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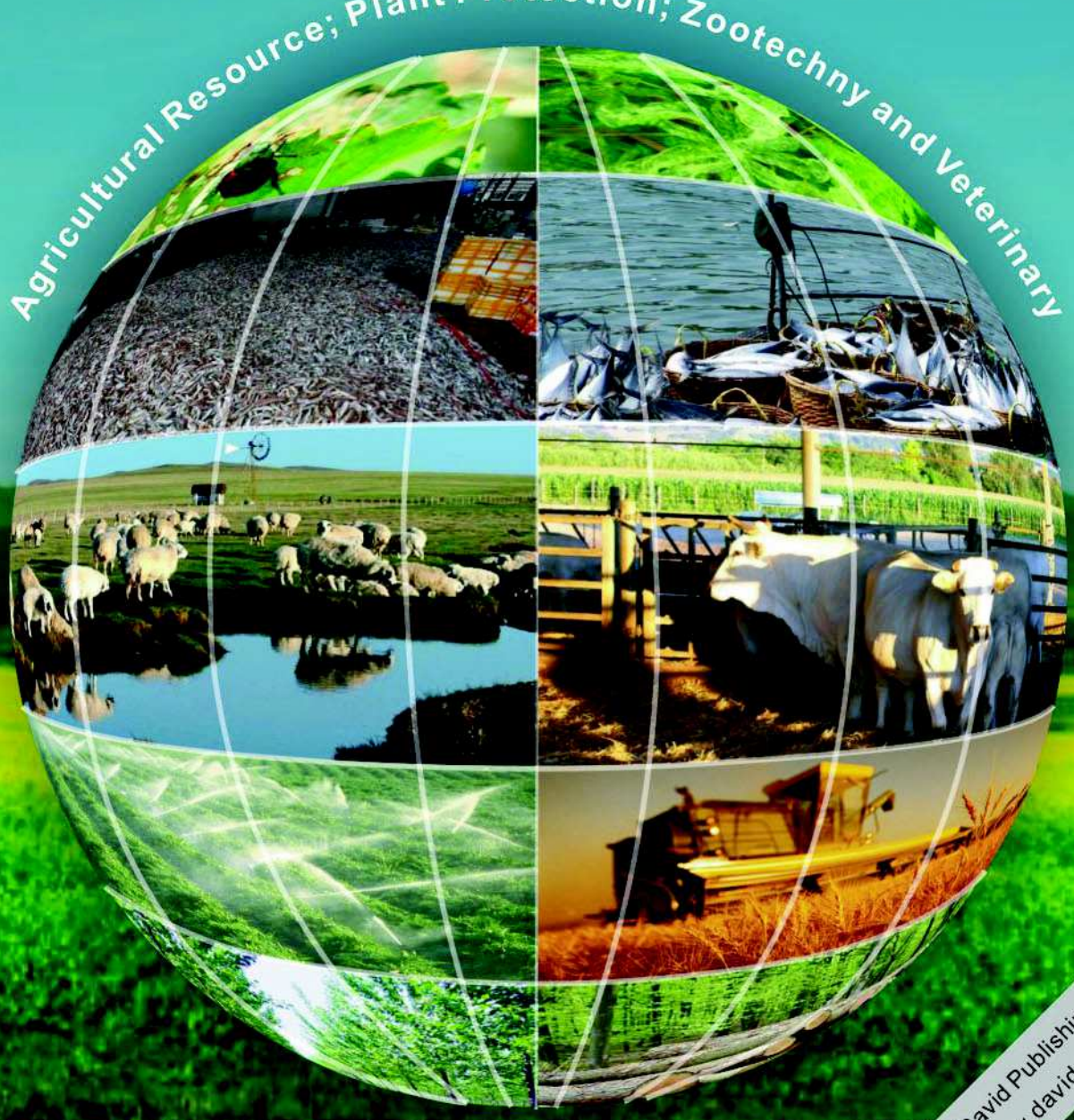

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Modeling Time Series Analysis between Feedstuff and Hog Prices in Taiwan

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Abstract: Pork in Taiwan has played an important role in terms of domestic consumption, production and price fluctuation in several decades. This study attempts to investigate the causal relationship between hog and feedstuff prices in Taiwan by using monthly time series over the period of January 2000 to October 2010. Prices from hog, feedstuff, soybean meal and corn are considered and performed through a multivariate vector autoregressive (VAR) model. As the empirical results, the long-run equilibrium is captured identifying price elasticity among the variables using the Johansen cointegration diagnosis. Then, the Granger causality approach shows that bidirectional relationship is detected running from feedstuff to corn and from soybean meal to hog as well as unidirectional relationship running from corn to hog, from feedstuff to hog and from soybean meal to feedstuff. In the conclusions, we point out to raw material prices of feedstuff, namely corn and soybean meal that have an importance to hog price as the cost of meat production. Pig farmers and policy-makers should understand the behavior of price interactions to manage the risks on hog market and to increase the profitability on suitable price.

Key words: Cointegration, feedstuff price, granger causality, hog market, Taiwan.

1. Introduction

Pig production is one of the most important food proteins in livestock sector. Because the world population has increased extremely, meat demand therefore becomes a choice of pork market to push the future consumption. Taiwan in particular, the highest domestic consumption is shared through pork, approximately 38 kg per capita and consumers have spent average 70% to 85% for their meat expenditure on pork products.

Pig price is fluctuated through demand, supply and other factors such as outbreak of diseases, increasing of feedstuff prices, consumer behavior, and so on. Feed price is the major cost on pig production which 60% to 70% of the cost function is generated through feedstuff including corn and soybean meal. As the limited of raw materials, Taiwan has imported corn and soybeans meal to supply the demand of domestic feed production because both raw materials are necessary for producing feed in order to supply for pig and other livestock industries [1]. The "hog price cycle" variation has caused by feed grain prices, supplies of competitive meats, economics, and etc.. For an example, prices of grain and soybean were raised in 2007, and then it affected to Taiwan's pig production cost per 100 kg live weight of hog increased from NT$ 4,757 in 2006 to NT$ 5,338 [2].

The prices from feedstuff including soybean meal and corn have an importance to hog production. Therefore, this study aims to understand the causal relationship of the prices between hog and feedstuff variables. The rests of this study are structured to provide the data and methodology which consist of econometrics methodology such as (1) the unit roots

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for the stationarity of the time series, (2) the cointegration for the long-run equilibrium, and (3) the Granger causality for the causal relationship among hog, feed, soybean meal, and corn prices. Afterwards, the empirical results are presented.

2. Data and Methodology

Monthly time series based on prices from hog, feed, soybean meal and corn are utilized over the period of January 2000 to October 2010 which 130 samples are observed and transformed to natural logarithm form. The LHPR, LFEED, LSOYB and LCORN are used as the representative of the variables, respectively.

The methodology used of this study is applied the tests through unit root, cointegration and causality. In the first step, we test for identifying time series properties. The Augmented Dickey-Fuller (ADF) and Phillips and Perron (PP) unit roots [3-5] including intercept term (α) and time trend effect (T) in the model are employed to indicate the stationarity of the variables which can be written as Eq. (1) below:

$$\Delta \mathrm{S}_t = \alpha_0 + \delta T + \beta_1 \mathrm{S}_{t-1} + \varepsilon_t \quad (1)$$

Where Δ is the different order, S is the time series, p is the lag length, ε is the error, and α, δ and β_1 are the parameters to be estimated.

If two or more variables are integrated in the same order, then Johansen [6, 7] and Johansen and Juselius [8] suggested that the linear combination can run forwards in the long-term movement. The second step, therefore, we apply the Johansen cointegration approach to indicate a long-run equilibrium among variables which can be written as Eq. (2) below.

$$\Delta Z_t = \alpha_0 + \Pi Z_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta Z_{t-i} + \varepsilon_t \quad (2)$$

Where Z is the matrix time series, $\Pi = \sum_{i=1}^{p} A_i - I$, and $\Gamma_i = -\sum_{j=i+1}^{p} A\mathrm{j}$.

In the final step, if the variables are stationary and then cointegrated with order 1, $I(1)$. The long-run equilibrium should be detected among the variables and at least one directional relationship of Granger causality has to be found Engle and Granger [9]. A vector autoregressive (VAR) model is performed in forms of Granger causality approach to indicate the causal relationship which can be written as Eq. (3) and Eq. (4) below:

$$\Delta \mathrm{Y}_t = \alpha_1 + \sum_{i=1}^{p} \beta_{11i} \Delta \mathrm{Y}_{t-i} + \sum_{i=1}^{p} \beta_{21i} \Delta \mathrm{X}_{t-i} + \varepsilon_{1t} \quad (3)$$

$$\Delta \mathrm{X}_t = \alpha_2 + \sum_{i=1}^{p} \beta_{12i} \Delta \mathrm{X}_{t-i} + \sum_{i=1}^{p} \beta_{22i} \Delta \mathrm{Y}_{t-i} + \varepsilon_{2t} \quad (4)$$

Where X and Y is the observed time series. The F-statistic is applied to test a causal relationship with under the null hypothesis that β_{21} and β_{22} equal to zero.

3. Empirical Results

The results of ADF and PP unit roots are shown in Table 1. The time series in forms of logarithm transformation are adjusted based on the price series from hog, feed, soybean meal and corn. The statistical results present that all series cannot be rejected the hypothesis of non-stationarity in level, and then rejected when the first differencing order have been taken with the statistical significance at 5% level.

Next, Table 2 presents the results from the Johansen cointegration test. The null hypothesis of no-cointegrating relationship is rejected with the statistical significance at 5% level. Therefore, the long-run equilibrium has been detected among the prices from hog, feed, soybean meal and corn. Moreover, normalized equation reveals the price elasticity among the variables that if corn price has changed by 1%, then prices of hog, feed and soybean meal can be fluctuated by 6.642%, 8.262% and 12.137%, respectively.

Turning to the Granger causality test in Table 3, the results show that bidirectional relationship of Granger causality is detected between feed price and corn price, and soybean meal price and hog price as well as unidirectional relationship of Granger causality running from corn price to hog price, from feed price to hog price, and from soybean meal price to feed price.

Table 1 ADF and PP unit root tests.

Variable	ADF-test			PP-test		
	none	α	$\alpha + T$	*none*	α	$\alpha + T$
Level						
LHPR	0.992 (3)	-0.743 (3)	-2.027 (3)	0.450 (3)	-1.069 (3)	-2.999 (3)
LFEED	1.536 (1)	-0.121 (1)	-2.745 (1)	1.459 (1)	-0.312 (1)	-2.680 (1)
LCORN	1.237 (0)	-0.901 (0)	-2.254 (1)	1.237 (0)	-0.901 (0)	-2.306 (1)
LSOYB	1.048 (2)	-1.256 (1)	-3.001 (1)	1.061 (2)	-1.265 (1)	-3.039 (1)
First difference						
ΔLHPR	-8.984* (2)	-9.043* (2)	-9.032* (2)	-16.246* (2)	-16.601* (2)	-16.967* (2)
ΔLFEED	-4.076* (0)	-4.378* (0)	-4.464* (0)	-4.076* (0)	-4.378* (0)	-4.464* (0)
ΔLCORN	-9.661* (0)	-9.750* (0)	-9.712* (0)	-9.661* (0)	-9.750* (0)	-9.712* (0)
ΔLSOYB	-7.294* (0)	-7.494* (1)	-7.464* (1)	-7.294* (0)	-7.294* (1)	-8.12* (0)

Δ and * denote the different order and rejection of the hypothesis at the 5% level, respectively.

The number in parentheses is the lowest optimal lag value (p) that is selected based on the Schwarz information criterion. Non-stationarity is carried out for the null hypothesis, H_0.

Table 2 Johansen cointegration test.

Hypothesis (H_0)	Trace test		Max-eigen test	
	Statistical result	Critical value	Statistical result	Critical value
None	51.499*	47.856	31.450*	27.584
At most 1	20.048	29.797	13.907	21.131
At most 2	6.140	15.494	6.140	14.264
At most 3	0.000	3.841	0.000	3.841

Normalized equation: LCORN = 8.262LFEED + 6.642LHPR – 12.137LSOYB

* denotes the rejection of the hypothesis at the 5% level.

Lag length of two is the lowest optimal VAR lag selection that is selected based on the Schwartz information criterion. The null hypothesis, H_0 is no-cointegrating vector.

Table 3 Granger causality test.

Explanatory variable (Y)	Dependent variable (X)			
	ΔLCORN	ΔLFEED	ΔLHPR	ΔLSOYB
ΔLCORN	-	6.090*	3.798*	2.760
ΔLFEED	7.982*	-	4.415*	7.085
ΔLHPR	1.956	1.799	-	3.892*
ΔLSOYB	1.705	5.247*	5.836*	-

Δ and * denote the first different order and the rejection of the hypothesis at the 5% level.

Lag length of two is the lowest optimal VAR lag selection that is selected based on the Schwartz information criterion. The null hypothesis is "X does not Granger case Y".

4. Conclusion

This study employs modeling time series techniques to analyze the causal relationship between hog and feed prices in Taiwan over the period of January 2000 to October 2010. The multivariate vector autoregressive (VAR) model is performed for the Johansen cointegration and Granger causality approaches. As the empirical results, the long-run equilibrium has been carried out among the prices from hog, feed, soybean meal and corn. The causal relationship then shows that bidirectional relationship is detected for feed and corn, and soybean meal and hog. In addition to unidirectional relationship is also detected running from corn and feed to hog, and from soybean meal to feed. In conclusions, policy-makers have to understand the price relationships and put the applications to solve the risk from the fluctuated of raw feedstuff materials.

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