Price and Nonprice Information Frictions in Regional Arbitrage: The Case of Rice Traders in Antananarivo, Madagascar

YUTAKA ARIMOTO
Hitotsubashi University

HISAKI KONO AND TSILAVO RALANDISON
Kyoto University

TAKESHI SAKURAI
University of Tokyo

KAZUSHI TAKAHASHI
Sophia University

I. Introduction

A well-functioning agricultural market is vital for efficient marketing and distribution of food across time and space. When markets function well, prices signal surpluses and deficiencies across regions and induce traders to arbitrage. Through arbitrage, markets eventually clear and prices converge across regions to form the "law of one price."

Many studies, however, find that agricultural markets are only partially spatially integrated (see, e.g., Sexton, Kling, and Carman 1991; Fackler and Goodwin 2001). A number of obstacles can raise transaction costs and prevent the full integration of agricultural markets. Among those, the availability of market information is often cited as one of the most crucial factors determining market (dis)integration (e.g., Fafchamps, Gabre-Madhin, and Minten 2005; Moser, Barrett, and Minten 2009). Indeed, a study of regional rice markets in the Philippines indicates that the presence of substantial information frictions leads to the failure of arbitrage (Allen 2014).

This study was conducted as part of rice market studies in Madagascar for the Project for Rice Productivity Improvement in Central Highland (PAPRIZ) implemented by the Japan International Cooperation Agency (JICA). An earlier version of this paper is circulated as Institute of Developing Economies (IDE) Discussion Paper no. 505. We are grateful to project experts and the staff at the JICA Madagascar office. This paper was financially supported by Hitotsubashi University, the Institute of Developing Economies–Japan External Trade Organization (B-104 [FY2013], B-1-04 [FY2014]), and Japan Society for the Promotion of Science (JSPS) KAKENHI grants 22223003 and 25245038. Contact the corresponding author, Yutaka Arimoto, at arimotoy@ier.hit-u.ac.jp.

Electronically published November 6, 2018

One promising technical solution to this issue is the expansion of mobile phone networks (for a review, see Aker and Mbiti 2010; Nakasone, Torero, and Minten 2014). Evidence indicates that mobile phone coverage is associated with regional price convergence (Jensen 2007, 2010; Aker 2010; Aker and Fafchamps 2015) and increased search activity of agricultural traders (Tack and Aker 2014).[1] A growing number of studies have used randomized controlled trials (RCTs) to examine the impact of providing market information to farmers through mobile phones.[2] For example, Fafchamps and Minten (2012) report positive effects on spatial arbitrage by traders' selling at distant wholesale markets rather than at the farm gate in India, but they find no effect on price received. Nakasone (2014) finds that treated farmers obtained higher sales prices in Peru; however, no such effect was found in Colombia (Camacho and Conover 2011) or Niger (Aker and Ksoll 2016).

Although these experimental studies are informative, two broad questions remain unanswered. First, the impact of providing information to traders, who play a major role in trade across regions, is unknown given that these experimental studies examine producers and not traders. Second, not much is known about even the basic facts of traders' arbitrage itself, despite it being a fundamental economic activity. To what regional extent do traders search and trade? How and how extensively do they obtain price information in various regions? What prevents them from making a better arbitrage? Does provision of price information alter traders' behavior?

This study investigates patterns of traders' spatial purchasing behavior and obstacles underlying their observed behavior, with an emphasis on the role of market information. We examine whether eliminating informational friction by providing traders with regional price information enhances their arbitrage. Since spatial market integration can be achieved through countless transactions across space by traders who are motivated by profit maximization via exploiting arbitrage opportunities, understanding how and how well traders make actual transactions across space is critically important for determining the barriers of market integration and formulating policies to improve the efficiency of agricultural markets.[3]

[1] See also Goyal (2010) for evidence that the regional dispersion of soybean prices decreased after the establishment of internet kiosks that provide wholesale price information to farmers in India.

[2] In a nonexperimental study, Svensson and Yanagizawa (2009) report that the market information broadcasted through the radio is associated with increased sales prices for farmers in Uganda. Using a matching method, Courtois and Subervie (2015) find that farmers with access to a mobile-based market information service received higher prices in Ghana.

[3] Stephens et al. (2012) show that spatial price adjustment can be achieved even without physical trade flow, although the precise mechanism of spatial price adjustment in nontrade periods is still

To elucidate traders' behavior in practice, we study the case of rice traders in Madagascar. While rice is the country's most important staple food, the Malagasy rice market is known to be spatially disintegrated, exhibiting large price dispersion over time and space (Mendoza and Randrianarisoa 1998). Evidence based on the 2001 national census of communes (counties) indicates that rice markets in Madagascar were relatively well integrated spatially only at the subregion level and not at the provincial or national level (Moser, Barrett, and Minten 2009; Butler and Moser 2010). Fafchamps, Gabre-Madhin, and Minten (2005) indicate the difficulty of long-distance trade due to poor infrastructure, whereas Moser, Barrett, and Minten (2009) suggest that high crime rates, remoteness, and lack of information restrict competition in Malagasy rice markets. Thus, there seems to be significant scope for better arbitrage.

We collected detailed data on rice trading for 224 rice traders based in the greater Antananarivo area formed by the city center and suburbs (also referred to as Tana, the capital of Madagascar). The data covered 1 year from August 2012 to August 2013, biweekly for 27 rounds. Additionally, to rigorously examine whether price information friction is the key factor affecting successful arbitrage, we implemented an RCT, whereby half of the randomly selected sample traders were sent price information in 10 major rice-producing districts via short message service (SMS) halfway through the survey.

Our main findings can be summarized as follows. First, many traders purchase rice from different districts at different prices including observed transportation costs. Consequently, some pay much higher prices than others. Second, most traders specialize in trading with a few common districts, where they regularly visit and purchase from the same trading partners even though these districts do not always have the lowest prices. Third, traders know little about prices in districts other than those in which they usually make purchases. Fourth, our intervention to provide regional price information had a null effect on purchasing behavior and arbitrage performance measured by whether a trader purchased from the cheapest district and the gap between price paid and price in the cheapest district. Fifth, in addition to price, traders were concerned about product quality and matching with trustworthy sellers. In fact, we found that before traders start visiting a new district, they usually establish a link to that district by purchasing from sellers who come to sell in Tana or by asking a mediator for an introduction.

These findings imply that traders' marketing behavior is constrained by information friction due to search costs but not solely by price information.

unclear. Our study considers physical trade flow as an important force of spatial arbitrage and explores in detail the barriers to better arbitrage by focusing on traders' behavior.

Traders cannot visit a new district without a link and therefore pass up seemingly more profitable opportunities in cheaper districts even if they are informed about them. Therefore, price information alone may be insufficient to encourage traders to expand their regional arbitrage. The findings suggest the presence of fixed costs to establish a link and the multidimensionality of information, including price and nonprice information such as volume and stability of supply, contact with trading partners, and product quality and characteristics.

This study enhances the knowledge of agricultural traders' arbitrage and marketing in several ways. First, it adds to the emerging but nonetheless limited study of traders' marketing behavior based on transaction data (Osborne 2005; Tack and Aker 2014). Using unique data, we demonstrate that search costs for agricultural traders' regional arbitrage exist in practice. Theoretical investigations of such costs based on search theory include studies by Fafchamps and Minten (2012), Allen (2014), and Aker and Fafchamps (2015). Details of search and transaction costs and the importance of fixed trust-based relationships have been documented by Fafchamps and Minten (2001, 2002), Fafchamps (2004), Jabbar et al. (2008), Tadesse and Shively (2013), and Gelaw, Speelman, and Van Huylenbroeck (2016). We complement these studies using new data and indicate the importance of fixed costs in establishing links. We further demonstrate that searches are based not only on price but also partly on nonprice factors such as volume, stability, and product quality.

Second, we provide additional evidence on the impact of providing price information on arbitrage in developing countries. Unlike previous experimental studies that provided information to farmers (Camacho and Conover 2011; Fafchamps and Minten 2012; Nakasone 2014; Aker and Ksoll 2016), we disseminate information to traders. Since traders are specialized in trading and arbitrage and bear the fundamental role in both regional marketing and distribution of the agricultural products, we believe that the provision of price information to traders is more relevant for the understanding of agricultural market integration.

Third, we contribute to the understanding of the barriers of rice market integration in Madagascar. As discussed previously, existing studies have repeatedly reported that Malagasy rice markets are spatially disintegrated (Barrett 1997; Fafchamps, Gabre-Madhin, and Minten 2005; Moser, Barrett, and Minten 2009; Butler and Moser 2010; Miyake and Sakurai 2012). We support this finding by adding a direct microfoundation that the basis of market integration, traders' arbitrage, is constrained.

The paper is organized as follows. Section II presents the conceptual framework. Section III describes the survey and data. Section IV presents descriptive

evidence that traders are not fully exploiting existing arbitrage opportunities and discusses potential obstacles. Section V reports the results of the RCT and discusses why the provision of price information was not effective. We discuss our findings in Section VI. Finally, Section VII provides conclusions.

II. Conceptual Framework

A. Setting

To sketch traders' purchasing behavior, we consider a simple model.[4] Consider rice traders operating in one city who engage in regional arbitrage. Trader i purchases rice by visiting a rural district j in round t at price (including transportation cost) p_{jt}, returns to the city, and sells it at the known common price p_t^M. Each trader is small and is a price taker. For simplicity, we assume that traders purchase only one unit of rice and visit only one district in each round. Thus, the traders' problem is to find and purchase from the cheapest district to maximize the regional price difference $(p_t^M - p_{jt})$.

B. Price Search

The price in each district, p_{jt}, is an independent random draw from distribution $F(p)$, which is identical across districts and rounds. The trader expends a per-search cost c to discover the price in one district. As an extreme benchmark, consider a trader whose search cost is zero. The trader knows the prices in all districts and purchases from the cheapest district. If the search cost is zero for all traders, all regional arbitrage opportunities will be fully exploited and the resulting equilibrium prices including transportation costs will be equalized among districts whose autarky price is below p_t^M. Traders execute a mixed strategy over these districts. As another polar benchmark, suppose c is prohibitively high such that the trader cannot make any search. This trader is "price blind" and therefore randomly selects one district to visit. Luck determines whether the trader visits the cheapest district, and often traders visit the "wrong" district and pay higher prices. The trader who visits a district where price exceeds p_t^M will choose not to purchase.

Actual practice lies between these extremes. Given moderate search costs (c), a trader will make a search based on the optimal stopping rule. If the searched price is beneath the reservation price, he purchases from that district. If it exceeds the reservation price, he searches until finding the district with a price beneath the threshold value. The reservation price is a decreasing function of the search cost. The lower the search cost, the more districts he searches.

[4] For a related but more comprehensive conceptual framework for regional arbitrage, see Fafchamps and Minten (2012), Allen (2014), and Aker and Fafchamps (2015).

With heterogeneous search costs, traders with lower search costs are more likely to find cheaper districts and purchase at the lower prices.

Now we consider the effect of providing free information about prices in several districts under the third realistic scenario wherein traders conduct some costly search. This intervention artificially enlarges the number of districts where traders know prices and raises the probability of visiting the least-cost district and purchasing at its lower price.

C. Assumptions of the Benchmark Model

Predictions about the cheapest district and purchase price above entail several simplifying assumptions. First, we assume that transportation costs are homogenous across traders. If they are heterogeneous, the cheapest district would vary among traders. Second, we have not considered transaction costs. Suppose there are fixed transaction costs TC_j to trade with market j (e.g., because this market is unsafe and the trader has to pay TC_j to employ a guard). Then the actual profit is $p_t^M - p_{jt} - TC_j$. If TC_j is substantially large, then even if the trader is informed that p_{jt} is low, he will opt not to visit there. If this is the case, it might be misleading to assess the arbitrage opportunity solely by observed prices. We discuss these points when describing traders' behaviors in practice.

III. Survey and Data

A. Surveys

The subjects of our survey are rice traders operating in Tana, Madagascar. Since we are interested in traders' spatial transaction patterns, the population of focus is the rice traders who engage in interdistrict rice trade (i.e., trade between Tana and districts outside Tana).[5]

The survey was conducted from June 2012 through August 2013. To create a list of rice traders, we first identified the geographical cluster offering a high probability of finding rice traders engaged in interdistrict trade. We selected 44 out of 192 wards in the city center and 17 out of 40 communes in the suburbs based on five criteria.[6] We then created a list of rice traders by visiting markets

[5] Rice traders such as retailers who purchase only from wholesalers or farmers in Tana and sell at retail are not considered as potential subjects because they are not likely to participate in interregional arbitrage.

[6] The five criteria are (1) wards where the city's main wholesale markets (Anosibe Andrefana and Andravoahangy Tsena) are located (two wards), (2) wards surrounding those two markets where rice traders most likely own a shop and/or live (10 wards), (3) wards in which there is a market managed by the Antananarivo city government (32 wards), (4) communes where traders reside according to the list of registered traders and wholesalers provided by the Institut National de la Statistique (12 communes), and (5) communes located along the national highways that are potentially active in rice trading (five communes).

and key informants in these clusters.[7] All the listed traders were then visited, and we confirmed whether they engaged in interdistrict trade. We ended up with a list of 318 interdistrict rice traders.

In July 2012, we conducted a baseline survey to collect general information about the characteristics of these traders and their trading activities. Out of the 318 listed traders, 241 (76%) agreed to cooperate and completed the baseline survey. Then we conducted periodic surveys every 2 weeks between August 6, 2012, and August 13, 2013, making 27 rounds in total. The periodic survey collected information on the following: (1) price searches; (2) details of all rice purchases, including information on district of purchase, transportation, price, and payment; and (3) management indicators, such as stock, quantities of purchases and sales, average price and margin, and costs. Of the 241 traders who completed the baseline survey, 234 initially agreed to participate in the periodic survey, but 10 dropped out before completion of all rounds. Our final number of sampled traders is thus 224, and the number of observations at the trader × round level is 6,033.[8]

Finally, we conducted a follow-up survey in February 2014 to collect additional information after preliminary analyses of the periodic survey. We obtained responses from 219 out of 224 traders who completed the periodic survey.

B. Intervention

Since information friction is considered as one of the major obstacles to traders' regional arbitrage, we experimentally filled the information gap by sending regional price information via SMS to half (112 out of 224) of the randomly selected traders after round 16 (out of 27) of the periodic survey. The SMS was sent on Wednesday each week. The information sent was the local price of milled rice at millers for the previous week, collected by Madagascar's Observatoire du riz (OdR), a government agency responsible for collecting and disseminating agricultural commodity price information.[9] We sent prices in

[7] The list of traders was made by (1) visiting the ward markets for the city of Antananarivo and the largest markets in the commune for the suburbs and listing all rice traders (retailers/wholesalers/traders/millers) operating in these markets; (2) visiting ward and municipality officials to introduce us to the largest rice traders that they know in their area, including wholesalers, collectors, and millers; and (3) visiting millers and asking for information about traders based in the ward and municipality.

[8] The total number of observations at the trader × round level should be $224 \cdot 27 = 6{,}044$. We had 11 missing trader × round observations due to refusal or questionnaire losses.

[9] OdR agents collect the rice price for week 1 from Monday to Saturday. Information is then sent to the OdR headquarters in Tana by Monday of week 2. We receive the information from OdR Tana on Tuesday evening or Wednesday morning at the latest. Therefore, we are able to send the information to traders every Wednesday. The SMS is dispatched before any prior report based on OdR-collected price data is publicly disclosed. Therefore, the information was new to traders. Our base-

the 10 most major rice-producing districts (Arivonimamo, Miarinarivo, Tsiroanomandidy, Ankazobe, Ambatondrazaka, Mahabo, Bealanana, Befandriana, Mandritsara, and Marovoay), which include distant districts in the Sofia region where prices are generally quite cheaper than those in the major purchasing districts near Tana (for a map of Madagascar, see fig. 1). We expected that this information would trigger trade with new districts.

C. *Modes of Purchase*

Given our interest in traders' regional arbitrage, we focus on interdistrict trades, which are trades between Tana and districts outside Tana. We classify interdistrict trades into two types. In "active" interdistrict trades, traders leave their store and make a purchase visit in various production districts outside Tana by themselves.[10] In "passive" interdistrict trades, traders stay at their store and purchase from sellers (trucks) who brought the product from various production districts. Either these sellers regularly visit the traders' store or the trader calls them to bring the product. The difference is that active purchases take place in the production districts outside Tana, whereas passive purchases take place in Tana. In both cases, intensive arbitrage can be involved; the traders can conduct multiorigin telephone searches to compare and negotiate prices before visiting (active) or asking the seller to bring the product (passive). We differentiate these two modes because we expect that the degree of arbitrage is considerably less for passive than for active interdistrict trades. The former is conducted in Tana, and competition by sellers should limit price differences (as we confirm below).

When examining passive interdistrict trades, we incorporate within-Tana trades. Within-Tana trades include purchases at the two major wholesale markets in Tana (Anosibe and Andravoahangy markets) and from local farmers, wholesalers, and millers in Tana.[11] We consider the three sources to be one alternative source or "origin district" of passive interdistrict trade since passive interdistrict and within-Tana trades are both conducted in Tana, and these two modes are alternatives once they choose Tana over outlying districts from the traders' perspective on where to make a purchase. Note that three modes are not mutually exclusive and that most active interdistrict traders conduct passive interdistrict and within-Tana trades as well.

---

line survey finds that only two traders checked price through information provided by OdR before our intervention.

[10] Traders engaged in active trades are often called collectors (*collecteurs*).

[11] Rice cultivation remains commonplace in Tana. Indirect interdistrict trades made in Tana that are mediated by a wholesaler or passed through a wholesale market are included as within-Tana purchases.

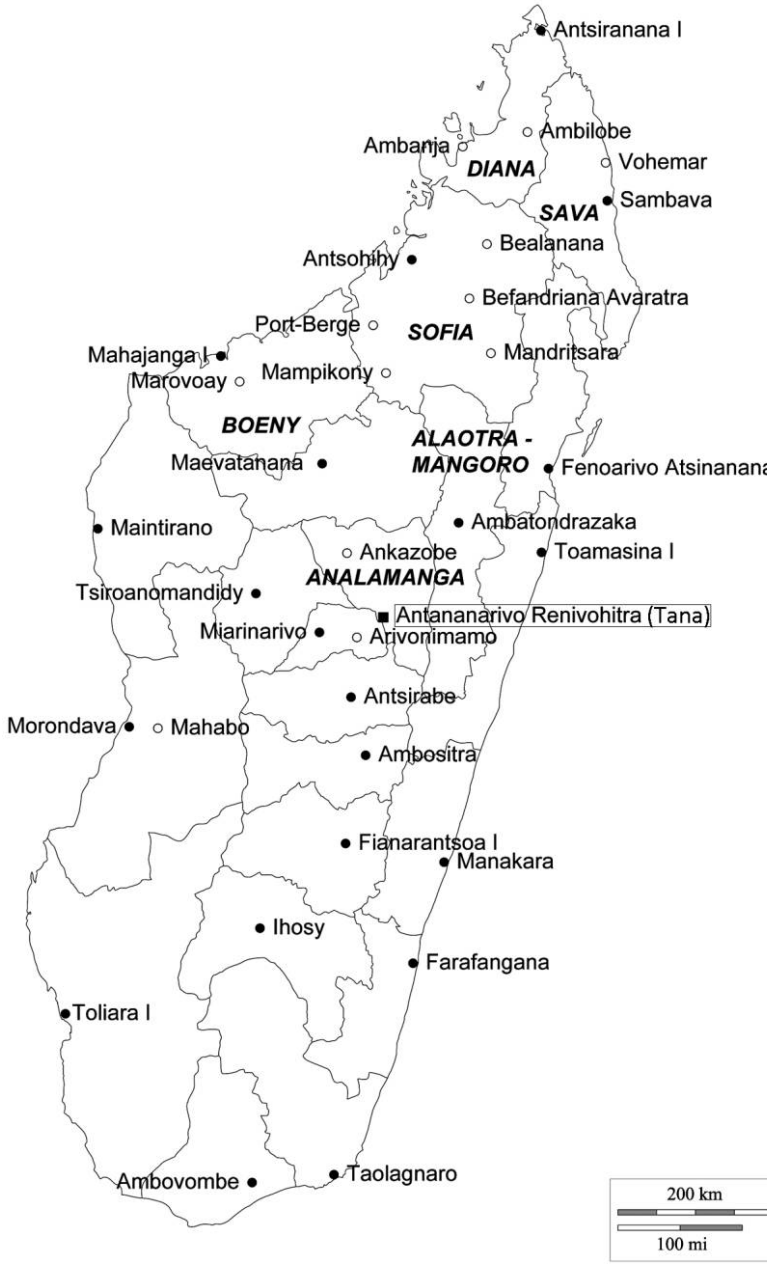

Figure 1. Map of Madagascar by regions and districts. Lines represent regional borders. This map names only the regions and districts mentioned in the paper. Region names are in all caps. Black circles signify the districts that are region capitals, and white circles represent other rice-producing/trading districts.

D. Price

We classify the varieties of rice into the following five categories: vary gasy, tsipala, makalioka, imported rice, and unknown.[12] Vary gasy and tsipala are the major common varieties. Makalioka is considered to be high-grade and is the most expensive rice, mainly produced around the Ambatondrazaka district (Alaotra-Mangoro region). Imported rice constitutes low-grade rice in Madagascar and usually comes from Pakistan or India.

To be able to compare prices across districts, we converted all observed purchase prices to the adjusted milled rice equivalent price (hereafter referred to as "adjusted ME price"), which represents the cost of purchasing 1 kg of milled rice, including transportation costs to Tana (recall that our sample traders are all based and operating in Tana) and milling fees, with adjustment for price differences between paddy and milled rice (for details, see app. A).[13] When we discuss regional price differences, we represent the district price by the median of actual prices paid by our sample traders for each variety at each survey round in each district.

Note that our adjusted ME price allows for the heterogeneous transportation costs based on the reported transportation costs. However, there will be other important costs (transaction costs, opportunity costs, costs to carry inventory, etc.) that cannot be fully captured from our data. We return to this point in the next subsection and in Section VI.G where we discuss the study's limitations.

E. Outcome Measures

Having those limitations in price data in mind, we construct two indicators to describe the change of traders' purchasing behavior before and after intervention. Since our sample traders are based and operating in Tana, we regard that their sales prices are similar; thus, we concentrate on purchase price. For each round $\times$ activity (active or passive) $\times$ variety, we identified the cheapest dis-

[12] Vary gasy literally means Malagasy rice and includes any locally produced rice other than tsipala and makalioka. Some are improved varieties introduced from outside the country, but their origins are not known. On the other hand, tsipala and makalioka are more specific, although they do not seem to be single varieties in the agronomic sense. We assume that both are improved varieties introduced by donors or the Ministry of Agriculture. Their appearances are quite different, and they are easily distinguished in the market: tsipala is relatively short and round, while makalioka is relatively long.

[13] For transportation costs, we directly asked the cost to transport per kilogram purchased. This is the most reasonable way to collect information about transportation costs in Madagascar, as that is how traders and transporters calculate, manage, and compare the costs. Virtually all traders and transporters that we interviewed could answer this question.

trict.[14] In total, we have 14,422 trader × round × activity × variety-level observations.

The first outcome measure is a dummy variable indicating whether a trader purchased from the cheapest district for the same round × activity × variety. The second measure is the actual to optimal price ratio θ, defined as

$$\theta = \frac{p_{itav}}{p^*_{tav}},$$

where p_{itav} is the actual adjusted ME price paid for the cheapest purchase by trader i in round t for activity a in purchases for variety v and p^*_{tav} is the median of actual observed adjusted ME prices in the cheapest district for the same round × activity × variety. The larger the value of θ, the greater the gap between the cheapest price and the actual purchase price. In both measures, for passive interdistrict purchases, we count three modes of within-Tana trades (purchase at the Anosibe market, purchase at the Andravoahangy market, and purchase from local sellers in Tana) as "districts," since these are good alternatives for purchase in Tana.

As described in Section II, these outcome measures provide a simple yet useful benchmark for reference when describing traders' purchasing behavior based on observed costs and examining changes in traders' purchasing patterns before and after we provided price information. Our two outcome measures, however, cannot be used directly to infer the extent of (absolute) efficiency in traders' arbitrage in the real world, given that our price per se does not capture many unobservable costs, including search costs. If these costs are heterogeneous across districts and traders, then the cheapest district and the effective purchase price will differ across traders, and our outcome measures would underestimate the extent of efficiency in traders' arbitrage.

IV. Descriptive Statistics

A. Characteristics of the Sample Traders

Table 1 reports the summary statistics of the study subjects. Out of 224 sampled traders, 104 (46%) engaged in active interdistrict trade, 209 (93%) engaged in passive interdistrict trade, and 91 (41%) engaged in within-Tana trade during the 1-year period survey.[15] The average annual milled rice equivalent volume of rice purchased was 341.8 (standard deviation = 581.6)

[14] Some traders purchased rice from multiple districts. In such cases, we selected the cheapest purchase.

[15] Out of 104 active interdistrict traders, 91 (88%, or 41% among all traders) also engaged in passive interdistrict trade.

TABLE 1

SUMMARY STATISTICS OF SAMPLE TRADERS

		All Traders					By Trader Type			
Variable	Source	Observations	Mean or *n* (*yes*)	SD or % (*yes*)	Min	Max	Active (*n* = 104)	Passive Only (*n* = 120)	Difference	*p*-Value
Rice trading:										
Engaged in active interdistrict trade, 2012–13 (dummy)	Periodic	224	*104*	*46.4%*			100%	0%	100%	**.000**
Engaged in passive interdistrict trade, 2012–13 (dummy)	Periodic	224	*209*	*93.3%*			88%	98%	−11%	**.002**
Engaged in within-Tana trade, 2012–13 (dummy)	Periodic	224	*198*	*88.4%*			78%	98%	−20%	**.000**
Purchased at Anosibe market (dummy)	Periodic	198	*129*	*65.2%*			65%	65%	0%	.945
Purchased at Andravoahangy market (dummy)	Periodic	198	*49*	*24.7%*			20%	28%	−8%	.168
Purchased from local sellers in Tana (dummy)	Periodic	198	*140*	*70.7%*			77%	67%	10%	.127
Total amount of rice purchased, 2012–13 (milled rice equivalent in tons)	Periodic	224	341.8	581.6	0	6,749.6	505.7	199.6	306.1	**.000**
Number of workers engaged in rice trading	Baseline	224	5.4	4.2	1	49	6.6	4.3	2.3	**.000**
Years running rice trading	Baseline	224	8.2	6.7	1	32	9.6	7.1	2.5	**.007**
Having updated *patente de collecteur* (dummy)	Baseline	224	*82*	*36.6%*			56%	20%	36%	**.000**
Pay wholesale tax (dummy)	Baseline	224	*152*	*67.9%*			62%	73%	−12%	.062
Keep income statements (dummy)	Baseline	224	*90*	*40.2%*			43%	38%	6%	.383
Sell imported rice (dummy)	Baseline	224	*173*	*77.2%*			65%	88%	−22%	**.000**
Business diversification:										
Sell food other than rice (dummy)	Baseline	224	*156*	*69.6%*			70%	69%	1%	.868
Sell nonfood items (dummy)	Baseline	224	*97*	*43.3%*			49%	38%	11%	.109
Operate rice mill (dummy)	Baseline	224	*36*	*16.1%*			28%	6%	22%	**.000**
Rent out truck or vehicle (dummy)	Baseline	224	*47*	*21.0%*			27%	16%	11%	**.045**
Profit share of rice trading	Baseline	222	.647	.311	.02	1	66%	63%	3%	.427

Representative:										
Representative's age	Baseline	220	37.1	9.6	20	69	38.0	36.4	1.6	.222
Representative is male (dummy)	Baseline	224	*111*	*49.6%*			63%	38%	24%	**.000**
Representative is literate (dummy)	Baseline	224	*221*	*98.7%*			99%	98%	1%	.643
Representative's education level (dummy):										
None	Baseline	221	2	*.9%*			0%	2%	−2%	.158
Primary	Baseline	221	42	*19.0%*			16%	22%	−6%	.217
Lower secondary	Baseline	221	79	*35.7%*			37%	35%	2%	.741
Upper secondary	Baseline	221	61	*27.6%*			32%	24%	8%	.172
Higher	Baseline	221	37	*16.7%*			16%	18%	−2%	.654
Asset:										
Have store for selling rice (dummy)	Baseline	224	*186*	*83.0%*			68%	96%	−28%	**.000**
Have private storage (dummy)	Baseline	224	*194*	*86.6%*			82%	91%	−9%	.051
Total capacity of private storage (tons)	Baseline	224	28.2	94.3	0	1,000	46.6	12.3	34.3	**.010**
Own vehicle (dummy)	Baseline	221	*61*	*27.6%*			36%	21%	15%	**.013**
Own truck (dummy)	Baseline	224	*77*	*34.4%*			53%	18%	35%	**.000**
Own cell phone (dummy)	Baseline	223	*201*	*90.1%*			91%	89%	2%	.570
Use mobile money for general purpose (dummy)	Baseline	223	*24*	*10.8%*			10%	12%	−2%	.605
Use mobile money for rice trading (dummy)	Baseline	223	*6*	*2.7%*			4%	2%	2%	.334
Price check:										
Checked price using newspaper (dummy)	Baseline	222	*24*	*10.8%*			12%	10%	2%	.677
Checked price using radio (dummy)	Baseline	222	*14*	*6.3%*			7%	6%	1%	.756
Checked price using TV (dummy)	Baseline	222	*21*	*9.5%*			13%	7%	6%	.133
Checked price using OdR (dummy)	Baseline	222	*2*	*.9%*			2%	0%	2%	.158
Checked price using SMS (dummy)	Baseline	222	*5*	*2.3%*			4%	1%	3%	.144

Note. "Having updated *patente de collecteur*" means to be up to date with tax obligations, allowing one to engage in collecting activities. The *p*-value of Welch's two-sample *t*-test on the equality of means is reported in the last column. A boldface *p*-value indicates that $p < .05$. Max = maximum; min = minimum; OdR = Observatoire du riz; SMS = short message service.

tons.[16] The sampled traders had 8.2 (standard deviation = 6.7) years of experience in rice trading. The business is somewhat diversified: 43% of the traders also dealt with nonfood items, 16% operated a rice mill, and 21% rented out a truck or vehicle. As a result, the mean profit share of rice trading was 0.647 (standard deviation = 0.311). The mean age of the representatives was 37.1 (standard deviation = 9.6). Half (50%) of the sampled traders are male, and they are almost completely (99%) literate. Regarding assets, more than 80% of the traders have a store to sell rice and a private storage facility with a mean capacity of 28.2 (standard deviation = 94.3) tons. Furthermore, 34% of the traders own a truck, and 28% own a vehicle. They usually (90%) have a mobile phone.[17]

Although all of our sampled traders engage in interdistrict trade, some do not actively visit other districts and engage in passive-only trade. Mean comparisons between passive-only and active traders in table 1 suggest that active traders are indeed more "active" at their business. They generally engage less in passive and within-Tana trade, trade larger volumes, have more employees and experience, operate rice mills, own and lease vehicles or trucks, and are more likely male. These differences suggest the possibility of selection into engaging in active interdistrict trading.[18] Therefore, the following analyses present separate results by trader type when necessary.

B. Regional Extent of Interdistrict Trade

We define the scope of spatial arbitrage on the basis of districts where we observe actual trade by our sampled traders. Observing actual purchases suggested that trade with that district was practically feasible and profitable, while districts without observed purchases were likely ones in which trade was not reasonable.

Table 2 reports the summary statistics of the number of different districts where we observed actual purchases for interdistrict trade, by round × activity × variety. Averaged over 27 rounds for passive purchases, vary gasy was purchased from sellers who came from 8.6 different-origin districts, tsipala from 10.3 districts, and makalioka from 3.6 districts in the same round. Districts

[16] Our sampled traders purchased 77,000 tons of milled rice per year. If consumers in Tana eat 100 kg per year per capita on average, annual rice consumption of Tana's 2 million people will approach about 200,000 tons. Considering the sampling rate of traders, the quantity of rice purchased by sampled traders is reasonable.

[17] Literacy among our sampled traders (99%) exceeds the national average (64.7%), but their average years of schooling is similar to the national average (10 years). Their cellular phone subscription rate (90.1%) surpasses the national average (39%). Averages are from the World Factbook (https://www.cia.gov/library/publications/the-world-factbook/geos/ma.html).

[18] Ideally, we would consider the selection process in the regression analysis. Unfortunately, we lack reasonable instrumental variables to overcome this selection issue econometrically.

TABLE 2
NUMBER OF DIFFERENT DISTRICTS IN WHICH SAMPLED TRADERS MADE ACTUAL PURCHASES IN INTERDISTRICT TRADE

Activity and Variety	Median	Mean	SD	Min	Max
Passive:					
Vary gasy	8	8.6	1.2	7	11
Tsipala	10	10.3	1.7	8	15
Makalioka	4	3.6	1.4	2	8
Active:					
Vary gasy	8	7.9	1.5	4	11
Tsipala	7	7.5	1.6	5	11
Makalioka	2	2.7	1.6	1	7

Note. The unit of observation is round × activity × variety ($n = 27 \times 2 \times 3 = 162$). The summary statistics are calculated over rounds ($n = 27$). Max = maximum; min = minimum.

where rice was purchased by active interdistrict trade were less diverse: vary gasy was purchased from 7.9, tsipala from 7.5, and makalioka from 2.7 different districts on average. The number of different districts from which makalioka is purchased is small because it is grown in a limited number of regions.

C. *Extent of Arbitrage*

Table 3 reports summary statistics on arbitrage at the trader × round × activity × variety level. We limit our attention to the most common varieties, namely, vary gasy, tsipala, and makalioka.

TABLE 3
EXTENT OF ARBITRAGE

			Actual to Optimal Price Ratio				
	Observations	Share of Purchase from the Cheapest District (%)	Median	Mean	SD	Min	Max
A. All transactions	14,422		1.055	1.072	.099	.638	2.509
If not purchased from the cheapest district	12,747	88.4	1.063	1.081	.100	.638	2.509
If purchased from the cheapest district	1,675	11.6	1.000	1.005	.057	.680	1.480
Vary gasy	5,099	7.0	1.064	1.085	.107	.680	1.847
Tsipala	4,402	10.0	1.066	1.079	.080	.729	1.891
Makalioka	4,921	17.9	1.042	1.053	.102	.638	2.509
B. Passive interdistrict trades	11,954	10.2	1.052	1.061	.070	.729	1.759
Vary gasy	4,130	6.4	1.056	1.071	.083	.743	1.759
Tsipala	3,619	9.3	1.061	1.073	.070	.729	1.653
Makalioka	4,205	14.6	1.040	1.040	.050	.790	1.386
C. Active interdistrict trades	2,468	18.7	1.091	1.128	.171	.638	2.509
Vary gasy	969	9.6	1.108	1.143	.165	.680	1.847
Tsipala	783	13.0	1.094	1.108	.112	.788	1.891
Makalioka	716	37.2	1.065	1.129	.224	.638	2.509

Note. The unit of observation is trader × round × activity × variety. Passive interdistrict trades include three modes of within-Tana trade as separate districts (origins). Max = maximum; min = minimum.

In only 12% (1,675/14,422) of the total observations, the purchase was made from the cheapest district. This low ratio of the purchase from the cheapest districts comes from the fact that the cheapest district changes over time, and many different districts turned out to be the cheapest. Tables A1 and A2 identify the cheapest district for each round × activity × variety by reporting the median adjusted ME price. For active purchases, 11 districts were the cheapest at least once during the 1-year survey period for vary gasy and tsipala, and seven were the cheapest at varying times for makalioka. For passive purchases, 14 districts (including three purchase modes of within-Tana trade) were the cheapest for vary gasy, 12 for tsipala, and nine for makalioka.

The median actual to optimal price ratio is 1.055 (mean = 1.072). This indicates that the median trader paid prices 5.5% above the median price in the cheapest district. The price premium is almost entirely attributable to purchasing from a "wrong" district. If the median trader purchased from the cheapest district, the price premium is 0.0% (median premium between purchases in the optimal vs. nonoptimal district is 1.000 vs. 1.063).

A comparison between active and passive trades reveals that active purchases were relatively well targeted toward the cheapest district; the share of purchases from the cheapest district was 18.7% for active compared to 10.2% for passive. However, the median actual to optimal price premium for active purchases is almost double that of passive purchases (active: 1.091 vs. passive: 1.052). This is because passive prices were relatively converged (standard deviation of actual to optimal price ratio: passive: 0.070 vs. active: 0.171). The relative convergence of passive prices is most likely due to competition in Tana. Consequently, the district of purchase origin made no significant difference in purchase prices.

Although our outcome measures have limitations that prevent us from inferring the efficiency of the arbitrage as we argued above, the result that traders did not purchase from the cheapest district in most cases indicates that traders face some barriers in visiting such districts. Since the cheapest district changes over time and many different districts turned out to be the cheapest, if traders are seeking to purchase from the cheapest district during all rounds, they need to conduct extensive searching to identify the cheapest district and then switch to the cheapest district once they identify it. Consequently, they should end up trading with many districts. The following subsections examine whether these conditions were met.

D. Extent of Search

How extensively are traders searching for price in different markets? In each survey round, we asked whether the trader knew the purchasing price in major rice-producing districts. In doing so, we listed 36 major rice-producing dis-

TABLE 4
EXTENT OF PRICE SEARCHES

	Share of Traders Who Knew Price in at Least One District		(If Price Known) Number of Districts in Which Traders Knew Price					
	Observations	%	Observations	Median	Mean	SD	Min	Max
A. Trader level:								
All traders	224	95.1	213	4	5.1	3.1	1	20
Passive-only traders	120	90.8	109	4	4.5	3.0	1	12
Active traders	104	100.0	104	5	5.8	3.1	1	20
B. Trader × round level (per round):								
All traders	6,033	76.2	4,599	2	2.1	1.8	1	12
Passive-only traders	4,405	68.8	3,030	1	2.0	1.9	1	11
Active traders	1,628	96.4	1,569	2	2.3	1.6	1	12

Note. We listed 36 major rice-producing districts to ask the extent of search. Max = maximum; min = minimum.

tricts to help improve traders' memory during interviews.[19] The enumerators asked traders whether they knew the purchase price of rice in these districts. For each district, when the trader said that he knew the price, the enumerators asked how much it is and how the trader acquired the information.

Table 4 reports the summary statistics. Searching for prices in these rice-producing districts was common, though not many districts were searched. At the trader level, 95% (213/224) of the traders searched for prices in the listed districts at least once during the survey period. Among those who did search, the median number of districts where they knew the price was four (mean = 5.1, standard deviation = 3.1). At the trader × round level (per round, or every 2 weeks), searches were conducted in 76% (4,599/6,033) of the observations; the median number of districts where they knew the price was two (mean = 2.1, standard deviation = 1.8). Active traders were more likely to search than passive-only traders.

Interestingly, traders' knowledge on prices was concentrated in a few common districts. For each round, we calculated the percentage of traders who searched for prices in each district, taking the total number of traders searched in that round as the denominator. Averaged over rounds, the most common district where traders knew the price was Antananarivo Renivohitra (79%), followed by Ambatondrazaka (46%), Miarinarivo (27%), Tsiroanomandidy

[19] The 36 districts are all 22 region capitals and 14 major rice-producing districts in the Analamanga, Boeny, Sofia, Sava, and Diana regions. They are as follows: Antananarivo Renivohitra, Ankazobe, Antsirabe I, Tsiroanomandidy, Miarinarivo, Fianarantsoa I, Ambositra, Manakara, Farafangana, Ihosy, Toamasina I, Fenoarivo Atsinanana, Ambatondrazaka, Mahajanga I, Maevatanana, Marovoay, Port-Bergé, Mandritsara, Befandriana Avaratra, Antsohihy, Bealanana, Maintirano, Mampikony, Toliara I, Morondava, Tolagnaro, Ambovombe, Sambava, Antsiranana I, Vohemar, Ambilobe, Ambanja, other districts in Boeny, other districts in Sofia, other districts in Sava, and other districts in Diana.

(20%), and Ankazobe (19%). Therefore, many traders were price blind; the extent of their knowledge on regional prices was limited.

E. Extent of Trade

In each survey round, we asked traders how many districts they trade with. We find that traders tend to purchase from few fixed districts. Table 5 reports the summary statistics of the number of different purchase districts for interdistrict trades. The main finding from the table is that more than half of the traders switched between only two districts per variety throughout the year, and almost all traders concentrated on purchasing each variety from a single district at each round (trader × round level). The median number of districts purchased through the observation period was two for vary gasy and tsipala and one for makalioka, where 61%, 52%, and 96% purchased from at most two districts, respectively. Passive-only traders were slightly more likely to trade with more districts than active traders (median: 4 vs. 3 at the trader level; 2 vs. 1 at the trader × round level). This is probably because passive interdistrict trades are

TABLE 5
EXTENT OF TRADE

	Number of Different Districts in Which Traders Made Purchases						Share of Observations (%) by Number of Different Districts in Which Traders Made Purchases					
	Observations	Median	Mean	SD	Min	Max	1	2	3	4	5+	Total
A. Trader level:												
By variety:												
Vary gasy	212	2	2.5	1.2	1	7	**20**	**41**	25	7	8	100
Tsipala	200	2	2.7	1.5	1	8	**25**	**27**	20	16	13	100
Makalioka	210	1	1.3	.6	1	4	**75**	**21**	3	0		100
By trader type:												
All traders	222	3	3.8	1.8	1	9	**6**	**19**	25	18	32	100
Passive-only traders	118	4	3.9	2.0	1	9	**8**	**23**	18	14	38	100
Active traders	104	3	3.6	1.5	1	9	**5**	**15**	33	22	25	100
B. Trader × round level (per round):												
By variety:												
Vary gasy	3,990	1	1.0	.2	1	3	**96**	**4**	0			100
Tsipala	3,526	1	1.0	.2	1	3	**96**	**4**	0			100
Makalioka	4,139	1	1.0	.1	1	2	**99**	**1**				100
By trader type:												
All traders	5,219	2	1.8	.7	1	6	**36**	**47**	15	1	0	100
Passive-only traders	2,782	2	2.0	.7	1	6	**23**	**55**	21	1	0	100
Active traders	2,437	1	1.6	.7	1	5	**52**	**39**	8	0	0	100

Note. The number of districts purchased from does not include the three modes of within-Tana trade for passive interdistrict trades. For statistics by trader types, the number of different districts covers purchase of the main three varieties.

easier than active trade (i.e., sitting at the store and calling the sellers vs. actually visiting the districts).

Not only do traders tend to operate in only a few districts, but these districts tend to be common across traders. In appendix B (available online), we report the tables showing the percentages of traders who purchased from each district, taking the total trader × district observations for each round × activity × variety as the denominator. We immediately recognize that the traders' purchases were concentrated in two or three districts for active interdistrict trade. Origin districts for passive purchases (including within-Tana trades) were relatively more dispersed but still concentrated in around four districts.

These common districts, however, were not always the cheapest districts to purchase in. For example, for active purchases of vary gasy, Tsiroanomandidy, which turned out to be the cheapest in four out of 27 rounds, did attract many traders. However, other common districts such as Arivonimamo and Anjozorobe were each cheapest in only one round. Districts that were frequently cheap, such as Ankazobe (cheapest in six rounds) or Maevatanana and Ambatondrazaka (cheapest in five rounds), were not so popular.

V. Impact of Providing Price Information on Traders' Purchasing Behavior

This section reports the results of our RCT in providing regional price information.

A. Empirical Method

We estimate the following simple difference-in-differences (DID) regression:

$$y_{it} = \beta_0 + \beta_1 \text{SMS}_i + \beta_2 \text{Post}_t + \beta_3 \text{SMS}_i \cdot \text{Post}_t + \varepsilon_{it},$$

where SMS_i is the dummy indicating that the trader was sent an SMS and Post_t is the dummy indicating rounds after intervention. The coefficient of interest is β_3, which captures the average treatment effect of our intervention.

B. Randomization

The randomization was mostly successful; most of the differences in preintervention characteristics between the treatment and control groups were statistically insignificant (table A3), except that traders in the treatment group were more likely to search (control: 72% vs. treatment: 80%; $p < .001$), though the number of districts searched is slightly smaller (control: 1.8 vs. treatment: 1.6; $p < .001$); engage in more active interdistrict trade (control: 24% vs. treatment: 33%; $p < .001$); and visit more districts (control: 1.9 vs. 2.1; $p = .044$)

but passively purchase from a smaller number of districts (control: 1.9 vs. 1.8; $p = .024$).[20]

C. Results

Table 6 reports the estimates for search and purchasing. The unit of observation is trader × round. The DID estimate (β_3) is positive and significant for whether a trader searched for price in other districts (col. 1) and the number of districts for which prices were known (col. 2). This implies that the intervention successfully improved the traders' knowledge of prices in diverse districts. However, the intervention had no impact on purchasing behavior. The treated traders did not engage in increased active and passive trading after intervention (cols. 3 and 5), and the number of districts purchased from in each round did not increase (cols. 4 and 6).

Table 7 reports the estimates for arbitrage outcome. The unit of observation is trader × round × activity × variety. We find no statistically significant impact of intervention on either purchases from the cheapest district or actual to optimal price ratio, except for a positive coefficient for actual to optimal price ratio for active purchase of vary gasy, implying that the intervention worsened the arbitrage outcome.

As a consequence, the provision of price information had no impact on profits. For each round, we obtained a crude measure of management indicators by asking the overall quantity and average price of purchases and sales as well as margins. The estimates reported in table 8 indicate that the intervention had no impact on quantity and price of purchases and sales as well as margins.[21]

VI. Discussion

A. Summary of Findings

The main finding from our intervention is that having price information did not impact traders' behavior and purchase prices. This adds evidence supporting the notion that price information alone may not be sufficient to foster better arbitrage, as suggested by some previous studies (Camacho and Conover

[20] To deal with these systematic differences between treatment and control groups, we conducted the following estimations with trader fixed effects. The results reported in app. B were significantly similar to those obtained without using trader fixed effects. Although the number of traders is rather small (112 in treatment and 112 in control), we have repeated observations for each trader (12 rounds), which increases the power of the test. Considering the within-trader autocorrelation, the power analysis shows that, with the significance level of .05 and power of 0.8, the effect sizes that can be detected by the model in col. 1 of table 6 are 8.4% changes in the probability of purchasing from the cheapest district and a 0.03 point change in the actual to optimal price ratio. This magnitude corresponds to about 0.3 standard deviation in both outcome measures.

[21] All the null results are also confirmed with estimations using trader fixed effects and estimations separating the samples by active traders and passive-only traders. The results are available in app. B.

TABLE 6

SHORT MESSAGE SERVICE (SMS) TREATMENT EFFECTS FOR SEARCH AND PURCHASING

	Know Price in at Least One District (1)	Number of Districts in Which Price Is Known (2)	Engaged in Active Trading (3)	Number of Active Districts in Which Purchases Are Made (4)	Engaged in Passive Trading (5)	Number of Passive Districts in Which Purchases Are Made (6)
SMS	.0810	−.152	.0981	−.0152	.0202	−.0736
	(.0500)	(.106)	(.0503)	(.0950)	(.0407)	(.0888)
Post	−.136***	−.432*	−.0492	.0712	.00638	.0160
	(.0262)	(.195)	(.0271)	(.109)	(.0261)	(.0793)
SMS × Post	.0753***	1.630***	−.00880	−.136	−.0217	−.00130
	(.0215)	(.245)	(.0221)	(.0924)	(.0190)	(.0484)
Constant	.834***	2.113***	.281***	1.374***	.829***	1.826***
	(.0342)	(.120)	(.0375)	(.106)	(.0329)	(.0839)
N	6,033	4,599	6,033	1,628	6,033	4,156
R^2	.025	.152	.018	.026	.003	.009

Note. The number of searched/active/passive districts (cols. 2, 4, and 6) is defined for nonzero observations only (intensive margin). The unit of observation is trader × round. Standard errors clustered by trader are in parentheses. Round fixed effects are included. Post = the rounds after SMS has been sent; SMS = traders who received the regional price information via SMS.

* $p < .05$.

*** $p < .001$.

TABLE 7

SHORT MESSAGE SERVICE (SMS) TREATMENT EFFECTS FOR ARBITRAGE OUTCOME

	All Transactions			Active Transactions			Passive Transactions		
	Vary Gasy and Tsipala (1)	Vary Gasy (2)	Tsipala (3)	Vary Gasy and Tsipala (4)	Vary Gasy (5)	Tsipala (6)	Vary Gasy and Tsipala (7)	Vary Gasy (8)	Tsipala (9)
A. Dummy if purchased from cheapest district:									
SMS	.0170	.0114	.0252	.0218	.0122	.0182	.00940	.00865	.0121
	(.00991)	(.0109)	(.0149)	(.0192)	(.0250)	(.0292)	(.00849)	(.0107)	(.0123)
Post	.107***	−.00719	.246***	.0131	−.0252	.0488	.121***	−.00632	.276***
	(.0213)	(.0177)	(.0389)	(.0404)	(.0574)	(.0570)	(.0239)	(.0173)	(.0443)
SMS × Post	−.0349	−.0151	−.0598	.0109	.00607	.0325	−.0333	−.0143	−.0590
	(.0212)	(.0163)	(.0337)	(.0343)	(.0377)	(.0512)	(.0225)	(.0174)	(.0352)
Variety (base = vary gasy):									
Tsipala	.0287***			.0335*			.0284***		
	(.00737)			(.0148)			(.00831)		
Constant	.00125	.0299*	−.00745	−.00336	.0404	−.0108	.00518	.0282	.00204
	(.0107)	(.0145)	(.0103)	(.0250)	(.0381)	(.0175)	(.0115)	(.0152)	(.0105)
N	9,501	5,099	4,402	1,752	969	783	7,749	4,130	3,619
R^2	.050	.059	.092	.128	.144	.371	.078	.095	.153

B. Actual to optimal price ratio:									
SMS	−.00478	−.00434	−.00668	−.00992	−.00454	−.0200	−.00572	−.00694	−.00481
	(.00496)	(.00505)	(.00620)	(.0133)	(.0122)	(.0180)	(.00441)	(.00414)	(.00577)
Post	−.0560***	−.0433***	−.0736***	−.117***	−.151***	−.0815*	−.0354***	−.0141*	−.0635***
	(.00852)	(.00881)	(.0104)	(.0294)	(.0309)	(.0316)	(.00523)	(.00626)	(.00626)
SMS × Post	.0138	.0169	.0114	.0361	.0460*	.0382	.00557	.00727	.00416
	(.00779)	(.00866)	(.00825)	(.0208)	(.0232)	(.0234)	(.00712)	(.00777)	(.00744)
Variety (base = vary gasy):									
Tsipala	−.00581*			−.0366***			.00155		
	(.00239)			(.00734)			(.00187)		
Constant	1.099***	1.078***	1.121***	1.219***	1.192***	1.216***	1.066***	1.048***	1.092***
	(.00785)	(.00762)	(.00943)	(.0244)	(.0237)	(.0309)	(.00441)	(.00516)	(.00520)
N	9,501	5,099	4,402	1,752	969	783	7,749	4,130	3,619
R^2	.158	.321	.117	.305	.694	.395	.228	.453	.163

Note. The unit of observation is trader × round × activity × variety. Standard errors clustered by trader are in parentheses. Round fixed effects are included. Post = the rounds after SMS has been sent; SMS = traders who received the regional price information via SMS.

* $p < .05$.

*** $p < .001$.

TABLE 8
SHORT MESSAGE SERVICE (SMS) TREATMENT EFFECTS FOR MANAGEMENT INDICATORS

	Biweekly Amount Sold (Tons) (1)	Biweekly Amount Purchased (Tons) (2)	Selling Price (Ar/kg) (3)	Purchasing Price (Ar/kg) (4)	Margin (Ar/kg) (5)
SMS	5.866	5.701	−3.030	−5.496	.383
	(3.113)	(3.248)	(8.786)	(8.618)	(3.593)
Post	2.054	−.0435	103.8***	108.3***	−.891
	(1.734)	(1.739)	(6.739)	(6.709)	(3.294)
SMS × Post	−2.179	−2.188	−5.529	−2.184	−.721
	(1.127)	(1.180)	(7.762)	(7.202)	(2.280)
Constant	8.260***	11.91***	1,125.5***	1,069.0***	52.56***
	(1.656)	(1.905)	(6.245)	(6.355)	(3.145)
N	5,769	5,862	5,830	5,716	5,814
R^2	.012	.011	.274	.280	.007
Mean and SD of dependent variable:					
Mean	12.3	13.8	1,263.1	1,208.9	53.6
SD	25.1	25.6	119.3	118.0	36.2

Note. The unit of observation is trader × round. Standard errors clustered by trader are in parentheses. Round fixed effects are included. Post = the rounds after SMS has been sent; SMS = traders who received the regional price information via SMS.
*** $p < .001$.

2011; Fafchamps and Minten 2012; Minten, Stifen, and Tamru 2014; Tadesse and Bahiigwa 2015). However, other studies do find a positive impact of price information provision on arbitrage and increased sales prices (Svensson and Yanagizawa 2009; Nakasone 2014). At the current stage of research, a micro-macro paradox seems to exist where several rigorous studies based on RCTs indicate a null effect or at least mixed evidence of market information provision at the micro level (i.e., farmers and traders), while the expansion of mobile phone networks does seem to foster market integration at the macro (regional) level (Jensen 2007; Aker 2010). Further study is required to identify the conditions in which price information provision improves arbitrage performance and market integration. The discussion that follows examines the (negative) result, drawing supplementary evidence from our follow-up survey in which we sought to discern why providing price information had no impact.

B. Obstacles to Starting to Visit a New District

Nearly 60% of the traders felt some difficulties in starting to visit new districts. In response to the question "How hard is it to start visiting a new district you have never visited before?" 42 out of 209 valid responses (20%) replied "very hard" and 80 (38%) replied "somewhat hard."[22]

[22] The remaining responses were "neither hard nor easy" ($n = 60$, 29%), "somewhat easy" ($n = 19$, 9%), and "very easy" ($n = 8$, 4%).

TABLE 9
OBSTACLES TO STARTING TO VISIT A NEW DISTRICT

	Total	First	Second	Third
Finding a trustworthy trading partner	25.1%	30.0%	25.9%	18.7%
Obtaining price information	21.1%	24.1%	17.8%	21.4%
Quality, variety, characteristics are uncertain	16.3%	7.4%	23.4%	18.7%
Safety	16.2%	18.7%	11.7%	18.1%
Collecting necessary quantity	9.8%	8.4%	9.6%	11.5%
Lack of experience	7.4%	10.3%	5.1%	6.6%
Payment will be inflexible/unable to purchase on credit	3.4%	1.0%	5.6%	3.8%
Lack of money	.5%	.0%	1.0%	.5%
Other	.2%	.0%	.0%	.5%
Total	100.0%	100.0%	100.0%	100.0%
Observations	582	203	197	182

Note. Based on the follow-up survey. Respondents are all traders who participated in the follow-up survey ($n = 219$).

Table 9 reports the obstacles to starting to visit a new district, determined by asking the traders to provide three reasons. In aggregate, we obtained 582 valid responses. "Finding a trustworthy trading partner" was the most mentioned obstacle (25%), followed by "obtaining price information" (21%), "quality, variety, characteristics are uncertain" (16%), "safety" (16%), "collecting necessary quantity" (10%), "lack of experience" (7%), and "payment will be inflexible/unable to purchase on credit" (3%).

C. Why Was Providing Price Information Not Effective?

Table 9 does imply that price information was one of the main constraints for traders to start visiting a new district. Why, then, did our intervention that eliminated this constraint not change the traders' behavior?

The first possible reason and also a potential limitation of this study is that the price information provided was not sufficiently reliable or timely. We asked how the traders utilized the information. Of the 219 respondents of the follow-up survey, 107 (49%) were in the treatment group but only 95 (43%) actually received the price information.[23] Among these 95 traders, only two (2%) used it to visit new districts. However, price information was used in some other ways; 31 (33%) passed the information to others, 42 (44%) used it to check the adequacy of prices, and 18 (19%) used it to negotiate a price with a seller. This suggests that the information was considered valuable but not sufficient to motivate a visit to a new district.

Why was the information not used for a visit to a new district? Table 10 summarizes the responses to our asking for three reasons from those who received

[23] The major reasons for those not receiving the information were changes in phone number and losing a SIM card.

TABLE 10
REASONS FOR NOT USING SHORT MESSAGE SERVICE (SMS) PRICE INFORMATION TO VISIT A NEW DISTRICT

	Total	First	Second	Third
Information was not reliable	31.5%	34.1%	38.3%	12.1%
Price may change during travel or transportation	20.7%	13.2%	35.0%	15.2%
Information was not timely	14.1%	3.3%	15.0%	42.4%
Only buy from fixed place/seller	11.4%	20.9%	1.7%	3.0%
Other	10.9%	16.5%	6.7%	3.0%
Price is not important	6.0%	2.2%	3.3%	21.2%
SMS price was expensive	3.8%	7.7%	.0%	.0%
Lack of money	1.1%	2.2%	.0%	.0%
Bad transportation	.5%	.0%	.0%	3.0%
Total	100.0%	100.0%	100.0%	100.0%
Observations	184	91	60	33

Note. Based on the follow-up survey. Respondents are traders who received our price information via SMS and did not use this information to start visiting a new district ($n = 93$).

the information but did not use it to visit a new district ($n = 93$). In aggregate, we obtained 184 valid responses. Ignoring the rank of responses, one of the major reasons indicated was the inadequacy of the supplied information: "information was not reliable" (32%), "price may change during travel or transportation" (21%), and "information was not timely" (14%).

These responses are understandable given that cheap districts (mostly in the Sofia region) are often far away and the road conditions are so poor that it takes several days or even weeks to make a round-trip. Traders may care about road conditions because car parts wear easily with bad roads, thus increasing maintenance costs. These interpretations coincide with those of Fafchamps, Gabre-Madhin, and Minten (2005) and Miyake and Sakurai (2012) that indicate the importance of improved road infrastructure to long-distance trade in Madagascar.

Discussions with the traders also made us aware of the possibility of underestimating the effective prices in distant districts because of opportunity costs. For example, districts in the Sofia region take at least 1 or 2 weeks to make a round-trip. In contrast, popular proximate districts such as Arivonimamo, Tsiroanomandidy, and Anjozorobe can be visited within 3–7 days. This implies that traders can visit these districts twice for the same amount of time it would take to visit the Sofia region once. Time taken for purchases is critical since traders seek to buy and sell as soon as possible to speed up capital turnover. Although direct transportation costs are captured in our prices, these hidden opportunity costs are not well accounted for, and the effective prices in the Sofia region may be much higher than the prices used in the analyses. The prices provided were also 1-week lagged.

In any case, the prices we provided are by far the most detailed, updated, systematically collected, and reliable publicly available information that one

can obtain in Madagascar. The prices provided are those at each district's millers, and we believe that they do reflect local wholesale prices. However, some traders who deeply search into remote villages and purchase at farm gates might feel that the provided prices were not sufficiently informative.

D. Trading with Fixed Districts

We are more interested in the second possible reason that stops traders from readily visiting a new district. We have already seen in Section IV.E that traders continue to visit a few fixed districts (table 5), and more than half of the traders traded with only two districts per rice variety. Table 10 adds to this by revealing that the fourth-most indicated reason in aggregate (and next most frequently indicated primary reason) for not using the provided price information to visit a new region was that the respondents buy only from a fixed place/seller (11% in aggregate or 21% among those providing this as their first reason). This indicates the possibility that traders forgo the arbitrage opportunity and stay with familiar trading partners even if they are informed about a cheaper price in a new district.

Why do traders continue to visit the same fixed districts? Section VI.B discussed the constraints on visiting a new district; nearly 60% of the traders expressed having some difficulty in starting to visit a new district, and nonprice issues such as finding a trustworthy trading partner, quality uncertainty, and safety were cited as the major obstacles (table 9).

Table 11 reports answers regarding the most important information needed to start visiting a new district. Again, we asked the traders to offer three reasons. Price information is indeed the most important information, comprising 33% out of the 640 aggregate valid responses. It is not, however, the single decisive factor. In fact, traders are also aware of "quality, variety, and characteristics" (26%), "contact of trading partner" (19%), and "availability (quantity) of rice"

TABLE 11
MOST VALUABLE INFORMATION WHEN STARTING TO TRADE WITH A NEW DISTRICT

	Total	First	Second	Third
Price	33.0%	51.1%	29.4%	17.2%
Quality, variety, and characteristics	26.1%	22.8%	30.3%	25.1%
Contact of trading partner	19.1%	16.0%	13.3%	28.6%
Availability (quantity) of rice	18.1%	6.8%	24.8%	23.2%
Safety information	1.4%	2.7%	.5%	1.0%
Road condition	1.3%	.5%	.9%	2.5%
Other	.6%	.0%	.0%	2.0%
Credit information	.5%	.0%	.9%	.5%
Total	100.0%	100.0%	100.0%	100.0%
Observations	640	219	218	203

Note. Based on the follow-up survey. Respondents are all traders who participated in the follow-up survey ($n = 219$).

(18%). These facts imply that nonprice information is also important for traders to visit a new area. This is in line with the previous observations that mobile phones can transmit but fail to agree on prices, possibly due to limited ability of transmitting other relevant information, such as quality (Minten, Stifel, and Tamru 2014; Tadesse and Bahiigwa 2015).

E. Links

The follow-up survey also revealed that traders had established a link before they started actively visiting the most frequently visited district. Of the 90 active interdistrict traders who replied to the follow-up survey, 46 (51%) answered that they had purchased from a seller from that district in Tana before actually visiting there by themselves. This "trial purchase" could serve as a device to check the product quality as well as to collect information on potential sellers and their trustworthiness in that district. Moreover, 74 (82%) indicated that they were introduced by a mediator during the first visit, who was a friend/relative in that district (63%), retailer/wholesaler/trader in Tana (28%), or seller/trader from that district (8%).

Once traders are linked to a destination, they tend to continuously and exclusively trade with fixed trading partners. Of the active traders, 93% (84/90) replied that they "always" (57%), "most of the time" (32%), or "sometimes" (4%) purchase from the same trading partners. The average number of partners whom traders contact in the most frequently visited district is 4.0 (standard deviation = 5.5), where these partners are collectors/agents (39%, 33/84), farmers (38%), or millers (23%).

Field interviews with the traders revealed that obtaining an introduction and establishing regular relationships are crucial. First, as there are so many collectors, farmers typically prefer to sell to a familiar buyer over an unfamiliar one, so that local buyers who make frequent visits to the villages have the advantage of getting the product first.[24] To compete with these local buyers, traders in Tana need to make frequent visits and maintain regular relationships. Second, having a regular and trustworthy trading partner is very important in ensuring a secure supply, as the trade does not occur in an open market but on an individual negotiation basis. Additionally, conflict resolution after a contract breach appears to be costly. To secure supply in quantity and quality and to save time spent in remote villages for product collection, traders occasionally make an advance payment when they place an order.[25] Then they visit

[24] One trader said that many people entered the rice-collecting business because of the recent availability of funds from a microfinance institution.

[25] In our data, 16% (719/4,494) of active interdistrict purchases involved an advance payment.

the trading partner at a mutually agreed time for collecting the products. The problems that traders may encounter if the partner is not trustworthy are late delivery, poor-quality product, side selling, or even money loss (the partner disappears).

These findings suggest that traders cannot readily visit a new district because they are also concerned about quality uncertainty and matching with sellers. Traders are able to overcome these issues by concentrating on trading exclusively with only a few districts, where they establish a link by paying fixed costs before starting a visit. These findings are consistent with previous observations emphasizing the importance of personalized exchange networks for reducing transaction costs (Jabbar et al. 2008; Tadesse and Shively 2013; Gelaw, Speelman, and Van Huylenbroeck 2016). They also support Fafchamps and Minten (2001, 2002), who report that agricultural traders in Madagascar narrow their extent and scope of trade. Fafchamps and Minten (2001, 2002) emphasize trust-based relationships as the dominant contract-enforcement mechanism among grain traders, given that legal institutions are inconsequential for enforcing contracts.

F. Extending the Conceptual Framework

To understand the behavior of our sampled traders, our findings and discussions suggest two necessary extensions or customization of the conceptual framework in Section II. First, we must consider the multidimensionality of information. Our study suggests that nonprice information is crucial alongside price in making purchasing decisions. Suppose, for example, that there are two varieties of rice, and each trader has a preferred variety (perhaps reflecting her customers' preferences). Lacking information about product variety, traders would not visit a new district because the variety in that district might not be his preferred type.

Second, we must consider the role of linkage to the districts—that is, reinforced relationships with the district based on repeated transactions that are established after traders invest a fixed sunk linkage cost. They could play two roles. First, they are necessary for obtaining both price and nonprice information in each district because a trader needs someone in the district to ask for detailed information. Even if we had provided price information relevant to a district, traders could not visit it without links that provide access to nonprice information. Second, they can mitigate contract enforcement problems, such as shortage of supply or purchase of product with inferior quality.

The importance of the linkage can be incorporated in our simplified framework by assuming that the traders can obtain information only from linked districts and that they need to invest a fixed sunk linkage cost s to establish

one. Then the scope of search and trade is limited to the number of links and where those linked districts are. In this setting, the traders first decide where and how many links they would establish. In principle, traders would link with districts that are constantly cheap on average throughout the year. Districts that are cheap for only a few rounds may not be worth sinking s. This could explain why many of our sampled traders trade with only a few districts and why these districts are common across traders.

G. *Limitations*

We are aware of several limitations of our findings and interpretations. First, as discussed in detail in Section VI.C, the null effect of our intervention may be due to limited reliability and timeliness of the information provided. In any case, our price information is the best available in the context, and there is currently no way to improve. We speculate that the traders' perception of unreliability toward our prices (local millers' price) comes from the gap with their actual purchase prices (most likely farm gate price) and that such a gap is larger for those who make intensive searches in remote villages. Investigating the extent of this price gap and its correlation with trader characteristics may be an interesting topic for future research, with important implications on the choice of price in studying regional market integration.

Second, it is also possible that the true effects of price information were reduced by spillover effects, as intense information exchange among traders and brokers is common (Gabre-Madhin 2001; Fafchamps and Minten 2002).

Third, as acknowledged in Section III.D, our price comprises purchase price and transportation costs only; it excludes other costs and disregards possible heterogeneity. Thus, our two outcome measures cannot elucidate the absolute efficiency of traders' arbitrage in practice.

Fourth, it could be possible that rice is more finely differentiated than our classification of major varieties. Primary hedonic pricing analysis does indicate price differences within each variety depending on product characteristics (Sakurai et al. 2015), which can imply that some traders may be purchasing at a higher price because the product characteristics or quality is different. How suppliers, traders, and consumers recognize and evaluate variety, quality, and other characteristics is an important question that remains to be understood in Madagascar's rice market.

Fifth, our study sample is limited to traders in Tana, who are buyers. Traders based in production districts acting as sellers may behave differently; therefore, we should be cautious when generalizing our findings and interpretations.

VII. Concluding Remarks

This study investigated the regional trading behavior and examined obstacles to improved arbitrage among rice traders in Antananarivo, Madagascar. Our major observational finding is that traders do not always buy rice from districts offering the lowest observed price and transportation costs. To demonstrate the importance of price information friction, we randomly gave half of our sampled traders regional price information and found no evidence of altered trading behavior. We obtained descriptive evidence that traders, when considering a visit to a new district, are concerned not only about price but also about product quality and characteristics, matching with trustworthy sellers, and collecting the necessary quantity of product. Traders tend to concentrate on trading with a few fixed districts, which are often linked by "trial purchases" from sellers in that district or asking a mediator for an introduction before starting to visit there.

On the basis of these findings, we interpret that the key obstacle preventing better arbitrage and market integration is not only lack of access to price information but also nonprice issues related to starting trade in a new district. These issues include access to nonprice information, such as volume and stability of supply, contact with trading partners, and product quality and characteristics. Traders overcome these issues by trading exclusively with linked districts. Because there is a fixed cost to establish a link, traders cannot easily increase the number of links, and without such links they cannot readily spontaneously visit a new district in response to information transmitting cheaper prices. Since obtaining price information in unlinked districts is of little use, many traders do not have an incentive to search extensively and therefore become price blind.

Although our intervention had null effect, we do not claim to have proven that providing price information is meaningless or that information friction is inconsequential to better arbitrage. In fact, descriptive evidence supports the importance of price information. However, we emphasize that information friction could be multidimensional and that price is only one piece of information for traders to expand their scope of regional arbitrage.

The policy implication derived from our findings and interpretations is that the provision of public price information in the current form is not sufficient to improve the market performance. Interventions that mitigate nonprice issues and transmit nonprice information or reduce the fixed cost of establishing a new link may foster better arbitrage and market integration. Standards, grading, a certification system, and opening of commodity exchanges are some of the possible solutions. However, since these institutions are not free of cost

and require administrative capacity for operation and management, careful examination of costs and benefits should be conducted in further studies.

Appendix A

Imputation of (Adjusted) Milled Rice Equivalent Price

In this appendix, we describe how we imputed and adjusted the purchase price of rice. The main concern is that a certain fraction of purchases were made in paddy, and the price for paddy is generally less than that for milled rice because paddy needs to be processed. To obtain comparability between the two prices, we construct a milled rice equivalent price (hereafter, ME price), which represents the price equivalent to purchasing milled rice per kilogram, including transportation costs and milling fees.[26]

When the purchased rice is milled rice, the ME price is simply the raw purchase price plus transportation costs. For purchases made in paddy, we impute the ME price on the basis of the following equation:

$$\hat{p}_{\text{milled}} = \frac{p_{\text{paddy}} + \tau + \mu - \alpha_{\text{bran}} p_{\text{bran}}}{\alpha_{\text{milled}}},$$

where p_{paddy} is the purchase price of paddy; τ is the transportation cost (of paddy); μ is the milling fee (per kilogram of paddy); α_{milled} and α_{bran} are the conversion rates from paddy to milled rice and paddy to bran, respectively; and p_{bran} is the sales price of bran. All prices and costs are measured per kilogram. The numerator is the total cost of purchasing 1 kg of paddy, net of sales of bran. The denominator is the quantity of milled rice obtained from 1 kg of paddy.

For all purchases made during the periodic surveys, we have information on p_{paddy} and τ but not on the others. We thus collected information on the rest of the parameters (μ, α_{bran}, α_{milled}, p_{bran}) in the follow-up survey. Out of 219 respondents in the follow-up survey, 70 (32%) purchased rice in paddy. For those who purchased in paddy, we asked about the details of milling for each variety, obtaining 133 trader × variety observations. Tables B5 and B6 in appendix B present the summary statistics. Of the 130 available observations, 110 (85%) were milled in Antananarivo Renivohitra. For milling cost μ, we use the milling fee in low season.[27] It is common for the traders to obtain and

[26] Price differences in the paddy and milled rice might create opportunities for the paddy-milled rice arbitrage. We do not investigate this dimension of the arbitrage since our focus is on the regional arbitrage and the impact of the SMS intervention on it.

[27] The milling fee for low season (nonharvest season: September to April) is higher than that in the high season (harvest season: May to August), though the difference is marginal. The fee for the high season is lower because of higher operation costs and competition. However, millers make up for these with the increase in operation volumes.

sell the bran. Out of 133 trader × variety observations, 52% were milled by the trader, thus retaining the bran. Even where a trader asked a miller to carry out the milling, the trader answered that they "always get the bran" in 71% of the observations. This indicates that the traders obtained the bran in 86% $(= 0.52 + (1 - 0.52) \cdot 0.71)$ of the cases. The bran is almost always sold (89%). We therefore assume that when traders purchase paddy, they get the bran and sell it, which requires bran sales to be deducted from the purchase cost.

To impute $\hat{p}_{\text{milled}}$, we use the median of variety-specific parameter (table B7). Suppose a trader purchased vary gasy in paddy at a price of 780 Ar/kg and transportation cost of 20 Ar/kg. Then the imputed ME price per kilogram is

$$\hat{p}_{\text{milled}} = \frac{p_{\text{paddy}} + \tau + c - \alpha_{\text{bran}} p_{\text{bran}}}{\alpha_{\text{milled}}} = \frac{780 + 20 + 20 - 0.10 \cdot 600}{0.70} = 1{,}086.$$

Thus, purchasing 1,000 kg of paddy at a price of 780 Ar/kg and transportation cost of 20 Ar/kg is equivalent to purchasing 700 kg of milled rice at a price of 1,086 Ar/kg including transportation cost.

Since the ME price is imputed for purchase in paddy, we checked whether it is systematically different from the purchase prices for milled rice. Fixed effect estimates of ME prices with a dummy indicating purchase in paddy, with activity × round × variety × district fixed effects and using all 19,422 purchased prices for vary gasy, tsipala, and makalioka, indicate that the ME price in paddy is 129.0 Ar/kg lower than the price of milled rice (table B7, col. 1). The constant (i.e., the price for milled rice) is 1,210.4, which indicates that paddy is 10.7% $(= 1 - (1{,}210.4 - 129.0)/1{,}210.4)$ cheaper than milled rice.

This price difference between paddy and milled rice might cause a bias. Out of the 1,339 activity × round × variety × district observations, 248 (19%) were for that purchased in paddy only, 748 (56%) were for that purchased in milled rice only, and 343 (26%) were for that purchased both in paddy and in milled rice (table B8). The percentage of purchases in paddy only is larger for active interdistrict trades than passive trades (49% vs. 2%), implying that the potential bias, if any, is more serious for active purchases.

To consider this potential bias, we construct the adjusted milled rice equivalent price. It adjusts differences between paddy and milled rice by adding the paddy's price discount compared to milled rice for purchases at the paddy (δ_{av}) to the imputed ME price explained above. We estimate δ_{av} for each activity × variety by regressing the ME price on a dummy indicating at-paddy purchases with round × district fixed effects, where δ_{av} are estimated as the coefficient of the dummy for at-paddy purchases (table B7, cols. 2–7). The adjusted ME

price is then calculated as $\hat{p}^{\text{adj}}_{\text{milled}} = \hat{p}_{\text{milled}} + \hat{\delta}_{av}$, where $\hat{\delta}_{av}$ are the estimated activity × variety-specific price discounts. For example, the price discount is 119.5 Ar/kg for active purchases of vary gasy. Thus, the adjusted ME price of vary gasy in paddy with a price of 780 Ar/kg and transportation cost of 20 Ar/kg is

$$\hat{p}^{\text{adj}}_{\text{milled}} = 1{,}086 + 119.5 = 1{,}205.5.$$

One would still wonder whether price influences the decision to buy paddy or milled rice. For example, traders seeing extremely low prices might buy a large quantity of paddy rice, as it is better suited for storage. If this causes selection bias, including quantity traded alters the coefficient of the paddy purchase dummy. Available on request, results indicate that including the trade quantity little affects the coefficients of the paddy purchase dummy, indicating reliability of our estimates.

Appendix Tables

TABLE A1

MEDIAN ADJUSTED MILLED RICE PRICE BY ROUND × VARIETY × DISTRICT (PASSIVE INCLUDING WITHIN-TANA TRADE)

	Round																										
Variety and District	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
Vary gasy:																											
Ambohidratrimo	**1,000**			1,150	1,260	1,300	**1,130**	1,195	1,290	1,295	1,280	1,265	1,230	1,270	1,270	1,250	1,255	1,230	1,260	1,145	1,240	**1,025**	1,180	1,175	1,170	1,180	**1,120**
Ankazobe	1,018	1,080	1,080	1,140	1,260	1,295	1,160	1,200	1,255	1,290	1,280	1,260	1,210	**1,250**	**1,250**	1,250	1,240	1,255	1,240	1,260	1,080	1,250	1,180	1,190	1,190	1,240	1,170
Arivonimamo	1,060	1,080	1,125	1,180	1,240	1,200	1,200	1,200	1,220	1,210	1,200	1,220	1,220	1,275	1,280	1,250	1,250	1,170	1,160	1,140	1,150	1,135	1,140	1,140	1,150	1,140	1,150
Manjakandriana														1,323	1,300												
Anjozorobe	1,055	1,070	1,100	1,150	1,180	1,240	1,240	1,240	1,180	1,170	1,190	1,180	1,200	**1,250**	1,300	1,290	1,300	1,275	1,180	1,102	**1,075**	1,060	1,132	1,175	1,180	1,219	1,180
Ambatolampy																			**960**	**960**							
Tsiroanomandidy	1,026	1,041	1,100	1,200	1,160	1,195	1,190	1,189	1,180	1,200	1,190	1,190	1,200	1,280	1,280	1,280	1,200	**1,100**	1,100	1,090	1,080	1,080	**1,090**	1,105	1,160	**1,120**	1,130
Miarinarivo	1,080	1,100	1,095	1,100	1,280	1,305	1,200	1,210	1,210	1,220	1,240	1,255	1,190		1,290	1,290	1,245	1,250	1,240	1,240	1,265	1,245	1,220	1,135	1,210	1,250	1,205
Soavinandriana															1,260												
Antananarivo-Atsimondrano	1,050		1,120	1,100	1,150	1,260		1,220	1,180	**1,160**	1,200	**1,160**	**1,180**				1,250	1,280	1,180	1,240	1,140	1,200	1,200	1,180	1,180	1,180	1,160
Toamasina I								1,250																			
Ambatondrazaka	**1,000**	**1,000**	**1,040**	1,125	1,180	1,195	1,169	**1,185**	**1,018**	1,190	1,180	1,195	**1,180**	1,350		1,300	1,240	1,380	1,300	996				1,289		1,220	
Andilamena						**1,140**																					
Marovoay									1,160	**1,160**	**1,160**	**1,160**												**960**			
Mandritsara		1,080	1,080														**1,150**					1,190					
Befandriana-Avaratra									1,220																		
Bealanana		1,080				1,240	1,389	1,389	1,230	1,354	1,250	1,263	1,250						1,240			1,220	1,220				
Mampikony										1,518																	
Other districts in Boeny					**1,100**																						
Tana: Anosibe	1,090	1,070	1,110	1,180	1,220	1,210	1,150	1,200	1,280	1,200	1,220	1,250	1,300	1,350	1,290	1,280	1,250	1,260	1,200	1,115	1,100	1,130	1,120	1,140	**1,143**	1,140	1,135
Tana: Andravoahangy	1,100	1,080	1,080	1,165	1,180	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,250	1,325	1,290	**1,240**	1,220	1,205	1,140	1,100	1,100	1,125	1,120	1,180	1,160	1,140	1,190
Tana: seller in Tana	1,040	1,050	1,050	**1,080**	1,180	1,180	1,146	1,200	1,220	1,220	1,220	1,190	1,300	1,300	1,300	1,295	1,250	1,270	1,120	1,100	1,080	1,080	1,100	1,175	1,180	1,180	1,170
Tsipala:																											
Ambohidratrimo				1,140	1,260	1,290	1,160	1,190	1,290	1,290	1,265	1,260	1,240	1,255	1,300	1,260	1,250	1,220	1,250	1,250	1,250	1,230	1,200	1,195	1,180	**1,120**	1,160
Ankazobe	1,000	1,039	1,080	1,140	1,270	1,285	1,135	1,190	1,290	1,290	1,260	1,250	1,200	1,255	1,220	1,270	1,250	1,240	1,250	1,250	1,240	1,250	1,190	1,190	1,175	1,245	1,160
Arivonimamo	1,050	1,070	1,150	1,160	1,180	1,200	1,180	1,200	1,200	1,200	1,180	1,220	1,200	1,200	1,200	1,220	1,240	1,210	1,200	1,140	1,155	1,220	1,140	1,140	1,166	1,150	1,160
Anjozorobe	1,035	1,070	1,080	1,150	1,170	1,270	1,220	1,230	1,140	1,140	1,170	1,170	1,180	1,180	**1,180**	1,280	1,280	1,300	1,280	1,240	1,200	1,180	1,175	1,250	1,180	1,250	1,180
Tsiroanomandidy	1,020	1,050	1,080	1,150	1,180	1,140	1,155	1,180	1,172	1,160	1,200	1,140	1,200	1,260	1,200	1,200	1,155	1,100	1,100	1,090	**1,060**	**1,060**	1,065	**1,080**	**1,125**	**1,120**	**1,120**
Miarinarivo	1,060	1,100	1,100		1,280	1,305	1,180	1,200	1,200	1,200	1,250	1,250	1,220	1,200	1,225	1,245	1,265	1,238	1,175	1,230	1,253	1,235	1,225	1,200	1,225	1,240	1,160
Soavinandriana		1,040											**1,140**	1,250		1,200					1,080	1,080	**1,060**	**1,080**			

TABLE A1 (*Continued*)

Variety and District	Round																										
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
Antananarivo-Atsimondrano	1,050		1,120	1,120	1,150	1,260		1,220	1,160	1,140	1,180	1,140	1,180				1,250	1,270	1,160	1,240	1,120	1,160	1,200	1,160	1,160	1,160	1,160
Fianarantsoa I						1,160																					
Ambatondrazaka	1,100	1,060	1,105		1,180			1,250		1,200	1,200	1,230	1,200					**1,040**	1,080							1,230	
Mahajanga I	1,050																										
Marovoay	990	1,029	**980**			1,160	1,200	1,200	1,130	**1,100**	**1,100**	**1,100**	1,155		1,250												1,130
Port-Bergé														1,150													
Mandritsara	1,050	1,050	1,040	1,110	1,120	**1,100**	1,130	**1,100**	**1,100**	1,110	**1,100**	1,120	1,160	1,200	1,190				1,100	**1,040**	1,070	1,080	1,110	1,140	1,160		
Befandriana-Avaratra	980	**1,020**	1,020	**1,080**	**1,100**	**1,100**	**1,090**		1,245																		
Antsohihy	1,000	1,100																									
Bealanana	985	1,030	1,080	1,120	1,160	1,180	1,140	1,135	1,150	1,115	1,140	1,150	1,180	1,200	1,200	**1,180**	**1,150**	1,200	1,100	**1,040**	1,070	1,220	1,240	1,140	1,155		
Mampikony	980				1,200					1,332	1,200			**1,140**													
Other districts in Boeny	**950**																										
Tana: Anosibe	1,040	1,050	1,095	1,170	1,220	1,230	1,160	1,215	1,210	1,215	1,210	1,230	1,260	1,240	1,310	1,300	1,250	1,265	1,190	1,110	1,110	1,135	1,110	1,140	1,150	1,140	1,135
Tana: Andravoahangy	1,080	1,130	1,080	1,160	1,200	1,170	1,160	1,195	1,150	1,140	1,180	1,175	1,190	1,210	1,215	1,260	1,270	1,165	1,120	1,060	1,100	1,150	1,120	1,150	1,160	1,150	**1,120**
Tana: seller in Tana	1,050	1,060	1,060	1,150	1,160	1,160	1,160		1,200	1,200	1,180	1,200	1,340	1,390	1,260	1,295	1,250	1,276	**1,020**	1,060	1,080	1,080	1,070	1,150	1,180	1,180	1,180
Makalioka:																											
Ambohidratrimo															1,400									1,260			
Ankazobe	1,200	1,100																									
Arivonimamo	1,090	1,060	1,160	1,240	1,265	**1,250**	1,300	1,270	**1,200**	1,280	1,310	1,320	1,375	1,420	1,400			1,380		1,400	1,400			1,300			1,300
Anjozorobe	1,120	1,120		**1,200**			1,296	1,320	1,230	**1,221**	1,300	1,290												**1,125**	1,300		**1,214**
Tsiroanomandidy	1,100	1,100					1,280							1,350		**1,370**		**1,300**									
Antananarivo-Atsimondrano	1,160	1,160	1,200			1,290	1,340		1,260	1,290	**1,290**	**1,280**	**1,290**	**1,300**	**1,350**	1,380	**1,370**	1,380	**1,380**	1,350	**1,260**	1,290	1,340	1,280	1,285	1,295	1,285
Ambatondrazaka	1,100	1,120	1,190	1,220	**1,250**	1,270	1,260	1,270	1,280	1,280	1,300	1,300	1,360	1,400	1,400	1,410	1,420	1,380	**1,380**	1,350	1,300	**1,240**	1,240	1,248	1,250	**1,250**	1,250
Mahajanga I	**1,050**																										
Marovoay	1,100		1,200				**1,200**	**1,200**																			
Tana: Anosibe	1,100	1,100	1,150	1,250	1,275	1,275	1,250	1,280	1,290	1,300	1,320	1,340	1,380	1,410	1,400	1,425	1,430	1,450	1,400	1,300	1,290	1,355	1,260	1,300	1,340	1,270	1,295
Tana: Andravoahangy	1,130	**1,050**	1,190	**1,200**	**1,250**	1,280	1,270	1,260	1,280	1,270	1,300	1,320	1,375	1,440	1,440	1,450	1,420	1,430	1,400	**1,250**	**1,260**	1,260	**1,200**	1,200	**1,210**	**1,250**	1,300
Tana: seller in Tana	1,140	1,100	**1,120**	1,240	1,260	1,280	1,275	1,270	1,270	1,285	1,320	1,340	1,410	1,420	1,415	1,440	1,440	1,445	1,400	1,380	1,275	**1,240**	1,240	1,270	1,260	1,270	1,300

Note. Each price is the median price for all observed paid prices in each round × activity × variety × district. The price is based on the adjusted milled rice equivalent price. The cheapest district for each round × variety is shown in boldface.

TABLE A2

MEDIAN ADJUSTED MILLED RICE PRICE BY ROUND × VARIETY × DISTRICT (ACTIVE)

Variety and District	Round																								
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
Vary gasy:																											
Ambohidratrimo		1,070	1,100	1,130	1,255	1,299		**1,138**	**1,160**	1,221	1,280	1,263	1,190		1,220	1,225	1,260	1,203	1,240	1,133	1,200	1,170	1,140	1,070	**1,080**	**1,110**	1,120
Ankazobe	1,020	1,062	**1,062**	1,091	1,205		**1,134**		1,200	1,203	1,205	1,230	1,200				1,220	1,213	920	**920**	1,210	**848**	**948**	**948**	1,105	1,123	1,090
Arivonimamo	1,020	1,028	1,120	1,150	1,210	1,245	1,270	1,210	1,195	1,230	**1,190**	1,160	1,170	1,230	1,230	1,230	1,230	1,240	1,205	1,170	1,085	1,110	1,100	1,120	1,125	1,120	1,150
Anjozorobe	1,062	1,062	1,084	1,134	1,177	**1,205**	1,205	1,212	1,205	1,212	1,205	1,262	1,262					1,234	1,005	1,020	1,062	1,091	1,091	1,105	1,134	1,191	1,177
Antsirabe I																	1,020										
Ambatolampy																**962**	**962**	962	962	962							
Tsiroanomandidy	1,091	1,010	1,205	1,234	1,205	**1,205**	1,234	1,234	1,220	**1,177**	1,205	**1,155**	1,177	1,277	1,205	1,205	1,212	**862**	1,162	1,077	1,077	1,077	1,105	1,112	1,134	1,170	1,166
Miarinarivo	1,020	1,205	1,140	1,160	1,205	1,348	**1,134**			1,205	1,205	1,191	1,191	1,205	1,241	1,062	1,062	1,062	1,062	991	**991**		1,062	1,062	1,134	1,134	1,177
Soavinandriana	**877**		1,205	1,205	**762**																						
Toamasina I	1,115	1,115																									
Ambatondrazaka	1,070	1,020	**1,062**	**1,070**	1,291		1,148	1,305	1,305	1,205	1,348		**1,020**		**1,091**	1,420			**777**				1,062			1,205	
Mahajanga I	920	**920**																									
Maevatanana		1,205	**1,062**	1,205	1,205	**1,205**	1,277	1,277	1,205	1,305	1,305		1,134	**1,134**			1,205	1,205	920	**920**				1,120	1,120	**1,062**	
Marovoay			1,220																								
Mandritsara																	1,241										
Befandriana-Avaratra										1,320																	
Bealanana		1,205					1,300	1,300	1,320	1,320	1,334	1,334			1,277						1,077	1,148	1,105		1,205	1,177	
Mampikony																							1,120				
Ambanja						1,348																					
Tsipala:																											
Ambohidratrimo		1,100	1,100	1,100	1,255	1,294		**1,128**	**1,135**	1,160	1,290	1,268	1,185		**1,220**	1,225	1,270	1,203	1,245	1,215	1,190	1,160	1,145	1,065	**1,095**	**1,105**	
Ankazobe	992								1,190	1,200		1,240	1,200				**1,210**	1,218		1,205	1,200	1,152	**930**	**1,020**		1,135	**1,016**
Arivonimamo	1,020	1,038	1,120	1,168	1,170	1,210	1,260	1,200	1,185	1,188	1,163	**1,150**	**1,170**	**1,190**	**1,220**	1,220	1,220	1,230	1,205	1,155	1,070	1,110	1,090	1,120	1,115	1,117	1,153
Anjozorobe	1,112	1,162	1,266	1,288	1,288	1,288				1,466										**1,045**							
Tsiroanomandidy	1,100	1,066	1,195	1,266	1,266	1,309	1,223	1,266	1,202	**1,123**	**1,123**	1,209	1,209	1,266	1,238	1,166	1,252	**1,138**	1,223	1,223	1,088	1,052	1,152	1,173	1,216	1,216	1,209
Miarinarivo	1,020	1,020	1,130	1,140	1,266	1,409	1,195					1,252	1,252	1,230	1,302	**1,123**	1,266	1,409	**1,138**	1,052	1,052	1,080	1,123	1,123	1,166	1,195	1,238

TABLE A2 (*Continued*)

Variety and District	Round																										
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
Soavinandriana	980		1,266	**1,045**		**966**																					
Fianarantsoa I							1,290	1,290																			
Ambatondrazaka			1,280		1,309	1,266																					
Marovoay	**873**	1,009	**1,016**			1,395	1,295	1,380	1,395	1,395	1,395	1,395	1,466	1,509	1,466	1,509	1,538		1,466	1,466		**966**	1,180	1,180	1,180		1,252
Mandritsara	1,000	1,040		1,240		1,140	**1,120**			1,150	1,150					1,250											
Befandriana-Avaratra										1,423																	
Bealanana	935	**975**	1,238	1,309		1,280	1,290	1,300	1,409	1,409	1,402	1,409									1,138	1,195	1,152		1,238	1,230	
Mampikony	887	995	**1,016**		**1,140**	1,295	1,280	1,380	1,395	1,395	1,395	1,395	1,466	1,509	1,466		1,538	1,552	1,466	1,466	**909**		1,173			1,123	
Makalioka:																											
Arivonimamo	1,065	1,095	1,130	1,230	1,270	1,290	1,290	1,295																			
Anjozorobe	1,099	1,099	1,099	**1,110**	1,150	1,150	1,217	1,217	**1,026**		**1,099**	**1,173**	1,209							**878**	**952**						
Ambatolampy																			**1,217**	1,217							
Tsiroanomandidy					1,300																						
Miarinarivo	673																										
Soavinandriana						**790**																					
Amparafaravola	980	1,110	1,210	1,230	**1,084**	1,099	**1,099**	**1,114**	1,128				**1,128**	**1,305**		**1,364**			1,276		1,158		**1,128**		1,261	1,276	
Ambatondrazaka	1,026	**1,055**	1,114	1,187	1,187	1,187	1,270	1,320	1,224	**1,246**	1,237	1,246	1,290	1,393	**1,467**	1,467	**1,496**	**1,496**	1,380	1,408	1,170	**1,246**	1,136	**1,143**	**1,143**	**1,158**	**1,151**
Andilamena			**864**																								
Marovoay	768																										
Mampikony	**614**																										

Note. Each price is the median price for all observed paid prices in each round × activity × variety × district. The price is based on the adjusted milled rice equivalent price. The cheapest district for each round × variety is shown in boldface.

TABLE A3
BALANCING TEST OF RANDOMIZATION

	Control (C)	Treatment (T)	Difference (T − C)	*p*-Value
Search and trade (periodic, trader × round level, pretreatment):				
Searched price in 36 listed districts (dummy)	.723	.804	.081	**.000**
(If searched) Number of districts with price searched	1.794	1.640	−.154	**.000**
Engaged in active interdistrict rice trading (dummy)	.236	.334	.098	**.000**
(If yes) number of districts purchased from	1.944	2.077	.133	**.044**
Engaged in passive interdistrict rice trading (dummy)	.815	.836	.020	.123
(If yes) number of districts purchased from	1.877	1.804	−.073	**.024**
Rice trading (baseline):				
Number of workers engaged in rice trading	5.0	5.7	.6	.260
Years running rice trading	7.2	9.2	2.0	**.024**
Having updated *patente de collecteur* (dummy)	.304	.429	.125	.052
Pay wholesale tax (dummy)	.688	.670	−.018	.776
Keep income statements (dummy)	.438	.366	−.071	.278
Sell imported rice (dummy)	.741	.804	.063	.267
Business diversification (baseline):				
Sell food other than rice (dummy)	.688	.705	.018	.773
Sell nonfood items (dummy)	.438	.429	−.009	.893
Operate rice mill (dummy)	.170	.152	−.018	.717
Rent out truck or vehicle (dummy)	.259	.161	−.098	.072
Profit share of rice trading	.647	.647	.000	.991
Characteristics of the representative (baseline):				
Representative's age	37.1	37.1	.0	.983
Representative is male (dummy)	.482	.509	.027	.690
Representative is literate (dummy)	.973	1.000	.027	.083
Representative's education level (dummy):				
None	.009	.009	.000	.995
Primary	.189	.191	.002	.974
Lower secondary	.351	.364	.012	.850
Upper secondary	.279	.273	−.007	.914
Higher	.171	.164	−.008	.881
Asset (baseline):				
Have store for selling rice (dummy)	.821	.839	.018	.723
Have private storage (dummy)	.902	.830	−.071	.118
Total capacity of private storage (ton)	22.6	33.8	11.2	.376
Own vehicle (dummy)	.255	.297	.043	.479
Own truck (dummy)	.304	.384	.080	.207
Own cell phone (dummy)	.901	.902	.001	.982
Use mobile money for general purpose (dummy)	.099	.116	.017	.684
Use mobile money for rice trading (dummy)	.009	.045	.036	.101
Price check:				
Checked price using newspaper (dummy)	.108	.108	.000	1.000
Checked price using radio (dummy)	.072	.054	−.018	.583
Checked price using TV (dummy)	.081	.108	.027	.494
Checked price using OdR (dummy)	.000	.018	.018	.158
Checked price using SMS (dummy)	.027	.018	−.009	.653

Note. "Having updated *patente de collecteur*" means to be up to date with tax obligations, allowing one to engage in collecting activities. The *p*-value of Welch's two-sample *t*-test on the equality of means is reported in the last column. A boldface *p*-value indicates that $p < .05$. OdR = Observatoire du riz; SMS = short message service.

References

Aker, Jenny C. 2010. "Information from Markets Near and Far: Mobile Phones and Agricultural Markets in Niger." *American Economic Journal: Applied Economics* 2:46–59.

Aker, Jenny C., and Marcel Fafchamps. 2015. "Mobile Phone Coverage and Producer Markets: Evidence from West Africa." *World Bank Economic Review* 29, no. 3:262–92.

Aker, Jenny C., and Christopher Ksoll. 2016. "Can Mobile Phones Improve Agricultural Outcomes? Evidence from a Randomized Experiment in Niger." *Food Policy* 60:44–51.

Aker, Jenny C., and Isaac M. Mbiti. 2010. "Mobile Phones and Economic Development in Africa." *Journal of Economic Perspectives* 24, no. 3:207–32.

Allen, Treb. 2014. "Information Frictions in Trade." *Econometrica* 82, no. 6:2041–83.

Barrett, Christopher B. 1997. "Food Marketing Liberalization and Trade Entry: Evidence from Madagascar." *World Development* 25, no. 5:763–77.

Butler, J. S., and Christine Moser. 2010. "Structural Model of Agricultural Markets in Developing Countries." *American Journal of Agricultural Economics* 92, no. 5:1364–78.

Camacho, Adriana, and Emily Conover. 2011. "The Impact of Receiving Price and Climate Information in the Agricultural Sector." IDB Working Paper no. IDB-WP-220, Inter-American Development Bank, Washington, DC.

Courtois, Pierre, and Julie Subervie. 2015. "Farmer Bargaining Power and Market Information Services." *American Journal of Agricultural Economics* 97, no. 3:953–77.

Fackler, Paul L., and Barry K. Goodwin. 2001. "Spatial Price Analysis." In *Handbook of Agricultural Economics*, vol. 1, ed. B. Gardner and G. Rausser, 971–1024. Amsterdam: Elsevier.

Fafchamps, Marcel. 2004. *Market Institutions in Sub-Saharan Africa: Theory and Evidence*. Cambridge, MA: MIT Press.

Fafchamps, Marcel, Eleni Gabre-Madhin, and Bart Minten. 2005. "Increasing Returns and Market Efficiency in Agricultural Trade." *Journal of Development Economics* 78:406–42.

Fafchamps, Marcel, and Bart Minten. 2001. "Property Rights in a Flea Market Economy." *Economic Development and Cultural Change* 49, no. 2:229–67.

———. 2002. "Returns to Social Network Capital among Traders." *Oxford Economic Papers* 54, no. 2:173–206.

———. 2012. "Impact of SMS-Based Agricultural Information on Indian Farmers." *World Bank Economic Review* 26, no. 3:383–414.

Gabre-Madhin, Eleni Z. 2001. "The Role of Intermediaries in Enhancing Market Efficiency in the Ethiopian Grain Market." *Agricultural Economics* 25, no. 2–3:311–20.

Gelaw, Fekadu, Stijin Speelman, and Guido Van Huylenbroeck. 2016. "Farmers' Marketing Preferences in Local Coffee Markets: Evidence from a Choice Experiment in Ethiopia." *Food Policy* 61:92–102.

Goyal, Aparajita. 2010. "Information, Direct Access to Farmers, and Rural Market Performance in Central India." *American Economic Journal: Applied Economics* 2:22–45.

Jabbar, Mohammad, Samuel Benin, Eleni Gabre-Madhin, and Zeleka Paulos. 2008. "Market Institutions and Transaction Costs Influencing Trader Performance in

Live Animal Marketing in Rural Ethiopian Markets." *Journal of African Economies* 17, no. 5:747–64.

Jensen, Robert. 2007. "The Digital Provide: Information (Technology), Market Performance and Welfare in the South Indian Fisheries Sector." *Quarterly Journal of Economics* 122, no. 3:879–924.

———. 2010. "Information, Efficiency and Welfare in Agricultural Markets." *Agricultural Economics* 41, no. 1:203–16.

Mendoza, M., and J. C. Randrianarisoa. 1998. "Structure and Behavior of Traders: The Case of Market Reform in Madagascar." Unpublished manuscript, International Food Policy Research Institute, Washington, DC.

Minten, Bart, David Stifel, and Seneshaw Tamru. 2014. "Structural Transformation of Cereal Markets in Ethiopia." *Journal of Development Studies* 50, no. 5:611–29.

Miyake, Hajime, and Takeshi Sakurai. 2012. "Improvement of Transportation Infrastructure and Integration of Agricultural Market: An Analysis of Rice Market in Madagascar." *Economic Research* 63, no. 3:209–26. [In Japanese.]

Moser, Christine, Christopher Barrett, and Bart Minten. 2009. "Spatial Integration at Multiple Scales: Rice Markets in Madagascar." *Agricultural Economics* 40, no. 3:281–94.

Nakasone, Eduardo. 2014. "The Role of Price Information in Agricultural Markets: Experimental Evidence from Rural Peru." Unpublished manuscript, International Food Policy Research Institute, Washington, DC.

Nakasone, Eduardo, Maximo Torero, and Bart Minten. 2014. "The Power of Information: The ICT Revolution in Agricultural Development." *Annual Review of Resource Economics* 6:533–50.

Osborne, Theresa. 2005. "Imperfect Competition in Agricultural Markets: Evidence from Ethiopia." *Journal of Development Economics* 76, no. 2:405–28.

Sakurai, Takeshi, Tsilavo Ralandison, Kazushi Takahashi, Yutaka Arimoto, and Hisaki Kono. 2015. "Is There Any Premium for Unobservable Quality?: A Hedonic Price Analysis of the Malagasy Rice Market." IDE Discussion Paper no. 504, Institute of Developing Economies, Chiba, Japan.

Sexton, Richard J., Catherine L. Kling, and Hoy F. Carman. 1991. "Market Integration, Efficiency of Arbitrage and Imperfect Competition: Methodology and an Application to U.S. Celery." *American Journal of Agricultural Economics* 73, no. 3:568–80.

Stephens, Emma C., Edward Mabaya, Stephan von Cramon-Taubadel, and Christopher B. Barrett. 2012. "Spatial Price Adjustment with and without Trade." *Oxford Bulletin of Economics and Statistics* 74, no. 3:453–69.

Svensson, Jacob, and David Yanagizawa. 2009. "Getting Prices Right: The Impact of the Market Information Service in Uganda." *Journal of European Economic Association* 7, no. 2–3:435–45.

Tack, Jesse, and Jenny C. Aker. 2014. "Information, Mobile Telephony and Traders' Search Behavior in Niger." *American Journal of Agricultural Economics* 96, no. 5:1439–54.

Tadesse, Getaw, and Godfrey Bahiigwa. 2015. "Mobile Phones and Farmers' Marketing Decisions in Ethiopia." *World Development* 68:296–307.

Tadesse, Getaw, and Gerald Shively. 2013. "Repeated Transaction in Rural Grain Markets of Ethiopia." *Journal of Development Studies* 49, no. 9:1172–87.