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Asymmetric Price Transmission and Market Power: A Case of the Aquaculture Product Market in China

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Abstract: In the aquaculture product market, the efficiency of vertical price transmission is an important manifestation, representing the marketization level of aquatic products. When the price of any sector in the aquatic product industry chain fluctuates slightly, the welfare of each sector will be affected accordingly. This study focuses on carp, the main freshwater fish in China, to explore the relationship between asymmetric price transmission and market power. We use the nonlinear autoregressive distributed lag model to simultaneously describe the short- and long-term asymmetric effects of wholesale-to-retail prices for carp, and apply the asymmetric autoregressive conditional heteroskedasticity model to analyze the differences in market power between wholesalers and retailers. The results confirm the evidence of a nonlinear cointegration between wholesale and retail prices in the carp market. There are also significant asymmetric effects in both the short- and long-term transmission speed and degree of price transmission from the wholesale to the retail market. It is evident that carp wholesalers have strong control over the price, resulting in an asymmetric effect in vertical price transmission, indicating a need to improve the development level and integration degree in the Chinese aquatic products market. Subsequently, the government should develop effective systems for aquatic product circulation, strengthen supervision over the aquatic product wholesale market, and establish a public aquatic product price platform to promote the healthy and stable development of China's aquatic product market.

Keywords: aquaculture products; asymmetric price transmission; market power; NARDL

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1. Introduction

On 16 October 1953, the Chinese government promulgated the "Order on the Implementation of Planned Grain Purchase and Planned Grain Supply [1]" Since that time, the agricultural product market has entered the era of "Unified Purchase and Sale", and the government has maintained the absolute stability of national agricultural product prices through administrative order [2]. Accordingly, the role of market value law was far from reflected in China's agricultural market. Following the Third Plenary Session of the Eleventh Central Committee of the Communist Party of China [3], the Central Committee and the State Council issued "Ten Policies on Further Activating the Rural Economy". The policies indicated that the government implemented contract ordering for some agricultural products, and the other portion of agricultural products were listed freely through a "double track system [4]" China's free trade market of agricultural products began to sprout. The report of the Fourteenth National Congress of the Communist Party of China in 1992 clearly asserted that a socialist market economic system was established and the market had a fundamental role in national resource allocation [5]. The Third Plenary Session of the Eighteenth Central Committee further clarified the fundamental importance of the market as a decisive role [6]. Subsequently, the price of agricultural products has gradually been determined by the process of market supply and demand. In short, throughout the course of China's economic system reform, the price of agricultural products has remained a vital

topic. Research on the vertical price transmission of agricultural prices can provide practical insights for the formulation of strategic agricultural policies to promote the ongoing development and progress of agriculture in China.

Aquatic products are one of the indispensable protein sources for urban and rural residents in China, and the proportion of aquatic products increases on residents' dining tables annually. Moreover, in 2020, China's total fishery output value reached CNY 12,775.86 billion—an increase of 1.62%—and the surplus of international trade in aquatic products was CNY 3.476 billion (data source: China Fisheries Statistics Yearbook 2021). However, some challenges have emerged amid the rapid development of the aquatic industry, among which the most core topic is the price of aquatic products [7]. As a signal of market supply and demand, aquatic product price not only represents the connection between market subjects but also reflects the efficiency of market mechanisms [8]. It is generally believed that effective market operation mechanisms can strongly promote the rational allocation of production resources. In fact, the price of aquatic products not only has a steady upward trend, but its price volatility in China has also become increasingly frequent (Figure 1). Specifically, the price of marine fish (e.g., yellow croaker and hairtail) has risen from CNY 15 to 40 per kilogram between 2006 and 2022, while the price of freshwater fish (e.g., carp, grass carp, crucian carp, and silver carp) has risen from CNY 8 to 15 per kilogram, and the price fluctuation of marine fish is more intense than that of freshwater fish. To some extent, this is due to the long production cycle of aquatic products [9]. At the same time, prices for aquatic products connect farmers and consumers, both of which are faced with opposing dilemmas. Higher price levels will improve farmers' production enthusiasm and raise their welfare level, and severe price volatility will exacerbate the inequality of income distribution among farmers [10], whereas price increases lower consumers' actual purchasing power, diminishing their welfare level. Moreover, volatile price fluctuations will generate malicious buying, resulting in market chaos [11]. Similar to the egg market [12], the intuition of aquatic product retailers is that when the price level for upstream aquatic products rises, wholesalers will rapidly increase prices to reduce the risk they bear, transferring it to downstream retailers. In contrast, when the upstream price of aquatic products falls, wholesalers slowly decrease prices to maintain profits. This means that aquatic products retailers recognize that the price level has the characteristics of "rising like rockets and falling like feathers [13]".

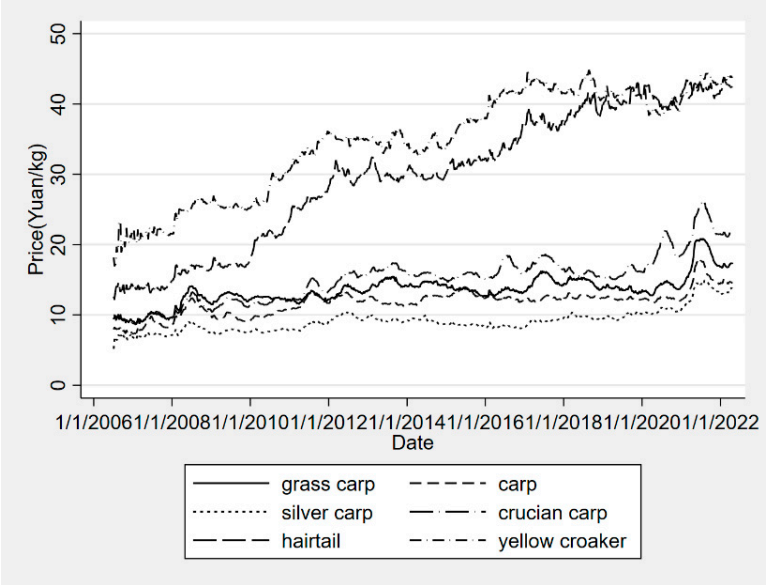

Figure 1. Break-line diagram of price fluctuation of different fish. (Data source: Website of Ministry of Commerce, PRC.)

Does retailers' intuition represent the actual situation in the aquatic products market? Is there, in fact, an asymmetric effect in the vertical price transmission of aquatic products? The existence of this effect is an important indicator of insufficient competition in the aquatic products market, hindering the maximization of social welfare, and the market cannot achieve Pareto optimality [14]. If there is an asymmetric effect in the vertical price transmission of aquatic products, then why does this happen? Do wholesalers of aquatic products have market forces that affect price levels, leading to asymmetric price transmission (APT) effects?

2. Literature Review

From the perspective of research content, scholars in China and abroad have primarily examined the types, measurements, and causes of APT in agricultural products. Regarding agricultural products, APT refers to the market state of when the price levels of agricultural inputs rise or fall, the responses of agricultural output prices to these two changes are not consistent in speed or amplitude [15], which is contrary to classical economic theory [13]. There are three different methods for dividing APT [16]. In the first classification, when the upstream input price rises, the change in the magnitude of the downstream output price is inconsistent with that of the input price, it is called magnitude APT. When the upstream input price rises, the change speed of the downstream output price is inconsistent with that of the input price, it is called speed APT. In the second classification, called positive APT, the product price reacts faster to the input price increase, and it is called negative APT when the product price reacts faster to the input price decrease. The third classification is called vertical APT when the APT effect occurs in different sectors of the same industry chain, and spatial APT refers to the asymmetric transmission of product prices between different regions. Most of the existing studies have focused on the asymmetry of spatial price transmission, and few studies have examined vertical APT. Additionally, most scholars have verified that the APT effect exists widely in dairy [17], livestock and poultry [18], vegetable [19], and grain markets [20,21]. Regarding the causes of agricultural products' APT, the relatively perfect explanations are market power and adjustment cost theories [22–24]. Farmers and retailers are relatively dispersed at both ends of the initial and final sectors in the agricultural products industrial chain, and their market power is particularly weak, whereas intermediate wholesalers' market power is relatively strong [25]. Consequently, wholesalers can manipulate the market price of agricultural products to obtain monopoly profits. Research on the vertical transmission of agricultural product prices can evaluate the operational efficiency and degree of competition of different markets in the industrial chain to provide practical insights for strategic government policy development [26].

In terms of common research methods, error correction and threshold autoregressive models are widely used in the current research. According to the risk theory of the pig futures hedging industry chain, Fu et al. divided the pig industry chain into four sectors, selecting the prices of corn, piglets, pigs, and pork to represent the price levels of different sectors in the industrial chain, and used the asymmetric error correction model to study the price transmission mechanism of the whole industrial chain of pigs [27]. Dong et al. focused on pig and pork prices, using threshold autoregression, momentum threshold autoregression, and asymmetric error correction models to verify the asymmetric effect of the two prices in the transmission [28]. Mkhabela et al. used the error correction model to explore the APT from poultry farm prices to retail prices in South Africa [29]. Zhou examined the domestic and foreign prices of peanut oil, rapeseed oil, and soybean oil using the threshold autoregressive model to examine the APT of domestic and foreign price transmission [30]. Chen et al. studied the integration mode and price adjustment mechanism of the rice market in different regions of China, based on the cointegration test theory and the threshold autoregressive model [31]. Clearly, whether studying vertical asymmetry or spatial asymmetry price transmission effects, regardless of the kind of agricultural products used as the research subject, scholars have predominantly applied asymmetric error correction and threshold autoregressive models for empirical research.

In general, previous studies have examined the price transmission of dairy products, meat and eggs, vegetables, and grain agricultural products; however, few studies have investigated the price transmission of aquatic products, which is one of the most significant agricultural products in China. Furthermore, to identify the possible causes of the APT of agricultural products, some scholars have only conducted qualitative analyses from the perspective of economic theory. For example, Chen et al. qualitatively analyzed the reasons for the asymmetric price transmission of vegetable prices, and the results showed that the market power of farmers was weak due to dispersed production and the perishable characteristics of vegetables [32]. The difference in market power is considered to be one of the important reasons for asymmetric price transmission, but quantitative evidence for this effect is relatively minimal in the existing research.

The marginal contributions of this paper are as follows. First, in terms of research content, we endeavor to analyze the APT effect of Chinese aquatic products from wholesale to retail and its possible causes. Second, in terms of research methods, the nonlinear autoregressive distributed lag (NARDL) model is used to determine the presence of an asymmetric effect between wholesale and retail price transmission for aquatic products. This model describes the variable relationship from a nonlinear perspective, considering both short- and long-term APT. This study also applies the exponential generalized autoregressive conditional heteroskedasticity model to investigate the differences in market power between wholesalers and retailers of aquatic products.

3. Research Design

3.1. Theoretical Analysis

Based on the whole production process, most of China's aquatic products industrial chain can be divided into three sectors [33]. The upstream sector conducts seedling cultivation, feed production, and biological agent research; the middle sector includes farmers, who invest in production materials for breeding and aquatic product processing; and the downstream sector includes wholesalers and retailers, who sell products to terminal consumers. According to classical price and market theories [34], the lower bounds of aquatic product prices are determined by farmers' production costs. When the market price of an aquatic product per unit is lower than the unit variable cost invested by farmers, farmers will cease producing [35]. From the supply–demand theorem, we know that a dynamic game between supply and demand determines the upper limits of aquatic products prices in the aquaculture products market; therefore, when the wholesale and retail market of aquatic products are both perfectly competitive, the equilibrium price of aquatic products is correlated to the actual production cost. At this point, the production cost of upstream aquatic products can complete the real transmission from wholesale to retail, wherein the retail price of aquatic products equals the initial production cost of farmers plus the intermediate production cost, and retail price adjustments are consistent with wholesale price adjustments in speed, magnitude, and direction. However, the wholesale and retail markets of aquatic products are not perfectly competitive markets [36] and are also not completely integrated markets. Based on the above, Hypothesis 1 is proposed.

Hypothesis 1. *APT from wholesale to retail price occurs in the Chinese aquatic products market.*

The production side of aquatic products includes a large number of scattered fishermen, while the demand side involves a massive number of consumers in China, along with differing preferences, incomes, and consumption habits [37]. The direct connection between the production and consumer sides makes the transaction and information communication costs too high; thus, wholesalers solve this problem. By 2019, the number of large aquatic products wholesale markets in China reached 96, there were 57,492 stalls in the market, and wholesale aquatic products markets were predominantly concentrated in coastal cities (data source: Statistical Yearbook of China Commodity Exchange Market 2020). The number of wholesalers is far lower than that of retailers and fishermen. With access to market infor-

mation resources [38], aquatic products wholesalers have continuously strengthened their control over market prices. When production costs rise, the aquatic product wholesalers pass the higher prices on to retailers; when production costs fall, wholesalers try to maintain the original price level for higher profits. Based on the above analysis and the existing circumstances of China's aquatic products market, the second hypothesis is proposed.

Hypothesis 2. *APT from the wholesale sector to the retail sector is correlated to the market power difference between wholesalers and retailers in China's aquatic products market.*

3.2. Data Sources

Since the Chinese government vigorously promoted the policy of "replacing catching with raising" in the 1970s, national freshwater aquaculture production has increased annually, reaching 3088.89 million tons in 2020. Among freshwater aquaculture fish in China, carp is one of the fish with both high production and consumption [39]. In 2020, the total carp output was 28.967 million tons, accounting for 9.38% of the total output of freshwater fish. This study used the wholesale and retail prices of carp as the research objects, which are representative of the Chinese freshwater aquaculture market. The sample ranges from November 2009 to October 2021. The data for the wholesale price of carp came from the commercial forecast website of the Ministry of Commerce of the People's Republic of China, and the weekly price data were converted into monthly figures using the arithmetic average method. The retail price was obtained from the Statistics Bureau of the People's Republic of China website. The wholesale and retail price statistics were obtained from the primary freshwater fish-producing counties in China, and the unit is CNY/kg.

The descriptive statistics for carp wholesale prices, retail prices, and volatility are presented in Table 1. It is obvious that the mean and standard deviation of the retail price are greater than those of the wholesale price. Price fluctuation is more frequent and intense in the retail market, and it appears that the wholesalers may exacerbate the volatility of the market price. The JB statistics of the variables are greater than 0, indicating that the two groups' price data deviate from the standard normal distribution. Compared to the standard normal distribution, the two groups of variables have obvious "peak thick tail" characteristics.

Table 1. Statistical description of carp wholesale and retail prices and volatility in China.

Variable Name	Variable Code	Mean	Standard Deviation	Skewness	Kurtosis	Jarque–Bera
Wholesale price	LIWP	12.2964	1.3024	1.1892	8.3826	207.7701
Retail price	LIRP	13.5453	1.3900	0.8255	7.0846	116.4617
Wholesale price volatility	LIWPR	0.0035	0.0271	1.3433	8.4238	218.2868
Retail price volatility	LIRPR	0.0033	0.0237	1.1779	6.5471	108.0344

3.3. Research Method

(1) NARDL Model

Shin et al. creatively proposed the NARDL model to study this nonlinear effect [40]. Specifically, the NARDL model divides the change in independent variables into positive and negative change accumulation, which can be used to study the short- and long-term asymmetric relationships between variables. Compared to previous co-integration models, the NARDL model has two advantages [41]. First, the NARDL model relaxed the requirement that all time series should be in the same order of integration. The time series in the model can be I (1), I (0), or I (0) and I (1) together. Second, the NARDL model is an extension of the ARDL model, which can be applied to small sample data, and the model estimation is not affected by endogeneity problems.

We applied the NARDL model to the transmission of carp wholesale prices to retail prices to examine the vertical price transmission of aquatic products, first establishing Equation (1) to describe the long-term transmission effect of the wholesale price to the retail price in the carp market. The explained variable is the retail price of carp, and the

explanatory variable is the wholesale price of carp. As Equations (2) and (3) show, $LIWP_t^+$ represents the accumulation of the positive carp wholesale price, and $LIWP_t^-$ represents the cumulative negative change of the carp wholesale price; therefore, α^+ refers to the magnitude of the long-term relationship between positive shocks in retail and wholesale carp prices, and α^- denotes the long-term relationship between negative shocks in retail and wholesale carp prices.

$$LIRP_t = C_1 + \alpha^+ LIWP_t^+ + \alpha^- LIWP_t^- + \rho_t \quad (1)$$

$$LIWP_t^+ = \sum_{i=1}^{t} \Delta LIWP_t^+ = \sum_{i=1}^{t} \max(\Delta LIWP_t, 0) \quad (2)$$

$$LIWP_t^- = \sum_{i=1}^{t} \Delta LIWP_t^- = \sum_{i=1}^{t} \min(\Delta LIWP_t, 0) \quad (3)$$

Second, Equation (1) is extended to general the NARDL model (4), which considers both short- and long-term asymmetry. Specifically, Δ represents the first-order difference of variables, p and q refer to the maximum lag order of the variables LIRP and LIWP, respectively, the values of which are determined using the Akaike information criterion, and μ_t represents the residual. $\sum_{i=1}^{p-1} \varphi_i$ represents the coefficient of the lagged dependent variable. $\sum_{j=0}^{q-1} \pi_j^+$ and $\sum_{j=0}^{q-1} \pi_j^+$ are positive and negative coefficients of the exogenous variables, respectively.

$$\begin{aligned} LIRP_t = {} & C_2 + \eta LIRP_{t-1} + \omega^+ LIWP_{t-1}^+ + \omega^- LIWP_{t-1}^- + \sum_{i=1}^{p-1} \varphi_i \Delta LIRP_{t-i} \\ & + \sum_{j=0}^{q-1} (\pi_j^+ \Delta LIWP_{t-j}^+ + \pi_j^- \Delta LIWP_{t-j}^-) + \mu_t \end{aligned} \quad (4)$$

Finally, we tested the asymmetric transmission effect between wholesale and retail prices. Because $-\omega^+/\eta = \alpha^+$ and $-\omega^-/\eta = \alpha^-$, it is only necessary to test whether $-\omega^+/\eta$ and $-\omega^-/\eta$ are significantly equal in the long term. If they are significantly different, a long-term asymmetric transmission effect is revealed. Correspondingly, the asymmetric effect of short-term price transmission is realized by testing $\sum_{j=0}^{q-1} \pi_j^+ = \sum_{j=0}^{q-1} \pi_j^-$. If the equation is not equal, this indicates an asymmetric effect of short-term price transmission.

(2) Asymmetric Conditional Heteroskedasticity Model

The exponential generalized autoregressive conditional heteroskedasticity (EGARCH) model is a typical asymmetric conditional heteroskedasticity model. At first, this approach was used to study the impact of good or bad news on stock returns caused by stock price changes in the financial market [42], and it has also been widely used to investigate the asymmetry of price fluctuations on agricultural products [43]. Zheng et al. and Rezitis et al. have further broadened the application of the EGARCH model [44,45]. The model can also be applied to characterize the positive and negative asymmetry of agricultural product price fluctuations, wherein positive asymmetry signifies that the volatility of the price series reacts more strongly to price rise, indicating that manufacturers in this sector have a certain market monopoly power and implying that manufacturers use the information regarding price rise to raise price levels; negative asymmetry indicates the opposite. Consequently, this study selected the EGARCH model to compare and analyze the market power between wholesalers and retailers.

We first established the mean equation of carp price volatility. The white noise test results show that carp price volatility is a non-random time series, so the ARMA model can be established to fit the mean equation. According to the minimum information criterion, the mean equation was set as Equation (5). The dependent variable is the price volatility of carp, and the independent variable is the price volatility and random disturbance term with one-stage lag. PR_t represents the price volatility of carp at time t, and ε_t refers to the residual term at time t.

$$PR_t = \alpha PR_{t-1} + \beta \varepsilon_{t-1} + \varepsilon_t \quad (5)$$

Second, we further applied the variance equation of the EGARCH model, where σ_t^2 denotes conditional variance, as shown in Formula (6). When ε_{t-1} is positive, the impact of positive shocks on price volatility is θ+κ; when ε_{t-1} is negative, the impact of negative shocks on price volatility is θ−κ. Accordingly, if the coefficient κ is significantly non-zero, this indicates that the price fluctuation is asymmetric. If $\kappa > 0$, the price fluctuation caused by good information is larger than that caused by bad information. If $\kappa < 0$, the price fluctuation caused by bad information is larger than that caused by good information.

$$\mathrm{Ln}\left(\sigma_t^2\right) = \gamma+\theta\left|\frac{\varepsilon_{t-1}}{\sigma_{t-1}}\right|+\kappa\frac{\varepsilon_{t-1}}{\sigma_{t-1}}+\delta\ln\left(\sigma_{t-1}^2\right) \quad (6)$$

4. Empirical Results

4.1. Augmented Dickey–Fuller Stationary Test

To avoid the false regression problem, this study used the augmented Dickey–Fuller (ADF) test method to determine the stability of variables. The standard of optimal lag order uses the Schwarz information criterion. The test results are presented in Table 2, indicating that the wholesale and retail price series of carp were determined to be stationary time series, and there was no second-order single-integer time series, which meets the prerequisite of NARDL modeling. In addition, under the critical value of 5%, the wholesale and retail price volatility series of carp are stationary time series without trends and constant items, which can further establish EGARCH models for subsequent empirical analysis.

Table 2. Stationarity test of variables.

Variable	ADF Statistics	Form of Test (c, t, p)	5% Critical Value	*p*-Value	Stationarity
LIWP	−4.7121	(1,1,1)	−3.4418	0.0010	yeas
LIRP	−4.1603	(1,1,1)	−3.4418	0.0066	yeas
LIWPR	−7.2759	(0,0,1)	−1.9431	0.0000	yeas
LIRPR	−7.1912	(0,0,0)	−1.9431	0.0000	yeas

Note: In the test form (c, t, p), c represents the constant term, t represents the time trend term, and p represents the lag order.

4.2. NARDL Model Estimation Results

(1) Bounds Test

We used a boundary test to determine whether there is a long-term nonlinear cointegration relationship between wholesale and retail carp prices [46]. The null hypothesis is that a linear cointegration relationship between wholesale and retail carp prices exists. Table 3 presents the empirical results. At a 5% significance level, the value of the f-statistic is greater than the upper bound, rejecting the null hypothesis. This indicates that there is a nonlinear cointegration relationship between wholesale and retail carp prices in the long term, which requires further testing to determine whether the cointegration relationship is symmetric. Furthermore, the series of carp wholesale and retail prices are suitable for analysis using the NARDL model, and the price of carp has a significant correlation with the vertical transmission from wholesale to retail, which is consistent with the objective reality in China.

Table 3. Bounds test results.

	f-Statistic	Confidence Level	Lower Bound	Upper Bound
Value	3.887625	5%	3.1	3.87

(2) Model Estimation Results

Table 4 presents the estimation results of the NARDL model from wholesale prices to retail prices in the carp market. The long-term transmission coefficient of the wholesale

price, α^+ and α^-, passed the statistical test at a 5% confidence level. Specifically, α^+ is equal to 0.6231, indicating that when the other conditions remain unchanged, each 1% increase in wholesale price resulted in a 0.6231% increase in the carp retail price. Similarly, α^- is 0.5160, indicating that every 1% decline in the wholesale price resulted in a 0.5160% decline in carp retail price. It is clearly evident that the long-term transmission coefficient of positive shocks in the carp market is stronger than that of negative shocks, which is consistent with the actual state of the "easy to rise and difficult to fall" carp price transmission phenomenon, indicating that the long-term asymmetric effect of price transmission occurs in carp wholesale and retail price transmission.

Table 4. NARDL model estimation results.

Variable	Coefficient	Standard Deviation	t-Statistic	*p*-Value
C_2	1.8154	0.5647	3.2147	0.0016
$LIRP_{t-1}$	−0.1684	0.0553	−3.0458	0.0028
$LIWP^+_{t-1}$	0.1049	0.0525	1.9985	0.0477
$LIWP^-_{t-1}$	0.0869	0.0500	1.7393	0.0842
$\Delta LIWP^+_t$	0.8698	0.0702	12.3840	0.0000
$\Delta LIWP^-_t$	0.6367	0.1250	5.0937	0.0000
C_1	10.7798	0.3407	31.6368	0.0000
$LIWP^+_t$	0.6231	0.1411	4.4144	0.0000
$LIWP^-_t$	0.5160	0.1620	3.1855	0.0018

Table 5 presents the asymmetric test of the NARDL model for wholesale-to-retail carp price transmission. At a 1% significance level, the results demonstrate that the transmission of carp price was significantly asymmetric from wholesale to retail in both the short and long term. In other words, the vertical price transmission of carp has an asymmetric relationship in the transmission degree and transmission speed between different sectors. The existence of APT is one of the primary manifestations of low market efficiency, indicating that the degree of integration in China's aquatic market can be further strengthened to make full use of market forces to achieve Pareto optimality.

Table 5. Test results of short- and long-term asymmetric relationships.

	t-Statistic	f-Statistic	*p*-Value
Long-term asymmetric relationship	9.2325	85.2386	0.0000
Short-term asymmetric relationship	−4.4613	19.9034	0.0000

To examine the asymmetric effect from wholesale price to retail price in more detail, we constructed a dynamic multiplier effect diagram, as shown in Figure 2, which reveals the negative or positive change curve representing the response of the retail price to declines or rises in the wholesale price. The response of the carp retail price to decreases in the wholesale price presents a short-term downward trend, reaching a peak in the second month, and remaining around −0.5 in the long term. The response of the carp retail price to increases in the wholesale price presents a short-term upward trend, reaching a peak in the second month, and continuing at around 0.6. The asymmetry curve indicates that in comparison to the decline of the wholesale price of carp, the retail price has a greater change related to the increase in the wholesale price, demonstrating that carp price has asymmetry price transmission from the wholesale price to the retail price in both the short and long term, verifying Hypothesis 1.

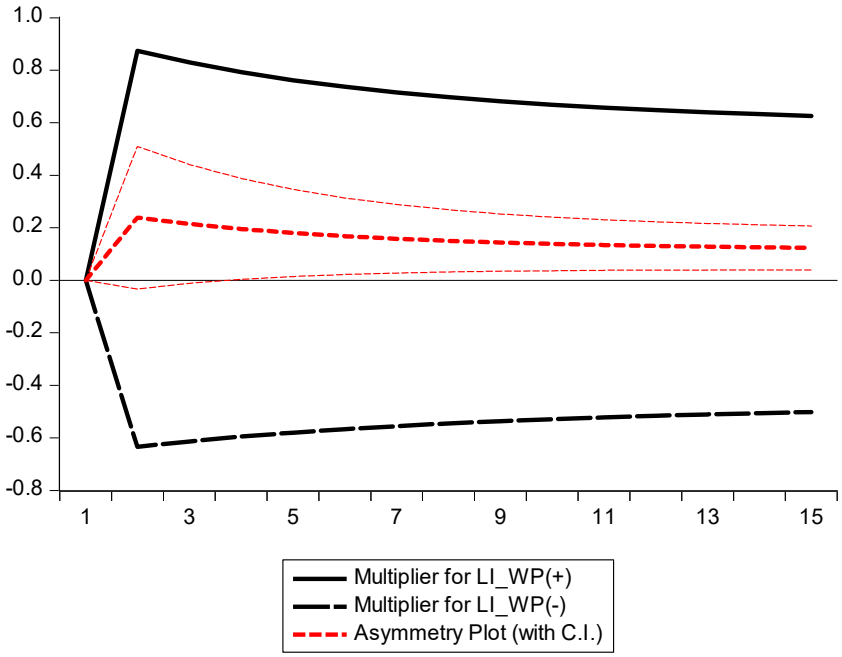

Figure 2. Cumulative effect of wholesale price on retail price.

4.3. Estimation Results of EGARCH Models

The above empirical analysis demonstrates that the game between supply and demand forms the price in the carp wholesale market, but this price is not evenly transmitted to the carp retail market, resulting in the uneven distribution of benefits. The root cause of this phenomenon is incomplete competition in the market. The production and retail sectors are closer to a perfectly competitive market in China. The number of fishermen is relatively large and scattered, and the products have certain homogeneous characteristics. Consequently, we further analyzed the influence of market power differences between wholesalers and retailers of aquatic products using the EGARCH model. The ARCH-LM test was carried out for the residual term of the constructed mean equation, and the test results are presented in Table 6. Obviously, at a 6% confidence level, both the wholesale and retail price volatility of carp have an ARCH effect. That is, the price fluctuation of carp is clustered, which meets the premise of establishing the EGARCH model below.

Table 6. ARCH effect test results of carp price volatility.

Variable	Lags	F-Statistic	*p*-Value	Obs × R-Squared	*p*-Value	ARCH Effect
LIWPR	3	22.3388	0.0000	62.2392	0.0000	yes
LIRPR	1	3.8492	0.0518	3.7998	0.0513	yes

The estimation results of the EGARCH model are presented in Table 7. When examining the wholesale or retail prices of carp, if the estimated value of the coefficient κ is significantly non-zero in the EGARCH model, this indicates that the response of price fluctuations is asymmetric with the news of a rise or fall in the wholesale and retail markets. The impact of positive shocks (good news) is 0.1534 for the volatility of wholesale prices, and the impact of negative shocks (bad news) is 0.0293 for the volatility of wholesale prices. Accordingly, the impact of positive shocks (good news) is −0.1353 for the volatility of retail prices, and the impact of negative shocks (bad news) is 0.5837 for the volatility of retail prices. Clearly, there is a positive asymmetry in the fluctuation of the wholesale price, while there is a negative asymmetry in the fluctuation of the retail price. To some extent, this suggests that carp wholesalers have a certain market bargaining power, and use the good news of increasing prices to raise prices to obtain higher profits.

Table 7. Estimation results of EGARCH model.

Coefficient	Volatility Rate of Wholesale Price	*p*-Value	Volatility Rate of Retail Price	*p*-Value
α	0.8244	0.0000	0.5163	0.0000
β	−0.6674	0.0000	0.1134	0.0534
γ	−0.2315	0.0014	0.0001	0.0008
θ	0.0914	0.0036	0.2242	0.0245
κ	0.0621	0.0030	−0.3595	0.0008
δ	0.9825	0.0000	0.6200	0.0000
θ+κ	0.1534	—	−0.1353	—
θ−κ	0.0293	—	0.5837	—

In summary, our results demonstrate that wholesalers have strong bargaining power and certain control over prices in the transmission of carp prices from wholesale to retail. Due to the characteristics of aquatic products being perishable, farmers must sell products to wholesalers to obtain some benefits; thus, wholesalers occupy a greater advantage in the bargaining process with farmers. Notably, as a link between farmers and retailers, aquatic wholesalers receive market information more expediently and accurately, thereby enhancing their bargaining power. Chinese carp retailers are in various forms, such as agricultural markets and supermarket chains, and are highly market-oriented and only able to passively accept upstream price levels. This explains the key reason for the asymmetric effect of vertical transmission of carp prices, wherein, when good news appears in the market, carp wholesalers leverage their market position to raise the price of carp. Therefore, Hypothesis 2 is validated.

5. Discussion

In 2021, China's aquaculture industry still maintained a good development trend. Specifically, there were 11.85 million national fishery practitioners, while the per capita net income of fishermen reached CNY 23,400; in addition, China's total output of aquatic products reached 66.90 million tons, while the per capita share of aquatic products was 47.36 kg (data source: China Fisheries Statistics Yearbook 2022). However, due to the impact of the COVID-19 pandemic and the volatile economic environment, the prices of production factors, such as labor, water, electricity, land, and bait, have continued to rise [47], which has severely reduced the profit of the fishery industry. Some farmers produce on a small scale, and there are problems such as irregular breeding management. More importantly, the price fluctuation of aquatic products is restricted by many factors. Firstly, the economic environment is the basic reason for price fluctuation, such as monetary policy [48] and economic policy uncertainty [49]. Secondly, the temporary impact of uncertain events is the direct cause of the sharp fluctuation of aquatic product prices in the short term, such as the COVID-19 epidemic [50]. To keep the price of agricultural products stable, the State Council executive meeting on 24 August 2021, decided to carry on with the "policy package". In 2022, CNY 10 billion in agricultural subsidies will be issued, in addition to the 30 billion that has been provided.

On the basis of previous studies, we analyzed the asymmetric effect of price transmission of aquatic products from wholesale to retail. Compared to Bai's research on the pork market [18] and Dong's research on the egg market [12], we took into account both short-term asymmetric price transmission and long-term asymmetric price transmission. The results show that when other conditions remained unchanged, each 1% increase in the wholesale price resulted in a 0.6231% increase in the carp retail price, and every 1% decline in the wholesale price resulted in a 0.5160% decline in the carp retail price. That is to say, there was also an asymmetric effect of price transmission on the aquatic product market, which is consistent with the discoveries of the milk market [17] and the grain market [20]. In order to better understand the formation of asymmetric price transmission, we applied the exponential generalized autoregressive conditional heteroskedasticity model to investigate the differences in market power between wholesalers and retailers of aquatic products,

which supplements the research on causes of asymmetric price transmission [32] from a quantitative perspective.

6. Conclusions and Recommendations

6.1. Research Conclusions

Based on the above research, we draw three conclusions. First, carp wholesale and retail prices have a nonlinear long-term cointegration relationship, and wholesale and retail prices are significantly correlated; second, whether in the short or long term, the transmission of carp prices is significantly asymmetric from wholesale to retail. Specifically, there are asymmetric effects of transmission in degree and transmission speed. Third, wholesalers have strong bargaining power in the price transmission of the carp industrial chain. To some extent, they can leverage information access to control the price level. China's carp retail sector is highly market-oriented, and carp retailers can only passively accept the price level established by the upstream sector. This is the primary reason for the asymmetric effect of the vertical transmission of carp prices.

6.2. Policy Suggestions

(1) Improve the Circulation Mechanism of Aquatic Products and Strengthen the Organization of Producers

The extension of the aquatic products industrial chain is an inevitable requirement for its fresh sales requirements; however, with the expanding market power of middle wholesalers, welfare levels have severely diminished for upstream farmers and consumers, and the market is far from Pareto optimality. It is evident that the government should encourage and guide aquatic producers to make full use of the power of e-commerce platforms and take advantage of the developmental advantages of China's cold chain logistics industry to realize the production and marketing of farmers and benefit final consumers. In addition, Chinese aquaculture producers' current production activities are both independent and highly dispersed. By establishing production cooperatives and other measures to connect individuals in the field, producers can enhance their bargaining power in market competition to improve production enthusiasm and benefits and address the existing asymmetry.

(2) Strengthen the Supervision of the Aquatic Products Wholesale Market and Formulate Relevant Laws and Regulations

At present, the target objects of agricultural policies are primarily aquaculture farmers in the field of aquatic products in China, through initiatives such as the provision of fish seedling subsidies. Although the farmers' production costs will be reduced, intermediate wholesalers will leverage their market power to raise prices; thus, eventually, consumers will still perceive aquatic products prices as "easy to rise and difficult to fall." In addition, China's current agricultural product circulation market is an area easily neglected by antitrust enforcement [51]. The government should improve and strengthen the supervision of the aquatic products market, particularly the supervision of the aquatic products wholesale market, through initiatives such as formulating maximum wholesale price limits. In recent years, the "Agricultural wholesale market construction and management guidelines (trial)" has achieved initial results in China [52]. The Chinese government should further introduce a "Law on Wholesale Market of Agricultural Products" to clarify the entry and exit mechanisms and market standards of relevant subjects in the wholesale market.

(3) Establish an Aquatic Product Price Announcement Platform to Accurately Guide Production and Consumption

The final retail price of aquatic products is jointly affected by the prices in all sectors of the industrial chain, and the distribution of price information is uneven among various actors. In particular, the channels are scarce for producers to obtain price information, and this blocked price transmission has severely damaged aquatic farmers' interests. Therefore, the government should establish a public information platform to include the prices of production materials, such as seedlings, bait, and biological agents, in the price of aquatic

products, and then from the wholesale price to the final retail price of aquatic products. Aquaculture producers will be enabled to reasonably arrange the production inputs for the next production cycle according to prices transmitted to prevent the phenomenon of "cheap grain hurts the farmer," which will promote the steady, equitable growth of farmers' incomes and the healthy development of the aquatic industry.

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