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Spikes and Pass-Through of Global Grain Prices on the Korean Agricultural and Food Markets

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1. Introduction

The trends of slower growth in production and more rapid growth in demand have contributed to a tightening of the global balance of grains. Furthermore, the shortage of grain stock means that global market prices of grains have risen to more than 60% above levels of 2 years ago. Rising global grain prices have caused riots in some countries and led to eliminating grain export subsidies and restricting export quantities in other countries.

Korea has a heavy dependency on grains such as wheat, corn, and soybeans acquired from the global market. The amount of imported grains has continuously increased. The imports of corn and wheat sharply increased after the market opening in 1995. However, the domestic production of grains has decreased from about 7 million tons in 1970 to 5 million tons in 2007. The self-sufficiency ratio of grains in 1970 was 80.5%, but it was 27.2% in 2007. It has decreased about 66% over time. The expansion of market liberalization would increase the amount of imported grains and directly affect imported grain and food markets in Korea. Therefore, it is crucial to analyze the pass-through effect of global grain prices on the domestic food market.

Recently a number of economists have become interested in the study of the causes and the effects of price spikes in the global grain market on the domestic market. However, there are few studies on the dynamic responses and the pass-through effects of global grain prices on domestic agricultural and food prices. Several studies have investigated the pass-through effect of the exchange rate on domestic inflation (e.g., Mann [13]; Menon [15]; McCarthy [14]; Campa and Goldberg [4]; Reyes [17]). This study examines the pass-through effects of the global grain price on domestic agricultural and food prices. In particular, this study examines differential pass-through effects of global price shocks on domestic grain, meat, and processed food.

Yang [23] examines futures price and volatility transmissions among three major wheat production and exporting regions, the U.S., Canada, and the European Union. Mitchell [16] examines the factors behind the rapid increase in internationally traded food prices, and estimates the contribution of various factors. The most important factor was the large increase in bio-fuel production in the U.S. and the EU. Trostle [19] also examines the factors which make global grain prices increase sharply. Long-term trends that led to slower growth in production and rapid growth in demand were found to contribute to a sharp downward trend in world aggregate stocks of grains and oilseeds.

The purpose of this study is to verify the impact that shocks in global grain prices have on imported grain prices in the domestic market and to empirically analyze pass-through effects of imported grain price to the producer and consumer prices for grain, meat, and processed food in Korea. Our main focus is to analyze whether the pass-through effects of global grain prices are significantly different on domestic prices of grain, meat, and processed food.

2. Preliminary Data Analysis

Monthly data on global grain prices (WIN),[1] imported grain prices (NIN), PPI and CPI of domestic grains (PG, CG), PPI and CPI of domestic meat (PM, CM), and PPI and CPI of domestic processed food (PPF, CPF), oil price (WTI) and exchange rate (EX) for the period 1985:8 through 2008:12 are used in this study. All variables were transformed to natu-

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Table 1. Empirical models

Model	Variables
Model 1	Imported Grain Price Index, Global Grain Price Index, WTI, Exchange Rate
Model 2	PPI and CPI of Domestic Grains, Imported Grain Price Index
Model 3	PPI and CPI of Domestic Meat, Feed Price Index, Imported Grain Price Index
Model 4	PPI and CPI of Domestic Processed Food, Imported Grain Price Index

ral logs before estimation.

Table 1 shows empirical models in this study. Model 1 is used to investigate the pass-through of the global grain prices on imported grain prices. Model 2, 3, and 4 are applied to study the pass-through effects of imported grain prices on the producer and consumer price for grain, meat, and processed food.

A series of preliminary data analyses were performed. Correlation analysis, unit-root tests, a co-integration test, structural change tests, and CV (coefficient of variation) analysis were conducted before empirical studies. In the case that all variables are stationary and do not indicate co-integration, a vector autoregression (VAR) model is used. If variables are co-integrated, a vector error correction model (VECM) is applied because the VAR in differences is misspecified because it ignores the long-run relationships among variables.

The correlation analyses of included variables are conducted. The results of these analyses report imported grain prices have a high positive correlation with the oil price, the global grain price and the exchange rate. It assumes that macro factors are related to imported grain prices and affect import grain prices in Korea. Imported grain prices and producer and consumer prices of domestic grains are positively correlated to one another, but the magnitude of correlation of domestic grains is greater than that of imported grain prices. Feed prices and domestic meat prices also have a high positive correlation with imported grain prices. This implies that feed grain is dominant in the imported grain market and that feed price affects the producer and consumer price of meat significantly. Strong positive correlations were found in imported grain prices and producer and consumer prices of processed food because imported grains are used to produce processed food. However, correlation analysis does not report cause and effect relations between variables, so further tests are required.

ADF (Augmented Dickey-Fuller) tests for unit roots with and without trend were conducted. These tests are reported in Table 2, and indicate that none of the variables is stationary in level. The lag lengths of the differentiated data in the ADF equations have been chosen according to the minimum of the SC (Schwarz Information Criterion) rule.

A further preliminary issue is the possibility of co-integration among variables in this study. Co-integration tests for each model are applied. We employ the test of Johansen and Juselius [9]. The test can not

Table 2. Unit root tests

	ADF Statistic	P-Value	AR Lag
Global Grain Price Index	−2.76	0.22	1
WTI	−1.99	0.29	1
Exchange Rate	−1.11	0.72	2
Imported Grain Price Index	−2.39	0.39	1
PPI of Domestic Grain	−1.23	0.90	2
CPI of Domestic Grain	−1.09	0.93	2
PPI of Domestic Meat	−3.30	0.07	2
CPI of Domestic Meat	−1.92	0.64	2
PPI of Domestic Processed Food	−2.35	0.41	1
CPI of Domestic Processed Food	−2.12	0.53	1

Table 3. Co-integration tests

	Hypothesized No. of CE (s)	Trace statistic	5% Critical value
Model 1	Rank = 0	1.55	47.86
	Rank = 1	0.31	29.79
Model 2	Rank = 0	30.44	29.79*
	Rank = 1	12.38	15.49
Model 3	Rank = 0	51.12	47.86*
	Rank = 1	23.01	29.79
Model 4	Rank = 0	31.19	29.79*
	Rank = 1	10.83	15.49

*Significant at the 5% level.

only detect co-integration but also indicate the number of co-integrating vectors for a set of data.

No co-integration was found in WTI, the exchange rate, the global grain or the imported grain prices in model 1. One co-integrating vector was found in imported grain prices, producer and consumer price of domestic grain in model 2 and in imported grain price, feed price, producer and consumer price of meat in model 3, and in imported grain prices, producer and consumer price of processed food in model 4. Therefore, VAR models were estimated in model 1 and VECM models were used to estimate model 2, model 3, and model 4. The test results are reported in Table 3.

Two tests for structural changes were conducted in each model. Intercept and slope dummies were used to test the structural change, and the likelihood test was applied. A structural change of trade liberalization was found during the period of 1995:1-2008:12 after the Uruguay round. It implies that imported grains can be imported more cheaply after agricultural market opening and the global grain price would directly affect domestic imported grain prices. Another structural test on global grain price spike was conducted. Structural changes were found during 2006:11-2008:12. It means spikes of global grain price influence the domestic agricultural and food markets significantly. However, there was no structural change in imported grain prices or the producer and consumer prices of grain. Domestic grain prices in Korea are not affected by market opening or global grain price shocks because of domestic rice. Monthly data from January 1995 to December 2008 is used for empirical analyses after trade liberalization.

According to CV analysis, there is greater increase in volatility of imported grain prices and domestic agricultural products than increase in those prices after trade liberalization. Without trade barriers, Korea imports grains cheaply, but fluctuation of global grain prices directly affect imported grain prices and the domestic food market. Another CV analysis of global grain price shocks is also conducted. Spikes of global grain prices significantly affect increases in prices of imported grain and domestic foodstuffs because Korea has a heavy dependency on global grain.

3. Empirical Results

1) Pass-through of global grain prices on imported grain prices

This study empirically investigates the pass-through effects of global grain prices on imported grain prices firstly and then the effects of the imported grain price to CPI and PPI of domestic grain, meat and processed food. For this purpose, both impulse-response functions and variance decomposition have been applied in this study.

It is expected that imported grain prices will respond sensitively to changes in global grain prices because grain consumption in Korea is highly dependent upon global grain.

Figure 1 shows impulse response function of imported grain prices to the Cholesky one standard deviation innovations. Shocks in both global grain prices and exchange rate influence imported grain prices positively. Imported grain prices respond to shocks in global grain prices more sensitively during the first two

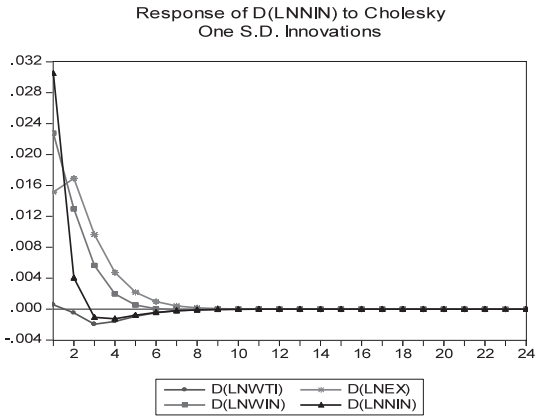

Figure 1. Impulse response function of imported grain prices

Table 4. Variance decomposition of imported grain prices

Month	D (LNWTI)	D (LNEX)	D (LNWIN)	D (LNNIN)
1	0.019	13.643	30.884	55.455
6	0.344	27.458	31.181	41.017
12	0.346	27.463	31.177	41.014
18	0.346	27.463	31.177	41.014
24	0.346	27.463	31.177	41.014

months. However, the effect of exchange rate shocks is bigger than that of shocks of global grain prices after two months, and the shocks continue for eleven months.

Table 4 displays the variance decomposition of imported grain prices. The variance decomposition separates the variation in an endogenous variable into the component shocks in the VECM. Thus, the variance decomposition provides information about the relative importance of each random innovation in affecting the variables in the system. It can be seen that shocks in global grain prices as well as the exchange rate are important determinants of the variation of imported grain prices. Global grain price shocks explain 30% of fluctuations in imported grain prices at month 1. At month 24, the global grain price explains 31% of fluctuations in imported grain prices. Shocks in the exchange rate explain 13% of fluctuations in imported grain prices at month 1 and 27% at month 24.

The results imply that global grain prices and the exchange rate positively affect imported grain prices, and these shocks last for almost one year. Furthermore, changes in global grain prices explain a large part of the variations of imported grain prices, and the exchange rate also explains the variations of the imported grain price. Therefore, the results assume that global grain prices and the exchange rate are the major factors to increase imported grain prices in Korea. However, oil price shock does not explain the variance of the imported grain price.

2) Pass-through of imported grain price on domestic grain prices

The co-integration vector indicates that the producer price of domestic grain has a positive relationship with the consumer price of domestic grain in the long-run equilibrium. The VECM estimates of imported grain prices and producer and consumer price of grain show that the producer and the consumer price of grain are influenced significantly by the producer price because PPI and CPI of domestic grain are mostly dependent upon domestic rice production. On the other hand, imported grain prices are mostly affected

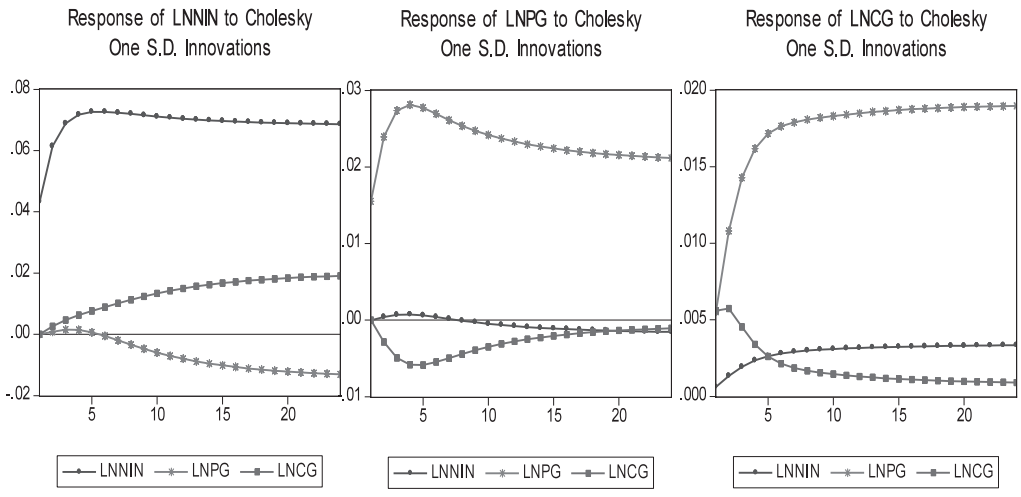

Figure 2. Impulse-response function of imported grain prices, PPI and CPI of domestic grain

by own prices. The effects of imported grain prices on PPI and CPI of domestic grain prices are positive but they are not significant.

Figure 2 shows impulse response functions of imported grain prices and the producer and consumer price of grain. Responses of PPI and CPI of domestic grain are mostly affected by the shock from PPI of domestic grain. On the other hand, imported grain prices are mostly affected by own price, and responses of imported grain to shocks from PPI and CPI of domestic grain were very small. This result indicates that domestic grain prices respond mostly to own price shocks because the domestic grain market is mainly influenced by rice.

Table 5 displays the variance decomposition of imported grain prices and domestic grain prices over a forecast horizon of twenty-four months in order to check the relative importance of each shock in explaining the variation of the above three prices. Changes in the imported grain price are explained entirely by the variation of own prices. About 97 to 100% of changes in PPI of domestic grain are explained by own prices and about 49 to 95% of CPI changes of domestic grain are explained by shocks from PPI of domestic grain.

This result indicates that domestic grain prices sensitively respond to production price shocks, and changes in domestic grain price are also explained mostly by the variation of production prices of grains. Imported grain prices do not influence domestic grain prices because domestic grain prices are dominated mainly by rice whose import is fully controlled by the

Table 5. Variance decomposition of imported grain prices, PPI and CPI of domestic grain

Variance decomposition of LNNIN			
Month	LNNIN	LNPG	LNCG
1	100	0	0
6	99.195	0.023	0.783
12	97.607	0.335	2.059
18	95.820	0.936	3.243
24	94.399	1.474	4.127
Variance decomposition of LNPG			
Month	LNNIN	LNPG	LNCG
1	0	100	0
6	0.043	96.663	3.292
12	0.040	97.098	2.861
18	0.101	97.615	2.284
24	0.176	97.939	1.884
Variance decomposition of LNCG			
Month	LNNIN	LNPG	LNCG
1	0.631	49.049	50.320
6	1.940	90.098	7.962
12	2.414	94.015	3.571
18	2.607	95.074	2.319
24	2.714	95.558	1.729

Table 6. Variance decomposition of imported grain prices, feed price, PPI and CPI of meat price

Variance decomposition of LNNIN				
Month	LNNIN	LNFE	LNPM	LNCM
1	100	0	0	0
6	97.678	0.795	0.808	0.719
12	96.968	0.648	1.293	1.090
18	96.479	0.531	1.679	1.309
24	96.140	0.457	1.951	1.452
Variance decomposition of LNFE				
Month	LNNIN	LNFE	LNPM	LNCM
1	5.209	94.790	0	0
6	26.457	65.279	3.307	4.957
12	42.042	39.683	9.995	8.289
18	48.620	27.768	13.861	9.751
24	51.758	21.776	16.003	10.462
Variance decomposition of LNPM				
Month	LNNIN	LNFE	LNPM	LNCM
1	0	0.287	99.712	0
6	2.739	0.374	90.754	6.132
12	14.854	0.682	79.842	4.621
18	28.142	1.321	67.181	3.356
24	38.592	1.907	56.932	2.568
Variance decomposition of LNCM				
Month	LNNIN	LNFE	LNPM	LNCM
1	1.184	1.867	32.464	64.485
6	0.291	3.699	60.329	35.679
12	1.396	3.273	56.368	38.963
18	2.839	2.873	52.299	41.988
24	4.091	2.580	49.168	44.160

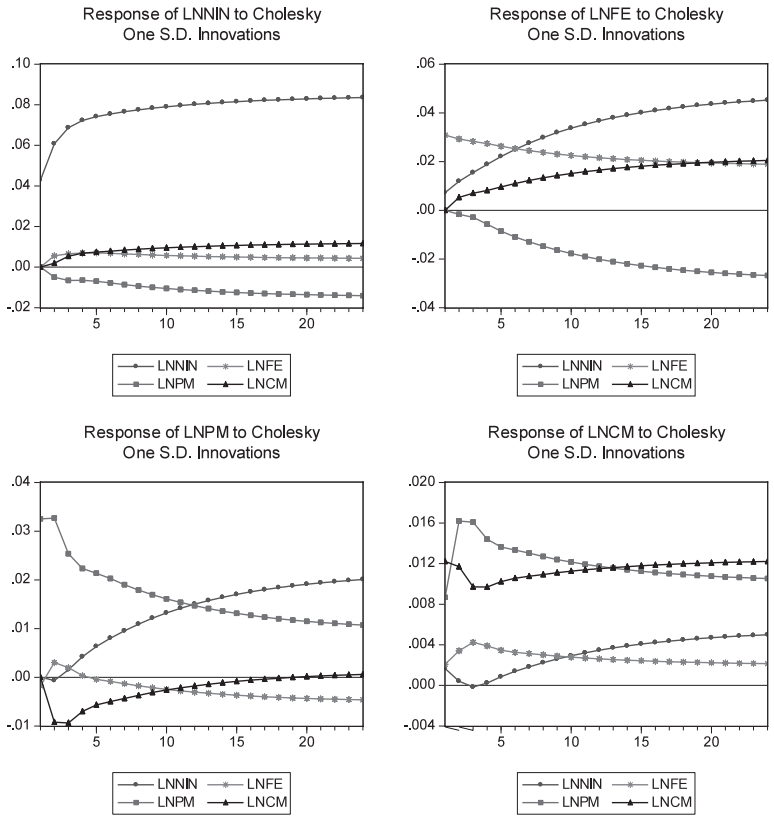

Figure 3. Impulse-response function of imported grain prices, feed price, PPI and CPI of meat

Korean government.

3) Pass-through of imported grain prices on meat prices

The VECM estimates of imported grain prices, feed price and PPI and CPI of domestic meat shows imported grain prices lead to increases in feed price in the long-run. These results imply that imported grain prices and feed prices positively affect each other because more than 70% of feed grain is imported. Furthermore, feed is a main production expense of livestock farms; therefore, the feed price affects the PPI and CPI of domestic meat.

The response of the feed price to shocks of imported grain prices is significant and its effect has been increasing for two years. The response of PPI of domestic meat to the shocks of imported grain prices is increasing. Furthermore, responses of CPI of domestic meat are mainly affected by PPI of meat and own price and imported grain price shocks give an upward response of the consumer price of meat.

As shown in Table 6, changes in imported grain prices are mostly explained by the variation of own prices. Imported grain prices explain 52% of the variation of feed price and 39% of PPI of domestic meat at month 24. The consumer price of domestic meat is mostly explained by the variations of PPI of meat and own price. These results indicate that imported grain prices directly influence feed price, and indirectly affect the producer price of domestic meat through feed price. It is also found that the main factor behind consumer meat price changes is the producer price of meat.

4) Pass-through of imported grain prices on processed food

The co-integration vector shows that imported grain prices and the consumer price of processed food have positive relations in the long-run equilibrium. The VECM estimates indicate that imported grain prices positively affect the producer price of processed food, and the consumer price of processed food is influenced

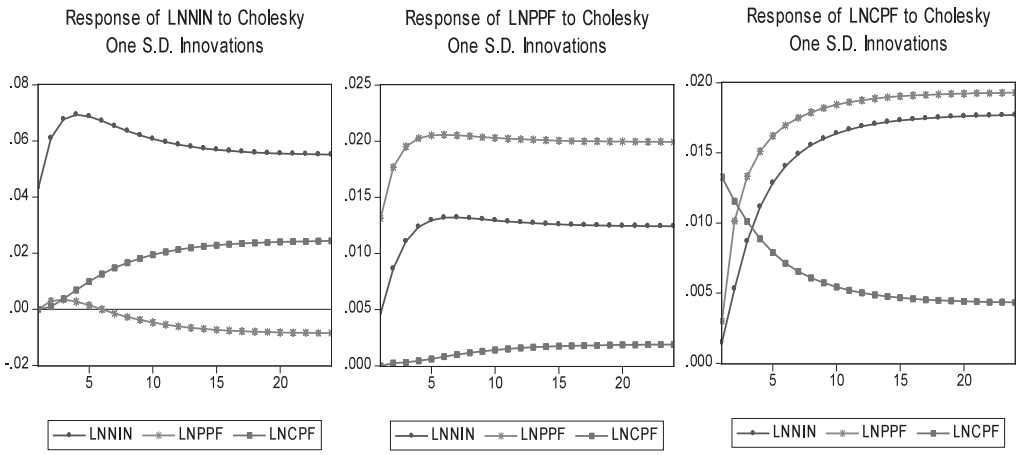

Figure 4. Impulse response function of imported grain prices, PPI and CPI of domestic processed food

by the producer price.

Figure 4 shows the impulse response functions of imported grain prices and PPI and CPI of domestic processed food. Imported grain prices are explained by own price, and an upward trend to the shock of consumer price. The response of the producer price of processed food to own price and imported grain price is positive. Consumer price is also positively affected by producer price and imported grain prices, and those effects are greater than in producer price.

Table 7. Variance decomposition of imported grain prices, PPI and CPI of domestic processed food

Variance decomposition of LNNIN			
Month	LNNIN	LNPPF	LNCPF
1	100	0	0
6	98.592	0.121	1.287
12	94.905	0.292	4.803
18	91.702	0.658	7.639
24	89.522	0.947	9.531
Variance decomposition of LNPPF			
Month	LNNIN	LNPPF	LNCPF
1	11.129	88.871	0
6	25.181	74.770	0.049
12	27.232	72.576	0.191
18	27.542	72.142	0.315
24	27.618	71.986	0.396
Variance decomposition of LNCPF			
Month	LNNIN	LNPPF	LNCPF
1	1.177	4.805	94.017
6	26.175	47.166	26.658
12	35.708	50.997	13.295
18	39.015	51.805	9.179
24	40.593	52.119	7.288

Changes of imported grain prices are mainly explained by variations of own price. For producer price of processed food, own price and imported grain price shocks are important in explaining producer price variance. Consumer price of processed food is mostly explained by the variation of own price in the short run, but it is mainly affected by producer price and imported grain prices in the long run. The influence of the imported grain price on the consumer price variance is greater than on the producer price variance. The results imply that consumer and producer prices of processed food sensitively respond to the producer price and imported grain prices because imported grain is used for raw materials of processed food. Furthermore, effects of imported grain prices on the consumer price are greater than on the producer price because imported grain in processed food is only used for consumption goods.

5) Asymmetry in global grain price transmission for imported grain prices

The understanding of price formation and price transmission, including asymmetric pricing behavior, is important in explaining the dynamics of price transmission processes. Korea depends in large part on grain from the global market, so imported grain

Table 8. Asymmetric price transmission

Variables	Coefficient	Std. Error	F-Test	
			Individual	Cumulative
c	0.004	0.005		
lnwin1	0.471	0.077*	F-stat = 85.04*	F-stat = 98.29*
lnwin2	0.329	0.075*		
lnwin3	0.116	0.078	F-stat = 4.880*	
lnwin4	0.078	0.074		
lnex1	0.369	0.086*	F-stat = 50.65*	F-stat = 84.57*
lnex2	1.010	0.199*		
lnex3	0.308	0.084*	F-stat = 13.33*	
lnex4	0.393	0.191*		
IMF	0.011	0.011		
GPS	0.009	0.007		
Statistics	R-squared	0.621	D.W.	1.826
	F-statistic	25.1	Prob (F-statistic)	0.00

*Significant at the 1% (5%) level.
The null hypothesis of individual F-test: the rising phases=the falling phases. The null hypothesis of cumulative F-test: cumulative sum of the rising phases=cumulative sum of the falling phases.

prices in Korea will respond differently when global grain prices and the exchange rate increase or decrease.

We employ Boyd and Brorsen's specification because it analyzes the speed of price transmission in specific periods and based on the sums of estimated coefficients it analyzes the magnitude (Boyd and Brorsen [3]). Table 8 shows estimates of price transmission. lnwin1 and lnex1 are rising phases of global grain prices and the exchange rate. lnwin2 and lnex2 are falling phases of global grain prices and the exchange rate. lnwin3 and lnex3 are lagged rising phases of global grain prices and the exchange rate. lnwin 4 and lnex4 are lagged falling phases of global grain prices and the exchange rate. IMF is the dummy variable of the financial crisis during the period 1997:11 through 1998:12. GPS is also the dummy variable of the global grain price shocks for the period 2007:7 through 2008:9.

The F-test of the null hypothesis that imported grain prices respond symmetrically to increases and decreases in the global grain prices and exchange rate is rejected at the 5% level. The rising phase of global grain prices is greater than the falling phase, but the rising phase of the exchange rate is less than the falling phase. The results also indicate that the cumulative effect of global grain price increases on imported grain prices exceeds the cumulative effect of global grain price decreases. However, the cumulative effect of the exchange rate increases is less than the cumulative effect of the exchange rate decreases. Moreover, the lagged rising phase of global grain prices is greater than the lagged falling phase. It indicates that imported grain prices adjust more slowly to increases in global grain prices. On the other hand, the lagged rising phase of the exchange rate is less than the lagged falling phase, so imported grain prices adjust more slowly to decreases in the exchange rate.

4. Conclusion

This study analyzes dynamic impacts of price shocks in the global grain market on the domestic market and empirically investigates pass-through effects of imported grain prices to the producer and consumer prices for grain, meat, and processed food. VAR and VECM models are applied to analyze the impact of global shocks on the domestic agricultural and food markets.

Global grain prices and the exchange rate positively affect imported grain prices, and the shocks last for eleven months because Korea has a heavy dependency on global grain with a low trade barrier. The

transmission effects of the rise in the imported grain price on agricultural and processed products are as follows: (1) domestic grain prices are sensitive to producer price shocks, but not imported grain prices because domestic grain prices are dominated by a major staple, rice, but most imported grains are feed grains; (2) responses of feed prices go on increasing continuously to shocks on the imported grain price. The consumer and producer prices of meat also respond increasingly to shocks of imported grain prices; (3) the producer price of processed food is affected by the imported grain price as global grain prices rise because domestic processed food mainly uses imported grain; (4) according to tests of structural changes, the impact of global grain prices on the price of imported grain in the domestic market is lower after the conclusion of the Uruguay Round and is higher after recent price spikes of global grain; (5) imported grain prices sensitively respond when global grain prices increase and the exchange rate decreases.

Korean agriculture is highly dependent upon the global grain market because the self-sufficiency ratio of grain is less than 30%. Therefore, it is necessary both to develop special schemes to import grain more stably and for the Korean government to encourage rice consumption amongst the young in order to lessen the impact of the global market.

1) Global grain price index was calculated with wheat accounting for 44.6%, corn 31%, and soybeans 24.4%. The weight of each grain comes from the actual trade volume in the year of 2005/2006.

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