Research on Price Fluctuation in the International Grain Market of Fish Feedstuff and Local Price of Milkfish in Taiwan

Jia-Jan Lee, National Chiayi University, Taiwan
Yi-Jing Su, National Taitung University, Taiwan
Chao-Chang Chiu, Yuan Ze University, Taiwan
Meng-Long Shih, Corresponding Author, National Taitung University, Taiwan
Wei-Yu Hu, China University of Science and Technology, Taiwan

ABSTRACT

The purpose of this research is to explore the influence of price fluctuation in the international grain market on fish feedstuff and on the local price of milkfish by constructing the DCC-GARCH model through an empirical research method based on setting the price of soybean flour and the local price of milkfish as the main variants. As shown in the statistical result, it is found that the price fluctuation in the international grain market exerts a positive direct and indirect passing effect on the raw material price of feedstuff and the local price of milkfish, while a bi-directional passing effect occurs between the price of milkfish and the price of soybean flour. As for the price fluctuation, there is both a short- and long-term impact between the price of milkfish and soybean flour. Their earlier price will result in a marked influence on their current price in which a bi-directional passing effect will take place as well.

Keywords: *International grain market, price of soybean flour, local price of milkfish, price passing effect*

INTRODUCTION

As the swell of the global population continues, demands from various social aspects are increasingly soaring. As a sea girt marine state, aquaculture in Taiwan is an important industry and is distinguished in the international community. Milkfish, which is widely raised in the Asia-Pacific area, is a very important kind of fish in Taiwan because both its culture area and output top the ranks in Taiwan. The multiplication and fry-breeding, cultivation, spawn, fecundation, raising, and nurturance of milkfish can be achieved ectogenetically in Taiwan.

On the breeding cost of milkfish, it is produced directly using feedstuff, fry, water, and electricity, in which feedstuff takes a bigger proportion, accounting for about 49% of the cost. Therefore, the price of feedstuff directly influences the price of milkfish. Mainly imported raw materials of fish feedstuff are made from fish meal, soybean flour, cornmeal blended with husk, fish oil, and other nutrients in which soybean flour is the higher additive in feedstuff. Hence, the price of soybean flour in the international grain market is the focus of this research.

The price of grain has been soaring in recent years because of the increase in international demand for consumption and energy use. Let us take soybean flour for example. Due to the fact of the decrease of soybean production, the imported price of soybean from United States has recently presented a tendency to increase gradually. The average forward price of soybean in 2005 was US 526 cents per bushel, US 587 cents in 2006, and US 700 cents in 2007. Even more, its price soared to US 1,259 cents per bushel in 2008, which is 40% greater than that in 2007, due to marked demand and the shrinking output from its importing countries. This indicates that the drastic fluctuation of soybean price will exert cost pressure to the importing countries. As the price of raw material rises, the price fluctuation of fish feedstuff will multiply the risk in aquaculture and consequently lead to the soaring of its local price.

Whether it is domestic or export sales, milkfish still occupies the leading position. Price fluctuation of the raw material also leads to a high fluctuation of the finery products. Therefore, by analyzing the price fluctuation in the international grain market of soybean price and the local price of milkfish in Taiwan, the purpose of this research is to find the fluctuation and interrelations among the three factors, providing reference for the related departments and fishery staff to take good command of the local price of milkfish.

LITERATURE REVIEW

Study Related to Price Fluctuation

Studies on price fluctuation are extensive, but the passing effect of price fluctuation is the main focus of stock and other economic markets (Lee, 2009； Patricia, 2009； Kappou, Brooks, and Ward (2010). Kanamura (2009) applied the supply and demand fluctuation model on the price of energy and found that after exponential transformation, the supply curve will reflect the reversed lever effect in the energy market, while there is a positive relation between the price of energy and its fluctuation. Narayan and Narayan (2010) investigated the oil price impacts on the Vietnam stock price by analyzing data from 2002 to 2008 and found that overall stock price in Vietnam will fluctuate as the oil price sways. On the other hand, it is worth mentioning that the inflow of funds from both domestic investment of Taiwan banks and foreign securities is another major factor influencing the stock price in Vietnam.

In brief, although wide-ranging empirical research exists on price fluctuation, studies on the interrelations between grain price and feedstuff are rare. In previous research, the single variable model is usually applied for the empirical analysis, which cannot be used for the interrelations in transnational markets interflow, as the interactions occur among different markets. Especially on the drastic price change in the raw materials market, the Bivariate model is necessary to analyze the price passing effect between the international market and the Taiwan market. Therefore, DCC-GARCH Multi-variable Mode is adopted to investigate how the price of international grain market exerts an impact on the raw materials of fish feedstuff and local price of milkfish and to determine the correlations among price fluctuations.

Word-of-Mouth and Online Word-of-Mouth

Milkfish is the representative fish in Taiwan’s aquaculture.Due to the growing season and climate limitation, the price of milkfish always fluctuates. Therefore, a steady price of milkfish plays a key role in Taiwan’s aquaculture from the viewpoint of long-term development.

Xiao, Chen, and Ding (2003) made an analysis and forecast on the price, output, temperature, and feedstuff cost of milkfish in Taiwan based on a simple forecast model, recursive forecast, and ARIMA, indicating that the imbalance between production and sales is the reason for the fluctuating price of milkfish. Moreover, it has been found that there is no distinctive correlation between the anticipated wholesale price and the volume supplied at that time, while earlier volume supplied and production cost exert a positive impact on the volume supplied at current stage. In fact, this method forecasts the market price much more accurately than the producer and transporter of the aquaculture products, which may be a result of the price discovery scheme confined in the supply-demand and the producer failing to master the market price accurately.

Briefly, this thesis focuses on the forecast price of milkfish at the supply and demand level as well as the investigation of a single variable. After all, output is one of the causes that influence the actual price. Hence, this research intends to investigate the passing effect of international grain price exerted on the raw materials of feedstuff and local price in Taiwan, and to provide references for the related departments to analyze the correlations between the feedstuff price and local price of the milkfish.

RESEARCH METHOD

This study intends to investigate the passing effect of international soybean price on feedstuff price and local price of milkfish in Taiwan using the analytical method of time series. As the time series provides non-stationary data, the traditional regression estimating method is improper to be used. By not considering the non-stationary characteristic, spurious regression will be produced along with a wrong causality. In view of this, whether the serial data are stationary or not should be ensured. The following are the various models used in this study:

Unit Root Test

Generally, the unit root test is taken as a judging tool to examine whether the series is stationary. If the result obtained is non-stationary, differentiation should be conducted to make the series stationary. The Augmented Dickey-Fuller Test (ADF) is used to examine whether a series is stationary or not.

1. Random walk

$$\Delta y_t = \gamma y_{t-1} + \sum_{i=1}^{p} \beta_i \Delta y_{t-i} + \varepsilon_t$$

2. Random walk with drift

$$\Delta y_t = \alpha_0 + \gamma y_{t-1} + \sum_{i=1}^{p} \beta_i \Delta y_{t-i} + \varepsilon_t$$

3. Random walk with drift around a stochastic trend

$$\Delta y_t = \alpha_0 + \gamma y_{t-1} + \alpha_2 t + \sum_{i=1}^{p} \beta_i \Delta y_{t-i} + \varepsilon_t$$

Test for ARCH Effect

The coefficient obtained under an irregular regression residual conditional variance is ineffective. Therefore, what should be done first is to judge whether the time series possesses the ARCH effect. If it does, the least square method adopted in traditional regression cannot be utilized to conduct the model match, rather the ARCH or GARCH model should be used. The Lagrange Multiplier (LM) established by Engle (1982) is mainly used to test for the ARCH effect.

The LM method is used to test the ARCH model effect to examine whether the residual square regression coefficient in different stages is distinctive. Its testing hypothesis is as follows:

$H_0 : \alpha_1 = \alpha_2 = \alpha_3 = ... = \alpha_q = 0$.

The following are the testing procedures:

(a) Apply the OLS method to estimate the proper mean equation $y_t = X_t \hat{a}$, where $\hat{a}$ represents the coefficient after OLS estimation, and calculate the residual term. The residual square of estimation equation $\hat{\varepsilon}_t^2$ is then determined.

(b) Take $\hat{\varepsilon}_t^2$ to the drift and lag of q times as regression to calculate the value of R^2. The estimation equation is $\hat{\varepsilon}_t^2 = a_0 + \hat{\varepsilon}_{t-1}^2 + \hat{\varepsilon}_{t-2}^2 + ... + \hat{\varepsilon}_{t-q}^2$.

(c) Multiply R^2 to the total samples, T, to obtain the statistics of LM, which is the gradual distribution of the chi-square. The obedience of the degree of freedom is q, that is, $TR^2 \sim \chi^2(q)$

When finishing the testing procedure, LM statistics will be arranged according to the chi-square distribution table. If LM > critical value of $\chi^2(q)$, then reject the hypothesis of H_0, which indicates that this time series has the ARCH effect.

CCC-GARCH Model

As the single variable GARCH model will ignore the structure of price variables and will lead to the error of the estimated result, the double variable of constant conditional correlation (CCC) related to the fixed conditional GARCH model can be applied when considering the double variable GARCH model. In the past, CCC-GARCH model was widely used for empirical research on financial assets. However, it will result in a wrong estimation when it is employed to conduct a relative analysis under a condition of drastic price fluctuation. Tse (2000) found a robust condition using the LM testing method. When the time series provides non-stationary data, it will produce a better testing performance. Therefore, the LM testing method of TSE (2000) was employed in this study to verify whether related coefficient between the fish feedstuff and price of milkfish conforms to the hypothesis of CCC. Its mode of construction is as follows:

$$\rho_{xy,t} = \rho_{xy} + \delta_{xy} r_{x,t-1} r_{y,t-1},$$

where

$\rho_{xy,t}$ is the related coefficient of the dynamic condition of price data of two time series.

ρ_{xy} is the related coefficient of the fixed condition of price data of two time series.

$r_{x,t-1}$ is the price of x series

$r_{y,t-1}$ is the price of y series

Its null hypothesis is as follows:

$H_0 : \delta_{xy} = 0$

$H_1 : \delta_{xy} \neq 0$

When the testing result rejects H_0, it indicates that there is no fixed conditional characteristic between the two time series under which DCC-GARCH model should be adopted. On the contrary, if it accepts H_0, it indicates that the series possesses the characteristic of a fixed condition under which the CCC-GARCH model is adopted.

DCC-GARCH Model

The multivariable GARCH model can be applied to research on dynamic relations and serial data because it can describe the fluctuation that changes as time goes on. Wang and Nguyen Thi (2007) utilized the DCC-DARCH model to estimate the passing effect between the dynamic conditional correlation coefficient and structural transformation of US stock markets. The multivariable GARCH model is so complicated, and it has inconsistent standard deviations related to its conditional coefficients. Therefore, Engle (2002) produced a new mode of correlation dynamic conditions to solve the complicated parameter estimation using the two-phase estimation method. The correlation efficient between variables changes as time goes on, which means that the correlation dynamic coefficient is influenced by past information. The dynamic settings of various elements in the conditional covariance matrix H_t are as follows:

$$H_t = D_t R_t D_t$$

$$D_t = diag(\sqrt{h_{ii,t}}, \sqrt{h_{jj,t}})$$

$$\varepsilon_t = D^{-1} r_t$$

$$R_t = (Q_t^*)^{-1} Q_t (Q_t^*)^{-1}$$

$$Q_t^* = diag(\sqrt{q_{ii,t}} \sqrt{q_{jj,t}}),\ Q_t = \overline{Q}(1 - \sum_{m=1}^{M} \alpha_m - \sum_{n=1}^{N} \beta_n) + \sum_{m=1}^{M} \alpha_m (\varepsilon_{t-m} \varepsilon_{t-m}^{'}) + \sum_{n=1}^{N} \beta_n Q_{t-n}$$

where H_t is the conditional covariance matrix; D_t is the diagonal matrix, which is the conditional standard deviation of the mono-variant GARCH model obtained as time goes on; R_t is the dynamic correlation coefficient matrix; Q_t is the covariance matrix; $\overline{Q}$ is the non-conditional covariance of the standardized residual term;

α_m and β_n are the prior residual quadratic term and prior conditional variance coefficient of multivariate GARCH model, respectively; M and N are the lag; and Q_t^* is the diagonal matrix formed by the square root of the catercorner in the Q_t matrix.

The DCC model can reduce the complicated calculation when the CCC model processes multivariate data as well as provides a more elastic covariance matrix. The following is the log-likelihood function model of the DCC model.

$L = -\frac{1}{2}\sum_{t=1}^{T}(2\log(2\pi) + 2\log|D_t| + \log(|R_t| + \varepsilon' R_t^{-1}\varepsilon_t)$ To find the covariance matrix H_t required in the estimation of the DCC model, the maximum approximation estimation method is used to calculate the price of specific assets of the mono-variant GARCH parameters. Subsequently, a standardized residual term is worked out according to the parameters and then calculated to the price of assets $\overline{Q}$, whose restrictive conditions are $\alpha_m \geq 0$, $\beta_n \geq 0$, $\sum_{m=1}^{M}\alpha_m + \sum_{n=1}^{N}\beta_n < 1$. Finally, the values of α_m and β_n are estimated in the dynamic conditional correlation coefficient model.

Setting of Empirical Model

The purpose of this study is to investigate the passing effect of international grain price on fish feedstuff and its local price in Taiwan using the method of the DCC-GARCH bivariant model to make a relevant empirical analysis. Correlation variables are classified as shown in Table 1.

Table 1: Definition of the model variables, dada resource, and data processing method

Name of the Variable	*Sign*	*Unit*	*Data Processing*	*Material Reference*
Local Price of Milkfish	TFMP	TWD/Kg	Monthly price	Global Information Net of Fish Products
Price of Soybean flour in Taiwan	TSBP	TWD/Kg	Monthly Price	Price Inquiry System of Livestock Product
Forward Price of American Soybean	UFSB	Cent/Bushel	Price in Several Months	Data Stream Database
Exchange Rate of TWD and USD	EXRT	TWD/USD	Monthly Price	Data Stream Database
Spot Price of Taiwan Soybean	TISB	TWD/Kg	Monthly Price	Central Livestock Committee

Model setting is as follows according to the exogenous and endogenous variables of international grain price and local price of milkfish in Taiwan.

$$\Delta TMFP_t = c + a_i\sum_{j=1}^{m}\Delta TMFP_{t-j} + b_i\sum_{i=1}^{n}\Delta TSBP_{t-i} + \varepsilon_{1,t} \quad (3.5.1)$$

$$h_{TMFP\_TMFP,t} = \varpi_{1,0} + \sum_{i=1}^{p1}\alpha_{1,i}\varepsilon_{TMFP,t-i}^2 + \sum_{j=1}^{q1}\beta_{1,i}h_{TMFP\_TMFP,t-j} \quad (3.5.2)$$

$$\Delta TSBP_t = c + d_i\sum_{i=1}^{n}\Delta TSBP_{t-i} + e_i\sum_{j=1}^{m}\Delta TMFP_{t-j} + \lambda_1 TISB + \lambda_2 UFSB + \lambda_3 EXPT + \varepsilon_{2,t} \quad (3.5.3)$$

$$h_{TSBP\_TSBP,t} = \varpi_{2,0} + \sum_{i=1}^{p2}\alpha_{2,i}\varepsilon_{TSBP,t-i}^2 + \sum_{j=1}^{q2}\beta_{2,j}h_{TSBP\_TSBP,t-j} \quad (3.5.4)$$

$$q_{TMFP\_TSBP,t} = \overline{\rho}_{TMFP\_TSBP} + \psi(z_{TMFP}z_{TSBP} - \overline{\rho}_{TMFP\_TSBP}) + \zeta(q_{TMFP\_TSBP,t-1} - \overline{\rho}_{TMFP\_TSBP})$$

$$\rho_{TMFP\_TSBP,t} = \frac{q_{TMFP\_TSBP,t}}{\sqrt{q_{TMFP\_TMFP,t}\,q_{TSBP\_TSBP,t}}} \quad (3.5.5)$$

In the variables, Formula 3.5.1 and 3.5.3 are the reactive equations for milkfish price and soybean flour price; a_i and d_i represent the influence exerted by prophase milkfish price and soybean flour price upon the anaphase milkfish price and price fluctuation of soybean flour; b_i represents the influence exerted by the prophase price fluctuation of soybean flour upon the current local price of milkfish; e_i represents the influence exerted by the prophase fluctuation of the local price of milkfish upon the current fluctuation of soybean flour; and λ_1, λ_2 and λ_3 represent the influence exerted by the current price of soybean flour in Taiwan, forward price of US soybeans, and fluctuation of exchange rate upon the price fluctuation of soybean flour in Taiwan, respectively..

Formulae 3.5.2 and 3.5.4 represent the conditional variance equation of the local price of milkfish and price of soybean flour in Taiwan, respectively, demonstrating the fluctuation and passing effect; $\alpha_{1,i}$ and $\alpha_{2,i}$ represent the continual effect of the short impact of the local price of milkfish; and $\sum \alpha_{1,t} + \beta_{1,t}$ and $\sum \alpha_{2,t} + \beta_{2,t}$ are the continual effect of the long impact of local price of milkfish and price fluctuation of soybean flour, respectively.

In Formula 3.5.5, $q_{TMFP\_TSBP,t}$ represents the covariance of the local price of milkfish and soybeans in Taiwan, $\overline{\rho}_{TMFP\_TSBP,t}$ is the dynamic conditional correlation coefficient, ψ represents the influence exerted by the prophase standardized residual term upon the dynamic conditional correlation coefficient between two time series, and ζ represents the inter-temporal persistent effect of dynamic conditional correlation coefficient between two time series.

RESEARCH RESULTS

Result of Unit Root Test

Unit root test was conducted in this study to judge the correlations between the local price of the milkfish and the price of soybean flour. In Table 2, the price of milkfish and soybean flour is below the level of significance of 10%, 5%, and 1%, which means the original series cannot reject the null hypothesis, and the series is non-stationary. Unit root exists in both prices of milkfish and soybean flour. To avoid the false regression, the series has to make a difference. After the first-order difference, both prices of milkfish and soybean flour reject the null hypothesis, and the series is in a stationary state. Data obtained after first-order difference were used in the subsequent empirical research.

Table 2: Unit root test for the local price of milkfish and the price of soybean flour

Price	*Original Reference*			*Data after Difference*		
	Non-drift and Trend	***Drift and Non-trend***	***Drift and Trend***	***Non-drift and Trend***	***Drift and Non-trend***	***Drift and Trend***
Local Price of Milkfish	-0.163 (6)	-2.378 (6)	-2.376 (6)	-6.156*** (5)	-6.498*** (5)	-6.469*** (5)
Price of Soybean flour	0.759 (7)	-1.101 (7)	-2.748 (7)	-3.248*** (6)	-3.402*** (6)	-3.388** (0)

Note: 1.The numbers in brackets represent lag numbers.
2. *** represents level of significance of 1%, ** refers to level of significance of 5%.

Heterogeneity Test of the Residual Term

The heterogeneity test of the residual term in this study is presented in Table 3, which shows that the local price of milkfish is below the level of significance at 10% and 5%, the price of soybean flour is below 10%, 5%, and 1%, and the LM testing value for the price of milkfish and soybean is 25.32 and 19.309, respectively. The testing result shows that the residual variances of the price of milkfish and soybean flour are with a characteristic heterogeneity, that is, the heterogeneity test of the two prices reflects the ARCH effect. Therefore, it is fit for the allocation analysis with the GARCH model.

Table 3: Heterogeneity testing of the residual item on the price of milkfish and soybean flour

Verification of Heterogeneity / *Price*	*Testing for LM*
Local Price of Milkfish	25.32***
Spot Price of Soybean	19.309***

Note: 1. *** represents level of significance of 1%, ** refers to level of significance of 5%.

Descriptive Statistic Result

The purpose of this research is to investigate the passing effect of international grain price on fish feedstuff and local price of milkfish in Taiwan based on monthly data from January 1999 to April 2009 with a total of 124 samples.

From the descriptive statistics, Table 4 shows the changes in the statistics of the variable in the sample period. The local mean price of milkfish is TWD56.897 per kg, while the soybeans in Taiwan cost TWD10,237 per kg. The current price of soybeans in Taiwan is TWD10.012 per kg, while the US export price of soybeans is US 672.866 cents per bushel. The exchange rate between the US dollar and the new Taiwan dollar is USD1: TWD32.883. With regard to skewness, all have a right skewed distribution except for the exchange rate, which has a left skewed distribution. Moreover, all variables on the aspect of Kurtosis belong to the leptokurtic distribution except for the current price of soybean in Taiwan and the exchange rate, which belong to the platykurtic distribution. The emergent frequency of the extreme values of other variables is more than that in a normal distribution. Jarque-Bera shows that all sample variables are not the data of a normal distribution, and the prominent rejecting samples are subject to the hypothesis of a normal distribution.

Table 4: Sample of the descriptive statistics

Variables	*TMFP*	*TSBP*	*TISB*	*UFSB*	*EXRT*
Samples	124	124	124	124	124
Mean	56.897	10.237	10.012	672.866	32.883
Standard Deviation	16.222	2.348	2.579	251.156	1.291
Skewness	1.105	1.041	0.792	1.566	-0.137
Kurtosis	4.017	3.246	2.792	4.853	2.141
Jarque-Bera	30.569***	22.716***	13.181***	68.476***	4.204***

Note: 1. TMEP is the original price of milkfish (TWD/kg), TSBP refers to the price of soybean flour in Taiwan (TWD/kg), TISB represents the spot price of soybean in Taiwan (TWD/Kg), UFSB is viewed as the future price of American soybean (cent/), and EXRT is the exchange rate of TWD and USD.
2. *** represents level of significance is 1%.
3. Jarque-Bera refers to the normal test.

Test for CCC-GARCH Model

Before constructing the DCC-GARCH model, the first thing to do is to test whether the conditional correlation coefficient is a fixed value. If the time series is non-stationary, DCC-GARCH can be set. Tse (2000) verified whether the correlation coefficient between fish feedstuff and price of milkfish in Taiwan conforms to the hypothesis of the CCC-GARCH model using the method of LM, primarily focusing on the dynamic correlation coefficient of ρ_{TFMP_TSBP} in $\rho_{TFMP\_TSBP,t} = \rho_{TFMP\_TSBP} + \delta_{TFMP\_TSBP} r_{TFMP,t-1} r_{TSBP,t-1}$ is zero. If the testing result rejects the null hypothesis distinctively, GARCH-DCC model can be used to test the passing effect between international grain price and local price of milkfish, as shown in Table 5. When the value of LM is 577.256 under the condition of $\alpha = 0.05$, null hypothesis is rejected distinctively, that is, the conditional correlation coefficient between two time series is not zero without a fixed conditional correlation characteristic. Hence, DCC-GARCH model can be set further.

Table 5: Testing of the relevant coefficients under a stable condition

LM Testing / *Name of Variables*	*original price of milkfish and the price of soybean flour*
Local Price of Milkfish and the Price of Soybean flour	577.256***

Note: 1.LM testing statistics is obtained from TSE (2002). When LM testing is in significance, the null hypothesis relevant to the fixed condition is rejected.
2. *** represents level of significance is 5%.

Test for DCC-GARCH Model

The Rats6.0 software is used in this research to make an empirical model estimation, and the minimum value of SBC is taken as the optimal model principle. GARCH(1,1)-DCC is set as the major model, and the value of coefficient must be $\psi \geq 0$, $\zeta \geq 0$, and $\sum \psi + \sum \zeta < 1$. If all the results conform to the coefficient restriction, it indicates that the model is steady. Estimation result of this research is presented in Table 6 and 7 as follows.

According to the estimation result of GARCH(1,1)-DCC, the local price of milkfish of one lag period and two lag periods exert a distinctive influence on the current local price in the reactive equation of the local price of milkfish with values of 0.2956 and 0.1322. This result indicates that when price fluctuation increases by USD1 in one lag period, the current price will increase by USD0.2956. When the price of milkfish in two lag periods increase by USD1, its current local price will increase by USD0.1322. The value of price of soybeans in one lag and one period is 0.3483 and 0.1516 in two lag periods, indicating that the price of soybeans will exert a distinctive influence on the current price of milkfish when it at one lag or two lag period. When the price of soybeans increases by USD1 that of milkfish will increase by USD0.3483 and USD0.1516.

With regard to the reactive equation of soybeans in Taiwan, the value of soybeans in one lag period and two lag periods is 0.4265 and 0.2046, respectively, as seen from Table 6. As a positive influence is exerted on the current price of soybean, when the prices of soybeans in one lag period and two lag periods increase by USD1, the current price of soybeans will rise by USD0.4265 and USD 0.2046. When the value of price of milkfish in one lag period and two lag periods is 0.0728 and 0.0311, respectively, which indicates that the price of milkfish increases by USD1, then the current price of soybeans will increase by 0.0728 and 0.0311? The value of the current price of soybeans in Taiwan in one lag period is 0.7911, which indicates that when it increases by USD1, the price of soybean flour will increase by USD0.7911. While the forward price of US soybeans in one lag period increases by US 1 cent, the current price fluctuation of soybean flour will increase by USD0.0084. The exchange rate between USD and TWD also exerts a positive prominent influence on soybean flour with an estimated value of 0.0451, which indicates that when the exchange rate fluctuation increases by USD1, the price of soybeans will rise by USD0.0541.

Based on the above description, the local price of milkfish and price of soybean flour will exert a prominently positive influence on the current price of milkfish, in which the price fluctuation of soybean flour is bigger. In addition, the price of soybean flour and milkfish, the current price of soybeans in Taiwan, the US forward price of soybeans, and the exchange rate between TWD and USD exert a positive influence on the price of soybean flour in Taiwan. Therefore, the international price of grain will affect the price of soybeans in Taiwan distinctively and directly. Moreover, the price of soybean flour has a direct and distinctive influence on the local price of milkfish, while the international price of grain will influence the local price of milkfish indirectly through its impact on the price of soybean flour in Taiwan. In other words, the international price of grain exerts an indirect influence on the local price of milkfish in Taiwan.

Table 6: Mean equation estimation result - Bivariate GARCH(1,1)-DCC

Variable	Δ*TMFP*	*Variable*	Δ*TSBP*
Drift	-0.2498 (-0.3033)	Drift	-1.084 (-4.118)***

Local Price of Milkfish	0.2854	Price of Soybean flour	0.4266
(Lag-one Return)	(11.578)***	(Lag-one Return)	(8.711)***
Local Price of Milkfish	0.1378	Price of Soybean flour	0.2047
(Lag-two Return)	(1.425)**	(Lag-two Return)	(3.982)***
Price of Soybean flour	0.3617	Origin Price of Milkfish	0.0531
(Lag-one Return)	(1.086)*	(Lag-one Return)	(0.458)**
Price of Soybean flour	0..452	Origin Price of Milkfish	0.0304
(Lag-two Return)	(1.769)***	(Lag-two Return)	(0.989)**
		Spot Price of Taiwan Soya	0.7913
		(Lag-one Return)	(40.095)***
		Spot Price of Taiwan Soybean	0.0085
		(Lag-one Return)	(31.806)***
		Exchange Rate of TWD and USD	0.0447
			(5.549)***

Note: 1. △TMFP is local price of milkfish after difference, and △TSBP represents the price of soybean flour in Taiwan after difference.
2. * represents the level of significance 10%, ** represents level of significance 5% and *** refers to level of significance 1%.
3. The number in the bracket refers to the standard error.

Conditional variance and heteroscedasticity usually occur in many financial or economic time series according to many empirical research findings, that is, conditional variance changes as time moves forward. However, high self-relevance is usually on the serial fluctuation in the market with drastic price fluctuation. Hence, with regard to the estimation of conditional variance, its fluctuation, continual impact, and passing effect are usually considered.

Conditional variances of both prices of milkfish and soybeans in Taiwan influence the price fluctuation of milkfish and soybeans. In Table 7, the conditional variance of the local price of milkfish is based on the estimation value of 0.0344, and a prominent influence takes place in α_t and α_{t-1}^2, indicating that prophase price fluctuation will have a short and persistent impact on the current price fluctuation. On the other hand, the estimation value of 0.0601 of the conditional variance of the price of soybean flour shows that there is a prominent influence in α_t and α_{t-1}^2, indicating that the prophase price fluctuation will have a short and persistent impact on the current price fluctuation as well.

As for the long impact, it has been found in the conditional variance equation that both $\alpha_{1,1} + \beta_{1,1} = 0.9825$ and $\alpha_{2,1} + \beta_{2,1} = 0.9858$ are less than 1, which conforms to the parameter hypothesis of the GARCH model. This result indicates that bi-variant GARCH-DCC(1,1) can capture the fluctuation process between the local price of milkfish and price of soybean flour in Taiwan, that is, the prophase price fluctuation will have a long and persistent impact on current price.

With regard to the dynamic conditional correlation, ψ represents the influence on the dynamic conditional correlation coefficient between two time series exerted by the prophase standard residual term, and ζ represents the intertemporal persistent effect of the dynamic conditional correlation coefficient between two time series. In Table 7, the estimation coefficient value 0.9724 shows that there is a prominent ζ between the local price of milkfish and price of soybeans in Taiwan. This indicates the highly persistent effect in the dynamic conditional correlation coefficient between the price of milkfish and price of soybeans in Taiwan and the positive effect influenced by the prophase effect at the same time. The value of ψ is obviously less than that of ζ, with an estimation value of 0.0184. This means that the current dynamic conditional correlation coefficient is influenced by the prophase standardized residual term below the 1% significance level and is different from 0 prominently. Thus, it is less than the intertemporal persistent effect of the dynamic conditional correlation coefficient. Based on the above description, there is a relevant fluctuation change as time goes on between the local price of milkfish and the price of soybean flour.

Table 7: Estimation result of the conditional variance equation - Bivariate GARCH(1,1)-DCC

Variable	h_{TFEP_TFEP}	*Variable*	h_{TBRP_TBRP}
$\varpi_{1,0}$	0.4641 (19.682)***	$\varpi_{2,0}$	0.5644 (16.181)***
$\alpha_{1,1}$	0.0344 (61.464)***	$\alpha_{2,1}$	0.0601 (21.049)***
$\beta_{1,1}$	0.9481 (0.1421)*	$\beta_{2,1}$	0.9257 (0.0923)**
ψ	0.0184 (1.0512)*		
ζ	0.9724 (7.5892)***		

Note: 1. * refers to level of significance 10%, ** is level of significance 5%, *** is level of significance 1%.
2. Numbers in the bracket refer to gradual standard error.

CONCLUSIONS AND SUGGESTIONS

In this research, according to the monthly reference on the price of soybean flour and original price of milkfish from January 1999 to April 2000, the influence of the international price of grain on the price of soybean flour in Taiwan and the local price of milkfish is analyzed and verified using the relevant dynamic coefficient model bivariate GARCH-DCC. The conclusions drawn from the research result are summarized as follows:

(1) Direct and positive influence of international price of grain on the price of soybean flour in Taiwan.

The result of the heterogeneity variables shows that the price fluctuation of soybean flour in lag-on return will exert an influence on the spot price. Forward price of US soybeans in lag-one period and spot price of soybeans in Taiwan have a direct and distinctive influence on the price of soybean flour in Taiwan. Raw material of feedstuff in Taiwan mainly depends on import, and thus the price of soybean flour in Taiwan is affected by the international price of grain. When the price of US soybeans increases, the price of Taiwan soybean flour will also increase.

(2) A positive and indirect influence of international price of grain on the local price of milkfish in Taiwan.

The forward price of US soybeans makes a distinctive influence on the price of soybean flour in Taiwan, which has an effect on the local price of milkfish. Therefore, it is obvious that the price of US soybeans has an indirect effect on the local price of milkfish in Taiwan.

(3) Bi-direction and direct influence of the local price of Taiwan milkfish on the price of soybean flour and its fluctuation.

The previous price of soybean flour exerts a positive and distinctive influence on the local price of milkfish at present, as well as the previous local price of milkfish on the prevailing price of soybean flour. This influence is also bilateral and direct. As for the dynamic conditional relevance, intertemporal persistence of dynamic correlation coefficient exists between the local price of milkfish and the price of Taiwan soybean flour, and thus this coefficient is easily affected by the previous standard residual. The local price of milkfish and price of soybean flour in Taiwan fluctuate with time.

(4) Short-term and long-term impact of fluctuation of the prices of milkfish and soybean flour.

As for the conditional variance, the residual conditional variance of the current price of milkfish and soybean flour exerts a distinct influence on the square value of the previous residual variance. Thus, the previous price fluctuation will have a short-term but continuous impact on the current price. Furthermore, the fluctuation procedure of the local prices of milkfish and soybean flour in Taiwan is shown in the bivariate model GARCH-DCC(1,1). Previous price always has a long-term and continuous impact on the prevailing price fluctuation.

The local price of milkfish increases as the feedstuff has the biggest proportion in breeding cost, which also indirectly leads to the fluctuation of the price of milkfish. In view of the drastic influence of

international grain price on the price of feedstuff in Taiwan, aquaculture dealers should consider the price fluctuation of the international grain market when manufacturing feedstuff to avoid increase in risk and cost. Moreover, a perfect set of price earlier warning mechanism does not only provide reference for feedstuff producers and aquaculture producers, allowing them to cope with the drastic fluctuation of international grain price and to take corresponding measures on their production management, but also implements a steady fishery foundation with an aim to stabilize the price of fishery products.

REFERENCES

Engle, R.F., (1982). Autoregressive conditional heteroscedasticity with estimates of the variance United Kingdom Inflation. *Journal of Econometrica*, 50, 987-1007.

Engle, R.F., (2002). Dynamic conditional correlation: A simple class of multivariate generalized Autoregressive conditional heteroscedasticity models. *Journal of Business and Economic Statistics*, 20, 339-350.

Kanamura T., (2009). A supply and demand based volatility model for energy prices, *Energy Economics*, 31(5), 736-747.

Kappou, K., Brooks C., Ward, C., (2010). The S&P500 index effect reconsidered: Evidence from overnight and intraday stock price performance and volume. *Journal of Banking and Finance*, 34(1), 116-126.

Lee, C.Y., (2009). Characteristics of the volatility in the Korea composite stock price index. *Physica A: Statistical Mechanics and its Applications*, 388(18), 3837-3850.

Narayan, P.K., Narayan S., (2010). Modelling the impact of oil prices on Vietnam's stock prices. *Applied Energy*, 87(1), 356-361.

Patricia, C.S., (2009). *Price synchronicity: The closing call auction and the London stock market*. 19(5), 777-791.

Tse, Y.K., (2000). Test for Constant Correlation in a Multivariate Garch Model, *Journal of Economics*, 98, 107-127.

Wang, K.M., Nguyen Thi, T.B., (2007). Testing for contagion under asymmetric dynamics: Evidence from the stock markets between US and Taiwan. *Physica A*, 376, 422-432.

Xiao J.K., Chen Z.C., Ding C.D., (2003). Analysis and Forecast of Price of Milkfish in Taiwan. Taiwan Bank Quarterly, 54(3), 297-320.