our paper cannot definitively answer whether it is better quality tomatoes, farmers and traders sharing cartel rents, or a combination of the two that results in traders offering farmers higher prices than might be expected, our paper is, as far as we know, the first attempt to link theory and empirical evidence with both quality and quantity data to explore trader–farmer interfaces in African horticulture markets. Our paper suggests that, if the prices paid by traders are higher because of farmer bargaining power, policymakers would do better to focus on the full value chain—opening up the urban markets, reducing transaction costs, and increasing information along the full tomato value chain—rather than mobilizing groups of farmers in the rural areas.

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