Price Transmission and Trader Entry in Domestic Commodity Markets*

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Abstract

Using detailed data from three simultaneous surveys of producers, traders, and exporters, this paper examines the transmission of international coffee prices through the domestic value chain in Uganda. We find that producer prices fluctuations are inconsistent with constant transactions costs. We investigate three possible explanations for this finding: storage and contango; marketing costs that increase with price, and trader entry that raises search time. We test and reject the storage and marketing costs explanation, but we find some evidence of trader entry in response to a rise in export price. Our findings suggest that small itinerant traders enter in response to an export price increase, probably taking advantage of farmers' ignorance of the rise in wholesale price.

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1. Introduction

Many agricultural commodities originating in the tropics are produced by small farmers. Studies have documented the fact the producers receive a small fraction of the international price. The difference is typically explained by high transport and transactions cost and by monopsonic rents captured by private traders or public marketing boards (. Akiyama, Larson, Varangis & Baffes 1999, Coulter & Poulton 1999, Staatz, Dione & Dembele 1989, Osborne 2005)

Studies of the impact of liberalization on domestic agricultural markets in East and Southern Africa have highlighted that post-reform markets are generally competitive, characterized by a large number of small market participants but with few large traders and trading enterprises (e.g. Fafchamps & Minten 1999, Fafchamps, Gabre-Madhin & Minten 2005). The literature has also highlighted some limits to the success of liberalization, such as limited capital accumulation, nonexistent delivery mechanism for inputs and credit to farmers, inadequate storage capacity, significant inter-annual price variations, and growers' limited information on market prices (e.g. Jones 1995, Beynon, Jones & Yao 1992, Coulter & Golob 1992, Coulter & Onumah 2002).

Our focus here is not so much on the gap between producer and international prices but rather on the transmission process by which changes in international prices affect prices paid to producers. Work on the integration of agricultural markets in poor countries has typically relied on co-integration analysis to test whether price series move together (e.g. Dercon 1995, Baulch 1997, Shively 1996, Badiane & Shively 1998, Fafchamps & Gavian 1996). Such work is normally based on commodity prices collected weekly or monthly over a long period of time in a number of physical markets. Markets located in producing areas are taken to measure the price received by producers. Little work has been done to compare the prices that producers actually receive to those reported by traders and exporters. This paper fills this lacuna.

In Uganda the marketing and export of coffee have been fully liberalized. Uganda is thus

a perfect test case to study the transmission of international commodity prices through the value chain. Using original survey data collected simultaneously at all levels of the value chain, we examine the process by which changes in international commodity prices are reflected in domestic prices. The analysis is based on original data collected by the authors on all coffee exporters as well as on random representative samples of coffee traders and producers. To our knowledge, this is the first study of an African agricultural commodity using a combination of representative randomized surveys covering the entire value chain.

The data show that the price transmission mechanism in Uganda is different from what is typically assumed. We find that a rise in the international price is readily reflected in export and wholesale prices, down to the first processing stage, but that growers receive a smaller share of the international price when it rises. In other words, when the international price rises, all domestic prices follow except for the price paid to producers, which rises much less.

We investigate what is the likely cause. One possibility is that marketing costs rise with the price. We find that this is not the case: what traders spend on transport, handling, storage, and processing remains more or less constant in absolute terms when the export price rises.

Another possibility is that traders take advantage of farmers' ignorance about the rise in wholesale price. This is not implausible because Ugandan coffee growers farmers nearly always sell at the farm-gate (Fafchamps and Hill 2005) and during the study period had no access to publicly available price information. Normally we would expect the pure profits generated by exploiting farmers' ignorance to be eliminated by competition, of which there is plenty of evidence in our data. In the conceptual section, we nevertheless show that, because of a negative search externality, it is possible for trader entry to dissipate the pure profits without bidding the farmgate price up. This is because excess entry increases the search time of traders buying directly from producers scattered over a large area.

The data confirms that a rise in the wholesale price triggers entry by *ddebe boys* – small occasional traders who tour the countryside and purchase directly from the farm. The price at which ddebe boys buy at the farmgate does not rise proportionally with the export price, but the price at which they sell to wholesalers does. Transaction cost externalities associated with trader entry and exit have been previously modeled (e.g. Economides & Siow 1988, Roberts & Key 2005) and negative search externalities arising as a result of entry of market participants have been referred to in employment search models (e.g., Acemoglu & Shimer (1999)). This paper provides an empirical example of this externality.

The paper is organized as follows. In Section 2 we introduce the conceptual framework underlying the empirical analysis. The data used in the empirical analysis are discussed in Section 3. The empirical analysis is presented in Section 4.

2. Conceptual framework

Since our focus is empirical, it is beyond the scope of this paper to develop a fully fledged model of agricultural price formation.[1] But we need a modeling framework with which to approach the empirical evidence. We begin with a bare-bone model based on arbitrage and transactions costs. We show that, in this context, producer prices are more volatile than export prices unless transactions costs vary with price rather than quantity. We then introduce trader entry and farmer ignorance about price movements. We show that, in these circumstances, producer prices may fail to follow a rise in the export price in spite of free competition between traders.

[1] The reader is referred to Takayama & Judge (1971), Newbery & Stiglitz (1981) and Williams & Wright (1991) for detailed modeling of commodity price formation. See also Deaton and Laroque (1995) and Deaton and Laroque (1996).

2.1. Transactions costs and arbitrage

The standard approach to prices in a value chain starts from transactions cost and arbitrage (Williams & Wright 1991). To keep the presentation simple, we abstract from price uncertainty: for the overwhelming majority of traders, turnover is so fast – less than a week – that price risk can be ignored.[2] Formally, let p_x and p_f denote the export and producer prices, respectively. As Uganda is a small coffee exporter, it is reasonable to take p_x as exogenously determined. In a competitive value chain, the difference between producer and export prices reflects the actual search, transport, storage, and processing costs of traders. Given that speculative storage is not practiced by producers or traders in Uganda, we ignore it here and focus on marketing costs other than storage.[3] We revisit the issue of storage in the empirical section. To keep the presentation as clear as possible, time lags are ignored from the notation.[4]

Let unit marketing costs be denoted c. For now let us assume that these costs are constant. With perfect competition, a standard arbitrage argument ensures that:[5]

$$p_x - p_f = c \tag{2.1}$$

which implies that the variance of p_f is the same as the variance of p_x. Define r_{fx} as the share

[2] A handful of exporters with forward delivery contracts either hedge using financial instruments available abroad or rely on their parent corporation for cover. No price insurance contract is available locally.

[3] Unlike in Ethiopia, coffee is basically not domestically consumed in Uganda. There is, therefore, no need for seasonal storage to reconcile demand with seasonal production. The only motive for hoarding coffee would be to speculate on the international price, which varies wildly. Survey data show that coffee producers, traders, and exporters in Uganda do not store for extended periods of time, probably because they are too small to risk losing their working capital in speculative storage. An additional factor may have been that, at the time of the survey, Vietnam, the world's largest Robusta producer, was rumored to have hoarded large amounts of Robusta in response to low international prices.

[4] To the best of our knowledge, the physical delivery of coffee from a farm in Uganda to a warehouse in Europe takes from 3 to 6 weeks on average (one to two weeks from farm-gate to export from Kampala, and then two to four weeks transportation from Kampala to Mombasa and from Mombasa to American or European ports).

[5] In the context of the studied market, perfect competition is a natural starting point. Fafchamps, Gabre-Madhin & Minten (2005) have indeed shown that there is little or no evidence of increasing returns to size in African agricultural trade.

of the export price paid to producers. We have:

$$r_{fx} \equiv \frac{p_f}{p_x} = \frac{p_x - c}{p_x} \tag{2.2}$$

which shows that r_{fx} is an increasing function of the export price. In other words, a 10% rise in p_x should lead to a rise of *more than* 10% in p_f.[6]

The same reasoning can be applied to the difference between the Uganda export price p_x and the international price p_i. Let x denote the transport cost x from Uganda to major export markets in Europe. Again assume that x does not depend on the coffee price. It follows that the ratio of the Uganda export price on the international price $r_{xi} = p_x/p_i$ should be an increasing function of the international price p_i.

These simple observations imply that the producer price should be more volatile than the international price. Let the notation C_z denote the coefficient of variation (CV) of variable z.

[6] A similar result obtains with monopsony. To see this, let the domestic coffee supply be written $S(p_f)$ with constant price elasticity ε. Profit maximization by a monopsonist:

$$\max_{p_f} \pi_x = (p_x - p_f - c)S(p_f)$$

yields the usual 'mark-down' pricing rule:

$$p_f^* = \frac{(p_x - c)\varepsilon}{1 + \varepsilon}$$

As usual, ε must be greater than 1 for an interior solution. It follows that in the monopsonist case:

$$r_{fx} \equiv \frac{p_f^*}{p_x} = \frac{p_x - c}{p_x}\frac{\varepsilon}{1 + \varepsilon}$$

which again shows that r_{fx} is an increasing function of p_x.

We have:

$$\begin{aligned} p_f &= (p_i - c - x) && (2.3) \\ E(p_f) &= E(p_i) - (c + x) < E(p_i) \\ Var(p_f) &= Var(p_i) \\ C_f &\equiv \frac{\sqrt{Var(p_f)}}{E(p_f)} > \frac{\sqrt{Var(p_i)}}{E(p_i)} \equiv C_i && (2.4) \end{aligned}$$

Equation (2.4) shows that, if trade margins are constant in absolute value, the price variance should be the same but the CV of producer prices should be higher than the CV of international prices.[7]

Thus far we have assumed that c is constant. Now suppose instead that c increases when the international price rises. Many transactions costs, such as transportation, handling, and processing, depend on quantity, not on price (Gardner 1975). Consequently they should not change with p_i. But there also exist value-based transaction costs, such as the cost of working capital. Indeed, as the price rises, the need for working capital to finance purchases and storage rises proportionally. A sufficiently large increase in these costs could reduce fluctuations in p_f. It is also conceivable that a rise in p_i increases supply and hence raises the demand for (and price of) transportation, handling, and other marketing services. In the polar case where *all* transactions costs are value-based and quantities traded do not vary with p_i, the transactions cost c is proportional to p_i and we can write $c(p_i) = \alpha p_i$ and $x(p_i) = \beta p_i$. In this special case

[7] A slightly different result obtains with monopolistic competition. Let κ denote the monopsony power of traders and exporters (with perfect competition, $\kappa = 1$; with full monopsony, $\kappa = \varepsilon/(1+\varepsilon) < 1$). Maximizing profit yields the usual constant mark-down equation $p_f = (p_i - c - x)\kappa$, from which we obtain

$$\begin{aligned} E(p_f) &= \kappa E(p_i) - \kappa(c + x) < \kappa E(p_i) \\ Var(p_f) &= \kappa^2 Var(p_i) < Var(p_i) \end{aligned}$$

In this case, it is possible for $Var(p_f) < Var(p_i)$. But we still have $C_f > C_i$.

we have:

$$p_f = p_i(1 - \alpha - \beta) \tag{2.5}$$

implying that $C_f = C_i$, i.e., the variation in producer prices is proportional to the variation in international prices.

To summarize, we have seen that, in standard arbitrage models, producer prices are predicted to fluctuate at least as much as international prices – and to fluctuate more if transactions costs are less than proportional to price, which is normally the case. For producer prices to fluctuate less than international prices, it must be that transactions costs rise proportionally faster than the export price. We now introduce an alternative model that could deliver such a prediction. The key ingredients of this alternative model are farmer ignorance and increased trader entry leading to increased search costs.

2.2. Farmer ignorance and trader entry

Fafchamps and Hill (2005) have shown that most Ugandan farmers sell their coffee at the farmgate to small traders who tour the countryside on bicycles or motorcycles. Called *ddebe boys* after the ddebe container (a twenty kilo tin) that they use to measure coffee, these traders act as aggregators either for large independent traders or for exporters and their agents. Ugandan farmers have limited access to information on coffee prices, other than through ddebe boys. Would it be possible for these traders to take advantage of farmers' ignorance in an environment characterized by free entry? To this we now turn.

2.2.1. Model 1: trader entry

Extending the model to allow for farmer ignorance and trader entry, we show that producer prices can increase less than proportionally with export prices even though free entry ensures that no

trader makes pure profits. To keep the notation simple, we focus on domestic marketing. Imagine that producers are distributed over a large territory, each producer offering a quantity q for sale. Assume that each trader purchases a quantity q by incurring a search cost cq proportional to the time spent searching for a seller. The number of traders is denoted N. To capture the idea that the presence of more traders increases search costs, let the probability of finding a seller be $1/N$ per unit of time. The cost of one unit of time is θ. The expected cost of finding q is thus:

$$c = \theta N$$

Expected trader profit is:

$$\pi = (p_x - p_f)q - q\theta N$$

With free entry, traders enter up to the point where profit is zero. Setting $\pi = 0$ and solving for N we get:

$$N = \frac{p_x - p_f}{\theta} \tag{2.6}$$

which shows that, for a given p_f, N is an increasing function of p_x, the export price. For any level of p_f, entry occurs up to the point where the increase in search costs exactly matches the difference between p_x and p_f.[8] However, without further restrictions the solution (p_f, N) is not unique.

To tie down p_f imagine that the price at which farmers are willing to sell follows an adaptive process. Behind this assumption is the idea that farmers are ill-informed about changes in the export price p_x. In the context of Uganda, this is not an unreasonable assumption. Most farmers

[8] To see this formally, replace p_f in equation (2.6) by its value given by equation (2.1) and let $c = \theta N$. We obtain:

$$N = \frac{p_x - (p_x - \theta N)}{\theta} = N$$

which shows that the number of traders – and hence p_f – are indeterminate.

(80%) sell at the farm-gate and over half of the farmers interviewed (55%) report that they do not receive price information from anyone other than the buyer of their coffee. Only a minority of farmers travel to the market in order to sell their coffee, where they presumably acquire more up to date information about coffee prices.[9] Formally, let this adaptive process be written:

$$p_{ft+1} - p_{ft} = \gamma(p_{xt+1} - p_{ft}) \tag{2.7}$$

Parameter γ captures the extent to which farmers revise their offer price based the evolution of the export price p_x: if $\gamma = 0$, no price revision takes place; if $\gamma = 1$, p_f instantaneously adjusts to the export price.

Further assume that trader entry and exit are rapid so that the number of traders fully adjusts to the new farm-gate price.[10] Underlying this assumption is the observation that many Ugandan coffee traders also deal in other agricultural products, as is common in African agricultural trade (e.g. Fafchamps & Minten 1999, Fafchamps, Gabre-Madhin & Minten 2005). For them, entry and exit in coffee trade is only a matter of switching from one crop to another. With these assumptions, solving for the law of motion of N yields:

$$\begin{aligned} N_{t+1} &= \frac{p_{xt+1} - p_{ft+1}}{\theta} \\ &= \frac{1-\gamma}{\theta}(p_{xt+1} - p_{ft}) \\ &= (1-\gamma)\left(\frac{p_{xt+1} - p_{xt}}{\theta} + N_t\right) \end{aligned} \tag{2.8}$$

[9] Coffee prices used to be broadcast on the radio, but this was discontinued some years prior to the survey due to lack of public funding. At the time of the survey, coffee export prices could be received as phone text messages for a small fee, but few farmers had mobile phones. Monthly reports with coffee price trends are produced by the Uganda Coffee Development Authority (UCDA), but these reports have little circulation outside Kampala. Furthermore, for several decades the coffee price was set by the government for the whole season. Coffee farmers, who on average are quite old, may not have mentally adjusted to the idea that coffee prices change dramatically from week to week.

[10] It is possible to posit an adaptative process for entry and exist as well, in which case non-zero pure profits and losses would arise in the short-run. Given that the emphasis of this paper is empirical, we ignore these complications as they are not necessary to illustrate our point.

where we have made use of equations (2.6) and (2.7). Equation (2.8) shows that if $\gamma = 0$ an increase in the export price translates into an increase in N: traders enter to take advantage of farmers' failure to fully adjust the price at which they sell.[11]

This simple model has implications regarding the relative variation of p_f and p_x. If $\gamma = 0$ and p_f does not adjust at all to a change in p_x, gains from a rise in p_x are entirely dissipated by the negative search externality: N – and thus c – increase so as to exactly dissipate the rise in p_x. As a result, $C_f = 0 < C_x$: the producer price remains constant while the export price fluctuates. In contrast, if $\gamma = 1$ and p_f adjusts instantaneously, N – and hence c – remain constant but p_f rises, and $C_f > C_x$ as discussed earlier. Intermediate cases obtain for intermediate values of γ. It follows that, with trader entry and perfect competition, whether $C_f <$ or $> C_x$ therefore ultimately depends on γ. If farmers remain ignorant of international price movements and new traders rapidly enter to take advantage of this ignorance, it is possible for p_f to remain relatively unresponsive to a rise in p_x even with perfect competition among traders.

2.2.2. Model 2: trader specialization

Before we take these ideas to the data, it is important to recognize that trader entry need not take place at all levels of the value chain. To show this, imagine that there are two marketing tasks: search (looking for coffee by touring the countryside) and assembly (consolidation of unmilled lots into truck-size shipments of milled coffee). Search is labor intensive while assembly is capital intensive. Assume that traders differ in factor cost ratios. Those with a high cost of labor relative to capital specialize in assembly; those with a low cost of labor relative to capital – the ddebe

[11] The cautious reader will note that if $\gamma = 1$, $N = 0$. This result obtains because we have implicitly assumed that farmers could potentially sell at the export price without incurring any transactions cost. This is obviously a simplification. Adding a constant transaction cost to the model would ensure that $N > 0$. We abstract from this detail to keep our notation as simple as possible, but adding it to the model does not change the conclusion.

boys – specialize in search.[12]

With perfect competition in assembly and perfect information among traders, arbitrage implies that the coffee price, net of assembly costs a, is simply $p_x - a$. This is the price that search traders receive from assembly traders. In a stagnant coffee sector, the number of assembly traders is more or less constant.[13] The number N^s of search traders depends on the gap between p_f and $p_x - a$. We have:

$$N^s_{t+1} = \frac{p_{xt+1} - a - p_{ft+1}}{\theta}$$

Free entry by search traders yields the same equation as (2.8), with N^s_{t+1} replacing N_{t+1} and $p_{xt+1} - a$ replacing p_{xt+1}.

Introducing trader specialization yields slightly different predictions regarding the price at which traders buy coffee. Without specialization, all traders purchase at p_f. With permanent traders, some traders buy at p_f while others buy at $p_x - a$. The two models also make different predictions regarding quantities purchased by individual traders. To see this, suppose that total supply is constant. In the first model, as N rises the quantity purchased by each trader falls. In the second model, quantity traded remains the same for assembly traders but it falls for search traders. As we will see, these distinctions have important implications for data analysis.

2.3. Testing strategy

Having clarified the conceptual framework, we now turn to the testing strategy. We first note that a comparison of the variance of the farmer price and the international price provides a simple reduced-form test of the form of transaction costs in the aggregate value chain. There are three possibilities. If transactions costs are constant, arbitrage implies that $C_f > C_i$. This is true with

[12] These assumptions are a fair characterization of the way coffee marketing works in rural Uganda. In Africa trade attracts many unemployed young adults with little capital (Fafchamps and Gabre-Madhin 2006).

[13] The need for assembly services depends on quantity, which is more or less constant except for predictable seasonal variation.

perfect competition or monopsony power. If transactions costs increase proportionally with the international price, for instance because all marketing costs are value-based, then $C_f = C_i$. For C_f to be less than C_i, transactions costs must increase proportionally faster than the export price. This seems unlikely in a standard arbitrage model. But it we assume farmer ignorance about price movements, a rise in the export price may attract search traders – the ddebe boys – at the lowest echelon of the marketing chain. The resulting negative search externality makes the transaction cost increase with the export price. In this case, it is possible to observe $C_f < C_i$ in spite of free entry and no pure profit. If we find that $C_f \leq C_i$, detailed data on monthly prices at various stages of the marketing chain can be used to examine at which points constant transaction costs or imperfect information give rise to diverging margins.

Next, we can investigate specific marketing costs directly to determine whether they are value-based and increase with the international price, and if so whether they increase proportionately. We also examine the data for evidence that storage and contango may account for the observed pattern. Finally the relationship between price changes, trader entry, and quantities traded per trader at each stage of the market chain can be analyzed in order to assess whether the observed relationships are commensurate with a search trader model in which N^s increases as a result of a rise in export price p_x.

3. The data

The data used in our analysis come primarily from survey data collected by the authors. Detailed data on exporters, traders and producers come from surveys conducted in Uganda in early 2003.[14] The objective of the surveys was to look at the effect of commodity price fluctuations on producers and to assess the potential for risk management schemes. Data were collected on

[14] The data were collected by a team from the Uganda Bureau of Statistics in collaboration with the Centre for the Study of African Economies at Oxford University. Funding was provided by the World Bank.

all exporters of Robusta coffee. In addition, detailed interviews were conducted with a random sample of traders and producers in four coffee producing districts: Mukono, Luwero, Masaka and Bushenyi. These four districts combined account for about 50 percent of all Robusta coffee produced in Uganda.

A summary of the main variables and their method of collection are provided in Table (5.1). Details regarding the sample of each of the three survey groups – producers, traders, and exporters – is set out below.

3.1. Producer Survey

The sample of coffee producers was drawn randomly from a sampling frame constructed from a national household survey conducted in 1999/2000. This survey was used to identify coffee farmers in the four aforementioned districts.[15] Randomly selected coffee producers were revisited in early 2003. As the period between the baseline and the follow up survey was relatively short, there was little attrition resulting from death or migration. Most households were still in existence within the village and it was relatively easy to trace them.[16]

Respondents were asked many of the original household survey questions. They were also asked detailed questions about their most recent coffee sales – up to three transactions.[17] Producers were asked where they sold their coffee and whether they milled it before sale: 85% of farmers sell unmilled coffee and 80% sell at the farmgate. Farmers were asked who they sold to, but were often not able to give details beyond that it was a trader (i.e. they were unable to

[15] A stratified two-stage sampling design was used in the 1999/2000 survey. The country was divided into enumeration areas, typically the LC1 (local council level one – essentially a village), which constituted the first stage sampling unit. The second stage sampling unit was the household. Ten households were selected from each enumeration area randomly selected at the first stage. Stratification took place at both sampling stages – all enumeration areas were stratified into urban, other urban, and rural, and households within the rural areas were further stratified into small scale farmers, large scale farmers and non-farming households.

[16] Some farmers identified as coffee producers on the basis of their response to the 1999/2000 survey were no longer farming coffee. In these cases, the interview was nevertheless conducted but only the relevant sections of the questionnaire were completed. These respondents are not used in the analysis presented here.

[17] If a respondent was unable to recall the details of transactions, they did not respond.

indicate if it was a buying agent of an exporter, or a trader who milled coffee, or a ddebe boy). Most respondents only reported one or two coffee sales in the preceding year. These transactions were concentrated in the main harvesting months, suggesting that most farmers harvest all their coffee and sell it immediately. There is little coffee storage by surveyed farmers, who are mostly smallholders. As the questions asked specific information about individual transactions and the number of transactions is small, surveyed farmers were able to provide details of individual sales fairly easily.

3.2. Trader Survey

A considerable degree of heterogeneity exists among domestic coffee traders in Uganda. During field testing of the trader questionnaire, two broad classes of traders clearly emerged: those with a store or mill, and those without. Traders without a store are small itinerant traders who operate largely by bicycle and buy kiboko coffee directly from farmers to sell to other traders. These are the search traders or ddebe boys. Traders who own a store or a mill typically buy from large farmers and ddebe boys, and sell FAQ coffee to exporters in Kampala. These are the assembly traders.

Greater heterogeneity exists among the assembly traders than among ddebe boys. The latter all tend to operate in a similar way: they purchase coffee with the little working capital they have, they sell it immediately to a larger trader (sometimes milling it before they sell), and then they buy coffee again. For this reason it was decided to stratify the trader sample on the basis of these two types: ddebe boys and those who own a store or a mill.

The trader sampling frame was constructed as follows. In each of the four survey districts, a few days prior to the survey, we constructed a list of traders with a store or mill with the help of a local guide knowledgeable of the local coffee industry. Exporters who had buying centers

were not included to avoid duplication as these are accounted for in the exporter questionnaire. Traders were then randomly selected from this list.

Given the difficulty of locating itinerant traders – and the impossibility of conducting a listing exercise – it was decided to interview them at their point of sale, that is, when they visit coffee stores and mills. These traders were randomly selected among traders delivering coffee to a store or mill operated by an interviewed assembly trader.

A sample of just over 100 traders was randomly selected in the four selected coffee growing districts, divided equally between those with and without a store. As there are many more itinerant traders than assembly traders, the 50:50 stratification means that the latter are over-sampled. This is done on purpose to account for their greater heterogeneity in terms of size. Detailed questions on the quantities and prices in sales and purchases occurring in the 12 months prior to the survey (January to December 2002) provide the data for much of the analysis. Respondents were also asked a variety of questions about the marketing costs they incurred for their last completed transaction.

Descriptive statistics on these two types of traders are presented in the first two columns of Table (5.2). All traders without stores purchased from farmers in the year preceding the survey, and nearly all (87%) of their purchases were in kiboko. Although 23% of them report selling to exporters at some point, this basically meant selling to an agent of an exporter operating at the local market level. Traders without store thus constitute a fairly homogeneous category that corresponds broadly to what we have called search traders.

Traders with stores vary in size and are less homogenous: while 75% of them reported purchasing directly from farmers, most of their purchases are from itinerant traders and only 36% of their purchases are in kiboko, the form in which farmers typically sell their coffee – the rest is milled (FAQ) coffee. With a few exceptions and some variation in behavior, we can thus say that

traders with stores occupy an intermediate position in the value chain. About half of traders in each category (56% and 44%) reported operating as buying agent for a downstream trader at some point in the year preceding the survey. This is a common practice in African agricultural trade as it enables small traders to access working capital.

From the farmer survey we know that farmers most often sell their coffee unmilled at the farm-gate. In the latter two columns of Table (5.2) we divide sample traders depending on whether they purchase milled (FAQ) or unmilled (kiboko) coffee.[18] Nearly all traders who purchase kiboko report buying from farmers. Traders who buy FAQ are less likely to be purchasing from farmers, although 69% of them report occasional purchases of FAQ from farmers. In the analysis that follows, kiboko traders are regarded as possibly buying from farmers at the farm-gate. Ddebe boys form a large part of this group, but some traders with a store also purchase coffee in kiboko form.

Survey budget considerations meant that it was possible to survey traders only at one point in time. Recent developments in trader surveys have included observing randomly selected transactions to get a better measure of transaction costs and development of market institutions. However, given that the focus of this survey was on collecting information on price variation over time, observing a random sample of specific transactions at one point in time would not have provided much information. Instead traders were asked to recall for each of the previous 12 months, whether or not they had been active, and if so how much they had bought and sold. To respond to the question about how much was bought and sold, traders did not mentally aggregate all the transactions they had done, rather they gave a rough figure that captured the order of magnitude of their volume of trade during that month.

Traders were then asked what the price they had bought at during this month. Again the

[18] Three traders purchased kiboko during some months and FAQ during other months. These traders are included in both columns.

response was not a calculated average of the prices of each purchase, but rather the typical price the trader bought at for that month. Traders were also asked the quantity and price they sold at in this month. With the exception of exporters, few of the survey respondents keep written records. It is therefore that traders' and farmers' responses are affected by recall error. They should thus be treated as indicative data suitable for generating averages rather than as accurate point estimates. Since recall questions are used for both farmers and traders, both kinds of data should be subject to similar recall bias. Comparing the two should therefore not be too problematic. We see no serious reason to suspect that recall bias is correlated with other variables of interest. As measurement error raises the standard error, null hypotheses on non significant differences in prices become harder to reject. Yet, despite this we are able to reject a number of null hypotheses.

3.3. Exporter Survey

Coffee exporters in Uganda have to be registered with the Ugandan Coffee Development Authority (UCDA).[19] We interviewed all registered exporters of Robusta coffee. The survey is similar in content to the trader survey. The exporters were the hardest group from whom to elicit a response, but eventually questionnaires were completed for twenty of the twenty three exporters.[20] As in the trader survey, detailed questions on the quantities and prices in sales and purchases occurring in the 12 months prior to the survey (January to December 2002) provide the data for much of the analysis.

[19] It is believed that small quantities of Robusta coffee are exported by unregistered exporters towards neighboring countries (Sudan) for domestic consumption. It is also thought that some Robusta coffee crosses the border from Tanzania and DR Congo to be exported by Uganda. These informal border movements are ignored here as they are thought to represent a very small proportion of exports.

[20] Three refused to cooperate. Non-response occurred principally among local exporters in financial difficulties. We suspect that their reluctance to respond to interviews is related to their difficult relationship with banks and creditors. Given their financial situation, non-respondents are unlikely to have played a significative role in the price transmission mechanism. Their absence from the sample should therefore not bias our results.

4. Empirical analysis

Having clarified how the surveys were conducted, we now turn to the transmission of international coffee prices through the domestic value chain. We follow the testing strategy outlined in the conceptual section.

Here is a preview of this section. We first examine the evolution of coffee prices over time, drawing from the surveys as well as from secondary data. We begin by examining whether $C_f > C_i$. We cannot reject the hypothesis that they are equal. We also find that producer prices do not perfectly track export prices.

To find out why, we examine the prices paid by traders at different stages of the value chain. The value chain can broadly be divided into three main stages. In the first stage, search traders buy *kiboko,* that is, dry cherries of unmilled coffee, from farmers at the farm-gate. We call these the kiboko traders or *ddebe boys.*[21] The majority of Ugandan producers sell their coffee in the form of *kiboko.*

Dry cherries are then milled to separate the coffee beans from their husk. Milled coffee is known in Uganda as Fair Average Quality (FAQ) coffee. In the second stage, larger traders buy milled coffee (FAQ) from millers, ddebe boys, and a small number of large farmers who mill their coffee before selling it. We call these the FAQ traders since they deal in milled coffee. In the third and final stage, exporters based in Kampala purchase FAQ from FAQ traders, sort it, and ship it to international markets.

We find that purchase prices paid at the two latter stages track the international coffee price quite well, suggesting that trade margins and hence transactions costs are more or less constant for exporters and FAQ traders. In contrast, prices paid to farmers by ddebe boys fail to track

[21] There also exist small traders who purchase kiboko coffee from farmers on agricultural markets. Strictly speaking these are not ddebe boys since they do not purchase at the farmgate. Whenever the data allow, we keep the ddebe boy category distinct from the slightly more general kiboko trader category (see below).

international prices.

We then investigate possible explanations for this failure. We first examine whether price increases are associated with a more than proportional rise in measurable transactions costs other than search time, especially for kiboko traders. We find no evidence that this is the case. However we do find circumstantial evidence of trader entry and increasing search costs as the export price rises, especially for those traders buying kiboko. Taken as a whole, the evidence supports the ddebe boys model.

4.1. The evolution of prices over time

We begin by documenting the extreme volatility of international and domestic coffee prices over time. Figure (5.1) presents the evolution of the price for Robusta coffee over the last decade as indicated by secondary data. The top line represents the International Coffee Organization (ICO) international indicator price, which stands for p_i in our model. All prices are in constant 1991 US $. Over the recent past, p_i has gone through massive fluctuations. For instance, during the last decade, it rose from around US$1 per Kg in late 1992 to US$3.5 in 1994. It then fell below US$1.5 by 1996 before falling further to US$0.5 by early 2001. Fluctuations of a similar – if not larger – order of magnitude were observed in the 1980s.

Figure (5.1) also presents the evolution of Ugandan prices for kiboko (unmilled) and FAQ (milled) coffee, as reported by UCDA. To facilitate comparison with the international price, Ugandan prices have been converted to 1991 US$. Since most producers sell their coffee unmilled (Fafchamps and Hill 2005), we expect the farm-gate coffee price p_f to be similar to the kiboko price. We see that over the last decade, milled and unmilled coffee prices have largely followed international price movements, an outcome of the liberalization of coffee marketing in Uganda. If we take the kiboko price as a measure of the farmer price p_f, it is clear from Figure 5.1 that

p_f fluctuated widely after liberalization, from a high of US$1.12 in August 1994 to a low of US$0.09 per Kg in September 2001.[22] The question is: did p_f fluctuate more than p_i?

In the conceptual section we have seen that, with perfect competition and constant marketing costs/no entry, $Var(p_f) = Var(p_i)$. This is not what we find in the data. The variance of the farm-gate price p_f is 0.05, much below the variance of the international price which is 0.52. Testing for the equality of the variances using a variance ratio F-test, we easily reject the null hypothesis that the variances are equal against the alternative that $Var(p_f) < Var(p_i)$ (the F-statistic $F_{(45,47)} = 9.854$ is significant at the 1% level).[23] The data therefore reject the joint hypothesis of perfect competition and constant marketing costs/no entry.[24]

A test based on the variance is not fully conclusive because $Var(p_f) < Var(p_i)$ can arise from imperfect competition, even in the presence of constant transactions costs (see footnote 8).[25] We therefore examine how r_{fi} evolves over time. If transaction costs c remain constant over time, the share r_{fi} of the international price received by producers should increase when p_i rises, even in the presence of imperfect competition. A simple glance at the Figure reveals that this is not the case: if anything, the difference between p_i and p_f increases – and r_{fi} falls – when p_i rises.[26]

[22] Using UCDA's data on the farm-gate price of coffee since 1992 and data from (Henstridge 1997) on the farm-gate price of coffee before 1992, we computed the coefficient of variation of C_f before and after liberalisation. We find that C_f increased from 0.38 to 0.63 after liberalisation. This rise occurred even though, over the same period, C_i fell.

[23] The test of equality of two variances σ_x^2 and σ_y^2 is given by: $F = \frac{s_x^2}{s_y^2}$ (where s refers to the estimated standard deviation) which is distributed as F with $n_x - 1$ and $n_y - 1$ (where n refers to the number of observations used in the estimate of s). For this case the F-statistic is distributed as $F_{(45,47)}$ and the 1% critical value is 2.

[24] Since it takes approximately four weeks for coffee purchased in Uganda to reach international markets, the relevant reference price may be the one-month future rather than the spot price reported in Figure (5.1). Since the spot price is known to be more volatile than the future price, this may affect our results. Using data for 2002, we find that the future price is indeed slightly less volatile than the spot price (the ratio is 0.91 if we leave out December). But the difference is too small to change our conclusion.

[25] If imperfect competition were responsible for the gap between $Var(p_f)$ and $Var(p_i)$, then the implied κ would be 0.31. This corresponds to an exporter-specific supply elasticity of 0.44. As we will see, however, imperfect competition with constant transactions costs is not supported by the data.

[26] The null that the difference between p_i and p_f does not increases with p_i can be rejected at 99% confidence (p_i has a t-stat of 53.53 in a regression of p_i on the difference between p_i and p_f).

To investigate this formally, we test whether $C_f > C_i$. Using the data presented in Figure (5.1), we find that, as predicted by the constant c model, $C_f = 0.62 > C_i = 0.57$. The difference, however, is not significant: as is clear from comparing the confidence intervals for C_f and C_i displayed in table (5.3), the null hypothesis that C_f and C_i are equal cannot be rejected at any reasonable level of confidence.[27] This is consistent with a model in which transactions costs are proportional to price.

One possible explanation for these results is that UCDA prices are misleading and that Uganda producer prices are much more variable than is acknowledged in the published data. This would arise, for instance, if kiboko prices reported by UCDA were not in fact obtained from actual field observation, as claimed, but were constructed from export prices using a simple proportionality rule.[28] This would explain why p_f and p_i appear roughly proportional over the whole period covered by Figure (5.1).

The survey data we have collected, gathered during a period of rising prices, provide a simple way to resolve this issue. In Figure (5.2) farmers' sale prices from June 2002 to January 2003 are presented together with the international Robusta price during the same period. The same pattern as predicted by the UCDA data is observed: the share of the international price received by farmers falls in this six month period as international price rise (from 42% in June 2002 to 38% in January 2003). Examining the aggregated marketing chain indicates the presence of rising transaction costs or imperfect information at some stage of the marketing process. In the next section we use the survey data to determine at which stage this occurs.

[27] In carrying out the tests we have assumed that p_f, p_e and p_i are instantaneously related. It is however conceivable that is not the case, given the time lag between farmgate to export market. To allow for this we repeat the tests allowing for a lag of one, two and three months. This does not change the conclusions of the test results.

[28] Perhaps calibrated on very infrequent observation of actual kiboko prices.

4.2. Prices over time at each stage of the marketing chain

Looking at disaggregated data allows an examination of where in the value chain increasing transaction costs or imperfect information might be present. As noted above although many marketing channels are found, the following stylized stages can be identified: purchasing of kiboko by ddebe boys from farmers at the farm-gate, purchasing of FAQ by traders in local markets from large farmers and ddebe boys, and purchasing of FAQ by exporters in Kampala. Three prices are reported for these three stages: the price at which farmers sell kiboko at the farm-gate (p_f), the price at which FAQ is purchased by traders (p_{faq}), and the exporter purchase price (p_e). A fourth price is also estimated and discussed - p_{kib} - the price at which traders report buying kiboko. This price is a composite of prices paid by ddebe boys to farmers and by assembly traders to ddebe boys who do not mill their coffee. The kiboko price thus falls somewhere in between the first and second stages in the stylized marketing channel.

We disaggregate the data by the two distinct regional coffee markets represented in the survey: coffee markets in the south west of Uganda and coffee markets in the centre of Uganda. South western coffee growing areas have their main harvest season in May to August while central areas have their main harvest season in November to January. Disaggregating the data in this way helps control for seasonal changes in the geographical composition of reported prices. To the extent that these regions are located at different distances from Kampala, the price at which traders purchase coffee may also differ as a result of differential transport costs. Indeed median transport costs were on average 30% higher for traders in the western region of Bushenyi.[29]

To disaggregate trader prices, we estimate average monthly prices using regression analysis. To make milled and unmilled coffee prices comparable, a coffee price in FAQ equivalent is

[29] Markets within these regions are most likely well-integrated given the short driving time between the main market towns. Further disaggregation of price trends by market town is thus probably less useful. There are also not enough trader observations to do this.

calculated assuming an average of 0.54 Kg of FAQ for one Kg of dried kiboko and an average of 0.3 Kg of FAQ for one Kg of wet kiboko. This price is then regressed on monthly dummies for each type of coffee bought – kiboko and FAQ. The purchase prices for FAQ and kiboko (p_{faq} and p_{kib} respectively) are the coefficients of the monthly dummies. A weighted regression technique is used, weighting each observation by the quantity of FAQ equivalent coffee it represents. This is done so that the reported monthly average remains representative, given the likely correlation between transaction size and purchase price.

Estimated coefficients are reported in Table (5.4). To correct for seasonal changes in the geographic composition of supply, we first include a seasonal dummy (columns 1 and 2) and subsequently estimate the regressions separately for the two main coffee producing areas covered in the survey, namely the Central region and the Western region (Columns 3 to 6). Results in columns 1 and 2 show a sustained price increase in both p_{kib} and p_{faq} starting in October-November 2002. The price increase, however, appears much more pronounced for p_{faq} than for p_{kib} coffee: at the beginning of the period, the two prices are very close to each other, but by the end of the survey period p_{faq} is significantly larger than p_{kib}, as shown by a t-test of equality of means. The geographically disaggregated results in columns 3 to 6 confirm that coffee prices paid by traders started to rise in October-November 2002, but more so for p_{faq} than p_{kib} traders in the western region (t-stat=1.72).

A similar estimation technique is used for the price reported by producers. The producer price that was presented in Figure (5.2) is an average over all producers. Producer prices vary depending on whether farmers sell at the farm-gate or travel to the nearest market to sell their coffee. In the latter case, they obtain a slightly higher price, the difference between the two reflecting the travel and search costs for itinerant traders who buy directly from farmers (Fafchamps and Hill 2005). The type of coffee sold may also affect the price. The majority of

farmers sell their coffee dried and unmilled (this was the case in 85% of the recorded transactions). But some farmers do not dry their coffee before selling it, and a few mill it. Producer prices may also vary by region.

To allow for these effects, we regress the price received by producers on monthly dummies, a geographical dummy, a farm-gate sale dummy, and type of coffee sold dummy. Results are presented in Table (5.5). In column 1 the changing geographic composition of prices is controlled for by including a season-location dummy. In columns 2 and 3 results are reported separately for the Central and Western regions. A weighted regression technique is used, weighting each observation by the quantity of FAQ equivalent coffee that it represents.

Regression results show that producer prices vary systematically across regions and that, in general, farmers receive a higher price by drying, milling, and transporting their coffee to the market. On average farmers receive a premium of a little over 3 cents per Kg. for selling milled coffee. Milling costs were reported uniformly as 1.3 cents per Kg. of FAQ in all regions, which suggests a net return to milling for farmers.[30] Farmers also receive on average 5 cents less per Kg. for selling coffee wet. Selling wet coffee jeopardizes the quality of the coffee and also requires the trader to dry the coffee (by exposure to the sun for one or two weeks) before it can be milled. Farmers typically sell wet coffee as a means of accessing money quickly: 96% of survey respondents who sold coffee wet said they did so because they needed money urgently. The lower price received may thus reflect the opportunity cost of instant liquidity. Farmers receive, on average, a 2 cent premium per Kg. for selling at the market, but the difference is not statistically significant.[31]

Estimated trader and producer prices for the most common form of sale – FAQ purchase

[30] This is perhaps indicative of the uncertainty about the quality of unmilled coffee at the time of sale since the quality of coffee beans can only be assessed after milling.

[31] As discussed in Fafchamps and Hill (2005), the cost of selling at the market varies across farmers depending on their distance from the market, quantity sold and costs of transport. For this reason it is difficult to determine the net return to selling at the market.

price for traders (p_{faq}) and farm-gate kiboko price for farmers (p_f) – are displayed in Figure (5.3) together with p_e and p_i.[32] The top half of the Figure presents estimates from the pooled regression results, the bottom half is based on separate regressions for the Central and Western regions.

Let us first look at the ICO international indicator price p_i and how it relates to the price at which exporters report buying Ugandan Robusta, which we denote p_e.[33] Over time, Figure (5.3) shows a gradual increase in p_i and p_e over the study period, with a slight acceleration in late 2002. We see that p_e tracks p_i, although not perfectly. For instance, the sharp rise in p_i in September is not immediately matched by a similar increase in p_e. This is probably due to the fact that most exporters operate on 30 to 60 day contracts and are unable to reflect a rise in p_i immediately in their purchase price.

From the Figure we also see that movements of p_{faq} are similar across the two regions. The difference between p_e and p_{faq} remained more or less constant over the latter half of the year, but was higher during the main harvest period in the west of the country from April to June. This may be due to congestion in transport services or to the greater distance from the main harvest region to Kampala. Otherwise, we find that price increases passed on by exporters are immediately reflected in the traders' purchase price of FAQ coffee. This is not surprising given that coffee traders rotate their working capital very quickly.

[32] The FAQ purchase price shown in the graph is the estimated FAQ price less the 1.3 cents per kilo milling costs.

[33] We first note a large gap between p_i and p_e: on average over the period studied, p_e amounts to 54% of p_i. Accounting for median exporter costs prior to shipping (for bagging, transport, grading, tax, financing etc.) leaves a difference of some 46% on average between p_i and p_e. It would be interesting to investigate whether this difference corresponds to actual transactions costs x or whether it includes a market power component as well, by analogy with equation (2.3). Unfortunately we have no information regarding shipping costs between Kampala and foreign buyers and cannot pursue this further. The majority of coffee exports from Uganda are made free-on-truck (FOT) Kampala but we were unable to elicit information about prices received by surveyed exporters. (Since some of them are controlled by multinationals, such information may not have been useful since they could easily disguise profits through under-invoicing.) Nevertheless, the general feeling in Kampala is that there is ample competition among Ugandan exporters themselves – several have gone bankrupt – so it is unlikely that exporters as a group were capable of extracting large rents during the period of inquiry. Without further information, we cannot say that this is also the case for transport through Kenya and for shipping services in Mombasa. This issue deserves further investigation.

However there is a growing divergence towards the end of the year between p_{faq} and p_f, the farmgate price. To test whether this observed difference is statistically significant, we look at the standard errors associated with the coefficients of monthly dummies. Figure (5.3) reports the confidence intervals for monthly dummies from Tables (5.4) and (5.5). We find that, in the Central region, p_f is statistically lower than p_{faq} in December 2002 and January 2003. In the Western region, p_f is significantly lower than p_{faq} for most months after the end of the main harvest season in August.[34]

To check whether the observed difference in prices increases towards the end of the year (i.e. whether the price series incrementally diverge), we test whether the difference in p_{faq} and p_f in December is larger than the difference in November and likewise whether the difference in p_{faq} and p_f in January is larger than the difference in December and November. For the Central region we find that the difference in December is not significantly larger than the difference in November (t-stat=1.01), but we do find that the difference in January is significantly larger than the difference in November (t-stat=2.08) and December (t-stat=1.32). For the Western region, although the price differential increases towards the end of the year, the increase is not significant. However, overall the results confirm earlier findings obtained from the UCDA data: the share of the international coffee price that farmers receive tends to fall as the price rises.

4.3. Storage and contango

Before looking at evidence for increasing transaction costs or imperfect information and trader entry, we first consider whether this pattern could potentially be explained by storage, while

[34]It may be that the FAQ to kiboko conversion ratio that was used varies by geographical area as a result of varying quality of coffee beans (in particular the spread of disease). Although traders might be aware of this variation when they buy coffee and adjust the prices paid accordingly, it would only explain the observed diversion in prices if traders all buy from bad regions during the height of the coffee season in November, December and January. There is no evidence that this is the case from conversations in the field or from the data. Coffee wilt disease was already affecting farmers in the regions studied before the survey period. UCDA data suggests that by 2001 4% of trees were already affected by the disease in Mukono, 12% in Luwero, 2% in Masaka and 5% in Bushenyi.

keeping the assumption of constant marketing costs. Say the spot and future prices for Robusta on the London market are p_i and p_h, respectively, with $p_h = p_i(1+\tau)$. Further assume that the unit cost of storage over the same period is r. If $\tau > r$ spot and future prices are said to be *in contango* (Williams & Wright 1991). When prices are in contango, it is profitable to purchase coffee today at p_i, store it, and sell it anticipatively at price p_h.

In contango two types of arbitrage are potentially at work: spot arbitrage with constant trade margins, and intertemporal arbitrage through storage. If someone with sufficiently deep pockets did intertemporal arbitrage in Uganda, this would raise the local coffee price to the point where $p_f = \frac{p_h}{1+r} - c - x > p_i - c - x$. Storage arbitrage would thus result in a price above that implied by spot arbitrage. If Robusta was in contango in the Summer of 2002 but no longer was in contango by December, this could explain why the local price did not rise proportionally with the international spot price: if storage arbitrage lifted the July farmer price in anticipation of the December spot price increase, the increase in p_f between July and December would be less than the increase in p_i.

Can this mechanism explain our findings? We begin by examining the pattern of spot and future prices on the London exchange. In 2002 the contango months were January-February and July-September. Survey data confirm that farmers reported higher prices in the July-September period. This is a priori consistent with the contango hypothesis, albeit the price difference is not statistically significant. However, estimated returns to storage are low,[35] too low to account for observed discrepancy between exporter and producer price later in the year.[36]

[35] We estimate the capital cost of storage using an annual interest rate of 12%, which is the average interest rate on foreign exchange transactions reported by the Bank of Uganda during 2002. Based on this assumption, the return to storage in July and September 2002 was around 2%. This may not have been sufficient to cover non-capital costs of storage, such as warehouse rental, storage losses, and security personnel.

[36] To test this hypothesis, we simulate what the effective export price would have been if the 2% return to storage had continued until December. Under contango arbitrage, this would have raised the producer price in the October-December period. We then test whether the inflated producer price is statistically significantly different from the reported wholesaler and exporter purchase price. We find that it is.

Next we examine the data for evidence of an increase in storage in July to September. We begin by noting that growers do not store for any extended period of time. In any case they do not have access to the futures market and so could not be taking advantage of the arbitrage opportunity. The data further indicate that domestic traders hardly store anything. Given their small size, it is extremely unlikely that they would be able to sell coffee futures on the London exchange. The only Uganda-based agents who store Robusta are exporters. They are also the only ones who can sell futures and hence can avail themselves of the arbitrage opportunities offered by contango.

For contango to explain our results, it would have to be that hedging exporters accumulate stocks between July and September, raising the local price to $p_f = \frac{p_h}{1+r} - c - x$ and effectively driving out of the market domestic traders and other exporters. Is there evidence to this effect?

First we note that if contango allows exporters to drive non-hedging traders out of the market, p_{faq} should also be higher in July-September. This is not what we find: as shown in the previous section, p_{faq} follows the London spot price (p_i), suggesting that spot arbitrage applies to domestic trader prices throughout the year.

Secondly, we check whether hedging exporters drive out of the market non-hedging exporters during contango months. Survey results show that in 2002 exporters held aggregate stocks of 15,652 tons of FAQ (averaged across 12 months). Of this total, exporters who use hedging instruments (i.e., buy and sell futures) held 10,287 tons. The rest was held by smaller exporters who do not hedge. When we calculate monthly stocks in annual purchases in each months for all 17 exporters with complete data, we find a mean ratio of 19% for those who hedge and 17% for those who do not hedge. The difference is not statistically significant (t-value 0.41 for 153 observations). The same holds if we compare average annual stocks.

Finally, we examine monthly purchase data to see whether non-hedging exporters and traders

lose market shares when returns to storage are positive. Results (not reported here to save space) show that this is not the case: there is no evidence that the share of total purchases by hedging exporters rises in contango months relative to either non-hedging exporters or traders.

Taken together, these findings demonstrate that storage arbitrage in Uganda cannot explain the relative movement of producer and export prices.

4.4. Marketing costs

The evidence presented so far suggests that transactions costs between producers and traders increase more than proportionally with the export price. One possibility, which we investigate first, is that various marketing costs – such as transportation, processing, storage, and handling – increase with the export price. These costs, which can be measured directly, do not include search costs, that is, the time spent by the trader looking for buyers and sellers. Search costs are discussed later.

Transaction costs may increase with quantity, but we begin by noting that, in Uganda, aggregate coffee supply responds very little, if at all, to monthly fluctuations in price. Aggregating over surveyed FAQ and kiboko traders separately, we compute the total quantity of coffee purchased in each month of 2002. We then regress this quantity on the international coffee price and a high season dummy separately for FAQ and kiboko and for the two regions covered by the survey. Regression results shown in Table (5.6) demonstrate that the harvest season dummy is highly significant but the coffee price (with the exception of one regression) has no significant effect on the aggregate quantity of coffee purchased. Based on these results, it is unlikely that transactions costs would rise due to increased demand for transportation and handling services. This nevertheless leaves the possibility that transactions costs are based on value, not on quantity. We now turn to this possibility.

Survey results detail the kind of transactions costs incurred by Ugandan coffee traders. Table (5.7) describes the transaction costs faced at each of the three points of the marketing chain. Based on our a priori understanding of the nature of marketing costs, we divide them into costs that are expected to vary with quantity – such as bagging, transportation, milling and sorting – and costs that can be expected to vary with value, such as working capital, agent commissions, and insurance. We also report costs – such as personal transport – that are not expected to vary with either quantity or value.

The Table shows that, at all stages of the marketing chain, most marketing costs are expected to vary with quantity, not with value. This is particularly true for traders who buy directly from farmers. For these traders, on average 78% of transactions costs comes from bagging and sewing, transport and milling costs. Transport, processing and bagging are also the largest marketing costs faced by exporters and FAQ traders.[37] Information on the time spent by traders on each of these activities was not collected. It is unlikely that the time involved in the tasks considered here will increase with the price of coffee, although they may increase with the quantity of coffee traded. This means this table actually overestimates the share of costs that increase with price.

Ugandan coffee traders hold virtually no stocks and rotate their working capital extremely rapidly. The survey indeed shows that, for the most recent completed coffee transaction, the median length of time elapsed between purchase and sale to an exporter is 2 days. Furthermore 88% of surveyed traders report that, in their latest completed coffee transaction, at most a week elapsed between purchase and sale.[38] It therefore comes as no surprise that, on average, financing costs account for only 0.01% of the total costs of a transaction and that only 2% of the costs of a transaction can be identified as varying with coffee value.

[37] The bags used by exporters for shipping coffee are expensive: bagging accounts for about 25% of variable exporter costs.

[38] The data also show that most traders do not operate on contract with exporters, and that those who do have very short delivery contracts of 7 days or less.

Table (5.7) makes it a priori unlikely that transactions costs increase with price because they are value-based. It is however conceivable that actual transactions costs increase with price for reasons we do not understand. To investigate this possibility, we examine transactions costs per Kg reported by different traders for the last transaction they made and we test whether these unit costs vary systematically with the price at which they purchased the coffee. The international price is used as regressor, as this limits the attenuation bias on the coefficient of price. We control for quantity, the distance over which the coffee was transported, the time elapsed between purchase and sale, and whether the coffee was milled by the trader. Results are shown in Table (5.8) for all traders together, and for FAQ and kiboko traders separately. We find no significant association between unit marketing costs and coffee prices. From this convergence of evidence, we conclude that an increase in measurable marketing costs is extremely unlikely to explain why p_f increases less than proportionally with p_i.

4.5. Information asymmetries and trader entry

We now turn to our third possible explanation for the lack of responsiveness of producer prices, namely entry and exit of traders – particularly ddebe boys. As we discussed in the conceptual section, this is made possible by farmers' ignorance of movements in international prices. The literature on agricultural markets in Africa indeed suggests that, whilst traders are very knowledgeable about prices in their purchase and sale markets, farmers are much less knowledgeable about price movements (e.g. Coulter & Golob 1992, Jones 1995, Coulter & Onumah 2002). Traders may be able to take advantage of farmers' ignorance by increasing their trade margin when the price increases. This in turn may attract trader entry, leading to negative search externalities.

To study entry and exit in coffee trading, we examine whether traders actively traded coffee

in the 12 months preceding the survey. We want to know whether more traders are actively trading coffee when the average price is higher. To this effect, we estimate a logit model in which the dependent variable y_{it} equals 1 if a trader i is active in month t, and zero otherwise. Because trading activity is higher during the harvest season, we include a harvest season dummy. Unobserved heterogeneity is controlled for via trader fixed effects. We use p_i in the analysis rather than locally determined average prices to avoid any endogeneity. Results, shown in Table (5.9), conform to the ddebe boy model: entry is correlated with a rise in the price.

To verify that this process effectively increases the total number of traders involved in coffee trade, we also regress the proportion of surveyed traders buying and selling coffee in each month on the price of coffee during that month. A harvest dummy is included as well. Separate regressions are estimated for FAQ and kiboko traders. As discussed earlier, the harvest season is different in the Central and Western regions, so we estimate the regression separately for each region. Because the number of usable observations is quite small, we also estimate a pooled regression in which coefficients are allowed to vary across categories.

The results, shown in Table (5.10), provide unambiguous evidence that, in any given month, the number of traders actively buying and selling coffee varies strongly with price. The results are perhaps most convincing in the Western region because, in that region, the harvest season happened to coincide with a period of low international coffee prices. Regression results indicate that, in that region, the number of active FAQ traders did not vary significantly with the price, but the number of kiboko traders did. We also see that, in both regions the effect of price on the number of active traders is larger for kiboko. These results are consistent with the idea that high coffee prices incite ddebe boys to enter the market in order to take advantage of farmers' ignorance about the price increase. From Table (5.6) we know that a rise in the coffee price has no significant effect on the aggregate quantity of coffee traded. It follows that, when the price

rises, there are more traders chasing the same total quantity of coffee. Hence the search cost must go up.

To test this more directly, we test whether the quantity traded by individual traders falls with the median price, as would happen if a search externality makes it more difficult to find coffee. We estimate a regression in which the dependent variable is the quantity of coffee Q_{it} purchased by trader i in month t and the regressor is the median price paid in month t by all traders operating in the same district as i.[39] A harvest season dummy is included to control for possible changes in aggregate supply. We also include trader fixed effects to control for unobserved heterogeneity.

Two regressions are estimated. The first one includes all traders operating in month t. Since many traders only operate during part of the year, this regression only includes those traders actively trading coffee in that month; when they are not trading coffee, presumably they do not raise search costs for others. We also estimate a regression limited to permanent traders, that is, those who are active throughout the year. Permanent and occasional traders are quite different in the size of their operation: the median monthly purchase for continuously trading individuals is 43200 Kg. of FAQ equivalent coffee, while it is only 5000 Kg. for occasional coffee traders. To the extent that permanent traders specialize in assembly and processing and let ddebe boys buy directly from farmers, the search externality does not apply to them and so their quantity purchased should not change. Results, presented in Table (5.11), show that the price coefficient is negative but the effect is not statistically significant.

One possible explanation for this finding is that when ddebe boys are few, permanent traders purchase directly from farmers. But when ddebe boys are many, they purchase from them. This

[39] The median price paid in the district is separately calculated for each trader such that the price paid by a given trader is not included in the estimation of its median price. This is done to ensure the calculated median price is not endogenous to Q_{it}.

could explain why quantities traded remain more or less constant for permanent traders. But by inserting themselves between producers and permanent traders, entry by ddebe boys still reduces the price paid to producers. If permanent traders buy from occasional traders, the price paid by occasional traders should, on average, be lower. Moreover, if occasional traders buy from farmers when the price goes up, the price at which ddebe boys purchase coffee should agree with the selling price reported by farmers.

To investigate this directly, we regress the price paid by traders for kiboko (unmilled) coffee on monthly dummies and an occasional trader dummy. If these occasional traders are those buying from farmers unaware of price movements, this dummy should be significant. Results are presented in Table (5.12) for the pooled sample and separately for the Central and Western regions. Occasional traders are defined as those trading coffee for 3 months or less. We see that the occasional trader dummy is significant in all three regressions. Figure (5.4) graphs the producer and occasional trader prices with their standard errors and shows that there is no significant difference between the producer and occasional trader purchase prices. This confirms that new entrants are those buying directly from farmers at a price that does not increase proportionally with the price at which permanent traders purchase coffee from them.

5. Conclusion

We have examined the transmission of international coffee prices to Ugandan Robusta growers. Most of what we know about the transmission of prices to small African growers comes from data collected at the market level (e.g. Dercon 1995, Shively 1996, Badiane & Shively 1998, Fafchamps & Gavian 1996). This paper innovates by combining price information collected in three simultaneous surveys covering all levels of the value chain in Uganda.

As in previous studies, we find that fluctuations in the international coffee price are reflected

relatively rapidly in domestic prices paid by exporters and large traders. However fluctuations in the international price are not fully reflected in the farm-gate price. In particular, the volatility of the farm-gate price is not found to be as high as a model of constant transaction costs would suggest.

To account for this finding, we examine three possible explanations: storage and contango; variation in marketing costs other than search; and trader entry driving a rise in search time.[40] We reject the first two explanations: there is no evidence of storage arbitrage by hedging exporters, and the data show that marketing costs such as transport, handling, storage, and processing do not increase with price.

We then investigate whether the number of traders rises when the price increases. We find that it does. Entrants tend to be small occasional traders – called ddebe boys – who tour the countryside in search of coffee. The price at which they purchase coffee does not rise proportionally with the price at which they sell, suggesting that they take advantage of farmer's ignorance about price movements to insert themselves between farmers and permanent traders. This finding is surprising – even more so given that coffee prices during the survey year were lower than usual. Although negative search externalities of firm entry have previously been hypothesized in labour search models (Acemoglu & Shimer 1999), to our knowledge, this is the first time that such perverse process is documented in agricultural markets.

The story we have told is unexpected. Normally as economists we believe that competition is good, yet here it does not achieve the desired result. Unfortunately. the data that we collected

[40] One possibility that we have not discussed is that coffee wilt disease is driving these results, however this does not seem to be the case. If wilt disease exploded just at the time prices began to diverge, it would have generated a lower ratio of FAQ coffee per Kg of kiboko, and hence a lower kiboko price. However, the coffee wilt disease was well established in the survey districts before the start of the survey period. Another possibility is that traders purchase the healthy kiboko first and diseased kiboko last. For this to be the case, buyers should be able to assess kiboko quality. Unfortunately, wilted kiboko beans look just like healthy ones. It is only after milling that wilt damage is revealed. So it is unclear how traders could purchase good kiboko first, even if they wanted to. Moreover the timing is wrong: price divergence takes place at the middle of the second harvest season in our survey year, and is not visible during the first one.

do not enable us to determine how long it takes for farmers to realize that the export price has risen. It is also unclear whether disseminating information about the coffee export price would help eliminate the entry of occasional traders. We suspect it would. These issues deserve further investigation.

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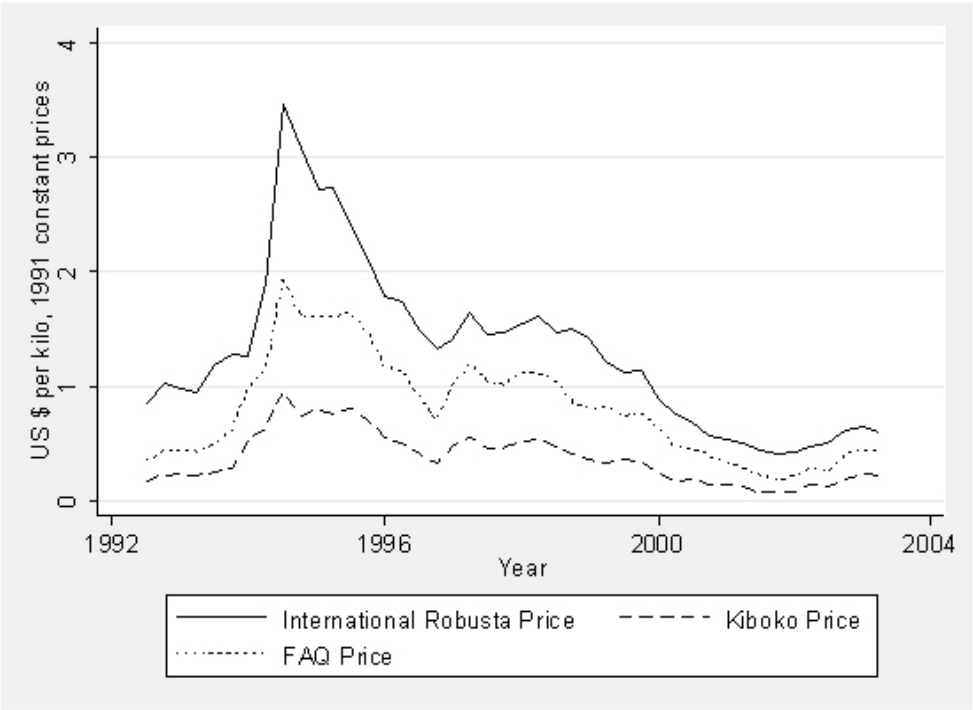

Figure 5.1: International and domestic coffee price movement, 1992 - 2003

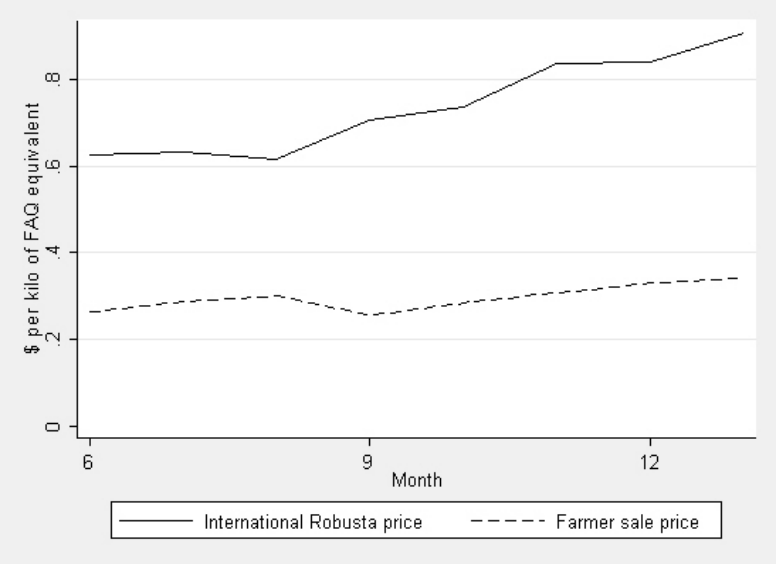

Figure 5.2: International and producer prices from June 2002 to January 2003 (US $ per kilo of FAQ equivalent)

Data source	Variable name	Description
ICO	Indicator price (p_i)	International coffee price data comes from the International Coffee Organization (ICO). The monthly average of the ICO international indicator price is used. This is a weighted average of prices actually paid for physical deliveries of unroasted Robusta coffee to American and French ports. As much as possible prices are recorded for sales made from origin.
UCDA	FAQ price	The price paid for milled coffee in domestic markets, reported by UCDA.
	Kiboko price	The price paid for unmilled coffee in domestic markets, reported by UCDA.
Exporter survey	Exporter purchase price (p_e)	The price at which Ugandan exporters report buying milled coffee. Collected during exporter interviews in January 2003 using exporter records for 2002.
	Exporter costs	Costs incurred in the last completed transaction undertaken by the exporter. Collected during exporter interviews in January 2003.
Trader survey	Trader purchase price	The price at which Ugandan traders report buying coffee (milled and unmilled). Collected during trader interviews in January 2003 using recall of prices at which coffee was purchased during 2002.
	Trader purchase price (p_{faq})	The price which Ugandan traders who buy milled coffee (FAQ) report buying at. Collected during trader interviews in January 2003 using recall of prices at which FAQ was purchased during 2002.
	Trader purchase price (p_{kib})	The price which Ugandan traders who buy unmilled coffee (kiboko) report buying at. Collected during trader interviews in January 2003 using recall of prices at which kiboko was purchased during 2002.
	Trader costs	Costs incurred in the last completed transaction undertaken by the trader. Collected during trader interviews in January 2003.
	Monthly quantity purchased	The amount of coffee purchased by a trader each month. Collected during trader interviews in January 2003 using recall of monthly quantities purchased during 2002.
	Trader is active in a month	Trader is considered active in a given month if he reported buying or selling coffee in a given month.
Producer survey	Farmer price (p_f)	Price received by farmer. Collected during household interviews in January 2003 using recall of month of coffee sale and price received.
	Farm-gate sale dummy	Takes the value of 1 if sale was made at farm-gate.
	Type of coffee sold	Categorical variable taking the value of 1 if coffee was sold wet, 2 if coffee was dried before sale, 3 if coffee was milled before sale.

Table 5.1: Summary of data used in the analysis

Disaggregating traders by:	Owns mill or store		Coffee type purchased	
	without store	with store	Kiboko	FAQ
Number of traders of this type	43	59	61	45
Annual quantity purchased (kg, median)	9,180	85,050	11,723	228,000
Average monthly quantity purchased (kg, median)	765	7,088	977	19,000
Number of months active in market	6	8	7	8
Proportion of purchases made in kiboko	0.87	0.36	0.98	0.04
Proportion of sales made in kiboko	0.05	0.02	0.05	0
Proportion of traders who own a store	0	1	0.36	0.84
In the last year the trader has: (% of traders)				
Purchased from farmers	100	75	97	69
Sold to exporters	23	88	39	89
Operated as a buying agent for another trader	56	44	51	49
Traded other crops	49	42	51	42

Table 5.2: Descriptive statistics of traders

Confidence	C_f		C_i	
Intervals	*Upper*	*Lower*	*Upper*	*Lower*
99 %	0.44	1.05	0.42	0.93
95 %	0.48	0.91	0.45	0.81
90 %	0.50	0.85	0.46	0.76

Table 5.3: Confidence internals for coefficients of variation of farm-gate and international price

	All traders		Traders in central region		Traders in western region	
Traders buying:	FAQ	Kiboko	FAQ	Kiboko	FAQ	Kiboko
January 2002	0.312 (0.025)	0.292 (0.031)	0.287 (0.018)	0.296 (0.045)	0.340 (0.051)	0.313 (0.024)
February	0.291 (0.014)	0.284 (0.022)	0.300 (0.015)	0.326 (0.046)	0.275 (0.022)	0.293 (0.001)
March	0.334 (0.016)	0.281 (0.023)	0.375 (0.028)	0.230 (0.023)	0.316 (0.005)	0.318 (0.015)
April	0.318 (0.010)	0.237 (0.021)	0.318 (0.011)	0.329 (0.032)	0.315 (0.009)	0.255 (0.004)
May	0.321 (0.016)	0.291 (0.042)	0.333 (0.030)	0.306 (0.014)	0.315 (0.014)	0.319 (0.040)
June	0.330 (0.014)	0.243 (0.024)	0.338 (0.033)	0.302 (0.022)	0.325 (0.009)	0.271 (0.016)
July	0.334 (0.012)	0.256 (0.021)	0.355 (0.015)	0.273 (0.030)	0.325 (0.009)	0.284 (0.011)
August	0.330 (0.016)	0.272 (0.021)	0.386 (0.011)	0.262 (0.043)	0.311 (0.011)	0.301 (0.010)
September	0.348 (0.026)	0.291 (0.026)	0.342 (0.033)	0.243 (0.019)	0.347 (0.031)	0.335 (0.026)
October	0.388 (0.023)	0.318 (0.027)	0.369 (0.022)	0.280 (0.013)	0.400 (0.035)	0.371 (0.037)
November	0.438 (0.021)	0.375 (0.028)	0.423 (0.021)	0.346 (0.016)	0.466 (0.042)	0.441 (0.052)
December	0.478 (0.019)	0.407 (0.019)	0.470 (0.021)	0.429 (0.011)	0.498 (0.043)	0.401 (0.053)
January 2003	0.577 (0.012)	0.444 (0.018)	0.560 (0.012)	0.479 (0.013)	0.602 (0.011)	0.442 (0.030)
Western region	-0.003 (0.012)	0.028 (0.019)				
No. of obs.	341	389	185	191	156	198
R-squared	0.5151	0.4323	0.5097	0.5776	0.5362	0.4090

Table 5.4: Results from regression on trader purchasing prices (All month dummies are significant at 0.99)

	Producer Price		
	Pooled	Central Region	Western Region
June	0.244 (0.020)	0.110 (0.026)	0.223 (0.024)
July	0.283 (0.023)	0.150 (0.035)	0.259 (0.027)
August	0.270 (0.021)	0.229 (0.032)	0.243 (0.025)
September	0.231 (0.020)	0.175 (0.026)	0.205 (0.024)
October	0.255 (0.021)	0.162 (0.025)	0.254 (0.024)
November	0.280 (0.020)	0.244 (0.019)	0.215 (0.021)
December	0.287 (0.022)	0.241 (0.020)	0.242 (0.033)
January 2003	0.292 (0.049)	0.242 (0.051)	0.249 (0.029)
Dummy for selling at the market	0.018 (0.014)	0.029 (0.019')	0.011 (0.017)
Dummy for drying kiboko	0.051 (0.019***)	0.101 (0.019***)	0.032 (0.024)
Dummy for selling FAQ	0.085 (0.028***)	0.130 (0.037***)	0.069 (0.033**)
Dummy for western region	-0.046 (0.011***)		
Number of observations	457	231	226
R-squared	0.2963	0.2702	0.2040

Table 5.5: Results for regression on producer price (*** denotes significant at 0.99, ** significant at 0.95, ' significant at .85, all month dummies are significant at 0.99)

	Central region		Western region	
	FAQ traders	Kiboko traders	FAQ traders	Kiboko traders
International price (p_i)	169.39 (67.99**)	1127.15 (844.73)	98.19 (128.41)	-103.39 (867.98)
High season dummy	48.63 (15.71**)	281.61 (195.13)	145.62 (30.39***)	1090.31 (205.45***)
Constant	-99.76 (44.74**)	-342.27 (555.85)	-13.37 (92.43)	533.22 (624.76)
No. of observations	13	13	13	13
R-squared	0.6550	0.2545	0.6395	0.7064

Table 5.6: Effect of price and season on total quantity purchased, dependent variable is total quantity purchased in a given month ('000 tonnes) by traders of a given type in a given region (standard errors in parenthesis, *** significant at 0.99, ** significant at 0.95, * significant at 0.90, ' significant at 0.85)

	Exporter (median in US$)	FAQ traders (median in US$)	Kiboko traders (median in US$)
Total variable costs of transaction	0.061	0.016	0.028
Costs that vary with quantity (share)	0.044 (77%)	0.006 (52%)	0.020 (78%)
Median expenditure for traders who reported incurring the following costs:			
bagging and sewing	0.015	0.001	0.003
transport*	0.010	0.006	0.008
milling costs	0.021	-	0.013
picking costs	0.009	-	-
Costs that vary with value (share)	0.008 (13%)	0.002 (19%)	0.0005 (2%)
Median expenditure for traders who reported incurring the following costs:			
commission	0.005	0.007	0.011
cost of working capital+	0.006	0.0004	0.0001
taxes	0.007	-	-
insurance	0.001	-	-
Other costs			
Median expenditure for traders who reported incurring the following costs:			
personal transport	0.005	0.001	0.003
other costs	0.005	0.003	0.004

* Transport here refers to transport costs from point of purchase to point of sale, i.e. the cost of transport after the coffee has been found.
+ The cost of working capital is calculated as the value of the coffee multiplied by the number of days taken for the coffee to be sold and the daily interest rate.

Table 5.7: median variable cost per kilo

	All traders	FAQ traders	Kiboko traders
Purchase price (US cents per kilo of FAQ equivalent)	-0.021	-0.029	-0.021
	(0.017)	(0.025)	(0.027)
Quantity purchased (tons of FAQ equivalent)	-0.006	-0.001	-0.128
	(0.013)	(0.012)	(0.070*)
Dummy if coffee was milled by trader (1 = milled)	1.380	-	1.707
	(0.310***)	-	(0.835**)
Distance coffee transported (miles)	0.006	0.007	0.011
	(0.004)	(0.004')	(0.012)
Duration of contract (days)	0.027	0.033	0.016
	(0.026)	(0.027)	(0.052)
Constant	0.027	0.029	0.025
	(0.009***)	(0.013**)	(0.012**)
Number of observations	101	41	60
R-squared	0.2249	0.0541	0.0306

Table 5.8: Effect of price and quantity on transaction costs, dependent variable is total per kilo transaction costs in US cents standard errors in parenthesis, *** significant at 0.99, ** significant at 0.95, * significant at 0.90, ' significant at 0.85

	All traders
International coffee price (p_i)	7.55 (0.81***)
High season dummy	2.37 (0.17***)
No. of observations	1152
Log likelihood	-377.45
LR χ^2	362.38***

Table 5.9: Conditional fixed effects logistic regression on whether or not a trader is active in a given month (standard errors in parenthesis, *** significant at 0.99)

	Central region		Western region		Pooled
	FAQ	Kiboko	FAQ	Kiboko	
$\widehat{P}_{FAQ}$ from Fig 5.3	82.17	91.95	9.36	54.98	
	(18.37***)	(26.07***)	(7.74)	(14.06***)	
$\widehat{P}_{FAQ}$ * dummy for Kiboko trader in central region					102.13 (15.25***)
$\widehat{P}_{FAQ}$ * dummy for FAQ trader in central region					76.55 (15.25***)
$\widehat{P}_{FAQ}$ * dummy for Kiboko trader in western region					53.28 (12.99***)
$\widehat{P}_{FAQ}$ * dummy for FAQ trader in western region					18.24 (12.99)
High season dummy	8.05	15.14	5.48	12.92	
	(1.84***)	(2.61***)	(1.01***)	(1.84***)	
High season * Kiboko trader					13.89 (1.33***)
High season * FAQ trader					7.04 (1.33***)
Western region dummy					19.20 (6.07***)
FAQ trader dummy					12.36 (5.82**)
Constant	-19.44	-26.14	6.08	-10.37	-29.32
	(6.53**)	(9.26**)	(2.95*)	(5.36*)	(5.49***)
No. of observations	12	12	12	12	48
R-squared	0.8104	0.8321	0.7189	0.8182	0.8149

Table 5.10: Effect of price and season on number of traders active in the market, dependent variable is number of traders of a given type active per month in a given region (standard errors in parenthesis, *** significant at 0.99, ** significant at 0.95, * significant at 0.90)

$Q_{\mathbf{it}}$	All traders, conditional on trading	Traders active throughout year
Median price paid in district	-10.12 (33.84)	-109.90 (115.53)
High season dummy	24.22 (3.59***)	45.23 (10.07***)
Constant	20.00 (11.24*)	77.31 (36.78**)
No. of observations	632	175
R-squared	0.0043	0.0693
No. of groups	102	16
F-test that all fixed effects = 0	$F(101, 528) = 8.84$***	$F(15, 157) = 8.59$***
Fraction of variance due to f.e.	0.529	0.432

Table 5.11: Effect of price and season on the quantity purchased by trader i at time t (standard errors in parenthesis, *** significant at 0.99, ** significant at 0.95, * significant at 0.90, ' significant at 0.85)

	All traders	Traders in central region	Traders in western region
January 2002	0.294 (0.031)	0.296 (0.045)	0.313 (0.024)
February	0.289 (0.021)	0.326 (0.046)	0.293 (0.001)
March	0.287 (0.023)	0.230 (0.023)	0.318 (0.015)
April	0.244 (0.020)	0.329 (0.032)	0.255 (0.004)
May	0.298 (0.042)	0.306 (0.014)	0.319 (0.040)
June	0.250 (0.023)	0.302 (0.022)	0.271 (0.016)
July	0.263 (0.020)	0.273 (0.030)	0.284 (0.011)
August	0.279 (0.020)	0.262 (0.043)	0.301 (0.010)
September	0.304 (0.024)	0.250 (0.022)	0.345 (0.021)
October	0.329 (0.027)	0.291 (0.017)	0.376 (0.037)
November	0.389 (0.029)	0.361 (0.013)	0.446 (0.051)
December	0.416 (0.018)	0.436 (0.008)	0.405 (0.053)
January 2003	0.460 (0.019)	0.498 (0.014)	0.447 (0.030)
Occasional trader dummy	-0.037 (0.016**)	-0.033 (0.015**)	-0.050 (0.029*)
Western region dummy	0.021 (0.018)		
No. of observations	389	191	198
R-squared	0.4435	0.5962	0.4191

Table 5.12: Results from regression on kiboko trader purchasing prices (All month dummies are significant at 0.99)

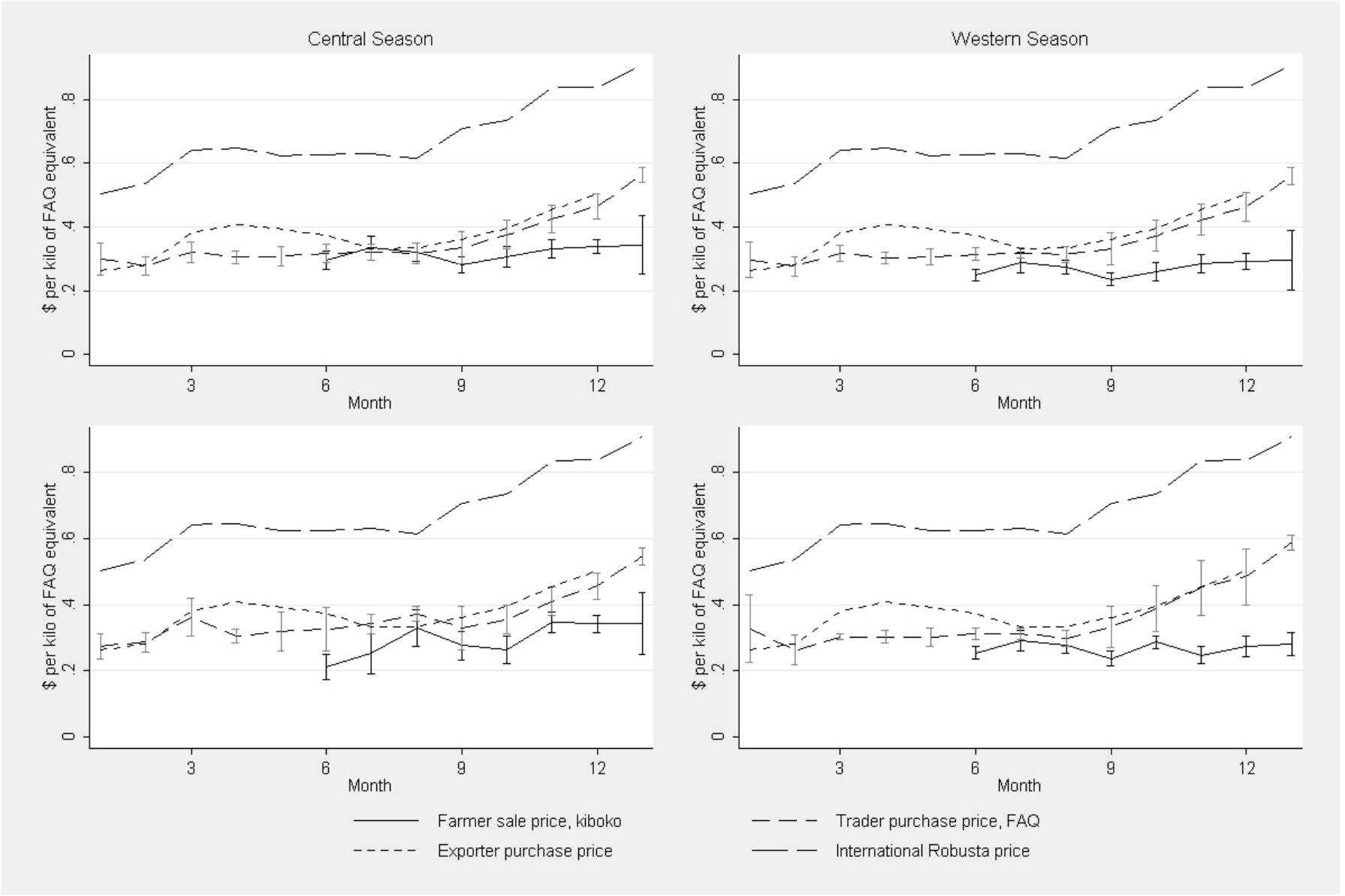

Figure 5.3: International (p_i), Exporter (p_e), Trader (p_{faq}) and Producer (p_f) prices from January 2002 to January 2003

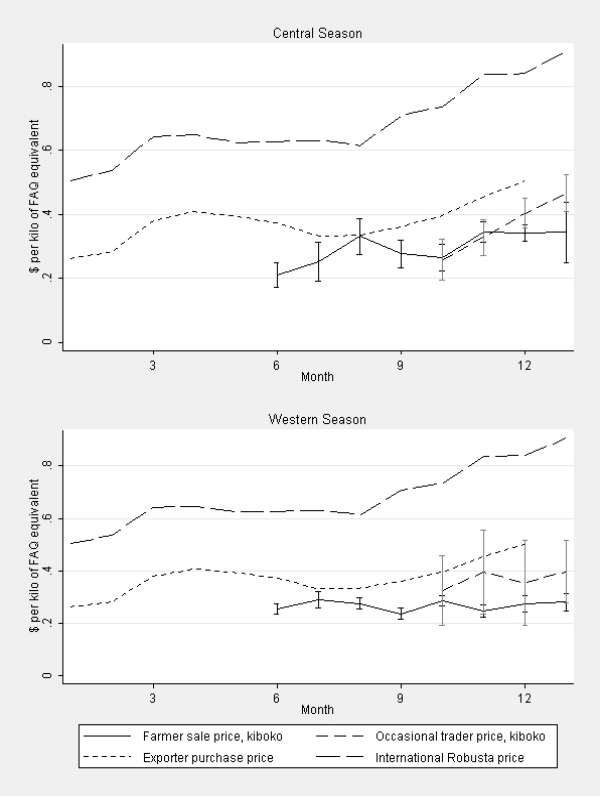

Figure 5.4: Producer and occasional trader prices