ADAPTIVE RESPONSE OF RICE MARKETS TO CLIMATE IMPACTS IN INDONESIA

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ABSTRACT**:** Van der Eng (2009) assessed how rice markets responded to variations in rainfall during 1935-40 in Java, Indonesia. The study finds that, while the unusually low rainfalls in El Nino years caused deficiencies in paddy production in some locations, they did not have a negative effect on variations in rice prices across Java. The finding indicates that, if well integrated, the market is able to adapt to climate stress by providing incentives that direct flows of rice from surplus to deficit areas. Building upon the above finding, the present study is aimed at analyzing the climate impacts and adaptive response of rice distribution between Surabaya and Kupang, the provincial capitals of East Java and East Nusa Tenggara (NTT) in Indonesia respectively. To this end, the monthly inflation rates of food over the last ten years are compared in these two areas. As NTT has a chronic deficit of rice and is substantially dependent on East Java for its supply, there is a correlation of inflation rates between the two provincial capitals. This study finds, however, that a seasonal variation exists. The inflation rates are consistently higher in Kupang than Surabaya in January, the lean season in NTT. The above findings suggest that, when and where seasonal factors are strong, a government intervention for rice price stabilization, if it is centrally operated, is less effective. Instead, a more seasonally and geographically targeted intervention becomes necessary to mitigate the climate impacts on rice distribution.

KEYWORDS**:** Adaptive response of rice market, climate impacts

1. INTRODUCTION

Rice is the staple food for most of the people in Indonesia. It is also an important part of the rural economy. While 38% of rural households produce rice, many more are connected to the rice economy through services, labor and trade. Getting the rice policy right is therefore essential for achieving food security, as well as providing income and employment opportunities in rural areas (McCulloch and Timmer, 2008). This is challenged, however, by the sheer size and heterogeneity of the country. According to the Central Statistics Agency (BPS) (2011), Indonesia has a population of 238 million as of 2010, the fourth largest in the world, and with more than 17,000 islands, it is also highly diverse in terms of climate as well as social and economic conditions.

Climate impacts on paddy production and its response in Indonesia have been the subjects of several studies (Amien et al, 1999; Keil et al, 2009; Kawanishi and Mimura, 2013). Little has been examined, however, as to climate impacts on rice distribution, even though food availability relies upon not only production but also distribution channels to get food where it needs to be, as elaborated by Ericksen et al. (2010). In this relation, Van der Eng (2009) assessed how rice markets responded to variations in rainfall during 1935-40 in Java. This study used local rainfall data to assess the impact of variability of rainfall on fluctuations in paddy production across 19 regencies in Java. The paper then examined local rice price data to assess the responses of rice markets to fluctuations in paddy production in these regencies. The study found that rice markets were highly integrated across Java. The unusually low rainfalls in 1935 and 1940, associated with El Nino, caused deficiencies in paddy production in some locations. They did not have a negative effect, however, on variations in rice prices across Java. The finding suggests that the rice markets worked to mitigate food deficiencies in areas affected by shortage of rainfall and falling paddy production. The study shows that, if well integrated, the market is able to adapt to climate stress by providing incentives that direct flows of rice from surplus to deficit areas.

Building upon the above finding, the present study has two objectives. Firstly, it is aimed at understanding a status and change in rice distribution between provinces in Indonesia, and their associated climate and economic factors. Secondly, it will analyze adaptive responses of distribution between Surabaya and Kupang, the provincial capitals of East Java and East Nusa Tenggara (NTT) respectively. To this end, monthly inflation rates of food over the last ten years are compared between them. These two provinces are chosen as target sites for the following reasons. Firstly, while East Java has a surplus of rice, NTT has a chronic deficit due to a short rainy season and a poor irrigation infrastructure, among other factors, as will be described later. Secondly, according to Varela et al (2012), the rice markets in the two provinces are one of the most strongly integrated pairs in Indonesia. The Institute of Economic and Social Research, Faculty of Economics, University of Indonesia (LPEM-FEUI) and the Asia Foundation (2010) also document that most goods directed to NTT are transported by sea through Surabaya.

2. METHODOLOGY

The status of rice distribution between provinces through the government channel was summarized in Table 1, using data from the Bureau of Logistics (BULOG). The status of rice production and consumption by province was analyzed and summarized in Table 2, using data from BPS and BULOG, in line with the following steps: (1) Paddy production figures were adjusted downward from BPS data by 17% to be conservative. This adjustment ratio was taken from Rosner and McCulloch (2008); (2) The official conversion rates from wet paddy to dry un-husked paddy (86.02%) and from dry un-husked paddy to rice (62.74%) were used to calculate the amount of milled rice available for consumption. The paddy production figures were all assumed to be those of wet paddy for the present analysis; (3) The national average of rice consumption, 7,427 kg/capita/month in 2010 (BPS, 2011), was used uniformly to calculate the rice consumption within households in each province; (4) The share of rice consumption within households is uniformly assumed to be 79.6% of the total provincial rice consumption. This ratio was taken from Rosner and McCulloch (2008); (5) Net rice transfer through BULOG was derived from Table 1. As data on rice distribution through private traders is not available for this study, the overall status of rice distribution is unknown. The above analysis, however, identifies provinces in rice surplus and deficit as well as directions of rice flow between them. A trend of rice transfer from East Java to NTT was depicted in Fig. 2, along with changes in rice prices, using data from BULOG, BPS and OECD. Climate impacts, particularly impacts of rainfall during wet seasons, on paddy production in NTT were also examined, using data from the Agency for Meteorology, Climatology and Geophysics (BMKG).

On adaptive responses of distribution between Surabaya and Kupang, monthly inflation rates of food in these two cities from 2002 to 2010, with a total number of pairs being 108, were utilized. Using price data as indicators of market adaptive responses, Van der Eng (2009) showed that the market, if well integrated, is able to adapt by providing price signals to direct flows of rice from surplus to deficit areas. Persistent price differences between locations imply weak supply responses to higher prices. Data on monthly inflation rates specifically for rice in these two cities was not available for the present study. Instead, data on monthly inflation rates of food items, available from BPS, was utilized. Cereals, in particular rice, are the dominant item in this data, even if its share is not clearly specified by BPS. Other items include vegetables, beans, fruits and spices, among others.

Data on farmers' terms of trade is used to gauge the ability to pay in NTT, as this is available from BPS on a monthly basis and farmers are the dominant group in the province. As sea transport is a dominant mode for transportation of food between the two cities, the impact of wind velocity on food price differences between the two cities was also examined, using data for monthly wind velocity in Surabaya, available from BPS. The corresponding data in Kupang was only available for very recent years. Other potentially relevant data, such as the number of navigational warnings and ship accidents, was only available on an annual basis for this study.

3. STATUS AND TREND IN RICE DISTRIBUTION IN INDONESIA

3.1 Overview of East Java and NTT

East Java, one of the provinces in the Island of Java, is located at 7°1'-8°5' south latitude and 111°0'-114°.4' east longitude with a land area of nearly 48 thousand km^2 and a population of 37.5 million, predominantly Muslim (BPS East Java 2010). Its intra-annual rainfall pattern is characterized by one peak and one trough with an influence of two monsoons, namely the wet northwest and the dry southeast monsoons. Accordingly, it has two seasons: wet from November to May, and dry from June to October. As for inter-annual climate variations, like most other parts of Indonesia, East Java is under the influence of the El Nino-Southern Oscillation (ENSO). The agricultural sector accounts for 15% of the provincial gross domestic product (GDP), with rice being by far the most important crop. As of 2010, the area of wet paddy field is around 1.2 million ha, nearly 80% of which are irrigated with a varying degree of technical sophistication.

NTT is located at the eastern end of Indonesia, at 8°-12° south latitude and 118°-125° east longitude with a land area of nearly 47 thousand km^2, spreading over 1,192 small islands, four of which are relatively larger: Flores, Sumba, Timor and Alor. Most of the land is mountainous and hilly. The province has longer dry and shorter rainy seasons than other parts of the country, with its wet season spanning only four months from December to March. It has a population of 4.7 million, predominantly Christian, with a poverty rate 21%, much higher than the national average 12% (BPS NTT 2011). The malnutrition rate among children is also high. The agricultural sector accounts for 37% of the provincial GDP. As presented by Muslimatun and Fanggidae (2009), and Salim (2010), while rice and maize are the two most important crops, rice is increasingly considered to be the main food staple of households.

It also gives prestige to those who consume it.

3.2 Status and trend of rice distribution between provinces

As documented by OECD (2012) and Ariga and Kitano (2000), around 70% of rice produced is retained as farmers' own household consumption, while the remaining 30% is sold through two channels: one private, and the other run by the government. The private channel accounts for roughly 80% of the total rice traded, and the government for the remaining 20%. Not being obliged to sell rice through the government channel, famers sell it to private collectors or millers when the purchase price in the private sector is favorable. The government-run channel is managed by BULOG, which performs the following three tasks. Firstly, BULOG is responsible for distributing rice to poor households through the so-called "Rice for the Poor" program. To deliver rice to rural areas under this government program, BULOG operates more than 50,000 distribution points throughout Indonesia. Secondly, BULOG has the function of releasing rice onto the open market to stabilize retail prices of rice. Finally, it is also responsible for management of the government rice reserve in anticipation of emergency situations caused by natural disasters or climatic events. BULOG imports rice if domestically procured rice is insufficient to perform these three functions adequately.

Table 1 Rice transfers between provinces through BULOG in 2009 (upper) and 2010 (lower) (Original data from BULOG, 2011)

		Rice amount received (thousand tons)							
		East Java	South Sulawesi	North Sumatra	NTT	Irian Jaya	Other provinces	Total	Share (%)
Rice amount supplied (thousand tons)	East Java	-	0	196	135	30	209	570	49.5
		-	0	116	0	56	150	322	38.5
	South Sulawesi	0	-	0	0	175	186	361	31.4
		0	-	0	56	107	168	331	39.6
	North Sumatra	0	0	-	0	0	32	32	2.8
		0	0	-	0	0	12	12	1.4
	NTT	0	0	0	-	0	0	0	0
		0	0	0	-	0	0	0	0
	Irian Jaya	0	0	0	0	-	0	0	0
		0	0	0	0	-	0	0	0
	Other provinces	0	0	40	37	0	111	188	16.3
		0	0	0	70	0	101	171	20.5
	Total	0	0	236	172	205	538	1,151	100
		0	0	116	126	163	431	836	100
	Share (%)	0	0	20.5	15.0	17.8	46.7	100	
		0	0	13.9	15.1	19.5	51.5	100	

Table 1 shows the amounts of inter-provincial rice transfer through BULOG in Indonesia as of 2009 and 2010. South Sulawesi and East Java are the two dominant suppliers, representing around 80% together of the total amount of rice supplied to other provinces. On the other hand, Irian Jaya, NTT and North Sumatra are the three largest recipients of rice, jointly accounting for about a half of the total amount of rice received. While similar data on rice transfer through the private channel is not available for the present study, Table 1 gives an indication of the directions of inter-provincial rice flow.

Table 2 Rice production and consumption by province in 2010 (thousand tons unless otherwise stated) (Original data from BPS, 2011 and BULOG, 2011)

Province	Population (thousand persons)	Paddy production	Adjusted paddy production	Milled rice available for consumption	Rice consumption	Rice transfer through BULOG (net)	Rice surplus/ deficit
East Java	37,476	11,243	9,332	4,870	4,196	-322	352
South Sulawesi	8,033	4,501	3,735	1,949	899	-331	719
North Sumatra	12,985	3,515	2,917	1,523	1,454	104	173
NTT	4,679	567	471	246	524	126	-152
Irian Jaya	2,852	104	87	45	319	163	-111
Other provinces	171,531	48,221	40,023	20,887	19,205	260	1,942
Indonesia	237,556	68,151	56,565	29,520	26,597	0	2,923

Table 3 Paddy productivity and economic welfare by province (Original data from BPS, 2011 and WFP, 2009) (Note: (*) The national poverty line is defined as US$1.55 per person per day.)

Province	Paddy production per capita (thousand tons, 2010)	Paddy productivity (kg/ha, 2010)	Population below the national poverty line (%, 2007) (*)	Households without access to electricity (%, 2007)
East Java	300	6,046	9.07	2.89
South Sulawesi	560	5,088	21.33	12.32
North Sumatra	271	4,746	13.90	9.04
NTT	121	3,104	27.51	61.32
Irian Jaya	37	3,835	39.31	53.63
Indonesia	287	5,062	16.58	8.53

Table 2 shows the estimated level of rice self-sufficiency in the above-mentioned five provinces, as well as at the national level. It indicates that, even if self-sufficiency of rice may be achieved at the national level, some provinces, such as NTT, still have a deficit, relying upon others for supply. The negative numbers in the rice surplus/deficit column for NTT and Irian Jaya may arise from errors in the assumptions as described in the methodology section. These deficits, if any, may be covered by private distribution, which is not taken account of in Table 2. A striking contrast exists, as shown in Table 3, between provinces in terms of rice productivity, as well as indicators concerning access to food, such as numbers of the population below the poverty line and households without access to electricity.

The trend of paddy production in NTT along with rainfall amount during the wet season in Kupang is depicted in Fig. 1, where the strong influence of rainfall during the cropping season on paddy production is observed. This reflects low irrigation coverage and high reliance on rain-fed harvesting in NTT. The proportion of irrigated land, including that which is primitively irrigated, of the total agricultural land in the province, is less than 4% as of 2010 (BPS NTT, 2011). Figure 2-1 shows the change over the last decade in rice distribution to NTT. The comparison between Fig. 1 and Fig. 2-1 indicates that the trend of rice transfer from outside the province, including imports, is not necessarily associated with a change in paddy production in NTT. Instead, rice was imported when domestic rice prices were higher than international prices in 2002, and from 2006 to 2007. This is also the case for imports at the national level, as indicated in Fig. 2-2.

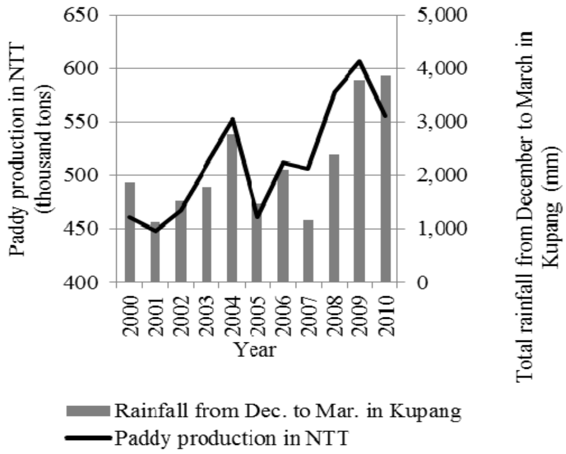

Fig. 1 Paddy production and rainfall in NTT (Original data from BPS NTT, 2001-2011 and BMKG Lasiana-Kupang, 2012)

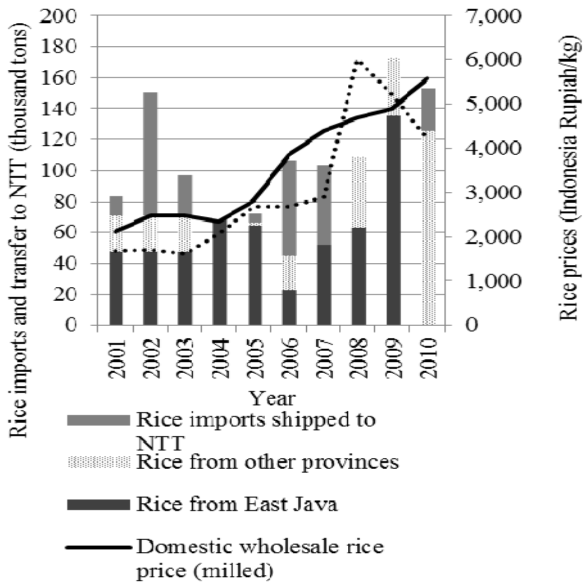

Fig. 2-1 Rice imports and transfer to NTT, with domestic and international rice prices (Original data from BPS NTT, 2002-2011, BULOG, 2011 and OECD, 2012)

The timing and volume of imports were not linked with a trend of national paddy production. Instead, imports were made when domestic prices exceeded the international level. These fell upon the years of El Nino. While multiple factors existed for price increases, as discussed by Dawe and Slayton (2010), rice prices increased partly in anticipation of El Nino-induced harvest failure. On the other hand, as shown in Fig. 2-1, domestically procured rice, in particular from East Java, flowed into NTT significantly from 2008 to 2009, despite increasing paddy production in the province, when global prices significantly increased and imports were terminated.

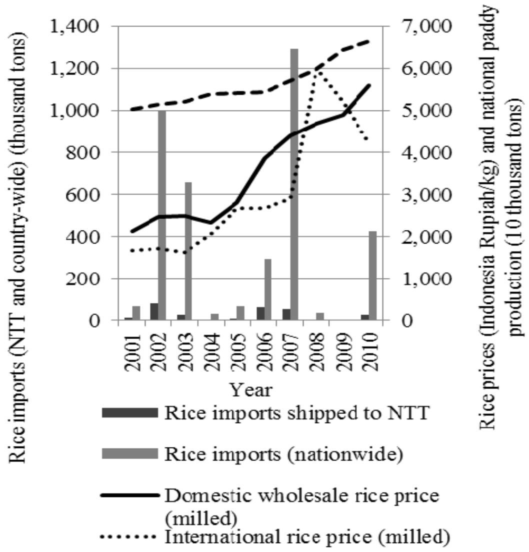

Fig. 2-2 Rice imports to NTT and the whole country, with domestic and international rice prices, and national paddy production (Original data from BPS, 2002-2011, BPS NTT, 2002-2011, BULOG, 2011 and OECD, 2012)

Thus, with a short dry season and lack of irrigation, NTT has a chronic deficit of rice, relying upon others for supply. The trend of rice transfer from outside the province, including imports, is not necessarily associated with a change in paddy production in NTT. Instead, it is more affected by a change in domestic and international rice prices, indicating a strong supply response to higher prices of rice.

4. SEASONALITY IN CORRELATION OF RICE MARKETS

4.1 Seasonality in correlation of rice markets

The correlation of monthly inflation rates of food items between Surabaya and Kupang from January 2002 to December 2010 is discussed in this section. Figure 3 shows that the correlation is highest at 0.42 when neither of the two data sets is shifted on the time horizon. This indicates that there is no significant time lag of price movements between the two cities.

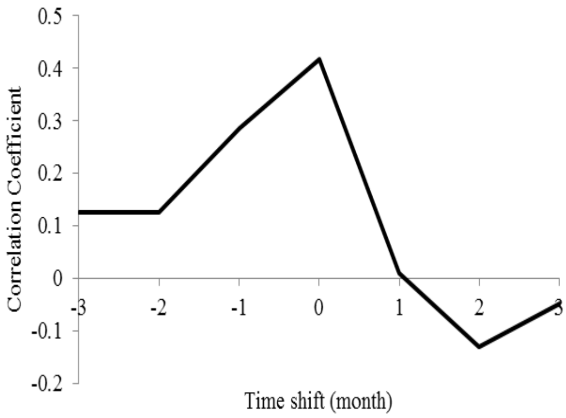

Fig. 3 Correlation of monthly inflation rates from 2002 to 2010 between Surabaya and Kupang, where plus one (1) on the horizontal axis indicates that one of the data sets is shifted on the time horizon so that Kupang is behind Surabaya by one month (Original data from BPS East Java and BPS NTT, 2002-2011)

Figure 4 illustrates average food inflation rates by month with the following two findings. Firstly, the intra-annual variation in price changes is similar in both cities. The average inflation rates were higher around December and January before harvesting, while they were lower or even negative between March and June after harvesting. This is linked with the cycle of wet and dry seasons, which regulates the timing of planting and harvesting. Secondly, the average inflation rate in January in Kupang (5.6%) is significantly higher than that in Surabaya (1.7%).

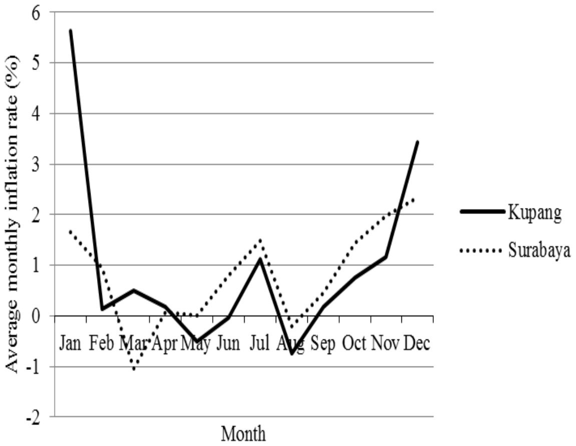

Fig. 4 Average inflation rates of food by month from 2002 to 2010 in Surabaya and Kupang (Original data from BPS East Java and BPS NTT, 2002-2011)

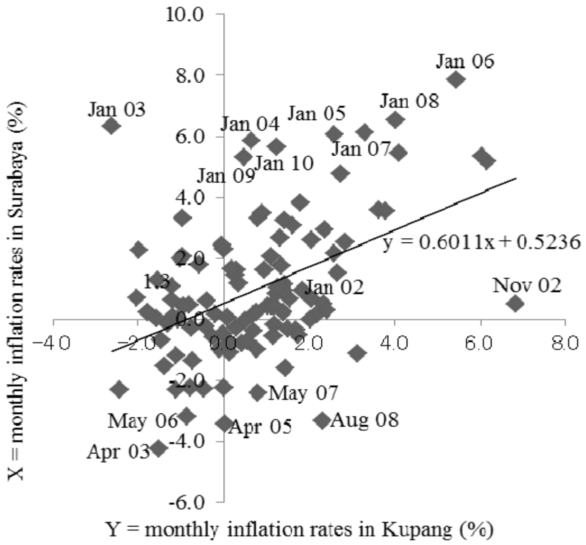

Fig. 5 Plots of monthly inflation rates of food in Kupang against those in Surabaya from January 2002 to December 2010 (Original data from BPS East Java and BPS NTT, 2002-2011)

Figure 5 displays plots of monthly food inflation rates in Kupang against those in Surabaya during the same time horizon. The plots far above and below the approximation line are dated, with the following findings. Firstly, a positive relationship of monthly inflation rates between the two cities is observed. Secondly, the plots which are far above are all dated January each year, affirming consistently high inflation rates for this month in Kupang. A positive relationship is also observed among those plots dated January, with their approximation line being expressed by y=0.2252x+5.2244. For the remaining months, on the other hand, it is expressed by y=0.4143x+0.2846. This indicates that, if there were no inflation in Surabaya, the inflation rate in Kupang would be higher by 5% in January than in other months. Thirdly, the plots which are far below include those dated April and May when rice becomes available in the market after harvesting.

4.2 Intra-annual factors for seasonality in correlation of rice markets

As documented by Basu and Wong (2011), NTT suffers from a predictable annual hunger period, locally known as *musim paceklik* (famine season) before harvesting. Van der Eng (2009), on the other hand, finds that the market is able to mitigate food deficiencies by providing price incentives that direct flows of rice from surplus to deficit areas. If this were the case, the predictable annual hunger period would be avoided through supply response to higher food prices. Van der Eng (2009) identifies some conditions under which markets may mitigate food deficiencies. Firstly, there should be a surplus area. Secondly, the population in a deficit area should have the means to purchase food from a surplus area. Thirdly, societies should have sufficiently developed communication and transport facilities to facilitate trade. The validity of these conditions will be examined below in the context between Surabaya and Kupang.

In terms of the first condition above, East

Java, with a surplus of rice, is a main supplier for NTT, as presented in Tables 1 and 2. There is a seasonal variation in rice stock in the province, however. Figure 6 shows the rice stock managed by BULOG by month based on data available for the most recent three years. While it does not take account of rice traded in the private sector, Fig. 6 indicates that the rice stock is also regulated by a cycle of wet and dry seasons. The rice stock begins to build up around March and April after harvesting, peaks around May and June, starts to decrease afterwards, and reaches bottom around the year end, when East Java can less afford to supply rice to other provinces, including NTT.

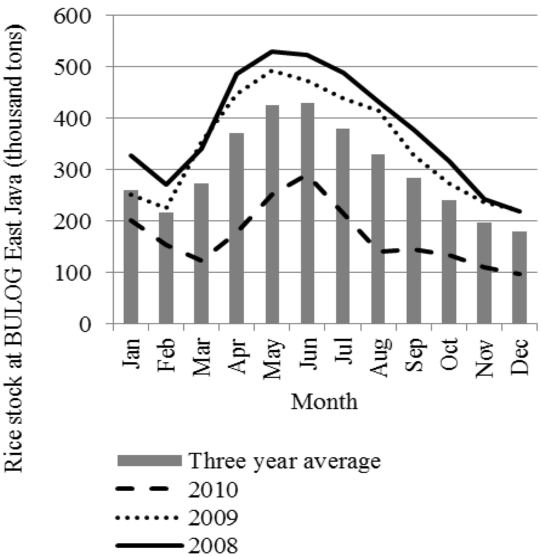

Fig. 6 Rice stock at BULOG by month in East Java (Original data from BPS East Java, 2009-2011)

As for the second condition, Fig. 7 depicts the intra-annual variation in farmers' terms of trade, using data available for the most recent years, to gauge the ability to pay in NTT. It demonstrates that farmers, the most dominant group in NTT, are relatively better off after harvesting, and worse off towards the year end before harvesting. There is a seasonal variation of livelihoods, which is also regulated by the intra-annual climate cycle.

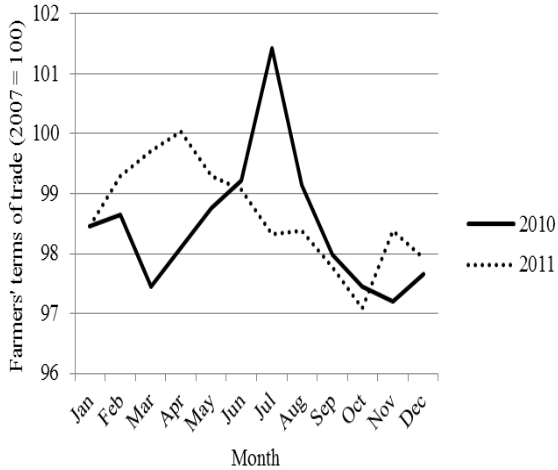

Fig. 7 Farmers' terms of trade in 2010 and 2011 in NTT (BPS NTT 2011 and 2012)

Lastly, NTT depends on sea transport for rice supply from East Java. Gurning et al (2010), however, document that the number of incidences of navigational warnings and port accidents due to high waves has recently increased. According to LPEM-FEUI and The Asia Foundation (2010), strong winds and high waves occur in January and February, reducing the frequency of crossings to between 44% and 65% of the average number of crossings in and around NTT. These findings lead to the hypothesis that a strong wind may disrupt sea transport between Surabaya and Kupang, causing large differentials in food prices between the two cities in January. In this regard, Fig. 8 displays plots of monthly wind velocity in Surabaya on one hand, and excesses of monthly inflation rates of food in Kupang over those in Surabaya on the other, with some of the plots far above and below being dated. This, however, does not exhibit any clear relationship between the two sets of variables, and does not therefore support the above hypothesis. Similarly, monthly wind velocity in Kupang, for which data is only available for very recent years, does not have any clear relationship with excesses of monthly inflation rates of food in Kupang over those in Surabaya.

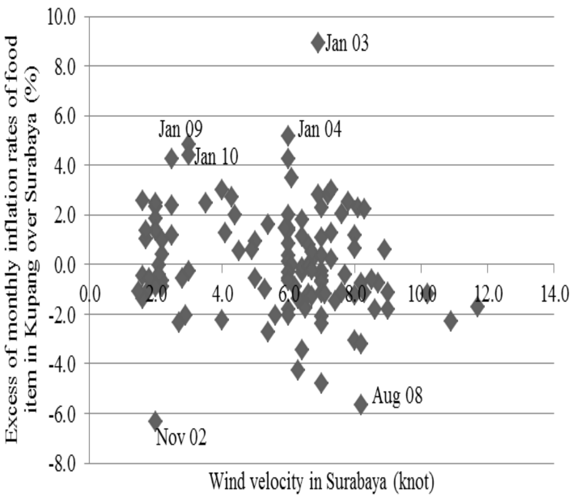

Fig. 8 Wind velocity by month in Surabaya, and excess of monthly inflation rates of food in Kupang over Surabaya from 2002 to 2010 (Original data from BPS East Java and BPS NTT, 2002-2011)

4.3 Inter-annual factors for correlation of rice markets

As described before, a positive relationship is observed among the outlying plots dated January in Fig. 5. Among these plots, the inflation rates for January in Surabaya were relatively higher from 2006 to 2008, while lower in 2004 and 2009. (A very low inflation rate in January 2003 is considered as a reaction to a very high rate in November 2002). This is generally in line with the trend in the wholesale prices of rice, as illustrated in Fig. 2-1 and 2-2.

As for the plots outlying below, while some are dated April and May after harvesting, others include November 2002 and August 2006. It is difficult to identify factors responsible for the deviation of these plots, given the data available for this study; the following are plausible reasons. November 2002 is just before Idul Fitri in the year of El Nino. Idul Fitri is an important religious holiday among Muslims that marks the end of Ramadan, the Islamic holy month of fasting. As demand for food is strong among Muslims before Idul Fitri, the inflation rates of food prices become higher. Price movements in this relation are different between Surabaya and Kupang, as East Java is predominantly Muslim while NTT is Christian.

August 2008 was in the midst of the Global Food Crisis, which started in late 2007 and peaked in mid-2008. As discussed by Dawe and Slayton (2010), the rapid increase of rice prices was attributed to multiple factors: expectations of an increasing demand for rice, imposition of export restrictions by major rice exporting countries, limited supply of other food crops such as wheat, increasing oil prices, use of food crops for biofuel purposes, and the weakening of the US dollar. In response, various policy measures were taken to reduce the transmission of the international rice price spike to the Indonesian market. As documented by Salim (2010), while imports of rice were stopped, the rice allocation for poor families was increased twice in Indonesia. In order to meet these distribution needs, BULOG increased domestic rice procurement in surplus provinces, including East Java. BULOG distributed rice in deficient provinces, including NTT. A large amount of rice was transferred from surplus to deficient areas in 2008, which may account for the price change observed in August 2008.

This section showed that inflation rates are consistently higher in Kupang than Surabaya in January, the lean season in NTT. This may be associated with seasonality in rice stock in East Java as well as the ability to pay in NTT, both of which are regulated by the intra-annual climate cycle. The present study does not support, however, the hypothesis that, by disrupting sea transport, strong wind may cause large differentials in food prices between the two cities in January.

5. CONCLUSION

The present study examines the status and change in rice distribution between provinces in Indonesia, and their associated climate and economic factors. It also analyzes adaptive responses of the markets between Surabaya and Kupang. These are relevant from a policy perspective. In the case, for example, where BULOG wants to sell rice to stabilize national rice prices in response to climate impacts, it would be irrelevant where rice is sold if the markets are well integrated. The excess of supply in a given place as a result of intervention would be transmitted to the rest easily. The present study finds, however, that inflation rates are consistently higher in Kupang than Surabaya in January, the lean season in NTT, indicating seasonally weakening supply response to higher prices. The above findings suggest that, when and where seasonal factors are strong, government intervention for rice price stabilization, if it is centrally operated, is less effective. Instead, a more seasonally and geographically targeted intervention becomes necessary to mitigate climate impacts on rice distribution.

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