National Cheng Kung University
Institute of International Management

Analysis of Price Volatility in the Indonesia Fresh Chili Market

Alan J. Webb and Ivan Aditirta Kosasih

National Cheng Kung University

Paper presented to the Annual Meeting of the International Agricultural Trade Research Consortium, December 11~13, 2011, Tampa, FL, USA.

Abstract:

Fresh chilies are an integral part of the Indonesian diet and are one of the 10 primary commodities whose prices are monitored by the government. Recent years have witnessed an increase in chili price swings that, more than once, have caused a doubling of prices within a 4-month period. Although fresh chili is a condiment with a very low price elasticity of demand, the level and persistence of price volatility does not explain why there has not been more of an adjustment on the supply side to take advantage of these price movements. The objective of this research was to determine whether monthly chili prices for 5 Java cities could be estimated with sufficient accuracy to simulate a chili storage activity that would generate sufficient gains to be economically feasible.

Estimates using monthly price data for the 10-year period starting in January 2000 show that Jakarta and Bandung prices respond to the previous month's price, relative prices in the previous month for other major cities, chili production in key production area and dummy variables for Ramadan and an October seasonal effect. Estimates for Semarang, Yogyakarta and Surabaya are similar but without the chili production and October seasonal effects. We used the results from Bandung, the primary chili trading center, to simulate a hypothetical 1-month cold storage strategy using forecasted prices. We show that traders implementing this strategy could generate annual returns of 25% over the cost of storage.

The authors welcome comments and suggestions. Please address them to: awebb@aswebb.com

Analysis of Price Volatility in the Indonesia Fresh Chili Market

Alan J. Webb and Ivan Aditirta Kosasih

National Cheng Kung University

Paper presented to the Annual Meeting of the International Agricultural Trade Research Consortium, December 11~13, 2011, Tampa, FL, USA.

Introduction

Fresh chilies are an integral part of the Indonesian diet and two varieties—bird's eye and red chili--account for 2 of the 10 primary commodities whose prices are monitored by the government. Recent years have witnessed an increase in chili price volatility that has more than once included price swings resulting in a doubling of prices within a 3- to 4-month time period. Consequently, chili price fluctuations have become a hot-button political issue. Although fresh chili is a condiment with a very low price elasticity of demand, the level and persistence of price volatility does not explain why there has not been more of an adjustment on the supply side to take advantage of these price movements. The objective of this research is to determine whether monthly chili prices for 5 major cities on Java Island can be estimated with sufficient consistency and accuracy to make it economically feasible to build a short term storage activity into the chili marketing system.

Background: The Market for Fresh Chili in Indonesia

Fresh chilies play a critical but limited role in the Indonesian diet. Three basic types of chili are consumed daily. They are red chili, Bird's Eye chili and green chili. Most chilies are consumed fresh from the market. A research report from Bank Indonesia (Prastowo, et. al., 2008) shows that red chili and Bird's Eye chili account for 50 percent and 42 percent of the fresh chili consumed with green chili accounting for the remainder.

A 2002 survey estimated consumption of chili and its products (converted to fresh weight) to be 185 g per week (AVRDC, 2006, p.182) of which more than 70% was consumed fresh. Consumers spent Rp 1234 per capita per week (or about US16 cents) on chili purchases. Even for most poor families, chili is not a very big expense. Not surprisingly, the survey estimated the price elasticity of demand to be -.03 to -.07 depending on the product and the magnitude of the price change. (p.184). There is no data on actual chili consumption nationally or by province but consumer purchase behavior suggests that, other than the holy month of Ramadan when there is a surge in demand, chili consumption is stable throughout the year. Price volatility in the fresh chili market is not—for the most part—driven by shifts in final consumer demand.

Because chilies are consumed fresh and because Indonesian consumers have a strong preference for the local product, very small quantities of fresh chilies are imported and almost no chilies are exported[1]. FAO data shows that from the 2000-2009 period, annual chili imports never exceeded one-tenth of a percent of production and exports only reached

[1] Fresh chilies are very perishable and this is a constraint on exports.

two-tenths of a percent of production once. Virtually 100% of production is consumed domestically so fresh chili is a very isolated market.

On the supply side, chili is mostly grown as a supplemental cash crop on small plots throughout Indonesia (AVRDC, 2006). Area harvested in 2009 was just over 200 thousand hectares for all of Indonesia and has been almost constant for the last 5 years (see chart 1, left scale). Average yields also have been steady over the period at around 5.9 tons per hectare (chart 1 right scale). As a result, nationwide annual production has not shown much variation in the recent 5-year period.

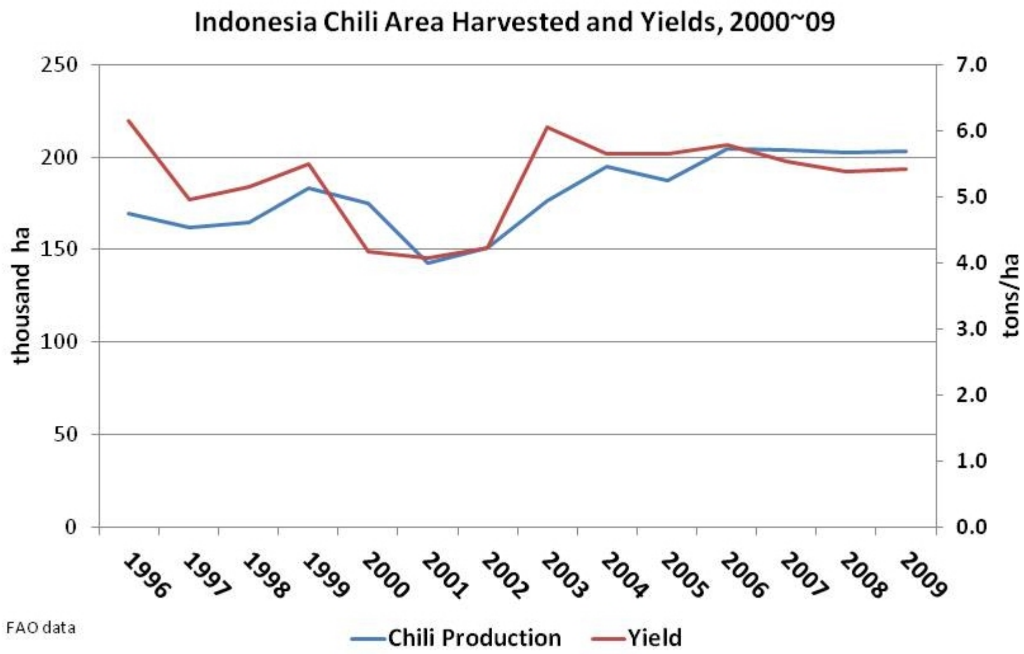

Figure 1. Indonesia Chili Area Harvested and Yields

Provincial data from the Indonesian Bureau of Statistics (BPS or Badan Pusat Statistik), summarized in Table 1, show that most of Indonesia's chili production is concentrated in the 3 Java provinces. These 3 provinces—West Java, Central Java and East Java together accounted for 56.6% of Indonesia chili production in 2009. The remaining 44% is scattered across other islands to the west and east. There is considerable geographic variation in yields across the archipelago and even on the island of Java. West Java yields were 15.6 tons/ha in 2009 compared to only 4.1 tons/ha in East Java—nearly a 4-fold difference.

Table 1: Red Chili Production in Indonesia in 2009 by Region

Province/Region	Land Area *Hectares*	Production *tons*	Yield *tons/ha*	Share of Indonesia *Percent*
Sumatra & West Islands	66,847	391,731	5.86	28.40%
Jawa Barat (W. Java)	23,212	315,569	13.60	22.89%
Jawa Tengah (C. Java)	40,729	220,929	5.42	16.02%
Jawa Timur (E. Java)	59,308	243,562	4.11	17.67%
North & East Islands	43,808	206,936	4.72	15.02%
Indonesia	**233,904**	**1,378,727**	**5.89**	**100.00%**

Source: BPS

Chili is produced year around in Indonesia but there are two main production seasons—one starting from mid-February with a harvest running from late April to early June and the second season starting in late July with a harvest running from September to as last as early November. (see figure 2).

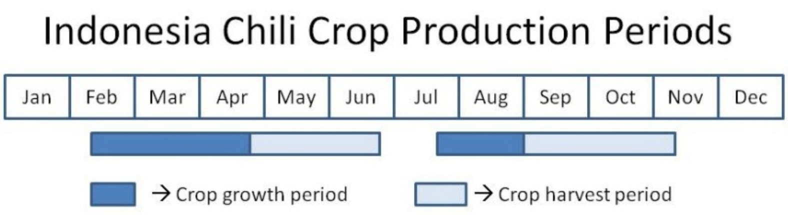

Figure 2. Indonesia Chili Production Seasons

Nevertheless, chili production for Indonesia does not exhibit a very strong seasonal pattern. As shown in Figure 3, monthly production of chili nation-wide, averaged by month over the period from 2000 to 2009, ranges from 60 to 100 thousand tons per month with peaks in April and a lower peak in September. With a standard deviation of 20 to 30 thousand tons in any given month, it means that variations in weather, planting and other factors can overwhelm seasonal output effects.

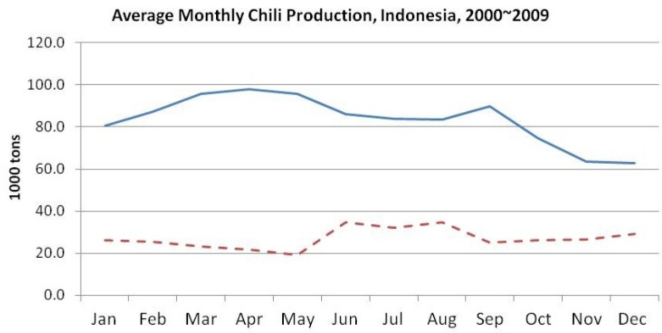

Figure 3. Indonesia average monthly chili production

The sources of chili price variability appear to lie mostly within the Indonesian production and distribution system. Other than the Ramadan holy month, consumer demand fluctuations are unlikely to have a significant influence on price movements. The following sections will take a closer look at monthly price movement for chili for the island of Java and estimate the linkage between prices in producing and consuming areas.

Chili Price Volatility on Java

Our analysis examines the price relationships between producing and consuming areas on the island of Java. We have been able to obtain unpublished monthly prices for chili for 3 major producing areas—Magelang, Rembang and Brebes—and 5 consuming centers—Jakarta, Bandung, Semarang, Yogyakarta and Surabaya—for the 10-year period from 2000 to 2010 from Indonesia BPS[2]. These consuming and producing areas are shown in the Java map in Figure 4.

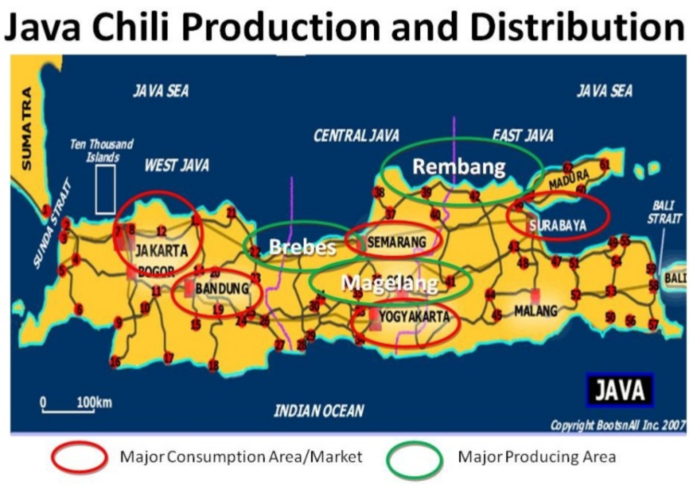

Figure 4. Map of Java with Chili Producing and Consuming Areas

[2] Data were also available for the earlier 10-year period from 1990 to 2000, but were not used because major commodity prices were under government control during the period prior to the 1997 Asian Financial Crisis. Prices during the crisis and the years immediately after the crisis were subject to extreme financial turmoil and exchange rate changes.

Java is a rugged but highly fertile island that supports a population of 135 million or 60 percent of Indonesia's population. It has one of the highest population densities in the world. Although Java has the most developed highway and rail network in Indonesia, congestion and mountainous highways can make transport of perishable products difficult and uncertain.

Chili prices over the decade have exhibited high month-to-month variability as shown in table 2. The wide range between the minimum and the maximum price show that there have been periods of distress selling when prices were extremely low and periods of severe shortages when prices were 3 or 4 times the mean.

Table 2. Summary of monthly chili prices for major Java cities, 2000-2010

City	Mean	Minimum	Maximum	Std Dev	Coef Var.
	(in Rp)	(in Rp)	(in Rp)	(in Rp)	percent
Jakarta	9537	1381	39189	7211	75.6
Bandung	7824	1017	33283	6314	80.7
Semarang	6678	767	29150	5645	84.5
Surabaya	6534	916	28780	5198	79.6
Yogyakarta	6486	717	35417	5912	91.2

Source: BPS

The price volatility exhibited in Table 2 was not confined to one or two extraordinary years or harvest periods but has persisted and become more pronounced in recent years as shown in the chart (Figure 5) for Jakarta monthly prices below. Note also that there is no consistent seasonal pattern to the price movements but there appears to be a definite upward trend after 2006. There is obviously a complex set of forces generating the monthly price variations.

Modeling Indonesia's Chili Price Movements.

Our purpose is to be able to forecast the retail price for chilies in the 5 major consuming centers on Java. If our model can forecast prices, even a month forward, it can be incorporated into a storage strategy that will generate economic returns to traders (and farmers and consumers) and reduce the severity of the price fluctuations. We already know that consumer demand is stable and shows very small response to price changes. The only seasonal change in consumption is an increase during the Ramadan holy month. In addition, there are no significant sources of imports or exports. Our forecast

Figure 5. Jakarta monthly chili retail prices, 2000-2010

model formulation can therefore focus on using past trends and production patterns as well as data from adjoining markets.

The conceptual framework for our price forecasts can be represented as:

$$RP_{i,t} = f(RP_{i,t-1}, \frac{RP_{i,t-1}}{RP_{j,t-1}}, R_t, \ S_m, \ (PP_{t-1} - PP_{t-4}) \ , QP_{k,t-1}, T \ ) \qquad (1)$$

where:

$RP_{i,t}$ is the retail price in the i^{th} consumer market in the t^{th} month.

$RP_{i,t-1}/RP_{j,t-1}$ is the ratio of the retail price in the ith consumer market with retail price in the jth consumer market.

R_t is a dummy variable for the Ramadan month (1 if a Ramadan month, 0 otherwise);

S_m is one or more dummy variables to capture seasonal production effects (1 if the seasonal effect is that month, 0 otherwise); m = 1, 2, …11 (Only significant months will be included.)

$(PP_{t-1} - PP_{t-4})$ is the difference between the producer price in t-1 and the producer price in period t-4.

$QP_{k,t-1}$ is the quantity of chili produced in producing area k in period t-1;

T is a trend variable;

and i,j are subscripts designating one of the five consuming areas (Jakarta, Bandung, Semarang, Yogyakarta or Surabaya);

k is a subscript designating one of the three producing areas (Brebes, Magelang or Rembang); and

t, t-1, t-n, are subscripts for time over 120 months where t = 1 is January 2000 and t = 120 is December 2009.

Hence this is a lagged adjustment model where the current month's price is partially determined by the price in the previous month. The expected adjustment is positive—that is, the dominant relationship over the period should be a re-enforcement of the price level of the preceding month.

The second term, $\left(\frac{RP_{i,t-1}}{RP_{j,t-1}}\right)$, is a ratio of the previous month's prices in the i^{th} market and one of the four other consumer markets (the j^{th} market). It is expected to have a negative sign because traders are expected to ship chilies to the market with the relatively higher price. Therefore a low ratio in the t-1 period is an indication that chilies moved to the j^{th} market during that period and prices in the i^{th} market in period t should increase. A significant sign on this term indicates an integrated regional market where chili quantities flow to the area with the highest prices.

R_t , dummy variable for the Ramadan effect, is expected to have a positive sign because specialty food consumption during the fasting month increases because Muslims tend to eat more when they break their fast during the evening hours.

S_m for seasonal effects may have either a positive or negative sign for the month of the year where there is a consistent departure from the expected annual pattern of prices. We test for effects for all months and will only keep the monthly dummy variable for those months that are statistically significant.

The variable, ($PP_{t-1} - PP_{t-4}$), is a measure of how the producer price has changed over a 3-month period. Because there is a 3-month lag between the planting decision and harvest, this variable is a measure how expectations have changed since planting. Within a 3-month period, the immediate supply is fixed and there is no ability to increase production until the current planting is ready for harvest. A positive value means that supplies have tightened over the past 3 months and therefore current retail chili prices should increase. A negative value implies that chili supplies at the farm level are relatively more abundant than 3 months earlier and current prices should decline.

The last variable, $QP_{k,t-1}$, captures the short term influence of production in a key producing region on consumer prices. This variable should also have a negative sign. It measures directly the effect of production in the k^{th} producing region in the t-1 period on consumer prices in the i^{th} market in period t. Chili is a perishable product consumed fresh so it seems appropriate to allow for a maximum 1-month lag between harvesting and delivery to a consumer market.

Table 3 shows the model estimation results for the 5 major consuming centers on Java. The empirical results are generally consistent with expectations although not all the hypothesized relationships were significant for all of the 5 cities.

Table 3. Model estimation results for chili prices in major Java cities.

Independent Variables	Dependent Variables									
	Jakarta		Bandung		Semarang		Yogyakarta		Surabaya	
Intercept	14644.10		8099.68		9405.44		6969.07		-8039.69	
Trend	57.40	*	47.22	*	34.56	*	43.17	*	12.05	*
RP_{t-1}	0.40	*	0.51	*	0.44	*	0.50	*	0.98	*
$RP_{i,t-1} / RP_{j,t-1}$ †	-6478.29	*	-3613.17	*	-4166.72	*	-3513.66	*	4752.26	*
R_t	1930.19	*	2705.98	*			1655.83	*		
S_t (October)	3397.99	*	1999.10	*						
$PP_{t-1} - PP_{t-4}$	0.09	*	0.07	*	0.07	*	0.06	*		
$QP_{Brebes, t-1}$	-0.33	**	-0.22	*						
R square	0.65		0.72		0.60		0.72		0.82	

Notes: *= significant in p-value 5%; ** = significant at 10%; † the ratio that produced the most consistent results was Jakarta/Surabaya and these are the results shown here for all cities.

Jakarta and Bandung have the most consistent results. The estimated Jakarta monthly price for chili trended up by 50 Rupiah per month and has a positive adjustment to the previous month's price of 0.43. Ramadan and a seasonal dummy for October accounted for an increase in prices of Rp2800 and Rp3100, respectively, while a change in the previous period's Jakarta/Surabaya price ratio results in an opposite change in price of Rp5800. The 3-month producer price difference was positive and significant. An increase in chili production in Brebes in the previous period reduces current chili prices in Jakarta. Bandung results have a similar interpretation.

For Semarang, Ramadan (Rt), seasonal factors (St) and chili production (QPk,t-t) were not significant and therefore omitted from the model estimation. Trend, lagged price, the Jakarta/Surabaya price ratio and 3-month producer price difference were consistent with the results for Jakarta and Bandung. Yogyakarta results were similar to Semarang with the added significance of Ramadan.

Surabaya prices were a function of trend, the previous month's price and a ratio of the lagged Jakarta-Surabaya price ratio only. Note that the sign on the lagged Jakarta-Surabaya price ratio is positive indicating the Surabaya prices in the current period will increase when the lagged ratio increases—that is, and increase in Jakarta prices relative to Surabaya prices in period t-1 will draw supplies to Jakarta and this will result in higher prices in Surabaya in period t.

Figure 6 plots the estimated and actual monthly prices for Jakarta to show how the model fits the data. Although the predicted values fall short of the major price peaks, they seem to follow the actual price movements with reasonable consistency and the estimates catch a number of the turning points. Plots for the results for the other cities were broadly similar with the results for Jakarta.

Simulating a Simple Storage Strategy

The true value of these forecast models is whether they can be used as a basis for a profit-generating chili market strategy. One of the simplest strategies to test is a one-month purchase-store-resell strategy. This strategy takes into account research by Sembiring (2009) that shows that fresh chilies can be kept in cold storage for a maximum of 30 days.

For a one-month purchase-store-resell strategy to be profitable, the difference between the purchase price and the resell price must be high enough to cover the costs of storage. We estimate the one-month cost of cold storage for 100 tons at a cost of Rp40 million ($4,465) based on the approximate volume of the cold storage area needed (10x12x4m) and current rental costs in Indonesia. We also factor in an 8% weight loss of the chilies during storage based on findings of Sembiring (2009) which increases the cost of storage of 100 tons to an estimated Rp43.5 million ($4853). This means that the minimum price increase to justify this strategy must exceed Rp435/kg ($0.048/kg) for the strategy to cover storage costs. Given the price volatility of the past 60 months and an average fresh chili price of Rp7800 in Bandung, the major trading center, this is not a difficult target to reach provided the initial purchase price is selected near the bottom of a price cycle.

The second and most important element of the strategy is selecting the price at which to make the 100-ton purchase. Logistically and financially, the optimal strategy would be to purchase fresh chilies in the Semarang market—the center of 3 major Java producing areas—and store and resell in Bandung—the major trading center for fresh chilies which is close the major consumer center, Jakarta.

We use a rule used in investment trading called the "golden cross" to simulate the optimal price for purchasing chilies. The rule holds that an investor should purchase a security when its short term moving average moves above its long term moving average. We calculate a 5-month moving average of actual prices and plot it against our 1-month predicted price movements (see figure 7). We use the points where the predicted crosses the moving average to determine optimal purchase points for our strategy.

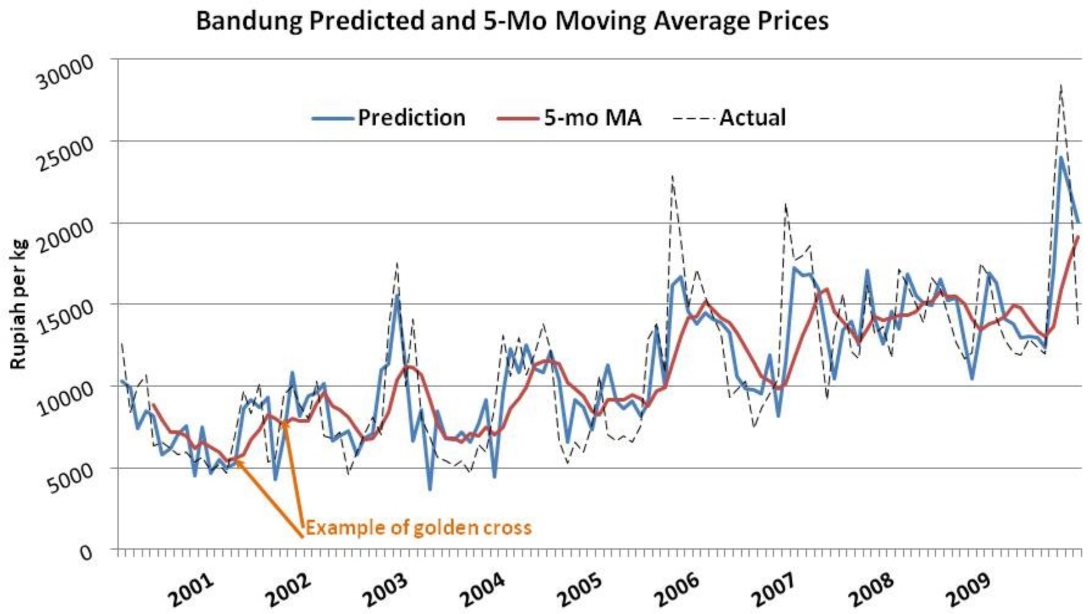

Figure 7. Bandung moving average and simulated monthly chili prices

Table 4 shows the results of implementing the golden cross decision rule using Bandung predicted prices and 5-month moving average prices for the period from 2000 to 2009. There are a total of 22 transactions of 100 tons each. The table shows the purchase price and resell price for each transaction and the returns to that transaction ***after*** deducting the storage costs and an 8% weight loss. Not all transactions generate a positive return, but over the period of 10 years, the strategy would generate a net positive return of Rp 3.68 billion ($411 thousand at a current exchange rate of Rp8945/$). For the 22 transactions of 100 tons each, this works out to a return of Rp1674/kg ($.19/kg at the current exchange rate). When adjusted for inflation, the return would be even higher.

These numbers are a rough approximation of the potential returns to storing fresh chilies in Indonesia. We should note that we may have underestimated cold storage costs and we have not included costs associated with the logistics of moving chilies into and out of storage. On the plus side, however, we have simulated a fixed 30-day storage rule based on the monthly data we used to estimate price changes. In an actual market, where traders are engaged in daily transactions, the market actors have far more flexibility on the timing of purchases and sales. Traders can store for less than 30 days and can respond to daily price changes not reflected in the monthly averages we used for our simulation. On balance, the returns to a fresh chili storage strategy should exceed those of our rudimentary simulation.

Conclusions

The extreme volatility of Indonesia chili prices are a focus of government and public concern. Using 10 years of monthly chili prices for 5 consuming regions and 3 producing regions on the island of Java, we have sought to estimate econometric models that could be used to forecast price movements with sufficient accuracy to enable market participants with sufficient information to implement successful trading strategies. Our econometric forecasts using previous month's prices, price ratios, production and past seasonal and consumer buying patterns tracked monthly price movements reasonably well. The true test, however, was a simulation of a simple one-month purchase-store-and resell strategy over the study period from 2000 to the end of 2009. The simulated strategy generated a return of Rp1674/kg over 10 years or a return of about 25% on investment.

Table 4. Simulation of purchase-store-resell strategy

Trans No.	Purchase Month	Purchase Price Rp/kg	Resell Price Rp/kg	Profit/ Loss (-)* million Rupiah
1	Sep-00	5,075	5,960	-7.12
2	Dec-00	5,325	4,800	-113.23
3	Apr-01	5,925	9,680	200.12
4	Nov-01	7,375	8,850	21.79
5	Aug-02	5,375	8,100	127.32
6	May-03	4,275	5,450	19.53
7	Jul-03	4,260	5,400	17.04
8	Sep-03	3,560	6,450	151.25
9	Dec-03	7,000	13,150	370.69
10	Jun-04	11,440	12,200	-57.40
11	Dec-04	8,000	10,583	99.88
12	Jun-05	5,675	12,883	457.65
13	Oct-05	12,200	13,700	-7.45
14	Oct-06	6,680	10,483	198.81
15	Nov-06	6,662	21,166	992.03
16	Aug-07	10,891	11,666	-52.75
17	Nov-07	11,225	13,650	67.39
18	Jan-08	10,650	17,183	375.56
19	Mar-08	13,833	15,053	-38.73
20	Jun-08	13,366	15,933	64.11
21	Feb-09	10,670	14,210	153.60
22	Sep-09	17,680	28,421	642.13
	Total (2200 tons stored)			3682.22
	Std Dev			262.82
	Average return/transaction			167.37
	Return / kg stored		Rp/kg	1,674

*storage costs and 8% weight loss already deducted

The key unanswered question is why there is not more widespread use of cold storage for fresh chilies. If there were, we would expect to see less volatile price movements in the fresh chili market. Less price volatility would mean lower risk premiums for traders and other middlemen and consequently narrower farm-retail price spreads and a more efficient market for a key Indonesian food product.

References

AVRDC, 2006. World Vegetable Center, *Chili(Capsicum spp.) Food Chain Analysis: Setting Research Priorities in Asia*, Technical Bulletin No. 38, Ali, Mubarik, editor. 2006. AVRDC Publication 06-678.

Mariyono, J and M. Bhattarai, (2009). *Chili Production Practices in Central Java, Indonesia: A Baseline Report*. AVRDC, The World Vegetable Center. (Draft Report).

Prastowo, N.J., Yanuarti, T., and Depari, Y. (2008), *Effect of distribution to commodity price and its implication on inflation*. (http://www.bi.go.id/web/id/publikasi/jurnal+Ekonomi.)

Sembiring, N. N. (2009). *Effect of wrapping material on quality of fresh red chili (Capsicum annuum L.) on cold storing*. Universitas Sumatra Utara (North Sumatra University), Medan.

Ministry of Agriculture of The Republic of Indonesia. (2010). *Chili production by province, 2000 - 2003*. Retrieved 29 December 2010. from http://database.deptan.go.id/bdsp/newkom.asp.

Badan Pusat Statistik. (1997-2010). *Producer price statistics food and smallholder plantation estate crops*. Jakarta: BPS

Badan Pusat Statistik. (2010). Harvest area, production and productivity chili, 2009 (Publication). Retrieved 29 December 2010: http://www.bps.go.id/tab_sub/view.php?tabel=1&daftar=1&id_subyek=55&notab=14

Badan Pusat Statistik [BPS]. (2010). *Social economic monthly data report*. Retrieved 29 December 2010. from http://www.bps.go.id/download_file/IP_January_2011.pdf.

Unpublished producer price statistics of the agricultural sector, 2003-2011. Mrs. Sri Kusumowati, Mrs. Sri Sayekti, Mrs. Solimah, Mr. Mulangin, and Mrs. Ida Eridawaty Harahap from Statistic Indonesia.