Hog Price Transmission in Global Markets: China, EU and U.S.

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Abstract

This paper analyzes the twelve years monthly hog price data from the China, U.S., and EU markets. The study's methodology includes cointegration tests and VECM, followed by tests for Granger Causality. The analysis provides a broad view of international hog markets price linkage and price transmission mechanism.

There are several results: Firstly, the relationships among the three markets are rather weak. Secondly china is the least easily influenced and EU is the most influenced by other markets . Thirdly the hypothesis of Grange causality is confirmed between the Chinese and the EU but not in both directions. Fourthly, the hog price of the U.S. market responds noticeably to the shock from EU but mildly to the shocks from Chinese.

*Key words:*Price transmission ,hog industrial ,VECM

JEL Classifications :F47,C32,Q17

Introduction

China is the largest consumer and producer of pork and it accounts for nearly half of the world's pork production and consumption. In 2011, its annual pork output reached 50 millions tons, nearly 4.5 times that of the United State and 2.3 times that of the European Union (EU) (USDA,2013). The EU is the second largest producer of pork and the largest exporter of pork in the world. United states (U.S.) is the third producer of pork and the second exporter of pork in the world. The three markes is the world mainly hog production which holds about 80 percent of the world production. The three areas of hog production and export trade would have a great effect upon the pork areas in the world. However the markets have difference in size, history, production system and trading time.

Historically, China has been a mostly self-sufficient pork Economy. Hog import were about 4.68 million tons which constitutes approximately 1.3% of its domestic slaughters in 2012(USDA,2013). However, there are constraints inhibiting hog production increase in China (Zhang and Nie,2010). There is an increasing trade among the three area: (1) China has poor natural resoures. According to Food and Agriculture Organization (FAO,2006) data, China must feed 13 persons for each hectare of arable land, whereas the EU must feed 4.1 persons, and the U.S. only 1.4 persons. (2) China has no advantages of feeding cost in hog production. China have less advantage of cost over U.S. and EU. There are gaps in corn price between U.S. and China(Fred.et,al,2012). (3) Environment problems caused by the scale of culticulature are greater in China. (4) There are also the supplementary in the pork consumers among in China, U.S. and the EU. The Chinese consumer and the U.S. and EU consumers like different parts of the hog. In

the U.S. and EU the pork is not the main meat entrée. The enumerated characteristics of the pork markets among these three major areas of the world suggest that there are opportunities for an explanded hog trade. With the obstacles of continuing production and with the china entry the WTO, China would increase the import demand and decrease the import tariff .

There are several countries, such as Holland and Denmark which have long breeding history and high technology to produce the hog in EU. There are some common advantages and conditions in hog production for the Europeans and United states. There are very excellent natural resources conducive to hog production and relative low concentrate corn and grains production cost. And their hog production practices are characterized by high standards and use of advanced techonlogies in all of the major phases of production. As major hog exporting areas , their production supply chain are driven by the wolrd's hog demand.

The illustrated demand and supply relationships suggest that the greater demand for hogs in China results in a larger p_c than in p_a(p_c is the Chinese hog price and p_a is the U.S. hog price)(Figure 1). When the demands increase, the U.S. hog price increases to p_a'. Because of China 's natural resoures constraints, the supply is unchanged, so the price will increase to the p_c'. And the China hog price will be much higher than US price for given increases in demand.

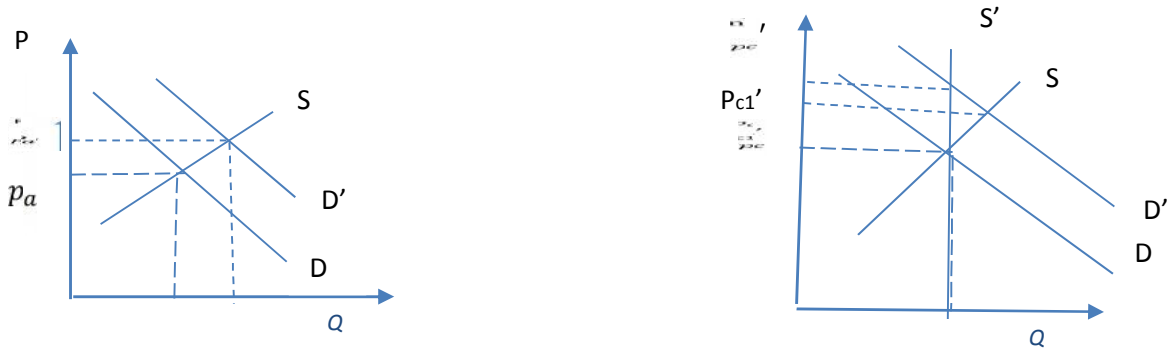


Figure 1:the Chinese and the US hog demand

According to EU Commercial, EU was largest export supplier of China's trade hub in 2011. And there are also additional relationship between China and U.S. hog production. China 's largest pork producer agreed to buy Smithfield Foods. This business transaction served as a signal that more foreign pork would enter China's market. The underlying price relationship s and sets of mutual interdependencies will influence the trends regarding the world's hog prices and production levels.

This study provides a broad and integrated view of the global hog markets. There are reasons for studying cross market price linkage and transmission mechanism for hog markets. First, correlations between the world's hog markets affect the volatility of hog production and hog price, and therefore it can assist hog and grain farmers, hog processing companies and other value-adding entities in formulating better trading and asset allocation Strategies. Second, information transmission mechanisms reveal the level of market efficiency allows traders to discover arbitrage opportunities, if any, between markets. And it will increase the volume of in world hog markets. Third, hog prices reflect the entire market dynamics so that study results may be generalized to hog spot markets and other related markets. The results may provide input for

both hog producers. Their input suppliers and consumers in the development of more effective risk hedging and purchasing strategies. Finally, the cross-market analysis reveals a long-term price relationship with all its participants which may have implications for each country to argue for more power.

The main purpose of this study is to investigate the price relationships across world's three largest hog markets. It creates information on cross-market correlation, information transmission mechanisms within and between the three markets, and identifies the price discovery processes within each market. The long-term price relationship among the three markets is analyzed. We examine the extent to which each market is influenced by the other two, and which market is most efficient. Additionally, we examine the issue of which market is the price determining market (i.e., the market that has the greatest influence over the other two in the price discovery process).

The main content of the study can be summarized as follows: Firstly, this study examines the long-term equilibrium relationship among hog prices in Chinese, EU and U.S.. Secondly, It uses the cointegration and VECM to analysize the transmission mechanism. It could provide strong evidence of cross-market information transmission efficiency. And its main purpose is to determine how well information is delivered and received between markets. Thirdly it uses the Granger causality test to make sure which market is the price determine market. And it could provide implications for productions, traders and even policy makers on the price discovering process of the hog price market as well as the information transmission mechanism. Its main purpose is to assess each of the three markets'effectiveness in price determination and dissemination and then to assess how well price information is received by each of the markets and then acted upon in enchaning. Fourthly, impulse response and variance decomposition analysis are used to investigate dynamic interactions of prices.

Literatures Review

Spatial Market Price Transmission

Spatial market transmission relates to the matters in which price violation and overnight return information is transmitted from one market to another. Many studies of spatial price transmission have appeared in the international trade literatures. That is the transmission from the high price (net demand areas) to the low price areas (net supply areas). Law of one price (LOP) states that prices for a homogeneous goods at different locations should differ by no more than the transaction costs of trading the good between these locations. Otherwise traders will engage in spatial arbitrage, which price transmission will occur till LOP is stored. And there are some reasons in the spatial price transmission: transactions costs, road systems, market development, transportation (Goodwin et al.,2001). However Internaltional price transmission also concerns about money policy, exchange rate adjustment and distribution of trade. The standard spatial price equilibrium analysis pioneered by ESTJ model (Enke 1951, Samuelson 1952, and Takayama et al.,1971) that given price differences which are larger than transport costs, the volume of trade between a given pair of markets is determined by local supply and demand functions.

The linkage between different markets could be described by elasticity of price transmission. The price transmission elasticity is a measure of comovement of price and shows the extent to which in the world price are transmitted back to within country price. In competitive systems,

spatial arbitrage should low the prices differenc. However agriculture productor have many characters render the process for trade, for example inadequate infracture, unreliable market. The degree of arbitrage depends on the price and transaction cost. Early Agriculture Economics estimating elasticity of export demands for specific agricultural commodities and aggregate agricultural exports (Johnson and tweetn, 1977). Mauny et al., (1979) estimated the foreign demand for American agriculture products to the price transmission Elasticity. Economists often consider the degree of spatial price linkages to be an indicator of market power and a factor that are used in define the extend of market. Some literatures directed to community price transmission elasticity (Bredalh et al., 1979; Zwart et al.,1979). The major determinants of the magnitude of transaction costs include the quality of the physical and facilitating marketing infrastructure, as well as market information. Because Government interventions that affect the import and export will have a pressure on transmission from the world to the domestic market. However Little attentions have given to how elasticity change as policy reforms are implemented.

The Econometric Models of Spatial Price Transmission

The empirical literatures addressing spatial price transmission issues are immense. They argue that there are rather loose terminology and different authors invoke different definition of concepts and their empirical results, so it is should be careful about the specific condition being valued to construct empirical tests .

Numerous studies of prices transmission used simple correction coefficients of contemporaneous prices and regression analysis on contemporaneous prices. Numerous studies have invested the market linkage and price transmission mechanism in major market. Autoregressive distributed lag (ARDL) and partial adjustment model (PAM) use the OLS to estimate the constant time series. However the static regression approach has been criticized for assuming instantaneous reponse in each market to changes in other markets.

In the 1980s, the research became aware of the nonstationarity. However, modern econometric analysis proposes a different framework for modeling nonstationary data. Allowing for possible cointegration relationships are especially important because cointegration itself has important implications for causality (Engle and Granger, 1987). With a large enough samples, any pair of nonstationary variables will appear to have a statistically significant relationship, even if they are actually unrelated to each other (Granger and Newbold 1974). However, The first difference ($\Delta x = x_t$-x_{t-1}) of a nonstationary variable may be stationary. If so, the original variable (x_t) is said to be integrated to degree 1 or I(1). Because the first difference is stationary, it could solve the problems about unstationary variables. Furthermore, two nonstationary variables may be related to each other by a long-term relationship even if thery diverge in cointegrated. Bachmeier and Griffin (2003) studies on both long and short dynamic price transmission. Researchers have employed cointegration and error correction models (ECM) extensively to examine international agriculture products price relationships to address the issue of nonstationary commodity prices. The vector models are multivariate extension of uniequational specification. More recent studies of information transmission and market efficiency in spatial markets rely on cointegration tests and a vector error correction model (VECM) .

More recent studies of information transmission and market efficiency rely on cointegraion tests and Vector Error Correction Model (VECM). Cointegration test and VECM are used to

analysis the staple food price transmission VECM to examine the cross-market interaction in Sahara African by Nicholas (2011). Based on their suggestion, if two series are cointegrated, a VAR model should be estimated along with the Error-Correction term which accounts for the long-run equilibrium between spot and futures price movements.

There are also other modern models on APT. Sexton, Kling, and Carman (1991), and Baulch (1997) applied endogenous switching models which account for the multiple regimes that may result from transactions costs. Considered by transactions costs, threshold models developed that deviations must exceed before provoking equilibrating price adjustments which lead to market integration(Hassan, 2001). TVECMs became popular with Balke and Fomby's (1997) article on threshold cointegration .Threshold vector error correction models (TVECM) are frequently used to model this regime-dependent spatial price transmission process. Tsay(1989) developed techniques for testing autoregressive methods for threshold effects and modeling threshold autoregressive processes.

Studies on world hog price markets

The primary focus of this study is the international hog markets. China is the largest pork production and consuming country in the world. As a consequence,any changes in the Chinese hog price and hog demand will affect the whole hog price transmission system greatly. China has not sufficient grain production because the land are intensive and labor are extensive, so the cost of feed will increase and the price of the pork will increase accordingly. It shows that it will significantly increase net pork and poultry import since China enter the WTO and reduce the trade tariff. The demand of pork import from other countries will increase in the future years . Primary challenges for the U.S. pig industry are animal welfare (driven by food companies down to the producer level), ethanol use of the limited raw feed stocks, labor availability, and environmental,political issues. European hog market faces high income consumers demanding product traceability and food safety. There are high production costs relative to other areas of pork production.

There are much literatures about the trade and price transmission among China, EU and U.S. Backyard production has contribute the 35% of the amount of the pork that will decrease the cost the pork. And Chinese prefer fresh pork to frozen pork. And the market developed not very quickly and logically. Fang et al.,(2002) compares the productivity and cost of production (COP) of China and the United States in producing corn, soybeans, and hogs. It showed that the U.S. Midwest (defined in this study as the Heartland region as classified by the U.S. Department of Agriculture's Economic Research Service) had a substantial advantage in land and labor productivities in producing corn and soybeans, especially compared to China's South and West producing regions.The fast-growing Western-style family restaurant and higher-end dining sector is another market opportunity for high-quality imported pork. Future grows in U.S. pork exports to China will depend upon how successfully U.S. pork exporters can supply the Chinese with high quality variety meats. EU hog price demand the production, internal demand and the ability to export. Strong external demand and high price generally have a positive influence on EU hog price.

Common conclusion from the literature is that China's import from U.S. and EU will increasing greatly in the near futures. The significance of prices in facilitating those imports justifies this study into its relationship and price transmission effectiveness between its three

major world market. It justifies the study of the volatility effectis in the transmission of hog prices between China ,U.S. and EU.

METHODOLOGY

Data collection

This study uses hog market price data from the three major hog markets: China hog market price (P_c) ,European hog market price (P_e) and United states market hog Price (P_a). P_c are obtained from China National bureau of statistic website. P_e are obtained from the European Union public data. P_a are obtained from USDA. The data period from January, 2000 to December, 2012. A total of 156 observations of time series data are collected for each market. The return of the three series, R_t is calculated as the difference between the month price and the previous month price.

$$\begin{aligned} Rlp_c &= lpc_t - lpc_{t-1} \\ Rlpe &= lpe_t - lpe_{t-1} \qquad (1) \\ Rlpa &= lpa_t - lpa_{t-1} \end{aligned}$$

Each price has been changed to real prices according the CPI published by the officical date(The Chinese CPI is according to the National bureau of statistic,The CPI of EU is from EU the American CPI is from Bureau of Labor Satistic). The data is converted from ton, kilogram into $/b, and Historical monthly exchange rate information from DataStream maintained by the International Monetary Fund (IMF 2012) is used for this price conversion. The U.S. dollar equivalent of the African domestic prices and U.S. dollar world prices were converted to real U.S.dollars (1980=100) using the U.S.consumer price index (CPI)

Research design

The first part is to make sure the relationships between P_c,P_e,P_a. Fundamental data analysis is performed to determine the similarities and differences in price and inter-market correlations between each of the three markets are calculated in order to examine these relationships.

The second step is to use the cointegration analysis to make sure which market is the most informative. If the three markets are highly cointegrated, then they can be seen as a long-term continuous trading market. The Johansen (1998) cointegration test is used in this analysis. Also the VECM model is used for empirical analysis to discover the potential long-term equilibrium in the three markets.

The third part is to make an analysis of short -run dynamic. If the difference of the price is cointegration, then it could use the impulse and variance decomposition to see the short-time price impulse. It could show that the cause of short fluctuation to each of the price.

The Fourth part is Granger test to find out which market has the dominate pricing power. It tends to underlying principle of the price discovering process in the hog world market.

Model specification

In this study, It applys cointegration and a vector error correction framework to examine the spatial market interation. Then it is followed by Granger's causualty tests. Specifically, we develop a multivariate cointegration and VECM model. For a cointergration relationship to exist

between the three markets it must be determined that all data have the same order of stationarity. A long-term equilibrium relationship between the three hog markets can be represented as :

$$z_t = lp_{ct} - \propto lp_{et} - \beta lp_{at} \qquad (2)$$

The form of the equation (2) is the modification of long term equilibrium relationship model :

$$lp_{ct} = \partial_0 + \partial lp_{et} + \beta lp_{at} + \mu_t \quad (3)$$

Where p_{ct} represents the dependent vaiable, p_{at} and p_{et} are independent ,∂ and β are slope coeffcients , ∂_0 is an intercept,and μ_t is the disturbance term. A standard unit root test is applied to all the three hog markets .It uses the p_{ct} series to explain the steps of the tests.

First, It uses the unit root test t.

$$dlp_{ct} = \alpha + \beta_1 lp_{c(t-1)} + \beta_2 dlp_{c(t-1)} + \beta_3 dlp_{c(t-2)} + \varepsilon_t \quad (4)$$

Where dlp refers to the difference between price t and its subsequent price (dlp_t=$lp_t - lp_{t-1}$). All α and β_i is regarded as constant parameters and ε_t is a white noise.A t-statistic is used to interpret the unit root order of the data series (Dickey & Fuller,1979). If the null hypothesis is to be rejected (i.e., $\beta_1 = 0$), then we will get a stationary data .

Secondly, The Akaike information criterion (AIC) rules and the final prediction error (FPE) is apply to determine the proper lag with minimn error square. Then we use Johanson test to determine whether the three seriers are cointegration. Cointegrated variables can be represented in error correction framework. We begin by determining the proper lag term for the model. The same lag term will be used in the VECM analysis. Assuming the hog price returns , $X \equiv (dlpc, dlpe, dlpa)$ is cointegrated, then we will have the VECM model as the following :

$$dX_t = \mu + A_1 dX_{t-1} + \sum_{i=1}^{k-1} A_i \, dX_{t-i} + \varepsilon_t \qquad (5)$$

Where dX_t equals $(X_t - X_{t-1})$, μ is a 3*1 vector of drifts; A_i 3*3 matrix of parameters and ε_t is 3*1 white noise.

Short-run dynamic Analysis

Short-run dynamic interactions of prices among China, EU prices ,U.S. could be visually identified through the impulse response analysis based on VECM models. Impulse response should be the consist series. There should be no root outside the unit circle. It shows that VECM model is stationary that could be meet the condition for the analysis of impulse and variance decomposition. The impulse response refers to the reaction of any dynamic system in response to some external change. The variance decomposition indicates the amount of information each variable contributes to the other variables in the autoregression. It determines how much of the forecast error variance of each of the variables can be explained by exogenous shocks to the other variables.

The Granger causality

The purpose of the last analysis used in this study is to identify which market (if any) is the price discovering market. The Granger test will be used to determine whether one or more of the three hog markets are useful in forcasting another one of those markets. we could use the Granger causality test based on VECM to determine whether one or more of the hog market is useful in forecasting another. The same lag term determined in the cointegration analysis is used for the Granger causality.

Results and discussion

Descriptive statistics and correlations

As discussed above, 156 monthly market price observations were collected for each of the three primary hog markets (China,EU,U.S.) for the twelve-year period from January, 2000 to December,2012. Figure 1 is the price trend of the three markets. It shows that Chinese hog price has an increasing trend in long time and especially there is a very acute and fluctuate trend since 2006. The sharp increases in China hog price were catalyzed by various including the rising cost of the feed, labor and the land. However it appears that there are relative gentle fluctuate in the U.S. and EU markets. And the price of hog in EU is a bit higher than U.S. The hog price in U.S. and EU were steady because the cost were low and productivity is very efficient.

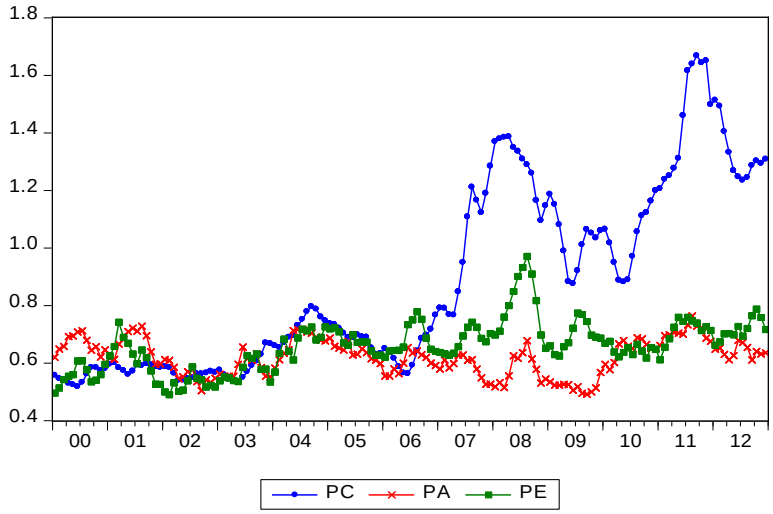


Figure 2: Trend of hog prices over the world's Major production Areas

Table 1 offers sets of descriptive statistics for each of the three major hog markets in the world. The range from high to low in the hog prices is China, EU and U.S. However the smallest rate of changes occurred in U.S. A total of six data series are obtained three markets (China, EU and U.S.) in two variables (price and return). Table 1 provides descriptive statistics for the EU and U.S. market have statistically equivalent mean prices ($0.6589 and $0.6204). However, the Chinese has a sighnificantly higher mean price ($0.8823) than both EU and U.S. There are rather a small negative and positive skewness which indicates a slightly left and right data distribution. And there are larger skewes in Chinese hog price which show a great right-data distribution. The Chinese hog prices has a significantly larger standard deviation ($0.3254)than EU and U.S($0.087 and $0.062, respectively).This may partially be explained by a significantly higher average price in the chinese hog market. The standard deviation in month returns ($0.0434)of the Chinese market is high than the standard deviation of EU and US($0.0335 and 0.026). Additionally, the Chinese market has the higher media than EU and U.S.

Table 1: Descriptive Statistic (In US Dollars Per Pound)markets

	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Mean	0.8823	0.6589	0.6204	0.0048	0.0014	0.0001
Media	0.7492	0.6573	0.6258	0.0018	0.0007	-0.0019
Standard deviate	0.3254	0.087	0.062	0.0434	0.0335	0.0263
Skewness	0.6688	0.4767	-0.1256	0.4148	-0.257	0.2556
Kurtosis	2.162	3.9706	2.185	5.9879	3.3505	2.9244
Observations	156	156	156	155	155	155

Table 2 privides price correlation results between the Chinese, EU and U.S. hog markets. There are a moderate high relationship between p_c and p_e. However the p_a have rather low relationship with p_c and p_e. Panel B shows the EU and U.S. are related together. However , Chinese have the extremely low relationship both with EU and U.S. In summary it appears from the data in table 1 and 2 that EU and U.S. share more consistency in both price and return, and the Chinese market is less integrated and features more independency in pricing and returns.

Table 2 provides price and return correlation results between the Chinese ,EU ,and U.S hog

Panel A				Panel B			
Market price	[illegible]	[illegible]	[illegible]	Market price	[illegible]	[illegible]	[illegible]
p_c	1			rp_c	1		
p_e	0.6447	1		rp_e	0.1506	1	
p_a	0.0838	0.1673	1	rpa	0.0105	0.3552	1

Spatial market information transmission – Cointegration

Many first-hand price data series are found to be nonstationary. Therefore, a unit root test is necessary to determine the stationary of the three sets of market price data before proceeding to the co-conintegration test. All variables were transformed into natural logs before estimation and testing for unit roots using the Augmented Dickey-Fuller (ADF) and phillps-perron(PP) test. And we find that the null hypothesis is not rejected under test (p<0.01), and therefore the price of Chinese EU and U.S. are unstationary, However if we check the prices consistent with I(1) (return of the price), we find the null hypothesis is rejected under test (p<0.01), all of the prices are stationary .

Table3: unit root test (ADF)

	lpc	lpe	lpa	rpc	rpe	rpa
Without linear tread						

ADF	-1.477	-1.328	-0.58	-7.47 ***	-9.49***	-10.814***
PP	-1.381	-1.396	-0.626	-5.39 ***	-9.21***	-10.82***
With linear tread						
ADF	-2.535	-4.23***	3.121	-7.40 ***	-9.44 ***	-10.74***
PP	2.416	-3.716 ***	-3.03	-5.18***	-9.157***	-10.75***

Because the first difference (returns of the price)is stationary, it can be estimated econometrically without the problems that standard regression analysis is carried out with nonstationary variables. Cointegration is used to describe this stationary relationship, and to investigate the international information transmission in the hog price markets. Assuming $p \equiv (p_c \;\; p_e \;\; p_a)$ is cointegrated, then the following VECM can be estimated :

$$dlp_t = \mu + \pi dlp_{t-1} + \sum_{i=1}^{k-1} \tau_k \, dlp_{t-k} + \varepsilon_t \qquad (6)$$

Where dlp_t equals $(lp_t - lp_{t-1})$, μ is a 3*1 vetor of drift; π is a 3*3 matrix of parameters and ε_t is 3*1 white noise. The appropriate lag length k , is determined prior to the cointegration test. In this study, Akaike information criterion (AIC) and the final prediction error (FPE) (AKaike,1969) to determine the lag term in a simple vector autoregressive model. As shown in the Table 4, the lag length k in the VECM chosen by the AIC and FPE is 2.

Table 4 :Lag order selection Criteria

Lag	AIC	FPE
0	-10.21	7.35e-9
1	-10.66	4.67-09
2	-10.7*	4.50e-09*
3	-10.61	5.95e-09
4	-10.57	5.13e-09
5	-10.51	5.47e-09
6	-10.47	5.70e-09
7	-10.47	5.68e-09
8	-10.48	5.69e-09

Then, We perform the Johansen cointegration test. Both trace and maximum eigenvalue test methods are applied in this study. As Table 5 indicates, the null hypothesis is rejected as both trace value and max eigenvalue exceed the 0.01 level critical value. This show that all the three markets are highly cointegrated, and have a high level of information transmission with synchronized moves in the long run. In this case, an vector error correction model (VECM) is appropriated to deal with the problems of dynamic effects and nonstationarity.

Table 5: Johansen Cointegration Test

Number of Cointegating Equations	Trace	Max.Eigenvalue
None	99.63***	52.68***

At most 1	49.94***	30.52***
At most 2	16.42***	16.42***

The regression for the cointegration equation between three markets fing the following coeffecint estimates.

$$lpe_{t-1} = 0.1892lpa_{t-1} + 0.2512dlpc_{t-1} - 0.2867 \qquad (7)$$

Table 6: Regression Output for the Cointegration Equaiton standard errors

lpa(-1)	0.1892(0.075)
lpc(-1)	-0.2512(0.021)
C	0.02867(0.0375)
R^2	0.47
Durbin Watson	0.246
Log likehood	145.1

Next, we solve the VECM model in order to examine the price transmission mechanism between hog markets. After checking the empirical regulations that exists in the data, we use the VECM for the model where dlnp_c refers to the difference between price on day t and its subsequent price ($dlnp_c = lnp_{ct} - LnP_{c(t-1)}$). The same is the $dlnp_e$ and $dlnp_a$. All β_0 and β_i can be regarded as constant parameters and ε_t is white noise. A t-statistic is used to interpret the unit root order of the data series (Dickey & Fuller, 1979). Long-term price equilibrium is the basis for studying cross-market information transmission. We perform the Johansen (1991) cointegration test. Both trace and maximum eigenvalue test methods are applied in this study. Vector error correction functions as a short-term force that helps to bring price deviations back to their equilibrium relationship. Cointegrated variables can be represented in an error correction framework. Since the three hog markets are found to be 1 difference integrated in this study, an error correction model is applied to investigate the information transmission mechanism. The result of the VECM is the table 6. The result are generally good. Some of the model coefficient exceed 5% significant level.

we solve the VECM model in order to examine the price transmission mechanism between three hog markets ,Equation(7) is as the follows:

$$\varepsilon_t = lpe_{t-1} - 0.1892lpa_{t-1} - 0.2512lpc_{t-1} + 0.028 \qquad (8)$$

Where ε_t is the error correction term in the VECM. The VECM is then formulated as follows using a lag term 2, We make VECM model as the following:

$$\text{dln}p_{ct} = \beta_0\varepsilon_t + \beta_1 dlnP_{c(t-1)} + \beta_2 dlnP_{c(t-2)} + \beta_3 dlnP_{e(t-1)} + \beta_4 dlnP_{e(t-2)} + \beta_5 dlnP_{a(t-1)} + \beta_6 dlnp_{a(t-2)+}\alpha_0$$

$$\text{dln}p_{et} = \beta_0\varepsilon_t + \beta_1 dlnP_{c(t-1)} + \beta_2 dlnP_{c(t-2)} + \beta_3 dlnP_{e(t-1)} + \beta_4 dlnP_{e(t-2)} + \beta_5 dlnP_{a(t-1)} + \beta_6 dlnp_{a(t-2)} + \alpha_0$$

$$\text{dln}p_{et} = \beta_0\varepsilon_t + \beta_1 dlnP_{c(t-1)} + \beta_2 dlnP_{c(t-2)} + \beta_3 dlnP_{e(t-1)} + \beta_4 dlnP_{e(t-2)} + \beta_5 dlnP_{a(t-1)} + \beta_6 dlnp_{a(t-2)} + \alpha_0$$

(8)

The results from running the VECM using equations (8) are presented in Table 7. The results are good generally. The F-statistics for each regression are significant (They exceed a 1% statistical significance level) and the R^2 value are high for the overall fitting of the VECM. This provides some evidence of spatial-market information transmission efficiency in returns .

Table7： Estimation of VECM model

Error correction	dlpc	T-statistic	dlpe	T-statistic	dlpa	T-statistic
ρ_U	-0.0051	-0.7225	0.0446	4.548***	0.021	2.253**
β_1	0.7847	9.859***	0.1708	1.559*	0.0559	0.537
β_2	-0.3099	-3.911***	0.2769	-2.539**	0.1545	-1.491*
β_3	-0.0083	-0.1407	0.2147	2.606**	-0.0169	-0.2164
β_4	0.0443	0.739	0.0476	0.576	0.1361	1.7353*
β_5	0.0689	1.0489*	0.2833	3.131***	0.1739	2.022**
β_6	-0.047	-0.705	0.0718	0.774*	-0.0778	-0.882
$\propto$	0.003	1.143*	0.0017	0.4788	-4.73E-06	-0.00137
R^2	0.4329		0.2475		0.076	
F	15.81***		6.8152***		1.712*	

*** Statistical sighnificance at the 1% level

** Statistical significance at the 5% level

*Stattistical significance at the 10% level

α_i and β_i refer to the correlation coefficients in equtions (8); where β_1 to β_2 are "lagged dlpc" coefficients; where β_3 to β_4 are are "lagged dlpe"; where β_5 to β_6 are "lagged dlpa" coefficients;

There are some conclusions from the results. First, although each market has a influence on the other markets, however the results are not very significant (t value is not very large). And the U.S. and EU market has no significant relationships on the Chinese hog market(t value is very small). It could show that the three markets are not connected tightly from each other. It's the same with the analysis on correction relationships. The strongest influence comes from Chinese hog market and U.S. market to the EU market(the t –statistics of 2.606,3.13) and the reverse isnot true. It shows that china is the least influenced and EU is the most influenced by other country .

Secondly, the influence of information flow between the three market are not always consistent in direction.It indicates that U.S. market and EU markets share information transmission efficiency and move together (the total error correction coefficients are positive in both direction of information flow). However the information power of the Chinese hog market on the other two markets is reversed in direction(the total error correction coeffienet is negative in both directions of information flow). It possilbly explains why Chinese hog markets is much more volatile than U.S.and EU markets. As the three markets move together .

Lastly, all the three markets show inefficiency in terms of information transmission. The price changing signal and volatility are not received and delivered between markets very well. It appears that there are arbitrage opportunities can be exploited in the process. Investors can seek the profits chances among the three markets.

Price discovering markets – Granger causality test

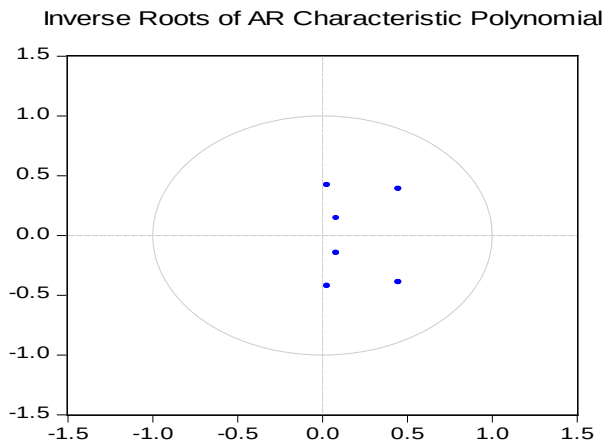
Granger casualty test are used to identify the price discovering market. Table 8 provides the VECM for the Granger casualty test. Granger causality can be used to test the influence of the three hog markets on each other since all three data series are found to be stationary without difference. The results indicate that the p_a have significant Granger casualty to the p_e and p_c have the significant Granger casualty to p_e, as all F tests are statistically significant at $p < 0.05$ level, However the not vice versa. There are no significant Granger casualty between the p_c and p_a. It shows that p_c will not affect prices that the changes taking place in p_e and p_a. And it also shows that p_a will not be affectef by other markets and it shows that the market especially the p_a is blocked by the other hog price .

Table 8:The Granger cause test

Null Hypothesis:	Obs	F-Statistic	Prob.
[illegible] does not Granger Cause [illegible]	148	0.0102	0.7688
[illegible] does not Granger Cause [illegible]		0.878	0.3248
[illegible] does not Granger Cause [illegible]	148	0.1918	0.8257
[illegible] does not Granger Cause [illegible]		4.25**	0.0153
[illegible] does not Granger Cause [illegible]	148	0.549	0.5781
[illegible] does not Granger Cause [illegible]		3.427**	0.0351

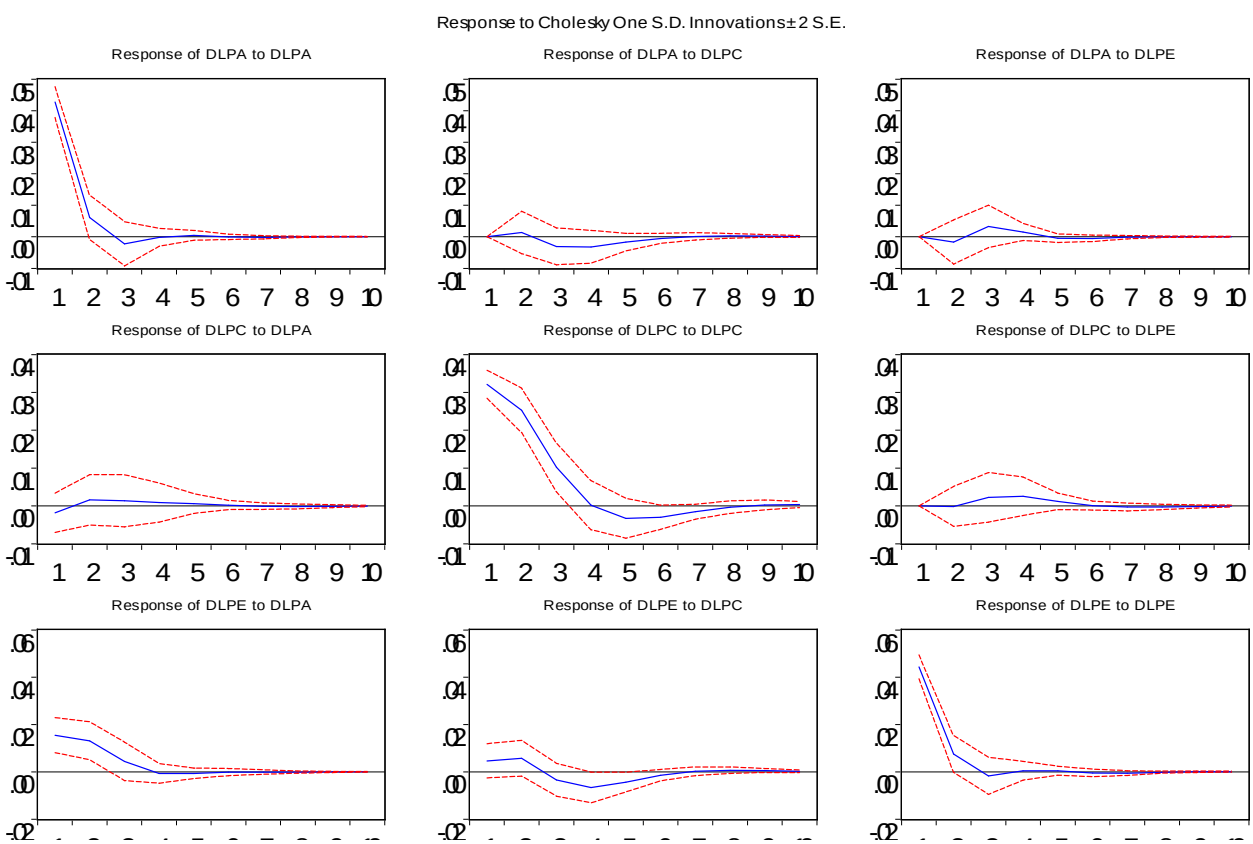
The short impulse analysis

The study uses the impulse as an additional check of cointegation tests of findings. Followed by Cholesktype of contemporaneous identifying restrictions are employed to draw a meaning interpretation. Before we make impulse analysis, we should see whether the variables are stabilities. And it shows that there are no root outside the unit circle in Figure 2. So it could be meet the condition for the analysis of impulse and variance decomposition.



Firgue 3: The AR root graph

From the figure 3 we could see that if we give the impulse of p_a and p_e to p_c, followed by a total cessation of the impulse after six periods, and the impulse will be end after about 8 periods. And p_e will give the p_c the greater impulse than p_a. Given the impulse of p_c and $p_e$to the p_a,we see p_a will have the very light fluctuation under p_c and p_e will bring much decrease to p_a and after 8 periods there will be the end of the impulse. Given the impulse of p_c and p_a to p_e ,We see that there are increasing trend and after 5 periods there will be the end of the impulse.



Figures 4 the impuse response functions to price shock in Chinese ,EU and US market

Variance decomposition analysis also holds, considering the possibility that a certain error term could move with other error terms within the framework of the impulse response analysis. The estimate of result are show in the table 9. After 50 periods of time, while more than 1.7% of p_c and 3.6% of p_e will contribute to the variance of p_a. About 15.36% of p_a and 45.06% of p_c will contribute the variance of p_e. Only 1.35% of p_a and 0.4% of p_e will contribute the p_c. So it shows that p_e is easily affected by the p_a and p_e. While p_a and p_c are self-dependent is not affected by the other markets greatly.

Table 9: Generalized forecast error variance decomposion

Month ahead	Chinese	EU	US
	Variance of Chinese price (percentage) explained by shock to prices		
1	1.0000	0.0000	0.0000
5	0.9848	0.0109	0.0041
10	0.9752	0.0187	0.006
20	0.9551	0.0189	0.00603
30	0.9749	0.0189	0.00604
40	0.9749	0.0191	0.00604
50	0.9749	0.019	0.00604
	Variance of EU price(percentage)explained by shock to prices		
1	0.0116	0.9883	0.0000
5	0.0316	0.9305	0.0378
10	0.0818	0.8645	0.0535
20	0.2468	0.6538	0.0992
30	0.3418	0.5335	0.1246
40	0.4053	0.4531	0.1415
50	0.4506	0.3956	0.1536
	Variance of us price(percentage)explained by shock to prices		
1	0.0022	0.0858	0.9119
5	0.0069	0.0469	0.9461
10	0.0071	0.0359	0.9569
20	0.0041	0.0368	0.9590
30	0.0028	0.0364	0.9606
40	0.0022	0.0362	0.9615
50	0.0017	0.0361	0.9620

Conclusion and Discussion

This study investigates price and volatility transmission for the three most import players in the international hog market. The period study was from January 2000 to December 2012. There are some findings in this paper that should be synthesized. Firstly, the relationships among the three markets hog price are rather weak. Chinese market are much more close relationship with EU than U.S. Secondly china is the least easily influenced and EU is the most influenced by other country. U.S. and EU share information transmission efficiency and move together. However the information power of the Chinese hog market on the other two markets is reversed in direction. Thirdly the hypothesis of Grange causality is confirmed between the Chinese hog price and the EU but not in both directions, that is, we find Granger causality from Chinese price to EU price but not the reverse. And the same between U.S. and EU hog price, we find the Granger Causality from U.S. to EU price but not the reverse .But the hypothesis of Grange causality is not confirmed between Chinese and U.S. Fourthly, according to the impulse response function, the hog price of the U.S. market responds noticeably to the shock from EU but mildly to the shocks from Chinese. But the price of Chinese responds to the U.S and EU. From the results of variance decomposition, it shows that Chinese and U.S. influlece the EU prices greatly. However ,the Chinese and U.S. are rather self-dependent market and are not affected by other markets .

Though the commercial volume of trade in Hogs is low and the price transmission effection is weak among the three markets, the trends in the variables favorable to increasing pork trade are emerging and are expected to be reality in the near future.The directions of price transmission reported in this study appear consistent with stages of growth in each of the world's three major hog markets .As the expected demands for U.S. and EU hog exported to china increase,So should the flows of hog price information. At this point, the paper may prove more instructive to policy markers and entrepreneurs going forward than it does now.

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