Front. Bus. Res. China 2014, 8(3): 327–345
DOI 10.3868/s070-003-014-0015-9

RESEARCH ARTICLE

Jingtao Yi, Xiangdong Liu

Noise Trader Model of Agricultural Product Prices: Evidence from the Chinese Garlic Market

Abstract This paper explores the determinants of the abnormal and volatile fluctuations of China's agricultural product prices in recent years by examining the trading behavior of traders, especially that of irrational noise traders. We present an overlapping generations model of the garlic market in which noise traders with erroneous beliefs influence prices. Noise traders' beliefs create a risk in the price of agricultural products that deters rational arbitrageurs from aggressively betting against them through changing supplies in a way that enables prices to diverge significantly from fundamental values even in the absence of fundamental risk. We also show that asymmetry of supply information, low price elasticity of demand, speculative capital inflows, restricted distribution channels, distorted wholesale markets from the perspective of market mechanisms and low risk aversion, biased self-attribution, and projection bias from the perspective of investor psychology, all influence expectations of investors and increase the volatility of agricultural product prices.

Keywords noise trader, agricultural product, price volatility, distribution system

1 Introduction

The efficient market hypothesis has long been upheld as a cornerstone doctrine in economics. Market participants are considered to be rational and will eventually drive prices back to fundamental values. The assumption of rationality still allows mistaken judgments in the context of information asymmetry. Yet these

Received November 13, 2013

Jingtao Yi[a] (✉), Xiangdong Liu[b]
School of Business, Renmin University of China, Beijing 100872, China
E-mail: [a]jingtaoyee@hotmail.com, [b]rdlxd@263.net

erroneous beliefs will be exploited by rational arbitrageurs who trade against them with the process of arbitrage ultimately eliminating disturbing effects on prices (Friedman, 1953; Fama, 1965, 1998).

However, abundant evidence show that many market participants act against rationality (Shleifer and Summers, 1990; Greene and Smart, 1999; Baker and Stein, 2004; Bloomfield, Hara, and Saar, 2005; Kumar and Lee, 2006; Barber, Odean, and Zhu, 2009; Levy and Yagil, 2012). Individual investors typically do not follow economists' advice to diversify their portfolios, holding instead a single stock (Lewellen, Lease, and Schlarbaum, 1974). Black (1986) believes that such investors, with no access to inside information, irrationally act on noise as if it were information that would give them an edge. Such investors are called "noise traders". They make decisions based on noise resulting from price volatility in the short run, which further creates more noise in the market and makes prices diverge significantly from fundamental values. As a result, the role played by rational arbitrage in stabilizing market prices is limited (Shleifer and Vishny, 1997; Shleifer, 2000).

In China, recent years have witnessed volatile agricultural prices, soaring to record new highs. Garlic, green bean and ginger prices have all risen quickly. This phenomenon has extended far beyond the explanation offered by the efficient market hypothesis (Yu, Dai, and Chen, 2011). Research indicates that active market participants come from different backgrounds, with some never previously involved in agricultural product transactions (Yan and Zhao, 2010; Yu, 2011). These traders cause agricultural product prices to deviate extraordinarily from their mean value through speculation (Chen, 2010). Although authorities have taken measures to act against the traders who destabilize market prices substantially, their efforts have not paid off. Agricultural product prices have tended to rebound to new highs after short downturns. So what appeals to these traders and how do they speculate in the market of low-volume agricultural products?[1] The answers to these questions remain incomplete and need further investigation.

Based on the above description, these traders can be considered to have the characteristics of noise traders, disturbing normal operations in the agricultural

[1] The products under study are low-volume agricultural products, e.g. garlic and ginger. Their price volatility has been less investigated in the literature, compared to large-volume agricultural products, e.g. corn and soybeans. The determinants may be fundamentally different from those for large-volume agricultural products as there are no corresponding financial derivatives available in the market.

product market. Yet research on speculation by noise traders concentrates on the field of behavioral finance, including stocks (De Long, Shleifer, Summers, and Waldmann, 1990a and 1990b; Brown, 1999; Ramiah and Davidson, 2007; Baklaci, Olgun, and Can, 2011; Levy and Yagil, 2012) and futures (Sanders, Irwin, and Leuthold, 1997; Ulibarri, Anselmo, Hovsepian, Florescuand, and Tolk, 2009) in the financial market, while ignoring noise trading in the goods market, especially for low-volume agricultural products. This paper intends to fill this research gap and to identify the factors underlying the fluctuating movements in agricultural product prices in China by taking into account noise traders. In this paper, we present a noise trader model of garlic transactions to investigate the determinants of garlic prices.

The paper contributes to the literature in a number of ways. The first contribution of our research is to extend the noise trader model first applied in financial markets to analyzing the goods market where low-volume agricultural products can easily be targets for speculation. Our second contribution is to enrich noise trading analyses by incorporating market inefficiencies from the perspective of market structure into the noise trader model to account for a new source to the limits of arbitrage or the failure of the efficient market hypothesis. In addition, our study reveals potential problems in price formation mechanisms for agricultural products through examining the characteristics of and bottlenecks in the agricultural product distribution system as well as in investors' psychology, thus shedding light on ways to reform the agricultural product distribution system, and improve price formation mechanisms, particularly with respect to China.

This paper demonstrates that noise traders speculate in agriculture product markets, thus pushing the price of the agricultural product to diverge significantly from fundamental values. This kind of speculative behavior is driven by their expectations based upon their belief in market inefficiencies in the agricultural product distribution system. This study also shows that asymmetry of supply information, the low price elasticity of demand, speculative capital inflows, restricted distribution channels, a distorted wholesale market from the perspective of market mechanisms and low risk aversion, biased self-attribution, and projection bias from the perspective of investor psychology all influence volatile movements in agricultural product prices. The remainder of this paper is organized as follows: section 2 illustrates the processes and characteristics of garlic speculation; section 3 presents a noise trader model of

garlic transactions and discusses the equilibrium conditions and the pricing function of that market; section 4 analyzes factors affecting model parameters; and section 5 concludes the paper with policy implications.

2 Speculation in the Garlic Market

This section presents a brief description of the garlic transaction process to see how speculation works for agricultural products in the goods market and analyzes the characteristics of the distribution system for agricultural products, particularly with respect to garlic.

Since garlic production is subject to natural conditions, its supply varies in response to the surrounding environment. Except for extreme weather, garlic prices can effectively reflect supply and demand until market equilibrium is reached. Fig. 1-(A) illustrates the normal garlic transaction process. A unique characteristic of garlic production is that producers are scattered throughout production areas, thus requiring dealers as go-betweens to collect garlic door to door to then sell to local wholesalers at relatively low costs (Chen and Lei, 2012). Local wholesalers then distribute garlic to retailers all around the country to finally be delivered to consumers. During the distribution process, all players share profits from price premiums in proportion to their respective roles in cutting costs.

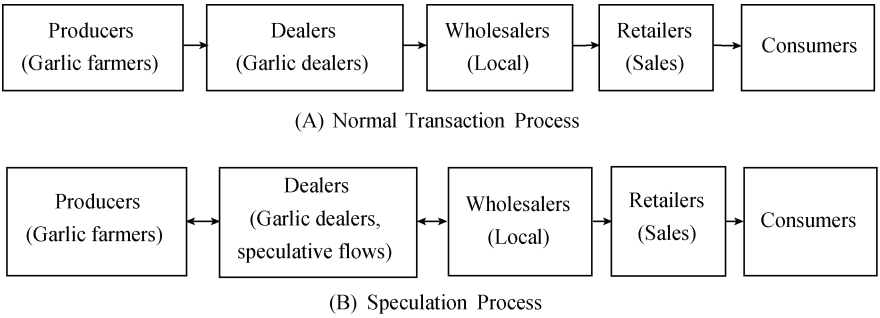

Fig. 1 Garlic Transaction Process

However, some players expect to earn excess profits by trading garlic when it is in short supply due to extreme weather. In this case, the garlic becomes more than just food on consumers' tables but turns into cake for speculators (mainly garlic dealers and traders) (Yu et al., 2011). When expecting extreme natural conditions, these speculators begin the speculative game (Chen and Lei, 2012):

garlic is bought from farmers in advance through land rental agreements (Yan and Zhao, 2010).[2] When new garlic comes out in May, dealers stock up and hoard it to increase the supply gap in the short-term and push up sales prices. In the meantime, they sell their garlic stock gradually to wholesalers at a high price until August when the garlic needs to be put into cold storage to avoid sprouting. Driven by huge profits, some wholesalers will join these noise traders. Since garlic dealers usually do not have access to cold storage, they must sell their stock before August while wholesalers who do have access to cold storage can store garlic much longer, thus extending the shortage period and further driving up prices. Since part of the garlic can be exported at a higher price than the domestic price, wholesalers have no incentive to stabilize the price even in the competitive wholesale market. Farmers with no land agreement are also reluctant to sell their garlic when the price is soaring, thus intensifying the supply shortage. Fig. 1-(B) describes the process for a speculative garlic transaction process. As mentioned above, when weather becomes extreme, garlic production shrinks and speculators buyout garlic as per their land rental contracts. Speculative transactions by dealers and traders, abundant capital inflows, and garlic withholding by farmers all push garlic prices to new highs.

The process of speculative garlic transactions demonstrates the characteristics of the distribution system for low-volume agricultural products (e.g. garlic), summarized as follows:

(1) Asymmetry of supply information: the output is uncertain before storage, thus leaving room for momentum strategy (buying high and selling low).

(2) Low demand elasticity: consumer demand is less elastic to price.

(3) Small industry scale and low threshold of market entry: easy speculative capital inflows.

(4) Restricted distribution channels: garlic dealers are dominant in distribution.

(5) Distorted wholesale market: price discovery malfunctions.

(6) Lack of "visible hand": government regulations are missing, leaving the market in chaos.

3 Noise Trader Model

This section introduces the concept of the noise trader into the normal transaction

[2] Farmers must deliver all the garlic from a set area of land agreed upon in the contract to dealers while receiving payment at the time the contract is signed.

process for agricultural products in the goods market and analyzes how these noise traders affect the price of the product and prompt abnormal movements through noise trading or speculation.

3.1 The Model

The model assumes that there are two types of agents in the agricultural products market: noise traders (denoted "N") and sophisticated investors (denoted "R"). Noise traders distort future returns on agricultural products and select their portfolios based on such erroneous beliefs. Sophisticated investors, on the other hand, pay attention to basic values and exploit noise traders' irrational misperceptions by arbitrage trading, thus driving the prices back to the mean.

If the market is efficient, the price of the product will eventually revert to its fundamental value through sophisticated investors' arbitrage trading. However, this is not the case when noise traders are present. Since the future opinions of noise traders are unpredictable, noise trader risk emerges (De Long et al., 1990a; Brown, 1999; Bloomfield et al., 2009; Baklaci et al., 2011; Levy and Yagil, 2012). If noise traders today are pessimistic about an agricultural product's market viability (e.g. garlic) and have driven down its price, an arbitrageur buying this product must recognize that in the near future noise traders might become even more pessimistic and drive the price down even further. If the arbitrageur has to liquidate before the price recovers, he is bound to suffer a loss. Fear of this loss should limit his original arbitrage position.

Our basic model is a stripped-down overlapping generations model with two-period lived agents (De Long et al., 1990a; De Long et al., 1991; Shleifer, 2000; Kurino, 2014).[3] The two-period model in the agricultural products market is that agents need to make an investment decision (purchase) in period I (young),

[3] The application of a two-period stripped-down overlapping generations model in the study of an Agricultural product is illustrated as follows: Each generation lives for two periods-"young" and "old". The first generation needs to invest in period I (young) and convert all investment to consumption in period II (old). The next generation also invests in period I and consumes in period II. In any given time period, the first generation in period II (old) coexists with the next generation in period I (young). Samuelson (1958) applied the two-period overlapping generations model to analyze consumption behavior while De Long et al. (1990a) used the same model to study stock investment. In addition, De Long et al. (1991) extend the two- period model to the multi-period model and find the results are robust to alternative model specifications. Furthermore, an overlapping generations model is often applied in micro studies in spite of the fact that it is mainly employed in macro studies, e.g. Kurino (2014) applied the overlapping generations model to house allocation analyses.

and sell all the product and spend all sales revenues in period II (old). In the course of trading the agricultural product, some agents purchase the product, namely in period I, while others sell it, namely in period II. The young or old stage in the overlapping generations model corresponds to the purchase or sale stage in the two-period trade of the product in the goods market.

For simplicity, there is no consumption, no labor supply, and no bequest in the first period. The only decision that agents make is to choose a portfolio when young. As a result, the resources that agents have to invest are exogenous. Assume that the economy contains two assets that pay identical dividends. One of the assets, the safe asset (S), pays a fixed real dividend r. Asset (S) is in perfectly elastic supply: a unit can be withdrawn from the bank at any time to pay for a unit of consumption in period II. Taking consumption each period as the numeraire, the price of the safe asset is always fixed at one. The dividend r paid on asset (S) is thus the riskless rate. The other asset, the agriculture product (A), always pays the same fixed real dividend r as asset (S).[4] But (A) is not in elastic supply: it is in a fixed and unchangeable quantity, normalized at one unit. If the price of each asset were equal to the net present value of its future dividends, then assets (A) and (S) would be perfect substitutes and would sell for the same price of one in all periods. But this is not how the price of (A) is determined in the presence of noise traders.

We assume that noise traders N are present in the model in measure ξ, that sophisticated investors R are present in measure $1 - \xi$, and that all agents of a given type are identical. Both types of agents choose their portfolios when young (period I) to maximize perceived expected utility given their own beliefs about the ex-ante mean of distribution of the price of (A) at period II. The representative sophisticated investor young in period I accurately perceives the distribution of price P_2 of (A) in period II, and so maximizes expected utility given that distribution. The representative noise trader young in period I misperceives the expected price of (A) in period II by the following linear decision rules:[5]

---

[4] he fixed dividend r of the agricultural product is the average rate of return in the industry or sub-industry. It is the same as the riskless return rate for the sake of simplicity as they have the same net present value of one.

[5] For simplicity, we assume that investors follow linear decision rules. The assumption enables us to interpret the results easily and clearly. We acknowledge that this is also the limitation of our research at the cost of ignoring the richness of the market context. Further studies are needed to extend this line of research.

$$\begin{cases} \eta = \lambda_1\alpha + \lambda_2\beta + \lambda_3\gamma + \lambda_4\delta + \lambda_5\kappa + \mu, \\ \sum_{\mathrm{i}=1}^{5}\lambda_{\mathrm{i}} = 1, \\ \mu \underset{\sim}{d} \mathrm{N}\left(0, \sigma_\mu^2\right). \end{cases} \tag{1}$$

where η is a measure of the "bullishness" of noise trader. α, β, γ, δ, κ are decisive factors of price judgment, that is, asymmetric supply information, low price elasticity of demand, speculative capital inflows, restricted distribution channels and a distorted wholesale market. λ_i indicates corresponding weights of different decisive factors. μ is the disturbance that follows i.i.d. $\mathrm{N}(0, \sigma_\mu^2)$. Given constant decisive factors and corresponding weights, the expected bullishness of price judgment is:

$$\mathrm{E}(\eta) = \lambda_1\alpha + \lambda_2\beta + \lambda_3\gamma + \lambda_4\delta + \lambda_5\kappa\,, \tag{2}$$

and the variance of noise traders' misperceptions of the expected return per unit of the agricultural product is the variance of the disturbance:

$$\mathrm{Var}(\eta) = \sigma_\eta^2 = \sigma_\mu^2\,. \tag{3}$$

Noise traders thus maximize their own expected utilities, given the distribution of (A)'s price in period II, P_2, and their false beliefs of bullishness η.

Each agent's utility is a constant absolute risk aversion function of wealth when old (period II):

$$\mathrm{U}(\mathrm{N},\mathrm{R}) = -\mathrm{e}^{-(2\phi)\mathrm{w}}, \quad \phi > 0\,, \tag{4}$$

where ϕ is the coefficient of absolute risk aversion, and w is the wealth that an agent possesses when old (period II). Suppose the returns to holding a unit of agricultural product follows normal distribution, the demand for agricultural product is positively related with the expected returns and negatively related with the variance of the returns. Then maximizing the expected value of Eq. (4) is equivalent to maximizing:

$$\mathrm{E}(\mathrm{w}) - \phi\sigma_{\mathrm{w}}^2\,, \tag{5}$$

where $\mathrm{E}(\mathrm{w})$ is the expected final wealth, and σ_{w}^2 is the one-period ahead variance of wealth. The sophisticated investor chooses the amount of (A) to maximize:[6]

[6] In the expression of w in period II, only P_2 is variable which has distribution function while all the others are constant. So the variance σ_{w}^2 of wealth w is only related with P_2.

$$\begin{aligned} \mathrm{E}\left[\mathrm{U(R)}\right] &= \mathrm{E}\left(\mathrm{w}\right) - \phi\sigma_{\mathrm{w}}^2 \\ &= \mathrm{c}_0 + \mathrm{d}_1^{\mathrm{R}}\left[r + \mathrm{E}_1(P_2) - \mathrm{P}_1(1+r)\right] - \phi(d_1^{\mathrm{R}})^2\,\mathrm{E}_1(\sigma_{P_2}^2). \end{aligned} \tag{6}$$

where c_0 is a function of first-period labor income (no labor supply in period I until the next period), d_1^R is a sophisticated investor's demand for (A) in period I, P_i, i =1,2 indicates the price of (A) in period I and II respectively. With the subscript denoting the time at which an expectation is taken, $\mathrm{E}_1(P_2)$ is the one-period expectation of (A)'s price in period II and $\mathrm{E}_1(\sigma_{P_2}^2)$ is defined as the variance of period I expectation of (A)'s price in period II:

$$\mathrm{E}_1(\sigma_{\mathrm{P}_2}^2) = \mathrm{E}_1\left[\left(\mathrm{P}_2 - \mathrm{E}_1(\mathrm{P}_2)\right)^2\right]. \tag{7}$$

The noise trader chooses the amount of (A) to maximize:

$$\begin{aligned} \mathrm{E}\left[\mathrm{U(N)}\right] &= \mathrm{E}\left(\mathrm{w}\right) - \phi\sigma_{\mathrm{w}}^2 = \mathrm{c}_0 + \mathrm{d}_1^{\mathrm{N}}\left[\mathrm{r} + \mathrm{E}_1(\mathrm{P}_2) - \mathrm{P}_1(1+\mathrm{r})\right] \\ &\quad - \phi(\mathrm{d}_1^{\mathrm{N}})^2\,\mathrm{E}_1(\sigma_{\mathrm{P}_2}^2) + \mathrm{d}_1^{\mathrm{N}}\eta, \end{aligned} \tag{8}$$

where $\mathrm{d}_1^{\mathrm{N}}$ is a noise trader's demand for (A) in period I, and η is the first period bullishness of (A)'s price in period II. The only difference between Equations (6) and (8) is the last term in Equation (8), which captures the noise trader's misperception of the expected return from holding $\mathrm{d}_1^{\mathrm{N}}$ units of (A). Sophisticated investors, however, move the price of (A) back to its mean value in period II, which means $\eta = 0$.

Given their beliefs, all young agents divide their portfolios between assets (S) and (A). When old, agents convert their holdings of (S) to consumption, sell their holdings of (A) for price P_2 to the new young, and consume their wealth.

3.2 Equilibrium

Since both utility functions of sophisticated investors and noise traders take the quadratic form of demand for (A), there is an equilibrium in our basic model with a unique solution.

$$\mathrm{d}_1^{\mathrm{R}} = \frac{\mathrm{r} + \mathrm{E}_1(\mathrm{P}_2) - \mathrm{P}_1(1+\mathrm{r})}{2\phi\,\mathrm{E}_1(\sigma_{\mathrm{P}_2}^2)}. \tag{9}$$

$$\mathrm{d}_1^{\mathrm{N}} = \frac{\mathrm{r} + \mathrm{E}_1(\mathrm{P}_2) - \mathrm{P}_1(1+\mathrm{r})}{2\phi\,\mathrm{E}_1(\sigma_{\mathrm{P}_2}^2)} + \frac{\eta}{2\phi\,\mathrm{E}_1(\sigma_{\mathrm{P}_2}^2)}. \tag{10}$$

The demand for (A) is a function of current price P_1, expected price P_2 and its variance as well as noise traders' bullishness η. The equilibrium condition shows that the demand is positively correlated with expected returns while negatively correlated with expected risk or variance. In addition, noise traders' demand depends on the expected bullishness of P_2. When they are optimistic about the expected price of (A), the equilibrium demand quantities exceed that of sophisticated investors and vice versa.

In the model, both sophisticated investors and noise traders limit their demand for asset (A), because the price at which they can sell when old depends on the uncertain beliefs of the next period's young noise traders. As long as this uncertainty limits their demand for (A), there is equilibrium in the model. If the price in the next period was certain, then noise traders and sophisticated investors would try to take zero or infinite bets against each other. Thus equilibrium would not exist. Noise trader risk limits all investors' positions, and in particular keeps arbitrageurs from driving prices to fundamental values, that is, the equilibrium price no longer equals to one (measured in consumption).

3.3 The Pricing Function

Because the old (period II) must sell all their holdings, the demands of the young (period I) must sum to one (i.e. the supply of (A) is one) in equilibrium. Solving Eq. (9) and Eq. (10), we obtain the equilibrium price of (A):

$$(1-\xi)\, d_1^R + \xi\, d_1^N = 1. \tag{11}$$

$$P_1 = \frac{r + E_1(P_2) - 2\phi\, E_1(\sigma_{P_2}^2) + \xi\eta}{1+r}. \tag{12}$$

Eq. (12) expresses (A)'s price in period I as a function of moments expectation of the distribution of (A)'s price in period II and its variance, of misperception by noise traders, of the technological (r) and behavioral (ϕ) parameters of the model. We consider only steady-state equilibrium by imposing the requirement that the unconditional distribution of P_2 be identical to the distribution of P_1. The endogenous one-period ahead distribution of (A)'s price can then be eliminated from Eq. (12) by solving recursively.[7]

[7] Taking the expectation of both sides of Eq. (12) and given that $E_1(P_1) = E_1(P_2)$, we can get the expression for $E_1(P_2)$. Then substituting it in Eq. (12), we get Eq. (13).

$$P_1 = 1 + \frac{\xi\left[\eta - E_1(\eta)\right]}{1+r} + \frac{\xi\, E_1(\eta)}{r} - \frac{2\phi\, E_1(\sigma_{P_2}^2)}{r}. \tag{13}$$

Eq. (13) reveals that only the second term is variable, since $\xi, r, \phi, E_1(\eta)$, $E_1(\sigma_{P_2}^2)$ are all constant. Solving Eqs. (2), (3) and (13) simultaneously, we obtain:

$$E_1(\eta) = \lambda_1\alpha + \lambda_2\beta + \lambda_3\gamma + \lambda_4\delta + \lambda_5\kappa. \tag{14}$$

$$E_1(\sigma_{P_2}^2) = \frac{\xi^2\sigma_\mu^2}{(1+r)^2}. \tag{15}$$

The final form of the pricing function for (A), in which the price depends on technological parameters (r, ξ), behavioral parameters ($\mu, \lambda, \beta, \gamma, \phi$) and market parameters (α, δ, κ) of the model and on misperception by noise traders, given as:

$$P_1 = 1 + \frac{\xi\mu}{1+r} + \frac{\xi\left(\lambda_1\alpha + \lambda_2\beta + \lambda_3\gamma + \lambda_4\delta + \lambda_5\kappa\right)}{r} - \frac{2\phi\xi^2\sigma_\mu^2}{r(1+r)^2}. \tag{16}$$

Eq. (16) indicates that noise traders divert the equilibrium price of (A) from its mean value of one. The last three terms show the impact of noise traders on the price of the agricultural product. As the distribution of η converges to zero, the equilibrium pricing function converges to its fundamental value of one.

The second term in Eq. (16) captures the fluctuations in the price of the agricultural product due to the variation of noise traders' misperceptions. The parameter μ reveals that the random disturbance factors, including emotion, information, gossip, etc. may divert μ from 0. When a generation of noise traders is more "bullish" than the average generation, they bid up (A)'s price. When they are more bearish than average, they bid down the price. When they hold their average misperception, the price remains unchanged with $\mu = 0$. As one would expect, the more noise traders there are relative to sophisticated investors, the more volatile asset prices are.

The third term in Eq. (16) captures the deviations of (A)'s price from its fundamental value due to the fact that the average misperception by noise traders is not zero. Since the low-volume agricultural product is distinct from the general commodity, noise traders' misperceptions are based on the characteristics of the agricultural product distribution system rather than a random disturbance. The asymmetry of supply information between various traders means the supply of the agricultural product is limited for a short period because farmers and wholesalers can store up some products during certain periods. This supply

uncertainty helps push up noise traders' bullishness. Meanwhile, the weak price elasticity of demand limits the effect of price increases on consumption, especially of necessities. Rigid demand also contributes to noise traders' optimism on future prices. Moreover, loopholes in the agricultural distribution system, including restricted distribution channels and distorted wholesale centers, further fan the flames. As long as they have sufficient capital, noise traders can move the price of the agricultural product far away from its fundamental value.

The final term in Eq. (16) is the heart of the model. Sophisticated investors will not hold the agricultural product unless compensated for bearing the risk that noise traders will become bullish and the price will increase. Meanwhile, this risk of price fluctuation leaves room for declining prices. Even if both noise traders and sophisticated investors in period I believe that the agricultural product is mispriced, neither group is willing to bet too much on this mispricing because P_2 is uncertain. Therefore, the model equilibrium exists: at the margin, the return from enlarging one's position in an asset that everyone agrees is mispriced (but different types of investors think it is mispriced in different directions) is offset by the additional price risk that must be run. Noise traders thus "create their own space": the uncertainty over what the next period's noise traders will believe makes the otherwise riskless agricultural product risky and profitable.

4 Model Analysis

Based on the above noise trader model of the agricultural product, it is noise traders that push the price to diverge significantly from its fundamental value and the gap between the two depends on the parameters of the model. These factors from the perspective of market mechanisms (characteristics of the agricultural product and its distribution) and investor psychology (changing beliefs on the price) are summarized in Table 1.

Table 1 Factors Influencing the Parameters in the Model

	Factors	α	β	γ	δ	κ	ϕ	μ	σ_μ^2
Market Mechanism	Supply information	*							
	Price elasticity of demand		*						
	Capital flow regulation			*					
	Local distribution channel				*				
	Wholesale center					*			

(*To be continued*)

(*Continued*)

	Factors	α	β	γ	δ	κ	ϕ	μ	σ_μ^2
Investor Psychology	Risk aversion						*		
	Self-attribution							*	*
	Projection bias							*	*

4.1 Market Mechanism

Market mechanism factors are derived from the characteristics of the agricultural product and its distribution system, which put the product in play even without fundamental risk and thus create space for noise trader speculation. From the garlic distribution process, we can see that the factors of asymmetry of supply information, low price elasticity of demand, speculative capital inflows, restricted distribution channels and a distorted wholesale market are all relevant.

(1) Supply information

Unlike general commodities, agricultural products are subject to natural conditions which directly influence their supply (Yu et al., 2011). Since production is unpredictable, sophisticated investors and noise traders have their own expectations for supply information (Chen and Lei, 2012). Bullish noise traders are able to store the product to intensify supply shortages and push the price up, thus earning large profits while selling at the top of the market.

The garlic market is a case in point. With natural conditions varying, the supply of and demand for garlic is unclear during the period when new garlic comes out in May and has yet to go into cold storage in August. Meanwhile, noise traders come in, buy garlic as the price rises and sell when the price falls, thus triggering volatile fluctuations in the garlic price. Sophisticated investors, however, familiarize themselves with supply information after the garlic is put into cold storage, which enables them to trade at the market price based on actual supply and demand. Apparently, the asymmetry of supply information stimulates noise traders' appetite for garlic speculation and their positive feedback investment strategies (buy when prices rise and sell when prices fall) move prices far away from their fundamental values (De Long et al., 1990b).

(2) Price elasticity of demand

In general, the price elasticity of demand for necessities like agricultural products is quite low, thus minimizing the effect on consumption when prices go

up. It is the low price elasticity of demand that stimulates noise traders to drive up the price. Noise traders supposedly take high risks for high returns by pushing up prices. Yet with low price elasticity, the high price risk is transferred to consumers. In this case, bullish noise traders, driven by relatively low risks and high returns, become more aggressive and are susceptible to positive feedback strategies.

(3) Capital flow regulations

In order to buy and store agricultural products, noise traders require abundant capital. Capital comes from many sources, e.g. loans, funds or joint-ventures (Yan and Zhao, 2010). With regards to the garlic market, the main capital sources are bank loans for garlic farmers, cash flow for garlic dealers as well as hot money flows. In particular, many merchants, who have never engaged in the garlic trade before, also join in (Yan and Zhao, 2010). Because the industry scale for garlic is relatively small and the capital threshold for entrance is relatively low, these funds flood in from all directions and overwhelm the whole garlic market, pushing garlic prices up and down significantly. These funds strengthen noise traders' abilities to blow up the price bubble and also enhance their capacity to bear risks when the bubble bursts. However, garlic farmers who cannot share profits when prices rise, yet suffer the loss when prices collapse, are in the weakest position. The small scale of the industry and low capital threshold for entrance fuel noise traders' bullishness to speculate in the market.

(4) Local distribution channels

The noise trade occurs mainly during the period when supply is uncertain, such as between May and August for garlic. However, restricted distribution channels are also to blame for speculation (Chen, 2010). Garlic from farmers mainly relies on dealers and wholesalers for collection and distribution. This high dependency breeds noise traders, especially amongst garlic dealers. They predict the market supply according to natural conditions and then buy garlic from farmers by land agreement in advance. With strong control of the supply source, dealers are able to manipulate the price and sell out to wholesalers at the top of the market (Yu et al., 2011). Therefore, restricted distribution channels also boost noise traders' confidence and result in the price's significant deviation from its basic value.

(5) Wholesale center

When noise traders have pushed up the price of garlic, they need to sell to

wholesalers at a high price in order to earn large profits. In the case of garlic, since noise traders (garlic dealers) usually do not have cold storage facilities, they must sell their entire stock to wholesalers before August when garlic begins to sprout. So wholesalers (sophisticated investors), with cold storage facilities, should have the power to negotiate prices and dampen fluctuations caused by noise traders. However, in reality this is not the case. Wholesalers and consumers are the price-takers in the garlic market. Wholesalers are still willing to trade with dealers at a high price as the supply is uncertain and the cost of cold storage is high (spare space implies waste). In addition, part of the garlic is designated for export. Trade with garlic dealers even at a high domestic price is still profitable as long as it is lower than the international market price.

In a healthy and competitive market, wholesale centers would contribute to mean-reversion, as products are centralized and homogeneous products compete with each other, allowing the price to go back to its mean. Ironically, in China, it is these wholesale centers that provide the platform for noise traders to speculate, because free hot money flows paralyze their price-reverting function, and wholesalers and noise traders collaborate for their own interests (Chen and Lei, 2012). The distorted wholesale center contributes to the bullishness of noise traders and the volatile fluctuation of garlic prices.

4.2 Investor Psychology

We also analyze the factors that influence the parameters of the model from the perspective of investor psychology. Noise traders create a demand for speculation, which is also driven by a series of psychological stimuli. The factors under consideration include low risk aversion, biased self-attribution and projection bias.

(1) Risk aversion

Risk aversion can dampen noise trade to some extent because of the high risk embedded in speculation. From the model we can see that an increase in risk aversion can decrease price deviation from fundamental values. However, noise traders are investors with low risk aversion and thus are willing to take high risks for high rewards. This factor encourages noise traders to speculate in the market and move the price away from its mean. For garlic dealers, the chase for high payoffs will reinforce noise trade behavior.

(2) Self-attribution

The study of psychology shows that individuals tend to attribute events that confirm the validity of their actions to their own abilities and events that refute their actions to external noise or sabotage (Daniel et al., 1998). When prices rise to a certain level, noise traders take it as an increasing trend and engage in speculation (Chen and Lei, 2012). As the price continues to go up, the self-attribution effect will reinforce their confidence in prior judgment and beliefs, thus triggering momentum in the price. Soaring prices in the garlic market not only confirm noise traders' beliefs in their current price judgment but also strengthens their bullishness on price for the next period.

(3) Projection effect

If noise traders earn lucrative returns from speculation and these returns have a projection effect on other investors in the market, they will join the group of noise traders (Grable et al., 2004; Zhang et al., 2005). Our model indicates that the proportion of noise traders in the market (ξ) will affect the extent to which the price diverges from its fundamental values. The more noise traders there are, the more significantly the price deviates from its mean.

When garlic speculation becomes lucrative, some garlic farmers, wholesalers and merchants with sufficient cash will join the noise traders (Yan and Zhao, 2010). In particular, when wholesalers with cold storage facilities get involved, the price of garlic fluctuates more significantly, in that cold storerooms enable wholesalers to extend the period of supply shortage in the market (Hart and Kreps, 1986). The projection effect thus intensifies garlic speculation and price fluctuations.

Based on the above discussions, the noise trade stems in part from loopholes in the market mechanism and in part from investor psychology factors, which thus destabilizes the price of agricultural products.[8]

5 Conclusions

This paper intends to examine abnormal fluctuations in garlic prices in China,

[8] Both market and psychological factors not only influence the direction of price deviation from the fundamental value but also the magnitude of price deviation. Our study is a theoretical piece which indicates the direction of price deviation, but an empirical investigation is needed to quantify the effect of price deviation. Due to data unavailability, we cannot perform an empirical analysis to test our theoretical predictions, which implies some scope for future research.

where policymakers have regularly experienced frustrations with the price management of low-volume commodities (e.g. garlic, ginger, green beans). Price fluctuations in the garlic market have increased in recent years, and supply and demand no longer move together to stabilize prices. This phenomenon is rather new and quite different from price fluctuations of large-volume commodities, e.g. corn and soybean (Yu et al., 2011). There is not a market for trading their financial derivatives and price variability is less affected by international factors. The deficiencies in the distribution system are becoming more important than supply shocks as the source of price variability, allowing noise traders to become involved (Chen and Lei, 2012). Thus, the paper develops a noise trader model of garlic prices and investigates the sources of garlic price variability in China from the perspectives of the market mechanism and investor psychology, which is helpful to provide some guidelines for the government. Although the framework of analysis is developed in the context of garlic transactions in China, the approach can be generalized and applied to other agricultural products and other developing countries.

We find that it is noise trader speculation in the garlic market that moves prices significantly away from fundamental values. The speculative behavior derives not only from loopholes in the market mechanism but also from factors in investor psychology. The study shows that asymmetry of supply information, low price elasticity of demand, speculative capital inflows, restricted distribution channels, a distorted wholesale market from the perspective of the market mechanism and low risk aversion, biased self-attribution, and projection bias from the perspective of investor psychology all influence expectations of investors and increase the volatility of garlic prices.

As indicated, the deficiencies in the distribution system in conjunction with noise traders have become the main source of price variability. Government actions on both supply and demand must diminish rather than augment price variability, particularly with regards to low-volume commodities. To this end, the government should reform and develop the distribution system while establishing intermediaries and institutions to collect and release supply information and provide guidelines for traders in the market. It also needs to develop diversified distribution channels, supervise wholesale centers, and keep order in the market.

Acknowledgements The research is supported by Beijing Higher Education Young Elite

Teacher Project (No. YETP0221) and National Natural Science Foundation of China (No. 71373010).

References

Baker, M., & Stein, J. C. 2004. Market liquidity as a sentiment indicator. *Journal of Financial Markets*, 7(3): 271–299.

Baklaci, H. F., Olgun, O., & Can, E. 2011. Noise traders: A new approach to understand the phantom of stock markets. *Applied Economics Letters*, 18(11): 1035–1041.

Barber, B., Odean, M. T., & Zhu, N. 2009. Systematic Noise. *Journal of Financial Markets*, 12(4): 547–569.

Black, F. 1986. Noise. *Journal of Finance*, 41(3): 529–543.

Bloomfield, R. J., O'Hara, M., & Saar, G. 2005. The limits of noise trading: An experimental analysis. NYU Working Paper No. FIN-05-015, New York.

Bloomfield, R. J., O'Hara, M., & Saar, G. 2009. How noise trading affects markets: An experimental analysis. *The Review of Financial Studies*, 22(6): 2275–2302.

Brown, G. W. 1999. Volatility, sentiment, and noise traders. *Financial Analysts Journal*, 55(2): 82–90.

Chen, C. 陈灿煌. 2010. 我国小宗农产品价格大幅波动的原因、影响及对策 (Antecedents and outcomes of fluctuating movements in prices of low-volume agricultural products). 价格理论与实践 (*Price: Theory & Practice*), 12(9): 15–16.

Chen, C. 陈楚天, & Lei, N. 雷娜. 2012. 我国大蒜价格波动特征及对策研究 (Analyzing fluctuating movements in garlic price and their policy implications). 价格理论与实践 (*Price: Theory & Practice*), 14(6): 42–43.

Daniel, K., Hirshleifer, D., & Subrahmanyam, A. 1998. Investor psychology and security market under- and overreactions. *Journal of Finance*, 53(6): 1839–1885.

De Long, J. B., Shleifer, A., Summers, L. H., & Waldmann, R. 1990a. Noise trader risk in financial markets. *Journal of Political Economy*, 98(4): 703–738.

De Long, J. B., Shleifer, A., Summers, L. H., & Waldmann, R. 1990b. Positive feedback investment strategies and destabilizing rational speculation. *Journal of Finance*, 45(2): 374–397.

De Long, J. B., Shleifer, A., Summers, L. H., & Waldmann, R. 1991. The survival of noise-traders in financial markets. *Journal of Business*, 64(1): 1–19.

Fama, E. 1965. The behavior of stock market prices. *Journal of Business*, 38(1): 84–105.

Fama, E. 1998. Market efficiency, long-term returns, and behavioral finance. *Journal of Financial Economics*, 49(3): 283–306.

Friedman, M. 1953. The case of flexible exchange rates. *In Essays in Positive Economics*. University of Chicago Press: Chicago.

Grable, J., Lytton, R., & O'Neill, B. 2004. Projection bias and financial risk tolerance. *Journal of Behavioral Finance*, 5(3): 142–147.

Greene, J. & Smart, S.1999. Liquidity provision and noise trading: Evidence from the investment dartboard column. *Journal of Finance*, 54(5): 1885–1899.

Hart, O., & Kreps, D. 1986. Price destabilizing speculation. *Journal of Political Economy*, 94(5): 927–952.

Kumar, A., & Lee, M. C. 2006. Retail investor sentiment and return comovements. *Journal of Finance*, 61(5): 2451–2486.

Kurino, M. 2014. House allocation with overlapping generations. *American Economic Journal: Microeconomics*, 6(1): 258–289.

Levy, T., &Yagil, J. 2012. Noise trader risk: the case of Jewish Colonial Trust and Bank Leumi Stocks. *Applied Financial Economics*, 22(11): 911–922.

Lewellen, W., Lease R., & Schlarbaum, G. 1977. Patterns of investment strategy and behavior among individual investors. *Journal of Business*, 50(3): 296–333.

Ramiah, V., & Davidson, S. 2007. Information-adjusted noise model: Evidence of inefficiency on the Australian stock market. *The Journal of Behavioral Finance*, 8(4): 209–224.

Samuelson, P. A. 1958. An exact consumption-loan model of interest with or without the social contrivance of money. *Journal of Political Economy*, 66(6): 467–482.

Sanders, D. R., Irwin, S. H., & Leuthold, R. M. 1997. Noise traders, market sentiment, and futures price behavior. In: *Finance*. RePEc:wpa:wuwpfi: 9707001.

Shleifer, A. 2000. Inefficient Markets: An Introduction to Behavioral Finance. Oxford University Press: Oxford.

Shleifer, A., & Summers, L. H. 1990. The noise trader approach to finance. *Journal of Economic Perspectives*, 4(2): 19–33.

Shleifer, A., & Vishny, R. 1997. The limits of arbitrage. *Journal of Finance*, 52(1): 35–55.

Ulibarri, C. A., Anselmo, P., Hovsepian, K., Florescu, I. & Tolk, J. 2009. Noise trader risk and Bayesian market making in FX derivatives: Rolling loaded dice? *International Journal of Finance and Economics*, 14(3): 268–279.

Yan, W. 鄢闻余, & Zhao, S. 赵晟. 2010. 山东金乡炒蒜者包地种蒜，大蒜价格暴涨到何时？(Speculation through land rental agreements in Shandong garlic market and when will the sharp rise in garlic prices be reversed?). *农业经济与科技* (*Rural Economy and Science-Technology*), 21(8): 12–14.

Yu, H. 虞华, Dai, X. 戴秀艳, & Chen, X. 程鑫. 2011. 我国小宗农产品价格异常波动原因探析及反思 (To analyze the determinants of fluctuating movements in prices of low-volume agricultural products). *农村金融研究* (*Rural Finance Research*), 32(8): 27–29.

Yu, X. 喻湘泉. 2011. 如何走出蒜价大起大落怪圈 (Explore the damaging boom-bust cycles in garlic price). 农村新技术 (*New Rural Technology*), 29(11): 49.

Zhang, X. 张晓蓉, Tang, G 唐国兴. & Xu, J. 徐剑刚. 2005. 投机泡沫的混合理性正反馈模型 (Hybrid rational model of speculative bubbles on positive feedback trading). *金融研究* (*Finance Research*), 48(8): 85–98.