PAPER • OPEN ACCESS

Price transmission on the Indonesian beef market

View the article online for updates and enhancements.

Price transmission on the Indonesian beef market

K Komalawati[1], A Malik[2], R K Jatuningtyas[1] and M E Wulanjari[1]

[1]Central Java Assesment Center for Agricultural Technology, Ministry of Agriculture
[2]East Java Assesment Center for Agricultural Technology, Ministry of Agriculture

Email: lalabptpjtg@gmail.com

Abstract. Beef has been seen as one of the strategic commodities in Indonesia. As the awareness of people to protein consumption increasing, demand for beef and its prices are also rising. However, the rising consumer price of beef is not followed by the increasing price of beef at the producer level. Therefore, the objective of this study is to analyze the transmission of beef prices at the consumer and producer level. This study used secondary data from the Agency for Central Statistics of Indonesia. The data used were the consumer and producer prices of beef from 2008 to 2016. The data were analyzed using the Vector Error Correction Model (VECM). The results show that the prices of beef at the consumer and the producer level are asymmetric and have uni direct relationships. The consumer prices of beef influence the producer prices of beef and not vice versa. It is recommended for the Government to formulate policies that could facilitate transparent information for every actor along the beef market chain. In the long-run, the Government needs to increase the population of domestic cattle and give incentives to domestic cattle farmers with large business scales.

1. Introduction

Beef has been seen as one of strategic commodities and the second source of protein [1]. Beef is also potential to be developed in Indonesia. Indonesia has abundance natural resources to feed the cattle [2] or to develop the integrated farming between cattle and plantation [3]. However, the potential development of beef has not been utilized optimally. Therefore, the growth production of local cattle as well as beef are slower compared to the growth consumption or demand of beef. From 2006 to 2015, the growth of beef production and cattle population increase respectively around 4.05 and 3.14% per year [4,5]. Meanwhile, the demand growth for beef increase slightly higher than beef production and cattle population which is around 4.08% per year [5].

The slightly higher demand compared to production and cattle population has increased the price of beef. As demand for beef increased, the price of beef is also rising and tends to be volatile. Between 2008 and 2016, the growth of beef price in the consumer level increases substantially around 0.57% per year [6]. The increasing price of beef in the consumer level has similar direction with the price of beef in the producer level. However, in terms of magnitude, the rising of beef price in the consumer level is higher than that in the producer level. The rising price of beef in the consumer level does not substantially increase the price of beef in the producer level.

The average gap of price between producer and consumer level tends to become wider every year. In 2010, the average gap between these two prices are around IDR 36,213/kg [6]. In June 2016, the average gap becomes wider and increases to IDR 76,488/kg or increases by more than twice from 2010

[6]. Imperfect price transmission or asymmetric price transmission could be caused by: (1) adjustment or menu cost; (2) market power; (3) government policy; and (4) asymmetric information.

There has been some studies on the transmission or integration of prices between markets [6,8], but there are none of the studies discussed the transmission of prices between producer and consumer markets by using Threshold Vector Error Correction Model (TVECM). Therefore, the objective of this paper is to analyze the price transmission of beef from producer to consumer market in Indonesia. By understanding the price transmission of beef in Indonesia, it is expected that the problems of asymmetric information in Indonesia could be identified and solved. The results could be used as a recommendation for government and related stakeholders.

2. Research method

2.1. Data collection
To analyze the transmission of beef prices in the producer and consumer level, the monthly time series data from January 2008 to December 2016 were used. The prices of beef in the consumer level were obtained from the Ministry of Trade of Indonesia. Meanwhile, the prices of beef in the producer level were collected from the Agency for Central Statistics of Indonesia. Other secondary data used are previous research journal and official reports of Ministry of Agriculture and other related agencies.

2.2. Model development
The integration analysis of beef market in Indonesia uses Vector Error Correction Model (VECM). In VECM, there is an assumption that must be fulfilled. This assumption is the time series data have to be co-integrated. Co-integrated implies the existence of long-term equilibrium relationship between those time series data used [9]. By having those data co-integrated also means that: (1) two variable series, for example price in the consumer and producer level, are non-stationary in levels but stationary in first differences; and (2) these two stationary data series have a linear combination [10]. If there is no co-integration exist, VECM cannot be used and Granger Causality tests or Vector Auto Regressive (VAR) model can be used to analyze the causal relationship between variables.

Therefore, the first step of using VECM is to test whether the series are stationary. The Augmented Dickey-Fuller (ADF) is used to test whether the series or the order of integration for each variable is stationary [10]. In ADF test, each series of price are tested for null hypothesis of $\gamma = 0$ or the price series are not stationary and $\gamma < 0$ or the price series are stationary. The equation for ADF test is as follows:

$$\Delta P_t = \alpha + \gamma P_{t-1} + \sum_{i=1}^{n} \beta_i \Delta P_{t-i} + \varepsilon_t \tag{1}$$

$$\Delta P_t = P_t - P_{t-1}; \ \Delta P_{t-i} = P_{t-i} - P_{t-i-1} \tag{2}$$

Where P_t is vector of the price at time t, α is vector of constants, γ and β are parameter matrices to be estimated, ε_t is the i.i.d. normal disturbance or the white noise error term, and i is the number of lagged differences.

If the coefficient on the ADF value is positive or less than the McKinnon Critical Value of 1%, 5%, and 10%, the price series will not be stationary I (1). On the other hand, the price series are stationary when the value of the ADF test is higher than the McKinnon Critical Value and negative. If the price series are not stationary, the test should be repeated using the lag price or ΔP_t as the dependent variable until the order of integration is determined.

The second step is to determine the optimal lag. One of the problems occurs in the stationary test or unit root test is in determining the optimal lag. If the lag used in the stationary test is too small, the white noise process cannot be displayed and the model cannot accurately estimate the actual error. The Akaike Information Criterion (AIC), Schwarz Information Criterion (SC), and Hannan-Quinn Criterion (HQ) are used in determining the optimal lag.

If the price series are stationary, the co-integration test could be conducted by using the optimal lag determined. As previously mentioned, the co-integration test is used to identify the long-term relationship of the price of beef in the producer and consumer levels. The co-integration test in this study

uses the maximum likelihood (ML) method developed by Johanson [11]. In Johanson method, the existence of long-run relationships between variable could be tested using trace test (TS) and maximum eigenvalue (ME). If the value of the TS and the ME exceed the t-statistic value then the null hypothesis is rejected. In other words, there is a long-term relationship between the variables analyzed.

The third step is to test the causality or the direction of changes in price. The causality test usually uses the Granger-Causality test. The Granger-Causality test also uses to see the direction of transmission. As previously mentioned, if data were stationary at level, VAR model could be used with general formula as follows:

$$PP_t = \alpha + \sum_{j=1}^{n} \beta_j PP_{t-j} + \sum_{j=1}^{n} \gamma_j PK_{t-j} + \varepsilon_{it} \tag{3}$$

$$PK_t = \alpha + \sum_{j=1}^{n} \beta_j PK_{t-j} + \sum_{j=1}^{n} \gamma_j PP_{t-j} + \varepsilon_{it} \tag{4}$$

Where PP_t is the producer price at t period, PK_{t-j} is the consumer price at t-j period, α is constant, β_j, γ_j are parameters estimated, ε_{it} is error with i = 1,2,...., j is the lag length with j = 1,2,....,k, k is the maximum lag length. If data were stationary at first difference and data were cointegrated in the long-term, the model used is Vector Error Correction Model (VECM). VECM model is used to anticipate the existing of *spurious regression* or false decision because of spurious regression. The VECM model used in this study is:

$$\Delta y_t = \mu_{0x} + \mu_{1x} t + \prod_x y_{t-1} + \sum_{i=1}^{k-1} \tau_i \Delta y_{t-i} + \varepsilon_t \tag{5}$$

Where Δy_t is vector of variables used in this study (beef prices in the consumer and producer level), μ_{0x} is the vector of intercepts, μ_{1x} is the vector of parameters estimated, t is time trend, $\prod_x$ is γ x β with β as long-term coefficient, γ is the adjustment speed, τ is short-term coefficient, $\prod_x y_{t-1}$ is Error Correction Term (ECT), k-1 is the order of VECM from VAR, and ε_t is error term.

3. Results and discussion
Figure 1 describes the movement of the price of beef in the producer and consumer level. As can be seen in figure 1, the prices of beef in the producer and consumer level have an increasing trend. The price movement in the producer level has similar direction with the price movement in the consumer level, but with different magnitude. According to the Law of One Price (LOP), in the condition of free trade, arbitrage or the different in prices of the same good in two different markets is equal to the transportation cost [12]. However, the arbitrage between producer and consumer of beef tends to wider from year to year. While the price of beef in the producer level tends to be constant, the price of beef in the consumer level tends to fluctuate and increase. Therefore, the gap of prices in the producer and consumer is not only related to transportation cost, but also related to other costs. The gap of prices will be studied further using price transmission in the producer and consumer level.

3.1. The price transmission analysis

3.1.1. Unit root test. Unit root test or stationarity test is used to prevent from spurious regression. Spurious regression is a condition where the regression of a variable to other variables produce a high determination coefficient (R^2), but those variables have no relationships economically [8]. Table 1 illustrates the result of ADF test used to analyze the unit root. According to table 1, all the price series used in this study are not stationary in level or zero order. This can be seen from the result of ADF test that all variable prices are smaller in absolute from the McKinnon Critical value. Since those variables are not stationary in level, the unit root test is repeated again with higher order or first difference. The unit root test in the first difference shows that the zero hypothesis of the existence of unit root test is rejected. This can be seen from the result of ADF test. All variable prices in the first differences are higher that McKinnon Critical value either in the significant value of 1%, 5% or 10%. Therefore, it could

be concluded that all variable prices are stationary in the first difference. This means that the first requirement of using VECM model is fulfilled and it could be continued to the next step.
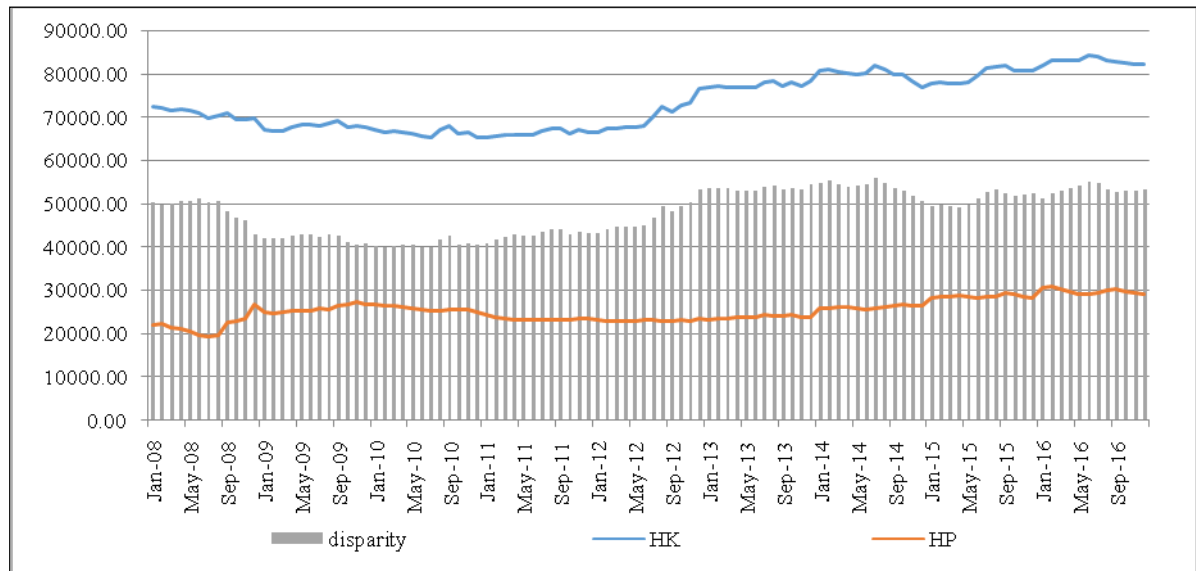
Figure 1. The movement of beef price in the producer and consumer level from January 2008 to December 2016.

Table 1. The Results of ADF test for riil price series of beef in the producer and consumer level.

| Variables | Differenced | Intercept with no trend | | | | Conclusion |
| | | The result of ADF test | McKinnon critical value | | | |
			1%	5%	10%	
Producer	I(0)	-0.667	-3.492	-2.889	-2.581	Not stationary
Price	I(1)	-10.856	-3.493	-2.889	-2.581	Stationary
Consumer	I(0)	-0.710	-3.492	-2.889	-2.581	Not stationary
Price	I(1)	-9.311	-3.493	-2.889	-2.581	Stationary

3.1.2. Determining the optimum lag length. Determining the optimum lag length is important in the analyzes using VAR/VECM. The lag of endogenous variables is necessary to understand since it will be used as exogenous variables. The aim of determining the optimum lag length is to reduce the problem of autocorrelation in VAR/VECM system [8]. The optimum lag length is determined by observing the value of *Log Likelihood Ratio* (LR), *Akaike Information Criteria* (AIC), *Schwarz Criteria* (SC), and *Hannan-Quinn Information Criteria* (HQ). The highest value of LR, and the smallest value of AIC, SC, and HQ will determine the optimum lag length. The results for the optimum lag length can be seen in table 2.

According to table 2, the optimum lag length is in lag 0 since it has the smallest value of AIC, SC and HQ. Therefore, it could be concluded that the optimum lag length that can be used in the integration analyzes between producer and consumer market is at lag 0 (lag 1).

Table 2. The results for the optimum lag length.

Lag	LR	AIC	SC	HQ
0	NA	-11.166*	-11.113*	-11.145*
1	1.076	-11.096	-10.939	-11.033
2	10.430*	-11.126	-10.864	-11.020
3	5.824	-11.109	-10.742	-10.960
4	6.680	-11.102	-10.630	-10.911
5	1.670	-11.041	-10.464	-10.807
6	1.862	-10.981	-10.299	-10.706
7	3.734	-10.945	-10.159	-10.627
8	1.486	-10.882	-9.991	-10.522

3.1.3.   Causality test. Causality test is used to identify the impact of changes in a variable to other variables or a market to other markets. In the case of vertical price transmission, shock caused by demand or supply will give different effect to the price transmission. The causality test usually uses Granger test. The null hypotheses of the test states that there is no significant relationships between two markets being compared, while another hypotheses mentions the significant relationships between two markets being compared. The results of causality test could be seen in table 3.

Table 3. The results of causality test with Granger method.

Hypotheses:	Obs	F-Statistic	Prob.
Producer price influencing consumer price	106	1.726	0.183
Consumer price influencing producer price		2.415	0.094

The results of causality test in table 3 shows a unidirect transmission of price from producer to consumer. As can be seen in table 3, the producer price is significantly influenced by the price of beef in the consumer level ($P<0.10$). On the contrary, the consumer price does not significantly influenced by the price of beef in the producer level ($P>0.10$). The causality results are rational since supply for beef does not come only from domestic sources but also from import [13]. As demand for beef is increasing and the availability of domestic beef is reduced, imports of beef and feeder beef continue to increase [14]. Therefore, the prices of beef in the consumer level are more likely to be influenced by the prices at the international markets and vulnerable to various shocks in major exporting countries such as Australia and New Zealand and exchange rate fluctuations. Meanwhile, cattle farmers usually use their cattle as saving and will likely sell their cattle when they need cash income. Hence, the producer prices will be influenced by the prices in the consumer level but it will not be applied oppositely.

3.1.4. Cointegration test. The cointegration test is used to analyze the long-run relationships of observed variables. The cointegration test could be used for observed variables that are integrated in the similar order. According to the unit root test, those variables observed are stationary in the first order or I(1). Therefore, the price series could be used for co-integration test. In Johansen test, the trace statistic and maximum eigenvalue are compared to the critical value of 5%. If the trace statistic or maximum eigenvalue is higher than the critical value, the price series are co-integrated or have long-run relationships, and thus, VECM can be used for analysing the relationships between prices in the producer and consumer level. The results of co-integration test could be seen in table 4.

Table 4 shows that the trace statistic and maximum-Eigen value are higher than the critical value of 5%. There are two co-integration equations. Therefore, there is at least one equation that can be used to explain the co-integration relationships between variables in the model. The results also indicate that there is an integrated relationships in the long-run between producer market and consumer market. The results of stationary test and Johansen Co-integration test indicate that the study could be analyzed further using VECM.

Table 4. The Results of Co-integration Test.

	Trace Statistic	Critical Value 5%	Max-Eigen Statistic	Critical Value 5%
None *	68.287	15.495	39.503	14.265
At most 1 *	28.783	3.841	28.783	3.841

3.1.5. The Estimation Results of VECM. After identifying the cointegration between markets and the number of cointegrating vector, the data could be estimated by using VECM (Vector Error Correction Model). If two or more variables are cointegrated, it means that there is a long-term relationship between two or more of these variables in the VAR system. The VECM model is used for stationary time series data at the difference and co-integration level. The VECM model is also used to see how deviations from long-run equilibrium can be corrected gradually through several adjustments.

Previous cointegration test results have shown the existence of cointegration in the integration model between the beef producer and consumer markets. The existence of cointegration shows the existence of a long-term structural relationship between the producer and consumer markets for beef. The long-term relationship between prices in producer and consumer markets can be seen in table 5.

Table 5. Long-term cointegration between producer and consumer markets.

Cointegration equation	Prices at the producer market	Prices at the consumer market	C
1st Cointegration	1.000	-0.523 (0.127) [-4.123]***	-0.002

Note: Numbers in [ ] is t-statistic values *** = significant at 1%, ** = significant at 5% and * = significant at 10%. t-table value : t(α=1%) = 2.326, t(α=5%) = 1.960, t(α=10%) = 1.645.

According to table 5, the consumer market has an influence on prices in the producer market by 0.523. The negative sign in cointegration analysis can be interpreted otherwise. This means that every 1% changes (increases or decreases) in prices on the consumer market will increase the prices in the producer market by 0.523%. According to the magnitude of the changes, the price changes at the producer level is smaller than the price changes at the consumer level or the effect of price changes in the consumer area on price changes in the producer area is relatively small. This shows the existence of price asymmetry between prices at the consumer and producer levels. Price asymmetry occurs due to different market forces between markets. In this case, actors in the consumer market have a higher market power than those in the producer market. Different strengths between markets has caused asymmetric information. In other words, price information from the consumer market could not be transferred perfectly to the producer market and the producer could not response to the price changes in the consumer market in the same speed or magnitude as well as direction. The asymmetric information indicates that the market for beef is not perfectly competitive.

The VECM model is not only used to identify the cointegration in the long run, but also the Error Correction Term (ECT). ECT absolute values could be used to measure the adjustment speed of actual prices towards long-run equilibrium. The larger the ECT coefficient, the faster the adjustment towards long-run equilibrium and vice versa. Table 6 shows that there is only one error correction (ECT) which is significant at the 1% significance level. This value indicates an adjustment from the short-term to long-term equilibrium of -1.148 or every month the error is corrected by -1.148 towards long-term equilibrium. Meanwhile, prices in the consumer market do not have significant ECT at either the 1%, 5% or 10% real levels. This shows that there is no adjustment from the short-term equation to the long-term equilibrium.

Table 6. Short-Term cointegration between producer and consumer markets.

Error correction	Prices at producer level	Prices at consumer level
CointEq1	-1.148 (0.114) [-10.092]***	-0.128 (0.093) [-1.374]
C	-0.000 (0.002) [-0.064]	-1.59E-06 (0.002) [-0.000]

Note: Numbers in [ ] is t-statistic values *** = significant at 1%, ** = significant at 5% and * = significant at 10%. t-table value : t(α=1%) = 2.326, t(α=5%) = 1.960, t(α=10%) = 1.645.

3.2. The implications

Asymmetric information could be one of reasons for asymmetric price transmission in the long-term [7]. The opinion of Meyer and von Cramon-Taubadel are supported by [15]. Through his study on the information economy explains that the ability of a market player to control price information in a market which tends to be imperfectly competitive is the main factor for the market players to be the market leader. The ability to control market information could increase the power of the player to control market, take more profits or "rent seekers" and could give wider impact to the market [15].

In the case of beef market, the influence of prices in the consumer level only to producer level indicates the power of traders or players in the consumer level that are higher compared to those in the producer level. According to Komalawati (2018), through their study on the volatility of beef prices and its impacts to the medium and micro scale business, mentions the important of import to fulfil demand of beef in the short and medium-term [16]. The import volume of beef that increases every year could indicate the power of beef importers in Indonesia that could be higher compared to the domestic beef traders. Some importers in beef market seemed to have more information on beef prices compared to the other importers and domestic beef traders. Therefore, it is recommended for Government to formulate policies to solve the problems of asymmetric information between producer and consumer. Every actor in the market either importers or domestic cattle farmers has the right to access information on prices and other data namely supply and demand of beef.

Therefore, in the long-run, government still needs to increase local cattle production by improving the reproduction of local cattle to achieve self-sufficiency. Changing the orientation of local cattle farmers to commercial orientation is also a big homework for Indonesian Government since it takes a longer period of time. However, Government could give an incentive or facilitation to cattle farmers with bigger business scales by increasing their opportunity for having more investors or other sources of capital.

4. Conclusion

According to the results of this study, the price transmission of beef from the producer to consumer tends to be asymmetric. The asymmetric of price transmission could be seen from different speed or magnitude and direction of changes in the prices of the consumer and producer. The effect of price changes in the consumer to producer level indicates the power of traders in the consumer market or asymmetric information between producer and consumer. The prices in the producer level could not influence the prices in the consumer market because meat in the consumer level is supplied mostly from import, and cattle farmers usually sell their cattle when they need cash income. Therefore, in the short-term, Government needs to formulate policies to avoid asymmetric information between producer and consumer, increasing the number of traders in the consumer market. In the long-term, Government needs to increase the population of domestic cattle and give incentive to domestic cattle farmers with bigger business scales.

The 3rd International Conference of Animal Science and Technology

IOP Conf. Series: Earth and Environmental Science **788** (2021) 012209

IOP Publishing

doi:10.1088/1755-1315/788/1/012209

References

[1] Ilham N 2001 Analisis Penawaran Dan Permintaan Daging Sapi Di Indonesia *Seminar Nasional Teknologi Peternakan dan Veteriner 2001* (Bogor, Indonesia: Pusat Penelitian dan Pengembangan Peternakan, Badan Litbang Pertanian, Kementerian Pertanian) pp 385–403

[2] Daryanto A 2009 *Dinamika Daya Saing Industri Peternakan* (Bogor : Inst. Pertan. Bogor)

[3] Riady M 2004 Tantangan dan peluang peningkatan produksi sapi potong menuju 2020 *Pros. Lokakarya Nas. Sapi Potong Strateg. Pengemb. Sapi Potong dengan Pendekatan Agribisnis yang Berkelanjutan* pp 3–6

[4] Badan Pusat Statistik 2015 *Indikator Kesejahteraan Rakyat: Welfare Indicators 2015* Ed A Said and E Lestyowati (Jakarta: BPS)

[5] Pusat Data dan Sistem Informasi Pertanian 2015 *Outlook Komoditas Pertanian Sub Sektor Peternakan Daging Sapi* (Jakarta: Pusat Data dan Sistem Informasi Pertanian Sekretariat Jenderal Kementerian Pertanian)

[6] Komalawati 2018 *Volatilitas Harga dan Respon Penawaran Daging Sapi di Indonesia* Disertasi (Bogor :Inst. Pertan. Bogor)

[7] Meyer J and von Cramon-Taubadel S 2004 Asymmetric price transmission: A survey *J. Agric. Econ.* **55** 581–611

[8] Zainuddin A, Asmarantaka R W and Harianto H 2015 Integrasi Harga Daging Sapi Di Pasar Domestik Dan Internasional *Bul. Ilm. Litbang Perdagang.* **9** 109–28

[9] Habte Z 2014 Market Integration For Oxen Prices Using Vector Error Correction Model (VECM) In Ethiopia *International Journal of Technology Enhancements and Emerging Engineering Research* **2** 6–9

[10] Myint T and Bauer S 2012 Market Integration and Price Causality in the Myanmar Rice Market *Asian J. Agric. Dev.* **7** 91–105

[11] Vavra P and Goodwin B 2005 Analysis of price transmission along the food chain *OECD Food, Agric. Fish. Work. Pap.* 1–58

[12] Chen B and Saghaian S 2016 Market Integration and Price Transmission in the World Rice Export Markets *J. Agric. Resour. Econ.* **41** 444–57

[13] Nuryati Y and Rostiani M 2017 Upaya Stabilisasi Harga Daging Sapi *Badan Pengkaj. dan Pengemb. Kebijak. Perdagang. Kemendagri* **V** 13–6

[14] Nuhung I A 2015 Achieving Cattle Meat Self-Sufficiency : Performance, Constraints and Strategy *Forum Penelit. Agro Ekon.* **33** 63–80

[15] Stiglitz J E 2017 The Revolution Of Information Economics : *NBER Work. Pap. Ser.* **23780** 28

[16] Komalawati K, Asmarantaka R W, Nurmalina R and Hakim D B 2018 Dampak Volatilitas Harga Daging Sapi terhadap Industri Pengolahan Daging Sapi Skala Mikro di Indonesia *Pangan* **27** 9–22