Research Article

Impact Effect of Food Safety Incidents on Price

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Abstract: Hidden danger of food safety is always one of the important factors causing food price fluctuation. Once some kind of food occurs large scale of safety incident, its price is bound to be impacted. To analyze the view above by example, this study analyzed impact effect of clenbuterol event on the market price of pork using method of relative price with a substitute. The results demonstrated that, relative price of pork and beef was in a co-integration relationship before clenbuterol event occurred; the first structural breakpoint appeared half year after CCTV reported clenbuterol event and the second one occurred in April, 2012, indicating the impact effect of clenbuterol event to market price lasted for half year. Evaluation of price impact effect by error correction model indicated that, the price of pork lowered 30.3% averagely in that period, while the price of its substitute beef tended to be higher, with an amplification of 8.2%.

Keywords: Clenbuterol, food price analysis, impact effect

INTRODUCTION

In recent years, food safety incident is often seen in China, but social influence caused by it is always equal to the practical risk level. It is because consumers usually exaggerate food safety risk when they are suffering from the harm brought by food safety incidents, leading to disastrous consequence and irreversible outcome (Zhou and Zhuo, 2010). For example, melamine incident not only resulted in bankruptcy of the largest dairy enterprise Sanlu and influenced the whole dairy industry at home; as a result, psychology of national people is deeply affected by domestic milk powder for a long time, bringing unprecedented challenge to the fame of domestic dairy industry. Even until today, many consumers still refuse domestic milk powder (Cheng *et al*., 2009).

Thus some scholars have carried out wide research on the influence brought by food safety incidents. However, it is a pity that, influence of food safety incidents on confidence, risk preference, risk perception and food purchasing behavior of consumers is dominated in research about this aspect (Xiong *et al*., 2011) and few are about quantitative analysis of the direct influence of food safety incident on market or industry. This study aimed to make up the blank of domestic research in this aspect by emphatically studying the impact effect of food safety incidents on market price with theoretical modeling and empirical test. Based on the investigation on clenbuterol event occurred in 2011, this study made an analysis taking clenbuterol event as the object of consideration and discussed change law of pork consumption behavior after the incident occurred. The reason why clenbuterol

event was chosen as the research object was that, this incident was exposed in 3.15 special programs by CCTV and widely spread by various media in a short time; it is able to be taken as an example due to huge repercussion induced by it in the market (Cheng and Yin, 2012).

MATERIALS AND METHODS

Selection of analysis method:
Comparison of known methods: Though impact effect of domestic food safety incidents to market price is seldom reported in literature, related studies abroad (including outburst of animal diseases) are rich. It can be known from the foreign literature that (Li and Pu, 2011), estimation method for impact effect of food safety incidents to price can be divided into the following three method based on different base price confirmation methods:

- Price comparison method, i.e., comparison of average price before and after the occurrence of an event. When this method is used, definite influence time of a known event on market should be acquired, in order to confirm price before and after occurrence of the event and events in same property are required to occur for many times, in order to test statistical significance of impact effect of the events
- **Event study method:** This method confirms base price when events do not occur based on portfolio theory. It is usually used for analyzing influence of an event to stock price of an enterprise rather than

estimating direct influence of an event to price of products

- Supply-demand structure model method (comparing practical observed price and price predicted by structure model). Correct setting is required in the method; improper model setting may result in mistaken judgment of structure change.

For clenbuterol event analyzed in this study, we only observe it and the definite date for the event can not be confirmed. Thus the first method (price comparison method) is not applicable. Moreover, price change of pork is usually explained by rational deposit and loan model, thus event study method is also not applicable. Besides, supply and demand model of pork is hard to be set because demand of pork is complex; clients from catering industry, food processing industry, family consumption have different demand functions, leading to different influences. Therefore, the third method is also not suitable for estimating impact effect of clenbuterol event to price.

Concept of method of relative price of a substitute:
This study made analysis on impact effect of clenbuterol event to price of pork referring to the method of relative price of a substitute proposed by Carter and Smith (2007). Basic idea for this method is that, relative prices of two products can be expressed as a function of supply and demand impact factors as follows:

$$\log\left(\frac{p_{1t}}{p_{2t}}\right) = g(Q_{1T}, Q_{2t}, Z_t) \tag{1}$$

where, pit and Qi express price and amount of product i at time point t, g (*) is a functions without setting of

detailed form and Zt expresses influence factor of supply and demand. Carter and Smith (2007) believe that, whether relative price function g (*) changes or not need to be tested, if changes of preference or relative technology need to be judged; but this test does not require accurate setting of function g (*) and even the form of g (*) is unnecessary to be set. They hold that, if the impact of supply and demand influence factor is temporary, then the change of relative price means changes of preference or relative technology; otherwise, if the impact effect of these influence factors to relative price is permanent, then this sequence is proved to have unit root and changes of preference or technology is incapable to be separated from other explanatory variable. Considering this point, we should first verify that the coordination relationship between relative price and other related variables is not induced by the event itself and then determine the change of specific parameters and estimate the size of price impact effect.

Selection of variable and related research:
Selection of substitute: When a research method is confirmed, a key of continued research is to a substitute product closely related to pork. It is known from related data that, beef is the second important source of animal protein next to pork. In addition, beef can be accepted by most consumers as it has no special flavor like mutton and beef is the same as pork in traditional cooking method; therefore, beef becomes an appropriate substitute of pork (Fan *et al.*, 2012). On the other hand, so far, news about beef containing clenbuterol has not been reported. As reported by media, mutton containing clenbuterol have found in many places, indicating consumers who intend to avoid clenbuterol are more prefer to replace pork by beef. Thus this study selects beef as the substitute of pork for analysis of relative price.

Table 1: Descriptive statistics of price of pork and beef unit: yuan/kg

Variable	Sample size (N)	Average value	S.D.	Max.	Min.
Pork price	242	32.6088	6.091803	47.86	25.78
Beef price	242	18.0656	3.310552	25.57	11.86
Relative price	242	1.8244	0.289106	2.43	1.28

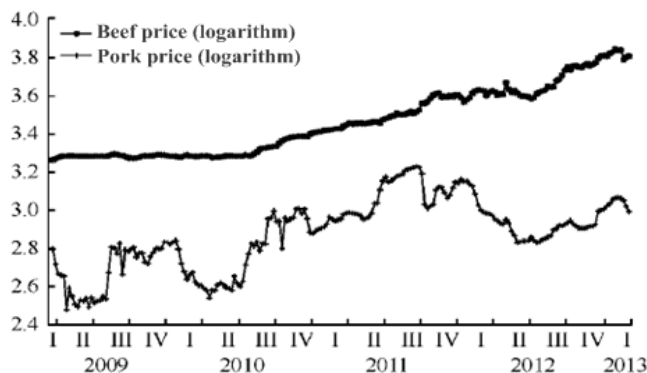S.D.: Standard deviation; Max.: Maximum; Min.: Minimum

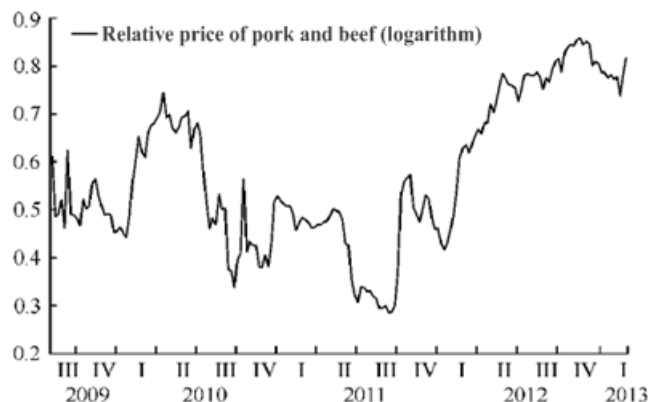Fig. 1: Dynamic change of pork and beef price (logarithm)

Fig. 2: Dynamic change of relative price of pork and beef (logarithm)

Analysis of changes of price of beef and pork: Information about changes of market price (average weekly price) of beef and pork from May 6th, 2009 to August 12th, 2013 comes from Chinese agricultural information website. There are totally 242 observation points. 125 observation points were found after clenbuterol event (March 15th, 2011) was reported. Statistical conditions of pork price logarithm (P_{po}), beef price logarithm (P_{be}) and the relative price (P_{be}-P_{po}) are shown in Table 1 and corresponding dynamic change graphs are shown in Fig. 1 and 2. It can be seen from the table that, during that period, average price of pork and beef is 18 yuan/kg and 32.5 yuan/kg respectively; amplitude of fluctuation and frequency of pork price are both larger than beef, which can be also concluded from Fig. 1. It should be specially mentioned that, after the occurrence of clenbuterol event, i.e., at the end of the second quarter and in the beginning of the third quarter in 2011, the price of pork tended to decrease and then rise.

RESULTS AND DISCUSSION

Comparison of results and discussion:
Market integration: Stationary test is performed on the price of beef and pork and the relative price using ADF method and the results are shown in Table 2. It can be obtained from the results that, before CCTV reported clenbuterol event on March 15th, 2011, the price of pork and beef (logarithm) both contained unit root and null hypothesis of "relative price has unit root" is refused at 10% significance level. It indicates that, two price sequences has coordination relationship of CI(1,-1) before market impact, thus the relative price of pork and beef is proved to have long-term stationarity.

Test of structural breakpoints: ADF test results demonstrate that, the price of pork and beef have a coordination relationship before CCT reported the clenbuterol event. We test whether relative price has breakpoint or changed parameters based on the samples

Table 2: Price of beef and pork (logarithm) and relative price before clenbuterol event (ADF test)

Sequence	T-statistic	p-value	Conclusion
ppo	-1.496256	0.5324	Have unit root
pbe	1. 060059	0. 9968	Have unit root
Pbe-Ppo	-3.194948	0. 0914	Have no unit root

one year after clenbuterol event, in order to deduce the definite time of clenbuterol event influencing market. But once we deduce according to the above method, tests on parameter change or structural breakpoint will be complex as the number of breakpoints is unknown.

Based on that, this study cited super F test method proposed by Bai nad Perron. This method solves the problem mentioned above by searching breakpoint amount and date at the same time their test procedure starts from the null hypothesis test "there is no breakpoint, otherwise there is one breakpoint". If the null hypothesis is rejected, then the first breakpoint is considered as given and the second breakpoint is tested next. The procedure continues until null hypothesis without new breakpoints is not to be rejected. Using this method, the test results of breakpoints obtained are shown in Table 3.

The table demonstrates that, there are two breakpoints appearing after CCTV reported clenbuterol event. The first one appeared in the beginning of September, 2011 and the second one appeared in the beginning of April, 2012. It means half year after the report of CCTV, market price effect began to come out and lasted for more than half year.

Estimation of influence caused by price: Breakpoint test indicates that the relative price of beef and pork rose for nearly 50%, but does not reveal the influence degree of decreased pork price and increased beef price on the rising of relative price. In the last procedure of the substitute relative price method, we estimate the influence of clenbuterol event on the price of pork, i.e., price influence estimation. As pork price and beef price have a coordination relationship, we construct an error correction model (ECM) to make a prediction and analysis. ECM is as follows:

Table 3: Test results of breakpoints

Breakpoint test	F-statistic	5 % Critical value	Estimated break dates	Conclusion
UDMax statistic	211.5912	8. 86		Significant at 5 % level
WDMax statistic	251.4472	9.93		Significant at 5 % level
0 vs.1	393.7419	8.58	4/09 2012	At least one breakpoint
1 vs.2	88.21176	10.11	7/19/2010	At least one breakpoint
2 vs.3	11.43608	11.44	9/05/2011	At least one breakpoint
3 vs.4	2.541796	11.79		Three breakpoints

Table 4: Eestimation of ECM before market impact

Model parameter	ppo	Pbe/ppo	pbe
μ		0.563482	
α	-0.130828		-0.007639
γ	-0.549782		-0.238790
δ	-0.262875		-0.023482

Table 5: Descriptive statistical analysis of forecast error

	Pork price forecast error	Beef price forecast error	Relative price forecast error
Mean	0.302892	-0. 081536	0.387386
Median	0.283253	-0. 090712	0.364573
Maximum	0.534841	0. 041272	0. 672850
Minimum	-0.008526	-0. 146553	-0. 002484
Standard deviation	0. 148487	0. 046467	0.177468

$$\Delta ppo_t = \alpha_1 Z_{t-1} + \gamma_1 \Delta pbe_{t-1} + \delta_1 \Delta ppo_{t-1} + \varepsilon_{1t} \quad (2)$$

$$\Delta pbe_t = \alpha_2 Z_{t-1} + \gamma_2 \Delta pbe_{t-1} + \delta_2 \Delta ppo_{t-1} + \varepsilon_{2t} \quad (3)$$

where, γ_i and δ_i are the coefficients of relative variables, $Z_t = pbe - ppo - \mu$ expresses error correction item, parameter α_1 and α_2 reflect the reaction of pork price and beef price to deviation from the long-term trend. The more α_1 and α_2 close to 0, the more time will cost when the sequence returns to long-term trend after impact. Next, we should first estimate the coefficient of ECM from May 6th, 2009 and September 4th, 2011 before market impact. The analysis result is as follows:

It can be seen from Table 4 that, all symbols in ECM are consistent with theoretical expectation. An error correction item coefficient of pork price and beef price is -0. 1308 and -0. 0076, respectively. It indicates that, pork price and beef price are regulated for 13.1 and 0.76% to correct the deviation from long-term trend. Error correction item coefficient α_1 of pork price is highly significant at 1% level, while error correction item coefficient of pork price α_2 is not significant. It means that, deviation from long-term trend is corrected by regulating pork price.

We predict every ECM within sample and the prediction interval is the period of clenbuterol event influencing price proved by breakpoint test above, i.e., from the beginning of September, 2011 to the beginning of April, 2012. Pork (beef) price forecast error can be obtained by taking the practical observation value after market impact from predicted pork (beef) price. This forecast error represents the impact effect of clenbuterol event on pork (beef) price. Detailed results are shown in Table 5.

It can be seen from the Table 5 that, average forecast error for pork and beef price is 0. 3028 and -0. 0815 respectively, suggesting that the price of pork after the occurrence of clenbuterol event is 30.3% lower than the price if clenbuterol event does not occur; meanwhile, beef price after the occurrence of clenbuterol event is 8.15 % higher than the price if clenbuterol event does not occur. Forecast error for relative price of pork and beef finds a 38.7% increase in relative price caused by clenbuterol event.

CONCLUSION

This study analyzes the dynamic characteristics of relative price of pork and beef in clenbuterol event using the method of relative price with substitute first proposed by Carter and Smith (2007) and quantitatively calculates the impact effect of clenbuterol event on market price (Quan *et al*., 2011; Liu, 2012). Differing from other literature at home, this study focuses on the direct influence of food safety event on market or industry. Practical market data is used to clearly illustrate the impact effect of food safety event on food price. This study provides a powerful reference for analysis of the influence of other great food safety event on market price of food in the future.

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