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IDE DISCUSSION PAPER No. 504

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March 2015

Abstract

This paper examines if consumers pay a premium for unobservable quality in the absence of quality standards and/or quality grading systems and, if so, how they assess that unobservable quality, using a rice retail market in Madagascar as an example. In Madagascar, the lack of quality standards and/or grading systems for rice makes is considered to be one of the causes of the rice market's spatial disintegration. Thus, quality standards and grading systems will be necessary to increase the market's efficiency. We hypothesize that consumers and retailers use product origin and rice name as observable indictors of unobservable quality and test the hypothesis using hedonic price regressions. We find that the interaction terms of product origin and rice name significantly affect the price after controlling for both observable quality and spatial and temporal price variation, but that the contribution of product origin and rice name to rice price variation is smaller than spatial and temporal factors. We thus conclude that consumers pay a premium for unobservable quality throughout Madagascar. This finding implies that quality standards and/or grading systems will work in the Malagasy market and that improving market infrastructure such as roads and storage will make them even more effective.

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Is There Any Premium for Unobservable Quality?
A Hedonic Price Analysis of the Malagasy Rice Market*

March 12, 2015

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* This survey was conducted during rice market studies in Madagascar for the PAPRIZ (Project for Rice Productivity Improvement in Central Highland) implemented by the JICA (Japan International Cooperation Agency). We are grateful to the project experts and staff of the JICA's Madagascar office. This paper was supported by JSPS KAKENHI Grant number 25245038.

1. Introduction

Developing an efficient market for agricultural products is crucial to increasing income and reducing poverty in developing countries, where most of the poor live in rural areas dependent on agriculture (World Bank (2008)). Since market integration is one of the most important indicators of market efficiency, many empirical studies have been carried out on it (for example, Ghoshray and Ghosh (2011) studied wheat in India; Baquedano et al. (2011) studied cotton in Mali and coffee in Nicaragua; Zakari et al. (2014) studied grain in Niger; Ali et al. (2014) studied pulse in Ethiopia). Such studies indicate that poor road conditions, the lack of market information systems, and the restriction of product movement across international and internal borders tend to cause spatial market disintegration. However, since most studies on market integration focus on the movements of and relationships among market prices, differences in product quality are not considered despite having several effects on spatial market integration. For example, the lack of quality standards and grading systems incurs product inspection costs and makes long-distance trade costly, leading to market disintegration. Therefore, this paper focuses on the relationship between product quality and market integration. Instead of analyzing it directly, though, this paper examines if consumers demand quality standards and grading systems, which would improve the spatial integration of the market.

Well-developed markets usually feature quality standards and/or quality grading systems for transaction efficiency. For example, consumers may use quality standards or brand names to predict unobserved product quality and may be willing to pay more premium than for a product whose quality is not assured. In developing countries, however, these institutions/regulations are rare or exist only for high-value products destined for export since standards are imposed by importers in developed countries. Few quality standards for staple food products exist in developing countries despite the evidence that they are useful for and are accompanied by the development of staple food markets. For example, the private grading of rice was introduced in Japan when the volume of long-distance trade became large around the turn of the twentieth century (Mochida (1970) and Tama (1986)).

In the absence of quality indicators, how can consumers in developing countries assess products' unobservable quality? Hedonic price analyses have been conducted on a variety of agricultural products, such as wine (Costanigro and McCluskey (2012)), coffee (Teuber and Herrmann (2012)), fruit juice (Szathvary and Trestini (2014)), and cowpeas (Ifegwu and Ajetomobi (2014)), in which observable characteristics (such as nutritional value) of the products are used as explanatory variables in regression analyses because consumers can know such factors from product's information on the labels. Unnevehr et al. (2002) examine several cases regarding rice in Asian countries and show that consumers generally pay a quality premium for rice; thus, not only do the observable characteristics such as broken rice content and whiteness affect the price of rice but the unobservable characteristics such as amylose content and cooking time do as well. A similar relationship between rice grain quality and price was found by Sakurai et al. (2006) in Ghana's urban wholesale market for locally produced rice. Unnevehr et al. (2002) and Sakurai et al. (2006) obtain the unobservable variables through laboratory measurements in their studies; these cannot be known by consumers because there is no grading or labeling for them in developing countries. Their hedonic model is thus not consistent with the theory that consumers can observe the characteristics of the product in question (Rosen (1974)), but they seem to implicitly assume that consumers know the unobservable qualities of rice from their long experience of eating it as a staple.

This paper adds to this growing literature by taking a hedonic approach to the rice market in Madagascar, where rice is the most important staple. It is produced, traded, and consumed almost everywhere in this country. However, Madagascar's rice market is known to be poorly integrated (Moser et al. (2009) and Butler and Moser (2010)). The disintegration of the Malagasy rice market is due to several constraints: for example, Miyake and Sakurai (2012) show that the Malagasy rice market is not well integrated because of high transportation costs and poor road conditions, while Arimoto et al. (2013) show that the costs of contract enforcement and product inspection may discourage traders from seeking new sellers and buyers in long-distance markets. Inspection costs are incurred because there is no standard for rice quality, even though rice is the nation's most-traded commodity. Inspection can be done for observable characteristics such as grain color, grain shape, content of broken rice, and contamination of foreign matters. Inspection for unobservable characteristics is more difficult, however, as brand name packaged rice is available only in supermarkets in big cities, and most rice is traded in bulk in retail markets, even in urban areas.

The main purpose of our paper is to examine how consumers in Madagascar infer the unobservable characteristics of rice. Our approach is different from that of Unnevehr et al. (2002) and Sakurai et al. (2006), who measured the unobservable characteristics of rice such as amylose content and cooking time in a laboratory. Since laboratory measurement is costly in terms of time and money, their sample had to be small, which prevented them from controlling for seasonality in rice prices and the market-specific factors influencing them. This paper uses weekly data collected from every region of Madagascar covering retail price, variety, name, and origin of the rice sold in 22 regional capitals from May 2012 to May 2013. These data represent a significant advantage over past hedonic analyses of rice prices in developing countries. We hypothesize that the combination of product origin and rice name is used as a signal or indicator for unobservable rice quality in the retail market. If the hypothesis is supported, consumers should be willing to pay a quality premium even if they cannot observe the quality directly. A supported hypothesis would carry the important policy implication that grading and/or quality standards should be introduced in developing countries, even for staple food products, if they convey better information at minimal cost.

We find that the combination of product origin and rice name affects the retail price of rice significantly even after controlling for observable characteristics, product origin, and rice name. This finding implies that consumers pay a premium for the unobservable quality of rice and hence that quality standards would work.

The rest of this paper is structured as follows. Section 2 explains the data collected from the major Malagasy markets. Then, in section 3, we present the models for hedonic price analysis and a decomposition analysis. Section 4 discusses the results of the analyses, and section 5 offers conclusions.

2. Data

2.1. The survey

The data used in this paper are based on the Rice Price and Trade Survey funded by the Japan International Cooperation Agency (JICA). The survey covers all the major markets in Madagascar: the main markets of the 31 district capital cities, including all 22 regional capital cities and nine of the district capital cities in the Diana, Sava, Sofia, and Boeny regions, located in the northern part of the island (see Figure 1). The region is the largest administrative unit in Madagascar: its 22 regions are divided into 111 districts. We use price data collected in the 22 regional capitals but describe the origins of the rice at the district level. We do not include price data from the nine selected district capitals because they are located in rice surplus areas, while the objective of this paper is to analyze the consumer market.

Weekly data collection was conducted by enumerators in the 31 markets for 70 weeks from April 2012 to August 2013. The enumerators visited the markets, randomly selected five retailers and five wholesalers and interviewed them about the prices and sale quantities of all the types of rice they sell, recording data such as names, origins, and observable qualities such as color, shape, and milling method. Representative weekly rice prices in all 111 districts have been reported since 2007 by the government organization Observatoire du Riz (OdR), but ours are sample data that include information on price, name, origin, and the observable qualities of all the rice samples available in the market. Thus, the observation unit is the rice sample obtained from the retailer or wholesaler at the time of each weekly market visit. The number of rice samples obtained depends on the number of different rice types distinguished by factors such as color, shape, name, origin, and price and thus differs each time. For a single rice type sold by several different sellers on the same day, we consider all of them; hence, the number of observations is equal to the number of sellers of that type of rice. Through this sampling, the number of retail price observations total 21,450, drawn from 31 markets over 70 weeks, implying that one retailer sells about two types of rice on average each day. The samples from the 22 markets in the regional capitals collected over 70 weeks total 16,104.

2.2. Rice Prices

First, the weekly prices of milled rice recorded at the 22 region capital markets during the 70-week period from April 2012 to August 2013 will be presented. Since Madagascar is diversified in terms of agro-ecology and ethnic culture and as its rice market tends to be segmented due to poor infrastructure (Miyake and Sakurai (2012)), we divide the island into five zones (as shown in Figure 1) based on rice trade patterns and ethnic cultures. The weekly prices are shown by zone in Figures 2.1 to 2.5. The prices are averages, weighted by the number of observations for each of the four categories of rice (which will be explained in the next section). The simple average of all 22 regional average prices is shown as the bold black line in Figures 2.1 to 2.5. The prices recorded were those at which the randomly selected retailers were selling on the day surveyed, usually the weekly market day except for big cities, which do not have specific market days. Although those prices are selling prices, we consider them as competitive market prices since many sellers and buyers go to the market on market day, and price negotiation seldom occurs for daily commodities such as rice.

Although the lines do not seem to be well synchronized, the mean price line shows seasonality in price movement: prices are highest in April, just before the main harvest season, and lowest in May and June, when the main harvest starts. However, prices do not fall as much in May and June of 2013 as in May and June of 2012. This is due to the poor harvest in 2013: Madagascar produced 4.4 million tons of paddy per year on average from 2008 to 2012, but production dropped to 3.6 million tons in 2013 according to the data provided by Food and Agriculture Organization of the Unuted Nations (FAOSTAT). Of all the prices recorded, the highest (1885 Ar/kg) is observed in Sambava, the capital of Sava region in Zone 4, in April 2012 (see Figure 2-4), while the lowest (817 Ar/kg) is observed in Antsohihy, the capital of Sofia region in Zone 3, in June 2012 (see Figure 2-3). Among observations limited to the pre- and post-harvest seasons of 2013, the highest is 1810 Ar/kg in Antsiranana of Diana region in March (see Figure 2-3), and the lowest is 890 Ar/kg in Ambatondrazaka of Aloatra-Mangoro region (see Figure 2-1). Concerning average prices over the survey period, Diana region has the highest (1494 Ar/kg) and Aloatra-Mangoro region the lowest (1054 Ar/kg). Price variability is assessed as the coefficient of variation over time: Sofia (see Figure 2-3) has the highest variability during the survey period (CV=0.17) and Vakinankaratra (see Figure 2-2) the lowest (CV=0.03). Antsirabe, the capital city of Vakinankaratra region, is the second-largest city in Madagascar and is located in the midst of the rice-producing central highland. It thus has good access to several rice surplus areas, which may contribute to its low price variability.

Figure 3 shows the relationship between the average prices of the 22 markets and the market prices' coefficient of variation. As mentioned, the average prices show seasonality, and the CV moves counter to them: when the price is low after the harvest, the CV tends to be high; when the price is high during the lean period, the CV tends to be low. Thus, the price drops after a large harvest in a surplus area, but the price surge in the lean period is not as high even in deficit areas, indicating imperfect market integration.

2.3. Rice Names

Rice in Madagascar is categorized into four groups: vary gasy, tsipala, makalioka, and import. The term “vary gasy” literally means “Malagasy rice,” and this group includes any locally produced rice other than tsipala and makalioka. Some may be improved varieties introduced from outside the country. Tsipala and makalioka are very specific kinds, although they seem not to be single varieties in the agronomic sense. We assume that both are improved varieties introduced by donors or the Ministry of Agriculture. Their appearance is distinctive, and they are easily distinguished in the market. Tsipala is relatively short and round, while makalioka is longer. Makalioka is considered high grade, and cleanly processed makalioka is the most expensive rice in Madagascar. It is packed in branded packages and sold in urban supermarkets. The import category comprises imported rice, usually from Pakistan. It includes low-grade rice but also some high-quality varieties such as Thai jasmine, although the share of such high-grade rice is small.

We will now use only the data collected during the one-year period (with some margins) from May 2012 to May 2013 to avoid an imperfect repetition of seasons. The total number of these observations is 12,565. As shown in Table 1, of 12,565 observations on milled rice sold in the market, 7,594 (about 60%) are on vary gasy. The observations on other categories are relatively few, and the diversity of names within the tsipala and makalioka categories is very small. This may imply that they were introduced and disseminated relatively recently and hence are not considered indigenous Malagasy rice and have not had their names diversified among local farmers.

Wide variation appears among the names recorded for vary gasy rice (i.e., the names retailers use): our survey found 135 different names; even if we count only the names with more than 20 observations, we find 42 different names. Some are used only in a particular market, but others are widely used in most markets. The vary gasy category is obviously a mix of genetically different rice varieties: for example, some are red, while others are white. On the other hand, we assume that some varieties have more than one name, although we have found no agronomic evidence of this. Table 2 lists the frequently recorded names for vary gasy (those with more than 50 observations). The total number of observations is 6,644, an 87.5% share, reflecting the multitude of minor names used in the market. Almost 37% of the vary gasy type is simply called "gasy," though this may not refer to a single, uniform variety. The lack of common names for local rice shows the segmentation in Madagascar's rice market. This lack makes it difficult to conduct long-distance trade.

2.4. Origins of the Rice

Of Madagascar's 111 districts, 59 were recorded as product origins in the 22 regional markets during the one-year period from May 2012 to May 2013. However, 18 districts have fewer than 10 observations, while 27 have more than 100, as shown in Table 3. The highest number was drawn from Ambatondrazaka, which has 2,017 observations or about 16% of the total. Imported rice comes second, with 1,427 observations; Tsiroanomandidy is third, and Marovoay is fourth. Ambatondrazaka and Marovoay have very large-scale irrigation schemes, which Tsiroanomandidy lacks.

As mentioned, Malagasy retail markets have no quality standards or product brands. It is thus hypothesized that retailers and consumers depend on rice's origin and name to assess its unobservable qualities. Table 4 shows the combinations of the top 10 rice-producing districts (including "foreign") and the top 10 rice names. Some, such as gasy and tsipala, are produced in many districts, while others are produced only in a few, for example *dista* in Ambatondrazaka and *manga* in Ihosy. Although *R*, produced mainly in Antsohihy, and *mifangaro*, produced mainly in Mahabo, are among the top 10 rice names, Antsohihy and Mahabo are not among the top 10 districts and hence are not shown in Table 4. Interestingly, some districts, such as Ambositra, produce only tsipala and gasy. By contrast, the top two districts, Ambatondrazaka and Tsiroanomandidy, produce several different kinds of rice. Therefore, although Table 4 has many zeros, origin-name combinations will provide more information than cases where only one is available for consumers to use to infer unobservable product qualities.

3. Method

3.1. Hedonic Model

We use hedonic price models to test the hypothesis. We develop the following hedonic CPD (county product dummy) model proposed by Silver (2009). An empirical application of this model is found in Aten (2006), who estimates differences in relative price levels for areas of the United States. The aim of hedonic CPD models is improving the efficiency of country-level price parity estimations by controlling for observable and unobservable product qualities. In our case, the objective is not to compare rice retail prices at the region level but rather to examine the influence of unobservable product qualities. Silver (2009) uses the interaction terms of product and outlet dummies to control for unobservable product qualities. In our case, the control variables are rice origins and names. Our regression model is

$$\ln P_{imt} = \alpha + \sum_p \beta_p \mathrm{NAME}_{pi} + \sum_d \delta_d \,\mathrm{ORIGIN}_{di} + \sum_{p,d} \gamma_{pd} \,\mathrm{ORIGIN}_{di} \times \mathrm{NAME}_{pi} + \sum_q \rho_q \,\mathrm{CHAR}_{qi} + \sum_m \mu_m M_m + \sum_t \omega_t W_t + \sum_{m,t} \varphi_{mt} M_m \times W_t + \varepsilon_{imt} \quad (1)$$

where the dependent variable P_{imt} is the retail price (Ar/kg) of i^{th} milled rice recorded in market *m* in week *t*. On each visit, we randomly selected five retailers in one market and recorded the prices of all the milled rice the selected retailers were selling. Therefore, the number of observations in each market (*m*) and week (*t*) varies. For the explanatory variables, the most important for our study are those for unobservable rice quality. They are ORIGIN_{di}, NAME_{pi}, and $\mathrm{ORIGIN}_{di}\times\mathrm{NAME}_{pi}$, which are binary dummy variables for the district of origin, the name, and their interactions of the i^{th} milled rice respectively. The rice names are classified into 49 distinct (*p*=1-49), of which 43 belong to the vary gasy category (42 are names with more than 20 observations and one other vary gasy, including all the minor ones), one belongs to tsipala, three belong to makalioka (i.e., *makalioka*, *dista* and *tsemaka*), and two are imports (low-grade import rice such as *importé*, *pakistan*, and *inde* and high-grade import rice). The reference category for NAME is low-grade import rice. For districts of origin, 59 of the 111 districts have at least one observation among the 12,565, as described above. Thus, subscription *d* for the district dummies ranges from 1 to 59, and the reference category is Foreign. Since we hypothesize that retailers and consumers use the origin–name combinations as an indicator of unobservable rice qualities, we add their interaction terms as regressors.

Observable rice characteristics and the seasonal and regional price differences due to the supply and demand situation in each market must be controlled for as much as possible if name and district of origin are to capture the unobservable rice qualities. Thus, CHAR_{qi}, M_m, and W_t are added as explanatory variables. CHAR_{qi} reflects the observable rice qualities of the i^{th} milled rice, consisting of five dummy variables: dummies for red color, red and white color mixture (the reference category is white color), short grain and long and short grain mixture (the reference category is long grain), and hand-milled rice (the reference category is machine-milled rice). M_m is the vector of market dummies. Since we use rice price data collected from markets in 22 regional capitals, the number of dummies is 21, setting Analamanga region (where Antananarivo is located) as the reference category. W_t is the vector of week dummies. The survey covers 70 weeks from April 2012 to August 2013, but we use data for only one year, from May 2012 (t=6) to May 2013 (t=60). As shown in Figures 2-1 to 2-5, the rice prices observed in 22 region markets co-move over a year but not strongly. We use their interaction terms, in addition to M_m and W_t, to capture market-specific seasonality.

Equation (1) is estimated by OLS with robust standard errors clustered by the markets. The hypothesis is tested based on the estimation results of the coefficients for the interactions of rice origin and rice name. The estimation is conducted using the whole sample as well as the subsamples by dropping minor rice with fewer than 20 observations or for each zone (as indicated in Figure 1) since consumer preference for rice is considered to vary by zone.

3.2. Decomposition

The next question is how significant the quality premium will be. Considering the huge spatial and temporal price variations, if the quality premium explains only a minor share of the price variation, the premium will not be an incentive for producers and traders to improve rice quality. We quantitatively estimate the contribution of unobservable qualities to price variation through regression-based inequality decomposition (Fields (2002)), a method of decomposing the total variance of the dependent variable explained by the model, measured as R-squared, into the factor contributions of each independent variable, as explained below.

Letting $\sigma^2(\ln P)$ be the total variance of the natural logarithm of retail rice price, X_j be explanatory variables in equation (1), ε be residual term, ξ_j be parameters obtained from the regression of equation (1), and $s_j(P)$ be the relative factor contribution that is attributable to the j^{th} explanatory variable, $s_j(P)$ can be calculated by

$$s_j(P) = \frac{\mathrm{cov}[\bar{\xi}_j X_j, \ln P]}{\sigma^2(\ln P)} = \frac{\bar{\xi}_j * \sigma(X_j) * cor[X_j, \ln P]}{\sigma(\ln P)},$$

where $\sigma(\ln P)$ and $\sigma(X_j)$ are the standard deviations of ln P and X_j, respectively. Fields (2002) shows that

$$\sum_{j=1}^{J+1} s_j(P) = R^2 \quad \text{and} \quad R^2 + \frac{\mathrm{cov}(\varepsilon, \ln P)}{\sigma^2(\ln P)} = 1,$$

meaning that the fitness of the model, R^2, is the sum of $s_j(P)$ excluding the residual component, ε, and the sum of R^2 and the unexplained part by the presence of ε equal to one. Given $\sigma(\ln P)$, the relative contributions of each factor j to total variance become larger (i) if the coefficient is larger implying that the j^{th} variable is important in determining the price (ii) if the standard deviation of the j^{th} variable is larger and (iii) if the correlation between the j^{th} variable and the dependent variable is larger.

4. Results

4.1. Hedonic results

The estimation results of equation (1) are presented in Table 5. The full sample uses all the observations obtained from the 22 regions' capital markets over 55 weeks from May 2012 to May 2013; we drop minor rice names in the case of the subsample. Although the number of observations differs, the estimation results are very similar. Regarding observable quality, white color and long grain are more expensive than the others. Regarding the origin-name combinations, most (85% of the dummies entered in the estimation) have a significant effect on rice prices at a level higher than 5%. Since there are so many interaction terms in the estimation, not all results are shown in Table 5, but several frequently observed combinations are selected as examples (please refer to Table 4).

Based on the full sample regression, mean price is estimated from the constant term to be about 1075 Ar/kg, and the mean of the quality premium is estimated at about -28 Ar/kg. The distribution of the quality premium estimated for each origin–name combination is shown in Figure 4. Since the estimated quality premium ranges from -339 Ar/kg to 436 Ar/kg and the estimated prices (mean + premium) fit well enough within the observed price range (from 700 Ar/kg to 2450 Ar/kg), the estimation results seem to be reasonable. Thus, the regression results imply that consumers pay either a positive or negative quality premium because the interaction terms of product origin and rice name are assumed to capture unobservable rice qualities at least partially after controlling for the observable characteristics. The share of significant coefficients is somewhat higher in the subsample than in the full sample, suggesting that the unobservable qualities of minor rice are not well-known in the market.

4.2. Decomposition

Table 6 shows the results of the decomposition analysis. The contribution of the rice origin-name interactions to rice price variation is the same as observable qualities' contributions to rice price variation. Although the influence is relatively small, the results may suggest that consumers pay a quality premium. If we reduce rice name diversity by eliminating the minor ones (i.e., in a subsample regression), product origin seems to have a strong impact on price variation, while rice name and origin-name interactions lose their impact. This result indicates that product origin influences the prices of the major rice types. Rice origin should thus capture the quality premium instead of origin-name combination, but it is not separable from the product origin premium.

The decomposition analyses indicate that the combinations of product origin and rice name contributes to rice price variation, implying that they play an important role in signaling unobservable qualities. However, the temporal and spatial price variations captured by week, market, and the interaction dummies are much more influential on variations in rice prices.

4.3. Zone-level Analyses

Madagascar is diversified in terms of agro-ecology and ethnic culture, and its rice market is segmented due to the nation's poor infrastructure (Miyake and Sakurai (2012)). Therefore, quality premiums are expected to differ depending on geographical location. We captured geographical differences by dividing the island into five zones (as shown in Figure 1) based on rice trade patterns and ethnic cultures. One of the important characteristics of each zone is its rice self-sufficiency—whether the zone imports rice from other zones or exports to them. Zones 4 and 5 are rice-importing, and zones 1, 2, and 3 are rice-exporting, based on Ralandison et al. (2015). Moreover, among rice-exporting zones, zone 1 is unique, as it includes the nation's capital, the largest city (with more than two million residents), and imports a large amount of rice from other zones.

Equation (1) is estimated for each zone separately. The results are shown in Table 7. Regarding unobservable qualities (i.e., the interaction terms of product origin and rice name), most of the coefficients are significant in the rice-exporting zones (1, 2, and 3), but the significance levels are relatively low in the rice-importing zones (4 and 5). This difference may occur because variations in rice types are few in the rice-importing zones: rice production within the zone is limited, and the origins of the rice from outside it are not highly diverse. The small variation is also partly caused by the market's weak integration with the markets in other zones due to the poor infrastructure in zones 4 and 5. In fact, as shown in Table 7, few origin-name interactions were entered in the regression for zones 4 and 5. In addition, the effects of the observable qualities differ from those in the full sample analysis and depend on the zone: in zone 1, grain color is not significant; in zones 2, 3, and 4, grain shape is not significant; and, in zones 1, 3, and 5, hand-milling has a negative significant effect. Such results may imply that the relative influence of rice origin and name may differ in each zone. In order to confirm this interpretation, we conduct a decomposition analysis for each zone. Table 8 shows the results.

As shown in Table 8, origin-name interactions have a relatively strong influence on rice price variation in zones 1 and 5, although their shares in total variation is smaller than in the full sample decomposition (shown in Table 6). These results are due to the large variations both in origin and name in these zones: zone 1 produces several types of rice but also imports rice from various parts of the country because it includes the capital, and zone 5 also imports rice, including from foreign countries, due to the deficit it has accrued although the variations in its rice are smaller than in zone 1. By contrast, rice origin, name, and their interactions hardly contribute to price variations in zone 4 because they are small due to market segmentation (as discussed above concerning Table 7). In rice-exporting zones 2 and 3, however, where most of the rice in the market comes from within the zone, origin-name combinations do not contribute to rice price variations. Therefore, rice name only (in zone 2), product origin only, or rice name only (in zone 3) provides sufficient information by which to distinguish among rice types in the rice-exporting zones.

Assuming that the quality premium is captured by origin-name combinations, such a premium exists in all zones, as shown in Table 7. However, its contribution to rice price variation differs significantly among zones, as discussed concerning Table 8. If the premium is too small, consumers will not demand quality standards since their benefits will be few.

5. Conclusion

As it is believed that grading and/or quality standards facilitate market integration, this paper investigates them in the context of the rice market in Madagascar, where the rice market is known to be segmented. As Demont et al. (2013a; 2013b) showed for Senegal using an experimental auction for rice, we assume that consumers who are willing to pay a quality premium wish to have quality indicators such as grades. In Madagascar, neither a public grading system nor private standards are applied to rice in the retail market except for private packages of rice in supermarkets. We hypothesize that the combination of product origin and rice name is used as a signal or indicator of unobservable rice qualities in the retail market.

We use retail rice price data collected through our own market survey conducted weekly from April 2012 to August 2013. The survey covered 22 markets located in each of the regional capital cities, as shown in Figure 1. We gathered 16,104 observations over a 70-week period. For our regression analysis, however, we use data collected over a one-year period (May 2012 to May 2013). The sample thus comprises 12,565 observations.

Following Silver (2006), a hedonic CPD regression model is used to test if origin-name interaction dummies have any effect on rice prices. The results largely support the hypothesis that the origin–name combination has significant effects on the retail rice price. This result implies that consumers pay a premium for unobservable qualities since they can infer them from the origin and name of the rice. Then, using Fields' decomposition method (Fields (2002)), we examine the relative contribution of each group of dummy variables to rice price variation. We find that the origin–name combination contributes to rice price variation, implying an important role in signaling unobservable qualities. However, its influence on price variation is much less than that of the temporal and spatial factors.

By conducting the same sets of analyses for each of the five zones, we confirm that the combinations of product origin and rice name have statistically significant effects on rice retail price determination in every zone. However, their contribution to rice price variation differs depending on the diversity of rice types in the market: in zones with large variations, the origin–name combination is used as an indicator of unobservable qualities, but, in zones with relatively small variations, the origin–name combination does not provide additional information about the rice's unobservable qualities. Thus, although a quality premium exists in all zones, its contribution to rice price variation differs depending on whether the zone is rice-importing or -exporting.

Therefore, since our analyses identify a quality premium in Madagascar's rice retail market, grading systems and quality standards could be introduced in the rice market, and if such institutions are used by traders and consumers, the efficiency of market transactions would then improve. However, the contribution of a quality premium may not be as strong as that of spatial and temporal price variations, which are caused by poor market integration. Although quality standards and grading systems could improve market integration (as discussed in the Introduction), their impact will be limited if the large spatial and temporal price variations persist. Therefore, quality standards and grading systems will be more effective if improvements in market infrastructure such as roads and storage are made at the same time.

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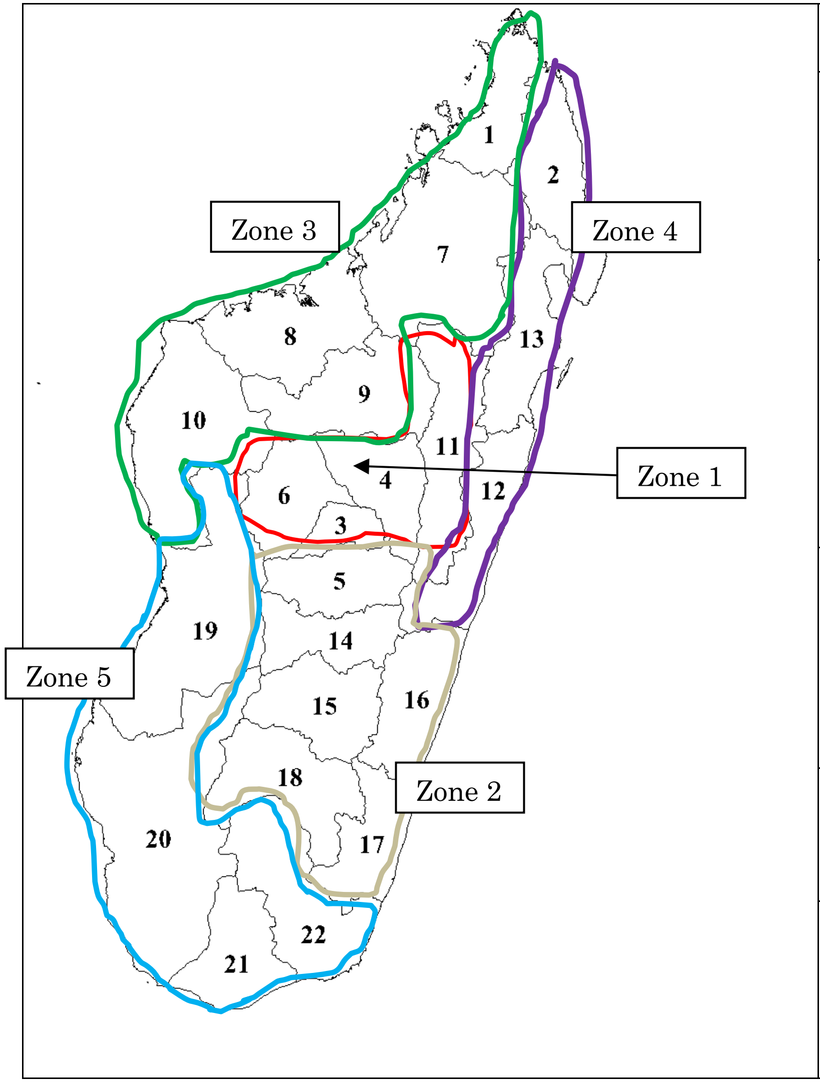
Figure 1 Regions of Madagascar with Zoning



Zone Number	Zone Name	Region Number	Region Name	Regional Capital
1	Central Highland North	3	ITASY	MIARINARIVO
		4	ANALAMANGA	ANTANANARIVO RENIVOHITRA
		6	BONGOLAVA	TSIROANOMANDIDY
		11	ALAOTRA MANGORO	AMBATONDRAZAKA
2	Central Highland South	5	VAKINANKARATRA	ANTSIRABE I
		14	AMORON' I MANIA	AMBOSITRA
		15	HAUTE MAHATSIATRA	FIANARANTSOA I
		16	VATOVAVY FITOVINANY	MANAKARA
		17	ATSIMO ATSINANANA	FARAFANGANA
		18	IHOROMBE	IHOSY
3	North West	1	DIANA	ANTSIRANANA I
		7	SOFIA	ANTSOHIHY
		8	BOENY	MAHAJANGA I
		9	BETSIBOKA	MAEVATANANA
		10	MELAKY	MAINTIRANO
4	North East	2	SAVA	SAMBAVA
		12	ATSINANANA	TOAMASINA I
		13	ANALANJIROFO	FENOARIVO ATSINANANA
5	South West	19	MENABE	MORONDAVA
		20	ATSIMO ANDREFANA	TOLIARA I
		21	ANDROY	AMBOVOMBE
		22	ANOSY	TAOLAGNARO

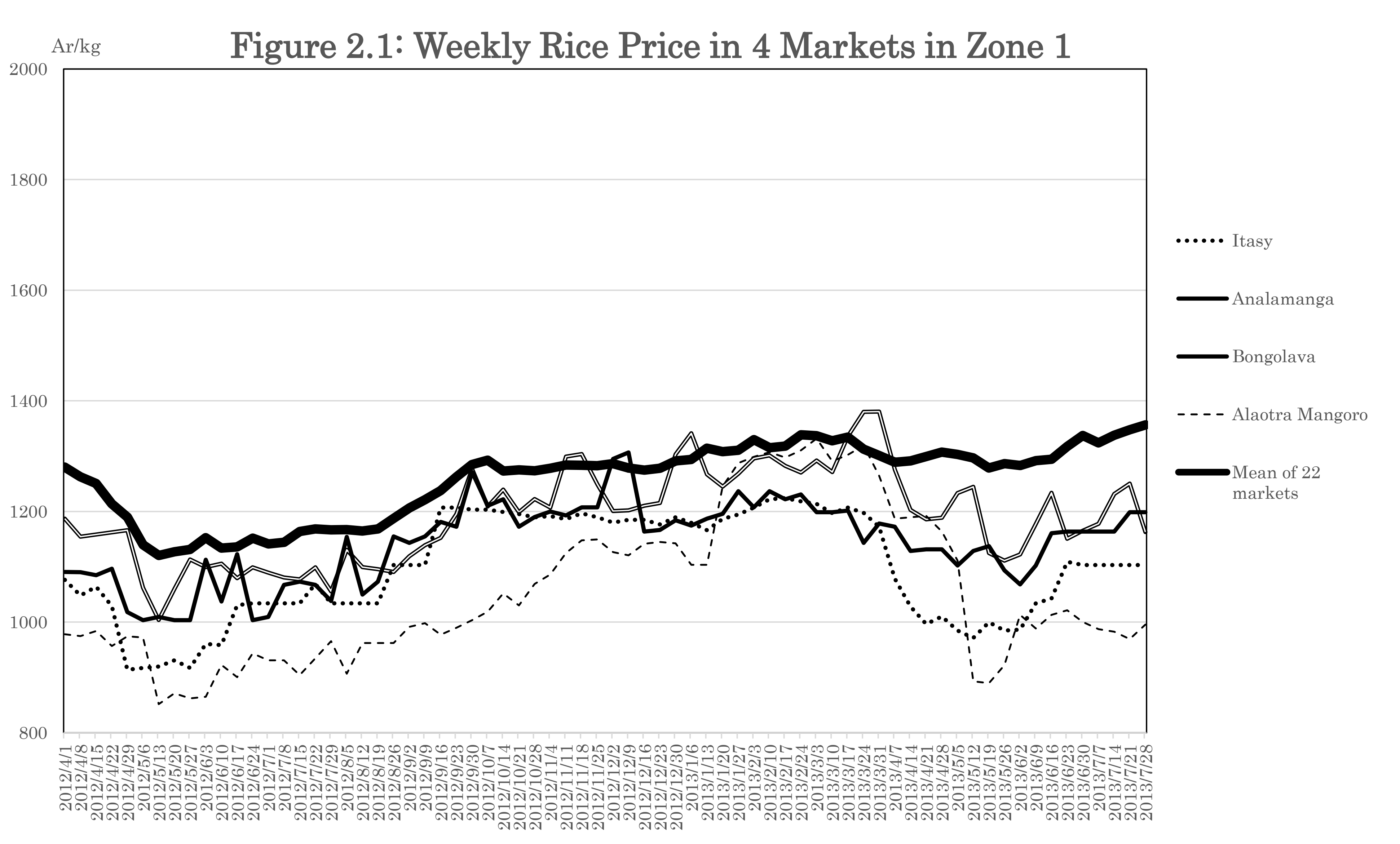


Figure 2.1: Weekly Rice Price in 4 Markets in Zone 1
Ar/kg
2000
1800
1600
1400
1200
1000
800
Itasy
Analamanga
Bongolava
Alaotra Mangoro
Mean of 22 markets

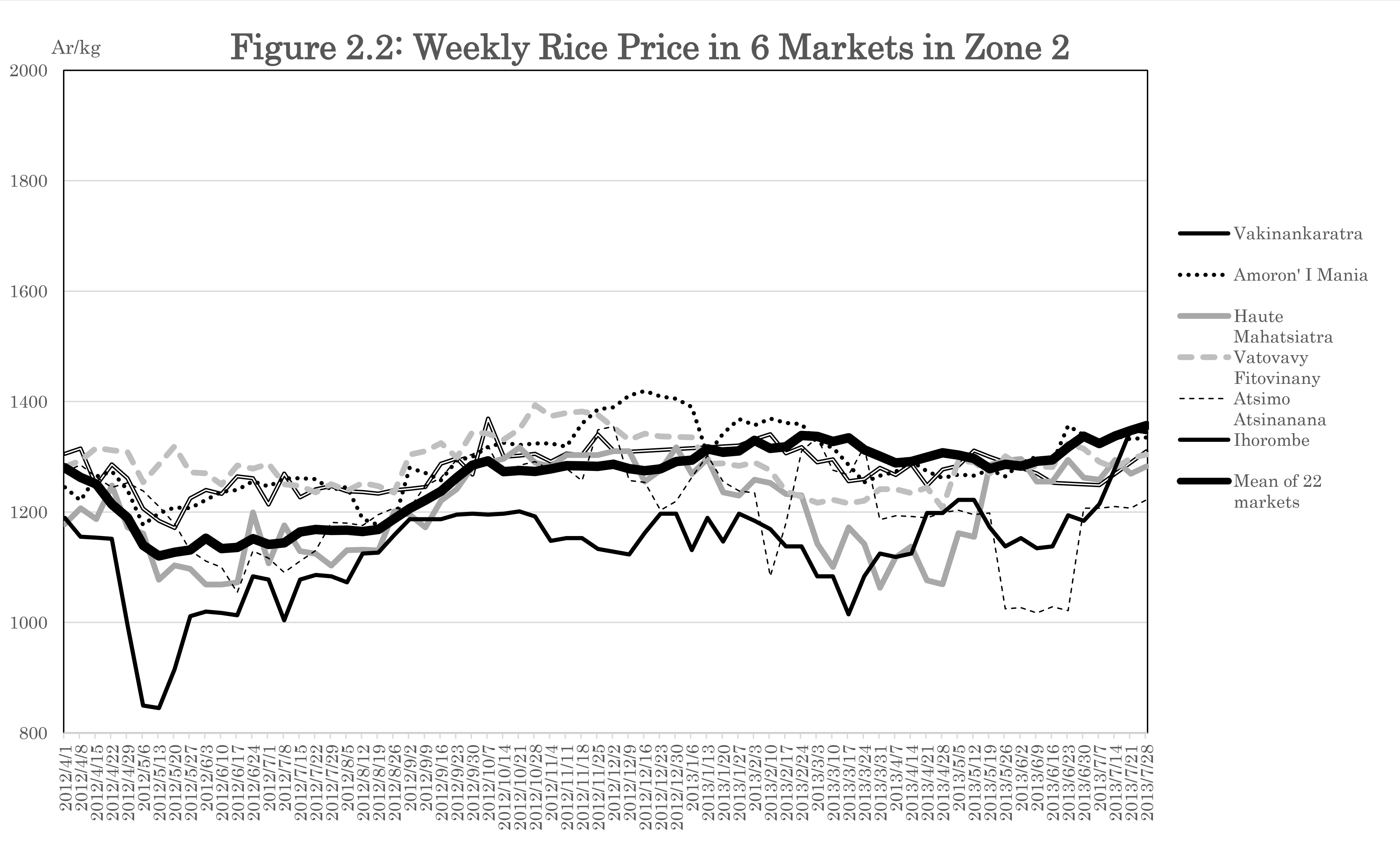


Figure 2.2: Weekly Rice Price in 6 Markets in Zone 2
Ar/kg
2000
1800
1600
1400
1200
1000
800
Vakinankaratra
Amoron' I Mania
Haute Mahatsiatra
Vatovavy Fitovinany
Atsimo Atsinanana
Ihorombe
Mean of 22 markets

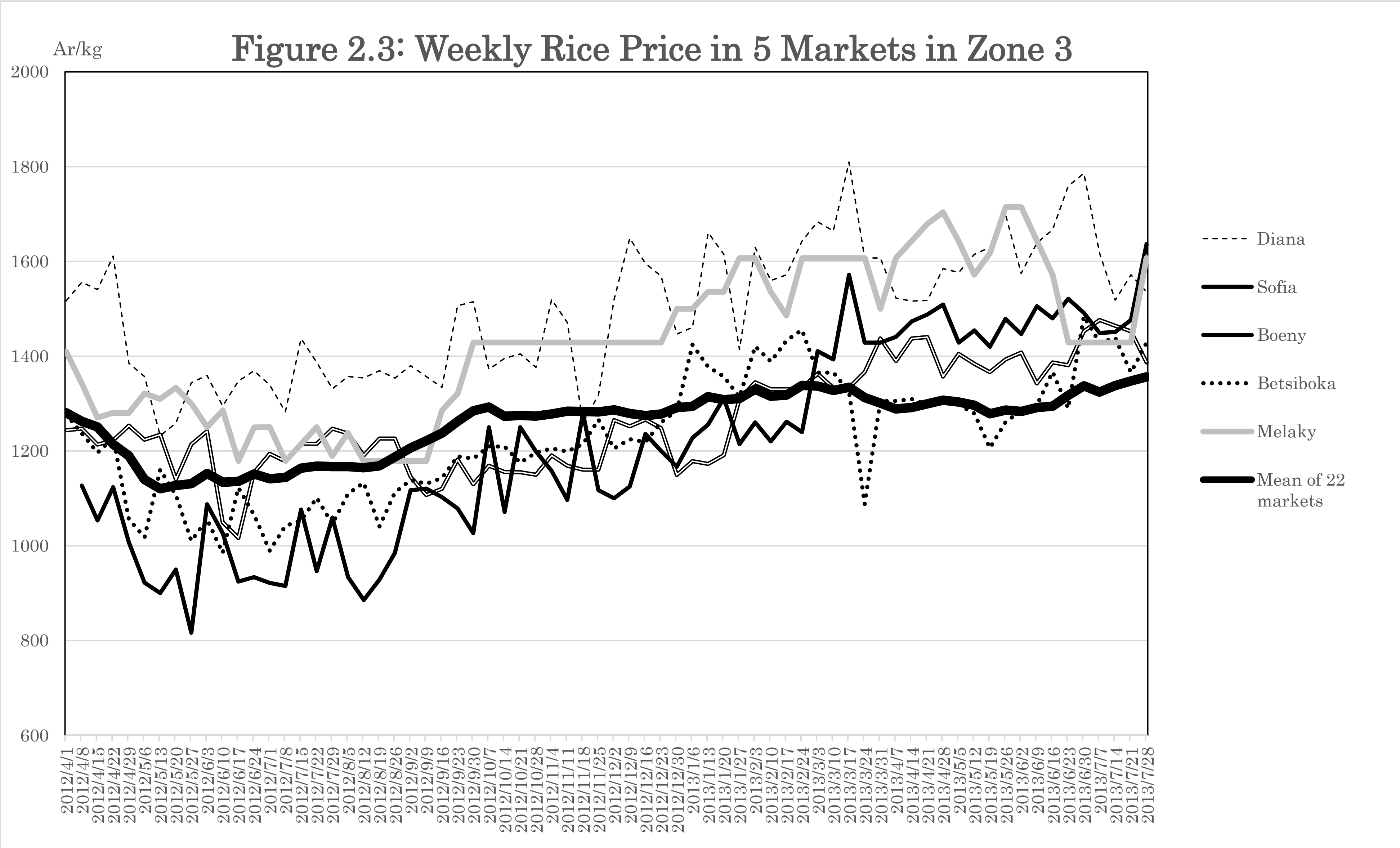


Figure 2.3: Weekly Rice Price in 5 Markets in Zone 3
Ar/kg
2000
1800
1600
1400
1200
1000
800
600
Diana
Sofia
Boeny
Betsiboka
Melaky
Mean of 22 markets

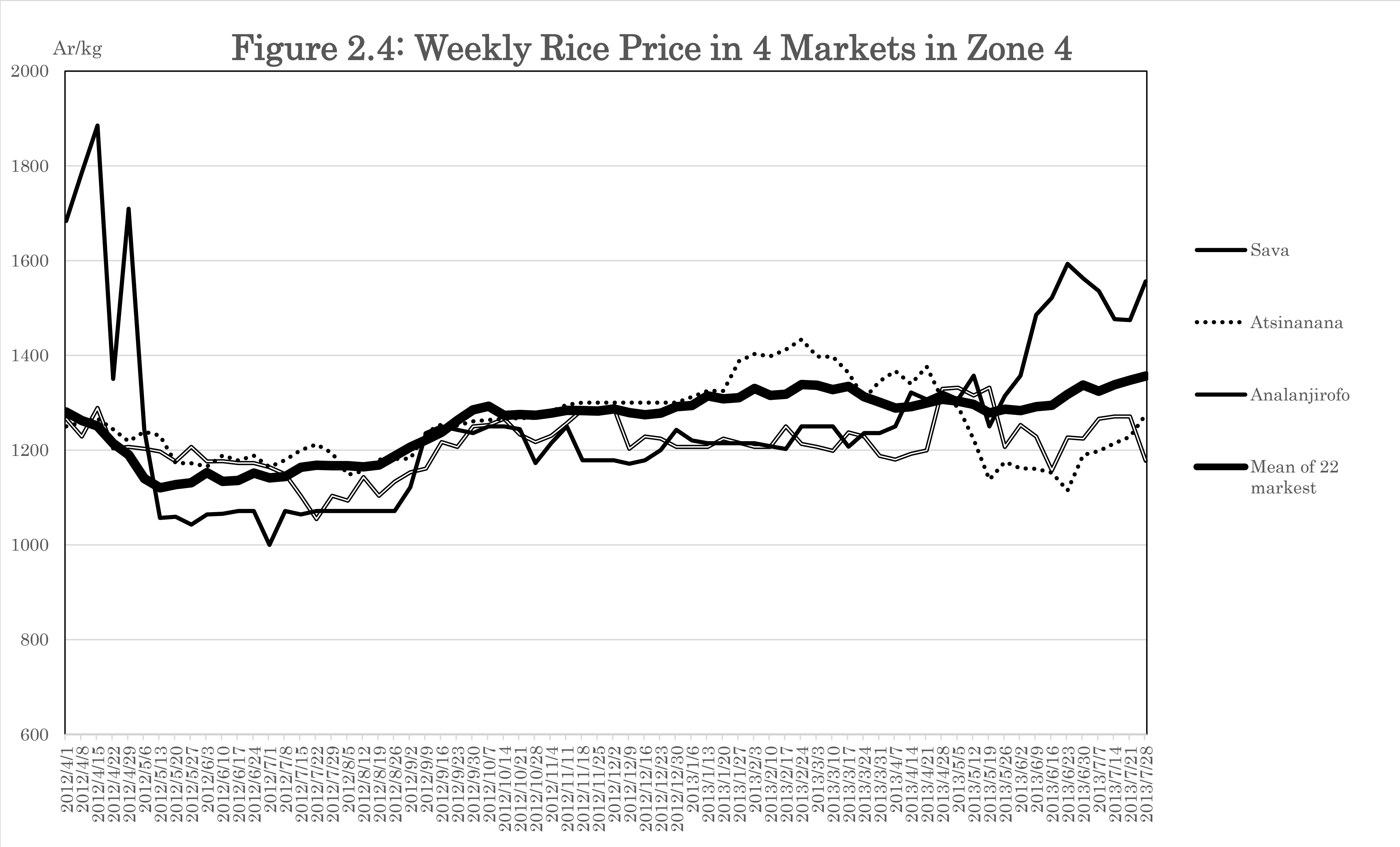


Figure 2.4: Weekly Rice Price in 4 Markets in Zone 4
Ar/kg
2000
1800
1600
1400
1200
1000
800
600
Sava
Atsinanana
Analanjirofo
Mean of 22 markest
2012/4/1
2012/4/8
2012/4/15
2012/4/22
2012/4/29
2012/5/6
2012/5/13
2012/5/20
2012/5/27
2012/6/3
2012/6/10
2012/6/17
2012/6/24
2012/7/1
2012/7/8
2012/7/15
2012/7/22
2012/7/29
2012/8/5
2012/8/12
2012/8/19
2012/8/26
2012/9/2
2012/9/9
2012/9/16
2012/9/23
2012/9/30
2012/10/7
2012/10/14
2012/10/21
2012/10/28
2012/11/4
2012/11/11
2012/11/18
2012/11/25
2012/12/2
2012/12/9
2012/12/16
2012/12/23
2012/12/30
2013/1/6
2013/1/13
2013/1/20
2013/1/27
2013/2/3
2013/2/10
2013/2/17
2013/2/24
2013/3/3
2013/3/10
2013/3/17
2013/3/24
2013/3/31
2013/4/7
2013/4/14
2013/4/21
2013/4/28
2013/5/5
2013/5/12
2013/5/19
2013/5/26
2013/6/2
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2013/6/30
2013/7/7
2013/7/14
2013/7/21
2013/7/28

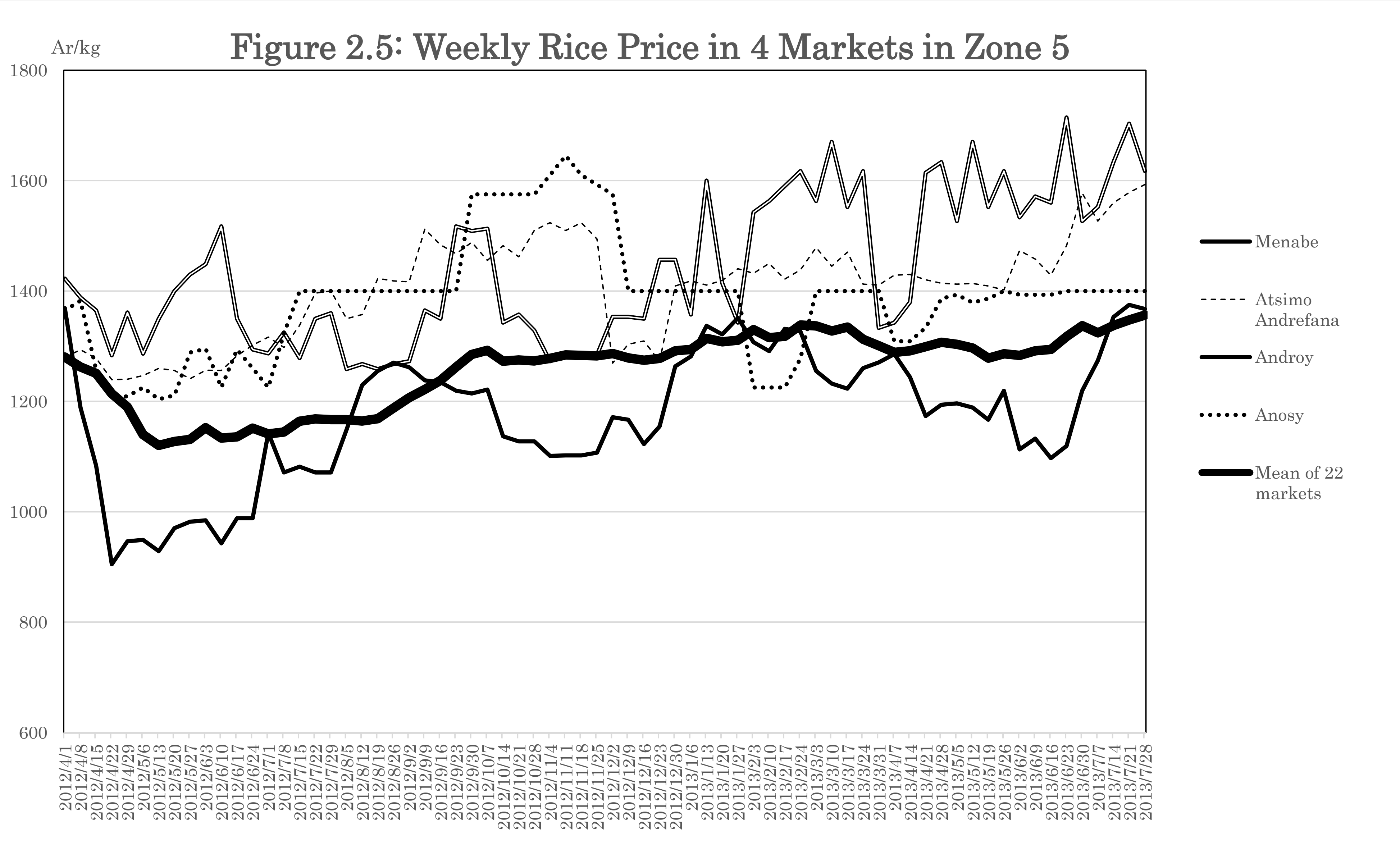
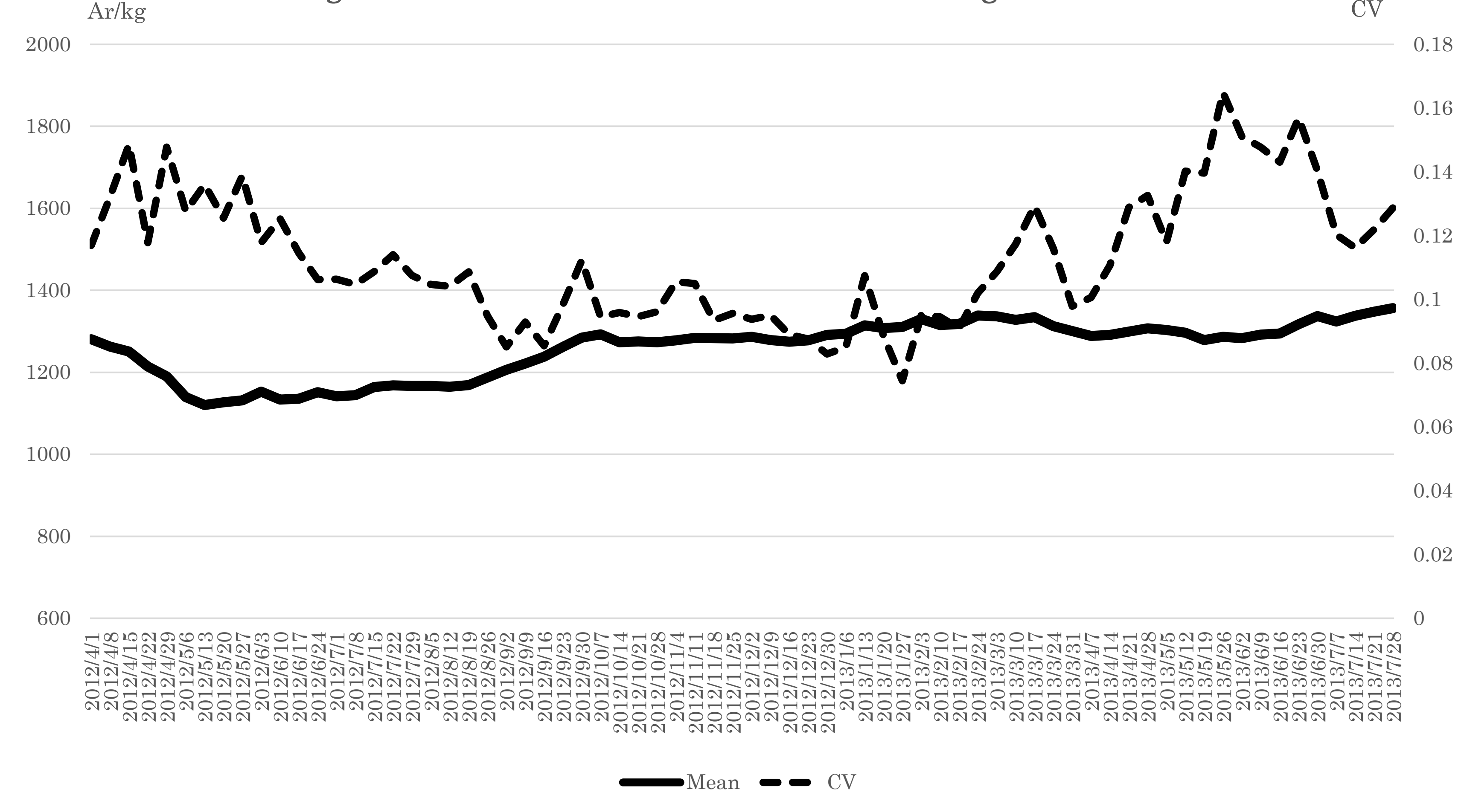


Figure 2.5: Weekly Rice Price in 4 Markets in Zone 5
Ar/kg
1800
1600
1400
1200
1000
800
600
Menabe
Atsimo Andrefana
Androy
Anosy
Mean of 22 markets

Figure 3 Mean Price and Price Variation among 22 Markets



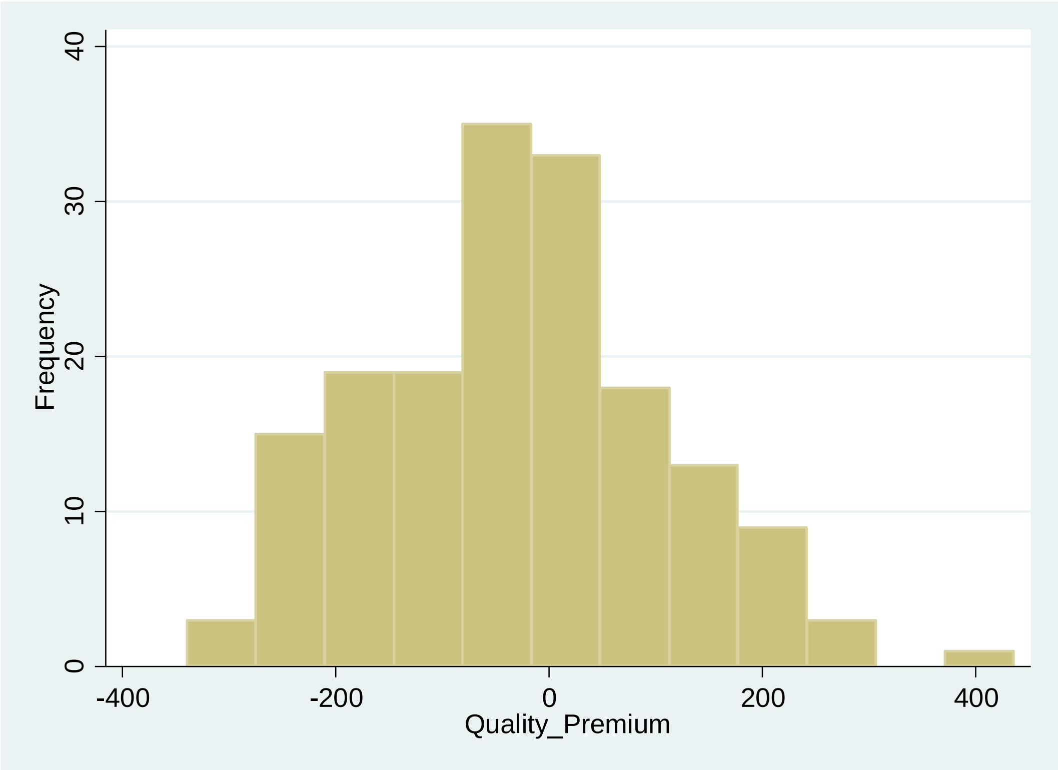


Figure 4 Frequency Distribution of Quality Premium Estimated: Full Sample Regression

Table 1 Rice Categories Recorded by the Survey

Category	Number of Observations Recorded	Number of Names Recorded[1]	Typical Names under this Category
Vary gasy	7,594	42	*Vary gasy* (37%), *Mena, Manga, R*
Tsipala	1,694	3	*Tsipala* (88%), *Semence, Ym*
Makalioka	1,850	3	*Makalioka* (78%), *Dista, Tsemaka*
Importé	1,427	3	*Importé* (72%), *Pakistan, Inde*
Total	12,565	51	

[1] Names with more than 20 observations only

Table 2 Frequently Recorded Names under Vary Gasy Category

Ranking	Name	Number of Observation	Share in Total Observation
1	*Gasy*	2,773	36.52
2	*Mena*	521	6.86
3	*Manga*	436	5.74
4	*R*	267	3.52
5	*Mifangaro*	229	3.02
6	*X*	224	2.95
7	*Botry*	206	2.71
8	*Fotsy*	188	2.48
9	*An-tanety*	163	2.15
10	*Rojo*	143	1.88
11	*Tc*	138	1.82
12	*Malaimbandy*	134	1.76
13	*Fianarantsoa*	117	1.54
14	*Taya*	117	1.54
15	*Be*	113	1.49
16	*Bory*	106	1.40
17	*Lava*	105	1.38
18	*Latsika*	104	1.37
19	*Tsy fantatra*	90	1.19
20	*Kalabory*	88	1.16
21	*Laniera*	73	0.96
22	*Mamoroforo*	69	0.91
23	*Angika*	66	0.87
24	*Chine*	66	0.87
25	*Manitra*	55	0.72
26	*Vao*	53	0.70
	Total	6,664	87.49

Table 3 Districts Frequently Recorded as Product Origin

Ranking	District Code	Region	District	Number of Observations
1	313	Alaotra Mangoro	Ambatondrazaka	2,017
2	99	Foreign	NA	1,427
3	111	Bongolava	Tsiroanomandidy	836
4	406	Boeny	Marovoay	696
5	108	Vakinankaratra	Antsirabe I	633
6	216	Ihorombe	Ihosy	589
7	203	Amoron'I Mania	Ambositra	542
8	112	Itasy	Miarinarivo	519
9	201	Haute Mahatsiatra	Fianarantsoa I	408
10	515	Anosy	Taolagnaro	398
11	105	Itasy	Arivonimamo	362
12	715	Diana	Antsiranana II	358
13	413	Sofia	Antsohihy	347
14	508	Menabe	Morondava	318
15	305	Analanjirofo	Fenoarivo Atsinanana	312
16	421	Melaky	Maintirano	282
17	213	Atsimo Atsinanana	Farafangana	276
18	712	Sava	Andapa	238
19	504	Atsimo Andrefana	Morombe	173
20	509	Menabe	Mahabo	173
21	404	Betsiboka	Maevatanana	169
22	218	Ihorombe	Ivohibe	162
23	414	Sofia	Bealanana	123
24	202	Amoron'I Mania	Ambatofinandrahana	115
25	520	Atsimo Andrefana	Toliara II	114
26	210	Vatovavy Fitovinany	Manakara	113
27	517	Anosy	Betroka	110
			Total Number	11,810

Table 4 Number of Observed Combinations of Rice-producing District and Rice Name[1]

Rice Name / Origin District	Gasy	Tsipala	Makalioka	Import low quality	Mena	Other vary gasy	Manga	Dista	R	Mifangaro	Sum	Total in the District
Ambatondrazaka	65	8	**1,147**	0	246	7	0	317	0	0	1,790	2,017
Foreign	0	0	0	**1,403**	0	0	0	0	0	0	1,403	1,427
Tsiroanomandidy	51	**236**	8	0	48	23	0	0	0	0	366	836
Marovoay	13	**314**	1	0	0	0	9	0	0	0	337	696
Antsirabe I	**223**	126	2	0	0	10	0	0	0	0	361	633
Ihosy	81	20	63	0	0	8	**416**	0	0	0	588	589
Ambositra	**463**	79	0	0	0	0	0	0	0	0	542	542
Miarinarivo	32	48	0	0	0	**70**	0	1	0	0	151	519
Fianarantsoa I	**71**	53	23	0	1	6	0	0	0	0	154	408
Taolagnaro	8	**153**	0	0	98	2	0	0	0	0	261	398
Sum	1,007	1,037	1,244	1,403	393	126	425	318	0	0	5,953	8,065
Total of this Name	2,773	1,694	1,444	1,403	521	448	436	318	267	229	9,533	NA

[1] The table shows the combinations of the 10 most frequently observed rice names and product origin districts. Shaded cells indicate the most frequently observed rice names among the top 10 names for each origin district.

Table 5 Results of Hedonic Price Analysis

Explanatory Variables	Full Sample	Subsample[1]
Indicators of Unobservable Quality		
Origin-*name* Dummies (reference: low quality import rice)	Among 168 dummies included, 85.1% are significant at a better than 5% level.	Among 77 dummies included, 87.0% are significant at a better than 5% level.
Examples of Origin-*name*[2]		
Ambatondrazaka**Makalioka*	-0.082 (0.014)***	omitted
Tsiroanomandity**Tsipala*	-0.174 (0.017)***	0.252 (0.011)***
Marovoay**Tsipala*	-0.027 (0.011)**	-0.0134 (0.023)***
Antsirabe I**Gasy*	-0.195 (0.014)***	0.138 (0.013)***
Ihosy**Manga*	0.066 (0.013)***	omitted
Ambositra**Gasy*	-0.017 (0.004)***	-0.018 (0.004)***
Miarinarivo**Other vary gasy*	-0.001 (0.004)	0.282 (0.017)***
Fianarantsoa I**Gasy*	-0.056 (0.014)***	0.010 (0.010)
Taolagnaro**Tsipala*	0.063 (0.035)*	0.055 (0.000)***
Name dummies	included	included
Origin dummies	included	included
Observable Quality		
Grain Color (reference: white)		
Red	-0.021 (0.004)***	-0.019 (0.005)***
Mix of white and red	-0.019 (0.006)***	-0.020 (0.006)***
Grain Shape (reference: long)		
Short	-0.015 (0.004)***	-0.014 (0.004)***
Mix of long and short	-0.013 (0.005)**	-0.012 (0.005)**
Milling (reference: by machine)		
By hand	-0.007 (0.006)	-0.009 (0.006)
Week-market dummies	included	included
Week dummies	included	included
Market dummies	included	included
Constant	6.980 (0.012)***	6.986 (0.011)***
R^2	0.9071	0.9093
Number of observations[3]	12201	11020

***, **, and * indicate significance at 1%, 5%, and 10% levels respectively.

[1] Subsample uses only the major rice names (those with more than 20 observations).

[2] These examples come from the shaded cells in Table 5.

[3] Due to missing values on milling (339 were missing), product origin (24), and grain color (1), this number is smaller than the number of prices recorded.

Table 6 Decomposition of Rice Price Variation

	Full Sample	Sub Sample[1]
Origin-*name* dummies	0.026	-0.037
Name dummies	0.125	-0.045
Origin dummies	0.043	0.307
Observable Rice Quality	0.026	0.025
Week-market dummies	0.032	0.039
Week dummies	0.173	0.173
Market dummies	0.434	0.367
Residual	0.139	0.171
Number of observations[2]	12201	11020

[1] Subsample uses only the major rice names (those with more than 20 observations).

[2] Due to missing values on milling (339 were missing), product origin (24), and grain color (1), this number is smaller than the number of prices recorded.

Table 7 Results of Hedonic Price Analysis by Zone

Explanatory Variables	Zone 1 Central Highland North	Zone 2 Central Highland South	Zone 3 North West	Zone 4 North East	Zone 5 South West
Indicators of Unobservable Quality					
Origin-*name* Dummies(reference: low-quality import)					
	Among 28 dummies included, 78.6% are significant at a better than 5% level.	Among 29 dummies included, 76.7% are significant at a better than 5% level	Among 53 dummies included, 84.9% are significant at a better than 5% level	Among 7 dummies included, 57.1% are significant at a better than 5% level	Among 17 dummies included, 64.7% are significant at a better than 5% level
Examples of Origin-*name*[1]					
Ambatondrazaka**Makalioka*	omitted	omitted	omitted	0.053 (0.037)	omitted
Tsiroanomandity**Tsipala*	-0.051 (0.012)**	omitted	omitted	omitted	omitted
Marovoay**Tsipala*	omitted	omitted	0.154 (0.015)***	omitted	omitted
Antsirabe I**Gasy*	omitted	0.014 (0.004)***	omitted	omitted	omitted
Ihosy**Manga*	omitted	omitted	omitted	omitted	omitted
Ambositra**Gasy*	omitted	-0.005 (0.003)	omitted	omitted	omitted
Miarinarivo**Other vary gasy*	-0.081 (0.005)***	omitted	omitted	omitted	omitted
Fianarantsoa I**Gasy*	omitted	0.060 (0.010)***	omitted	omitted	omitted
Taolagnaro**Tsipala*	omitted	omitted	omitted	omitted	0.001 (0.036)
Name dummies	included	included	included	included	included
Origin dummies	included	included	included	included	included
Observable Quality					
Grain Color (reference: white)					

Red	-0.009 (0.005)	-0.024 (0.007)**	-0.064 (0.020)**	-0.017 (0.004)*	-0.053 (0.003)***
Mix of white and red	-0.008 (0.006)	-0.022 (0.009)**	-0.042 (0.016)*	-0.000 (0.006)	-0.041 (0.001)***
Grain Shape (reference: long)					
Short	-0.010 (0.002)**	-0.012 (0.007)	-0.015 (0.015)	0.006 (0.015)	-0.013 (0.008)
Mix of long and short	-0.009 (0.009)	-0.012 (0.008)	-0.012 (0.010)	0.006 (0,003)	-0.027 (0.010)*
Milling (reference: by machine)					
By hand	-0.041 (0.006)***	-0.002 (0.008)	-0.017 (0.007)*	-0.023 (0.025)	-0.007 (0.001)**
Week-market dummies	included	included	included	included	included
Week dummies	included	included	included	included	included
Market dummies	included	included	included	included	included
Constant	7.00 (0.000)***	7.07 (0.033)***	7.23 (0.001)***	7.20 (0.006)***	7.29 (0.004)***
R^2	0.8893	0.8512	0.8946	0.8809	0.9523
Number of observations[2]	2786	3682	2291	1520	1922

***, **, and * indicate significance at the 1%, 5%, and 10% levels respectively.

[1] These examples come from the shaded cells in Table 5.

[2] Due to missing values on milling (339 were missing), product origin (24), and grain color (1), this number is smaller than the number of prices recorded.

Table 8 Decomposition of Rice Price Variation

	Zone 1 Central Highland North	Zone 2 Central Highland South	Zone 3 North West	Zone 4 North East	Zone 5 South West
Origin-*name* dummies	0.0197	-0.0044	-0.0495	-0.0057	0.0117
Name dummies	0.0268	0.0367	0.0434	-0.0084	0.0176
Origin dummies	0.0178	-0.0671	0.0453	-0.0093	0.0239
Observable Rice Quality	0.1226	0.0272	0.0564	0.0095	0.0517
Week-market dummies	0.0005	0.0135	0.0443	0.0144	0.0642
Week dummies	0.1716	0.1479	0.1922	0.1701	0.1116
Market dummies	0.0868	0.0160	0.0047	-0.0035	-0.0505
Residual	0.6614	0.8302	0.6626	0.8331	0.7707
Number of observations[1]	2786	3584	1715	1520	1922

[1] Due to missing values on milling (339 were missing), product origin (24), and grain color (1), this number is smaller than the number of prices recorded.