ECONOMIC IMPACTS OF THE LAW OF CATTLE AND BEEF TRACEABILITY IN MARKETING CHANNELS ON THE DOMESTIC HANWOO BEEF INDUSTRY*

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Abstract
The purpose of this study is to evaluate the economic impacts of the Law of Cattle and Beef Traceability in marketing channels on the domestic Hanwoo beef industry. The Law of Cattle and Beef Traceability might affect the demand and supply of Hanwoo beef. After introducing the Law of Cattle and Beef Traceability into the marketing channels, the price of Hanwoo beef has increased a lot in the Korean beef market. Domestically produced Hanwoo beef has a price premium compared with the imported beef from foreign countries such as the U.S.A. or Australia. There had been an incentive for beef dealers in the domestic market to deceive the origin of the beef to capture the price premium. The Law of Cattle and Beef Traceability expanded into the marketing channel on June 22, 2009, which increased the demand for domestically produced Hanwoo beef. A simulation result shows that the increase of demand for Hanwoo beef would be 36.7 - 55.7 percent. The net impacts of the law are 38.7-57.8 percent increase in price and 16.4-21.7 percent increase in quantity.

* This study is conducted based on the "The Impacts of Beef Tracking System on the Domestic Korean Beef Market" by KREI (Jeon et al. 2010). The authors wish to thank the anonymous reviewers for their helpful comments.
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I. Introduction

In Korea, the traditional Korean beef called Hanwoo has a large price premium over imported beef. As a result, there had been great incentives for beef dealers in the domestic marketing sector to deceive the origin of imported beef and sell it to consumers to capture the price premium.

The beef traceability system was first introduced in October, 2004 by a few brand entities sponsored by local governments. After several modifications, the Law of Cattle and Beef Traceability took effect at the farm level on December 22, 2008. The law was expanded to be applied to market sellers of beef on June 22, 2009.[1] The purpose of the law was to prepare quick and reasonable measures to prevent problems in sanitation and secure food safety by making it possible to track beef or cattle in various marketing channels from production to consumption. The enforcement of the law was intended to guarantee transparency in the beef market and prevent mis-labelling. The law forces all domestically produced beef to be traceable, but not imported beef yet. In addition, the Rule of Labelling the Origin of Beef in Restaurants took effect on July 8, 2008 to be applied to all domestic restaurants according to the Law on Quality Control for Agricultural Products.

Enacting these laws makes it harder for marketers or restaurant managers to deceive the origin of beef. Enacting these laws makes domestic consumers to demand domestically produced beef more than imported beef (Jeon et al 2010). These laws may not only have impact on the demand side but may also affect domestic farmers by giving them more incentives as Pouliot and Sumner (2008) demonstrated.

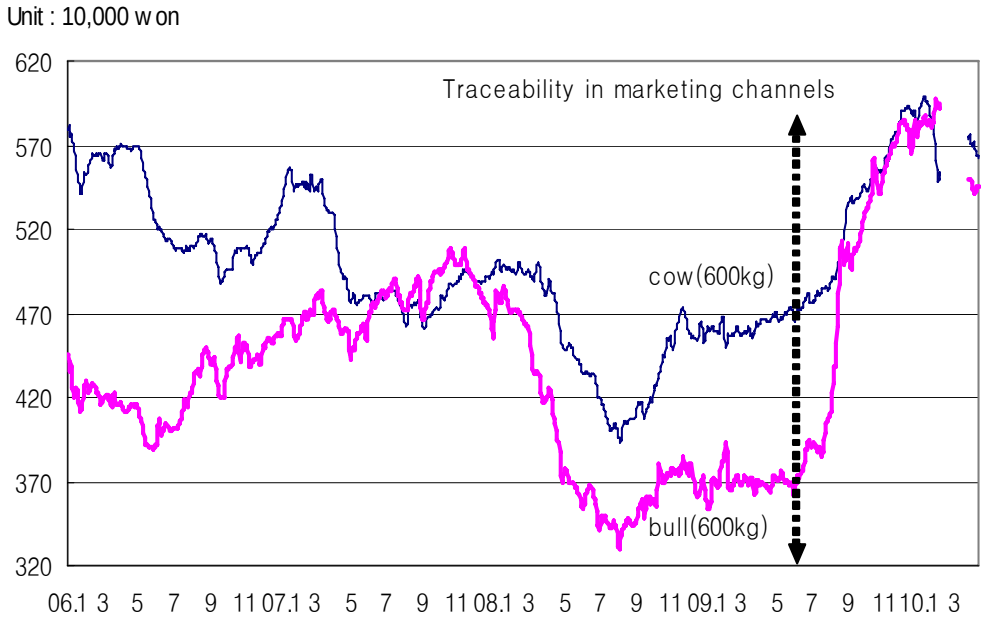
The domestic price movements in Figure 1 show that there might be a big shock after introducing the Law of Cattle and Beef Traceability in marketing channels. On the contrary, the impact of the Cattle and Beef Traceability Law at the farm level and the impact of the Rule of Labelling the Origin of Beef in Restaurants look relatively small or negligible. The purpose of this paper is to focus on measuring the net impacts of the Law of Cattle and Beef Traceability in marketing channels, which needs controlling

[1] The Law of Cattle and Beef Traceability holds for domestically produced beef only. It will be supposed to take effect for imported beef at the end of 2010.

the impacts of the Law of Cattle and Beef Traceability at the farm level and the Rule of Labelling the Origin of Beef in Restaurants.

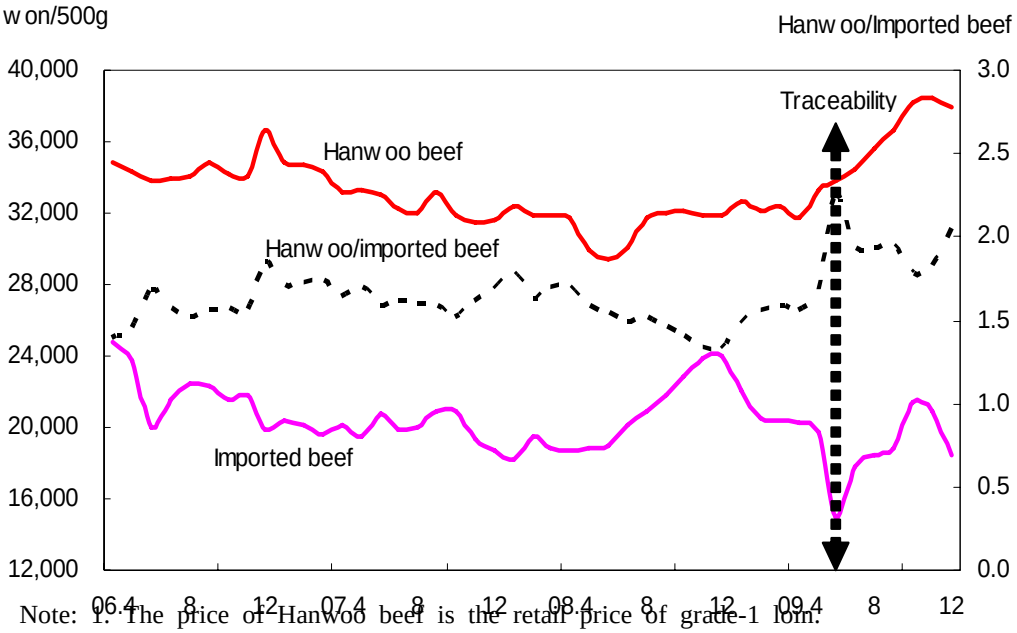
From now on, this paper only focuses on the Law of Cattle and Beef Traceability in marketing channels. The changes in demand and supply affect the prices along the marketing channels. Figure 1 shows the changes in the farm prices of Hanwoo bulls and cows before and after the enactment of the law. As shown in Figure 1, the farm prices rose rapidly after enacting the law. We can see a similar pattern of changes in retail prices. Figure 2 shows that the retail price of Hanwoo beef rises and the price gap between Hanwoo beef and imported beef becomes larger after enacting the law.

FIGURE 1. Trends of Farm Prices of Hanwoo



Source: National Agricultural Cooperative Federation.

FIGURE 2. Comparison of Retail Prices of Hanwoo and Imported Beef



Note: 1. The price of Hanwoo beef is the retail price of grade-1 loin.
2. The price of imported beef is the retail price of Australian loin beef.
Source: Korea Agro-Fisheries Trade Corporation.

Survey results also support our hypothesis. Table 1 shows the change in the willingness of domestic consumers to consume Hanwoo beef over imported beef before and after enacting the law. The ratio of Hanwoo beef consumption over imported beef was found to be increasing from 62.5 percent to 70.2 percent after enacting the law to be applied to marketing channels. The share of imported beef, on the contrary, showed to be decreasing from 37.5 percent to 29.8 percent.

TABLE 1. Beef Traceability and Change in Housewives' Willingness to Consume Beef

	Hanwoo beef	Imported beef	Total
Before the law (survey in Sept. 2009)	62.5%	37.5%	100%
After the law (survey in Dec. 2009)	70.2%	29.8%	100%

Source: Jeon et al (2010).

The law also makes the derived demand for Hanwoo beef by restaurant managers increased. Table 2 shows that the ratio of restaurant managers using Hawoo beef instead of imported beef increased from 27 percent to 51 percent after enacting the law.

TABLE 2. Beef Traceability and Change in Beef Consumption by Restaurant Managers

	Hanwoo beef	Imported beef	Total
Before the law (survey in May 2009)	27%	73%	100%
After the law (survey in Dec. 2009)	51%	49%	100%

Source: Jeon et al (2010).

Traceability has become a hot topic in recent years and has begun to be studied in several areas. Pelaez et al. (2010) analyze the productive opportunity of Imcopa, the first soybean crusher to implement a non-GM soybean traceability and certification system. Kim, Lee, and Han (2008) analyze the current shape of Good Agricultural Practices (GAP) and traceability in Korea. Pouliot and Sumner (2008) show how increased traceability contributes to protecting the reputation of firms by potentially limiting product recalls through stylized theoretical modelling. Compared with previous studies, this study actually measures the impacts of the Law of Cattle and Beef Traceability in marketing channels on the Korean Hanwoo beef industry.

The issues regarding traceability or origin of foods have drawn much attention in the domestic market. Lee, Hwang, and Son (2009) and Hwang, Choi, and Lee (2010) reviewed and evaluated the current origin labelling in the food service sector without measuring the impact of the rule. Jeong et al. (2010) measures the impact of the Rule of Labelling the Origin of Beef in Restaurants by assuming the quantity of mis-labelled products. In their analysis, they develop a partial equilibrium model which considers only beef without regard to pork and chicken. This study, on the contrary, develops a more generalized framework to include pork and chicken. There are a few local studies that measure the economic impact of adopting a traceability system. Most of them mention the way a traceability system is operated. See, for example, Huh (2007). This study focuses on measuring the economic impact of the Law of Cattle and Beef Traceability in marketing channels in terms of

price, quantity, and sales.

II. Theoretical Framework

1. Livestock Model

The beef traceability law may affect both domestic consumers and producers. It may change the consumers' value on domestically produced meat and the farmers' willingness to breed livestock domestically. To develop a model in which we can measure the economic impact of the traceability law, we need to incorporate the terms that represent what impact the law would have on the demand and supply side.

According to our model, the direct impact of the Law of Cattle and Beef Traceability is that the law will make domestic consumers to increase their demand for domestically produced Hanwoo beef. Secondly, the law may affect the willingness of local Hanwoo beef producers to market their breeding cows for slaughter, which may thus shift the supply of Hawoo beef.

The model analyzing the domestic beef market has to incorporate the pork and chicken market because pork and chicken are close substitutes to beef. To obtain an unbiased assessment of the economic impact of the law, we have to exclude any impact other than those that result from implementing the law in the domestic Hanwoo beef market. To control the shocks other than that of the law, this study considers as variables the prices of substitutes and income on the demand side and the natural rate of changing breeding herds on the supply side.

The domestic livestock model can be developed as below using nine equations. The first three equations are demand functions for Hanwoo beef, pork, and chicken. The next three equations are supply functions for Hanwoo beef, pork, and chicken. And the last three equations are identities that equilibrate the demand and supply of Hanwoo beef, pork, and chicken respectively.

Equation (1) shows that the demand (Q^D_{beef}) for Hanwoo beef is a function of Hanwoo price (P_{beef}), pork price (P_{pork}), chicken price (P_{ck}), imported beef price (P_{ibeef}), income (Y) and the demand shifting factor (z_{beef}). Similarly, the demand for domestically produced pork (or chicken) is a func-

tion of Hanwoo price (P_{beef}), pork price (P_{pork}), chicken price (P_{ck}), imported pork price (P_{ipork}) (or imported chicken price P_{ick}), income (Y) and the demand shifting factor (z_{pork}) (or z_{ck}), which is specified in equation (2) (or equation (3)). In equation (4), the supply of Hanwoo (Q^S_{beef}) is a function of its price (P_{beef}) and supply shifting factor (w_{beef}). Similarly, we can define the supplies of pork and chicken as shown in equations (5) and (6).

In the system, there are nine endogenous variables and nine equations as explained in Table 3. The impacts of the law can be captured by the terms z in demand side and w in supply side.

(1) $Q^D_{beef} = f(P_{beef}, P_{pork}, P_{ck}, P_{ibeef}, Y|z_{beef})$

(2) $Q^D_{pork} = f(P_{beef}, P_{pork}, P_{ck}, P_{ipork}, Y|z_{pork})$

(3) $Q^D_{ck} = f(P_{beef}, P_{pork}, P_{ck}, P_{ick}, Y|z_{ck})$

(4) $Q^S_{beef} = g(P_{beef}|w_{beef})$

(5) $Q^S_{pork} = g(P_{pork}|w_{pork})$

(6) $Q^S_{ck} = g(P_{ck}|w_{ck})$

(7) $Q^D_{beef} = Q^S_{beef}$

(8) $Q^D_{pork} = Q^S_{pork}$

(9) $Q^D_{ck} = Q^S_{ck}$

TABLE 3. Explanations for Endogenous and Exogenous Variables

Variables	Explanations
Endogenous variables	
Q_{beef}^{D}	Demand for Hanwoo beef
Q_{pork}^{D}	Demand for pork
Q_{ck}^{D}	Demand for chicken
Q_{beef}^{S}	Supply of Hanwoo beef
Q_{pork}^{S}	Supply of pork
Q_{ck}^{S}	Supply of chicken
P_{beef}	Wholesale price for Hanwoo beef
P_{pork}	Wholesale price for pork
P_{ck}	Wholesale price for chicken
Exogenous variables	
P_{ibeef}	Price of imported beef
P_{ipork}	Price of imported pork
P_{ick}	Price of imported chicken
Y	Income
Z_{beef}	Demand shifting factor in beef market
Z_{pork}	Demand shifting factor in pork market
Z_{ck}	Demand shifting factor in chicken market
w_{beef}	Supply shifting factor in beef market
w_{pork}	Supply shifting factor in pork market
w_{ck}	Supply shifting factor in chicken market

2. Equilibrium Displacement Model

The economic impacts of the Law of Cattle and Beef Traceability can be measured by a comparative statics model. The comparative statics model can be developed using a “Equilibrium Displacement Model (EDM)” which measures the rate of change of all endogenous variables before and after the introduction of the Law of Cattle and Beef Traceability.[2] A system of EDM can be derived as below. Equations (1)’-(9)’ correspond to equations (1)-(9) above.

The symbol E stands for the rate of change of the endogenous variables. The definitions of parameters in the EDM are shown in Table 4.

(1)' $EQ^D_{beef} = \eta_{beef}EP_{beef} + \eta_{beef,pork}EP_{pork} + \eta_{beef,ck}EP_{ck} + \eta_{beef,ibeef}EP_{ibeef} + \eta_{Ybeef}EY + \eta_{zbeef}Ez_{beef}$

(2)' $EQ^D_{pork} = \eta_{pork}EP_{pork} + \eta_{pork,beef}EP_{beef} + \eta_{pork,ck}EP_{ck} + \eta_{pork,ipork}EP_{ipork} + \eta_{Ypork}EY + \eta_{zpork}Ez_{pork}$

(3)' $EQ^D_{ck} = \eta_{ck}EP_{ck} + \eta_{ck,beef}EP_{beef} + \eta_{ck,pork}EP_{pork} + \eta_{ck,ick}EP_{ick} + \eta_{Yck}EY + \eta_{zck}Ez_{ck}$

(4)' $EQ^S_{beef} = \xi_{beef}EP_{beef} + \xi_{wbeef}Ew_{beef}$

(5)' $EQ^S_{pork} = \xi_{pork}EP_{pork} + \xi_{wpork}Ew_{pork}$

(6)' $EQ^S_{ck} = \xi_{ck}EP_{ck} + \xi_{wck}Ew_{ck}$

(7)' $EQ^D_{beef} = EQ^S_{beef}$

(8)' $EQ^D_{pork} = EQ^S_{pork}$

(9)' $EQ^D_{ck} = EQ^S_{ck}$

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[2] Comparative statics through an EDM can be found in many studies. See, for example, Alston et al. (2006) and Jeon (2009).

TABLE 4. Explanations for Parameters

Parameters	Explanations
Elasticities in demand side	
η_{beef}	price elasticity of demand for Hanwoo beef
$\eta_{beef,pork}$	price elasticity of demand for Hanwoo beef due to pork price change
$\eta_{beef,ck}$	price elasticity of demand for Hanwoo beef due to chicken price change
$\eta_{beef,ibeef}$	price elasticity of demand for Hanwoo beef due to imported beef price change
η_{Ybeef}	income elasticity of demand for Hanwoo beef
η_{zbeef}	demand shock elasticity for the law in Hanwoo market
η_{pork}	price elasticity of demand for pork
$\eta_{pork,beef}$	price elasticity of demand for pork due to Hanwoo price change
$\eta_{pork,ck}$	price elasticity of demand for pork due to chicken price change
$\eta_{pork,ipork}$	price elasticity of demand for pork due to imported pork price change
η_{Ypork}	income elasticity of demand for pork
η_{zpork}	demand shock elasticity for the law in pork market
η_{ck}	price elasticity of demand for chicken
$\eta_{ck,beef}$	price elasticity of demand for chicken due to beef price change
$\eta_{ck,pork}$	price elasticity of demand for chicken due to pork price change
$\eta_{ck,ick}$	price elasticity of demand for chicken due to imported chicken price change
η_{Yck}	income elasticity of demand for chicken
η_{zck}	demand shock elasticity for the law in chicken market
Elasticities in supply side	
ξ_{beef}	price elasticity of supply of Hanwoo beef
ξ_{pork}	price elasticity of supply of pork
ξ_{ck}	price elasticity of supply of chicken
ξ_{wbeef}	supply shock elasticity for the law in Hanwoo beef market
$\xi_{\wpork}$	supply shock elasticity for the law in pork market
ξ_{wck}	supply shock elasticity for the law in chicken market

3. Identification

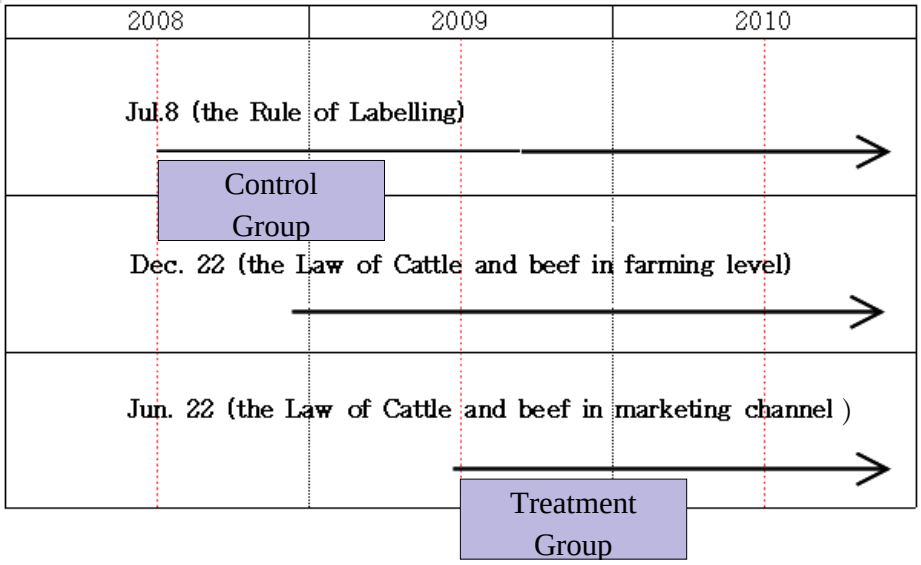
The impact of the Law of Cattle and Beef Traceability on the Hanwoo beef industry is measured by the term Ez_{beef} in demand side and the term Ew_{beef} in supply side given the system above. To identify the impact, we take three steps. First, equilibrium price and quantity are determined by both demand and supply. So this study develops a structural model rather than estimating a single equation. Furthermore, the developed livestock model considers beef, pork and chicken together to capture more generalized simulation results. Second, the equilibrium in the Hanwoo beef market is affected by substitutes such as pork, chicken, and imported meat. When measuring the net impacts of the law, this study controls the impact of substitution by inserting all relevant variables in the demand equation. The first and second steps are specified in the model developed above.

The last step is to control the impact of the Rule of Labelling the Origin of Beef in Restaurants and the Law of Cattle and Beef Traceability at the farm level. For this purpose, we can design a semi-natural experiment as below. To focus on the Law of Cattle and Beef Traceability, this study compares two groups of different periods. One group is called 'Treatment Group' for the period of July 2009 - March 2010, and the other group is called 'Control Group' for the period of July 2008 - March 2009. The Treatment Group is under the influence of the Rule of Labelling the Origin of Beef in Restaurants and the Law of Cattle and Beef Traceability at the farm level and marketing channels together. On the contrary, the Control Group is under the influence of the Rule of Labelling the Origin of Beef in Restaurants and the Law of Cattle and Beef Traceability at the farm level during which the Law of Cattle and Beef Traceability did not take effect in marketing channels (see Figure 4).

Measuring the net impact of the Law of Cattle and Beef Traceability in marketing channels can be conceptually explained as below. The endogenous variables that are affected by the law is specified by the term Y below. For the two groups, the endogenous variables are identified as Y^T and Y^C for the Treatment Group and Control Group respectively. In equations (10) and (11), the term X is a vector of explanatory variables, and D_{Res} is a dummy variable of "1" when the Rule of Labelling the Origin of Beef in Restaurants is in force and "0" when it is not. Similarly, $D_{TR,Farm}$ is a dummy

variable of "1" when the Law of Cattle and Beef Traceability at the farm level is in force and "0" when it is not. The dummy variable $D_{TR,Mkt}$ is "1" when the Law of Cattle and Beef Traceability in marketing channels is in force and "0" when it is not.

FIGURE 3. Treatment Group and Control Group



The Control Group is not under the effect of the Law of Cattle and Beef Traceability in marketing channels, so the dummy variable $D_{TR,Mkt}$ is zero in equation (11). The net impact of the Law of Cattle and Beef Traceability in marketing channels is obtained through equation (12). In equation (12), it is assumed that $E(\epsilon_T - \epsilon_C) = 0$.[3]

In Figure 3, the Control Group is partially affected by the Law of Cattle and Beef in farming level, which could make matter. But, the effect of the Law of Cattle and Beef in farming level is negligible as shown in Appendix. Hence, the dummy variable $D_{TR,Farm}$ can be dropped out of the equations and the problem caused by the partial intervention of the Law of Cattle and Beef in farming level can be eliminated.

[3] This study assumes the impacts of the Rule of Labelling the Origin of Beef in Restaurants and the Law of Cattle and Beef Traceability in farming level are constant in the two Groups. Simply, the accumulating effects of the rule and the law are ignored.

(10) $Y^T = \alpha + \beta X + \gamma_0 D_{Res} + \gamma_1 D_{TR,Farm} + \gamma_2 D_{TR,Mkt} + \epsilon_T$

(11) $Y^C = \alpha + \beta X + \gamma_0 D_{Res} + \gamma_1 D_{TR,Farm} + \gamma_2 D_{TR,Mkt} + \epsilon_C$
$= \alpha + \beta X + \gamma_0 D_{Res} + \gamma_1 D_{TR,Farm} + \epsilon_C$

(12) $E(Y^T - T^C) = \gamma_2$

Conclusively, this study uses a comparative statics which compares the equilibrium in the Treatment Group and the equilibrium in the Control Group. By comparing the two groups, we can find out the net impact of the Law of Cattle and Beef Traceability in marketing channels.

III. Empirical Simulation Analysis

1. Data

To measure the economic impacts of the Law of Cattle and Beef Traceability, the values for the parameters in the system have to be specified. The elasticities of demands and supplies are shown in Table 5, which are collected from the previous studies based on the authors' considerations in a reasonable range.

TABLE 5. Values for Parameters

Products	Price elasticity of supply	Demand elasticity				
		Price				Income
		Hanwoo beef	Pork	Chicken	Imported product	
Hanwoo beef	0.49	-0.62	0.22	0.04	0.47	1.26
Pork	0.31	0.25	-0.35	0.01	0.22	0.27
Chicken	0.32	0.21	0.01	-0.29	0.20	0.38

Note: The values in Table 5 are collected by referring to the previous studies: Kim and Kim (2003), Sung (1997), Song et al. (2004), Lee et al. (1999), and Jeong and Park (1998).

The developed model above has six endogenous variables because demand and supply are equal. Those variables are quantity and price variables for Hanwoo beef, pork, and chicken. The rate of changes of all the endogenous variables are shown in Table 6. The quantity data is a carcass weight and the price data is the average wholesale price of all grades. The reason for using these data is that it is hard to interpret and measure when we use the retail price and quantity consumed. Because there are many prices and quantities for different grades and different parts. Price decrease in pork may shrink the demand for Hanwoo beef and price increase in chicken may boost the demand for Hanwoo beef. These effects are controlled by the model above by inserting the prices of substitutes in the demand equations. The exogenous changes of imported product prices and income are shown in Table 7 and Table 8.

TABLE 6. Changes of Prices and Quantities Before and After the Law of Cattle and Beef Traceability

	Before the law ('08.7～'09.3)		After the law ('09.7～'10.3)		Rate of change (%)	
	Quantity (ton)	Price (won/kg)	Quantity (ton)	Price (won/kg)	Quantity	Price
Hanwoo beef	176,710	13,492	180,943	17,169	2.4%	27.3%
Pork	882,318	4,245	924,768	4,000	4.8%	-5.8%
Chicken	431,130	3,185	500,445	3,596	16.1%	12.9%

Note: The weight values are carcass weight.

Source: 1. Quantities are calculated by using the data from Ministry for Food, Agriculture, Forestry, and Fisheries.
2. Prices for Hanwoo beef and pork are from Animal Products Grading Service.
3. Price of chicken is from National Agricultural Cooperative Federation.

TABLE 7. Changes of Imported Prices Before and After the Law of Cattle and Beef Traceability

	Before the law ('08.7～'09.3)	After the law ('09.7～'10.3)	Rate of change (%)
Imported beef (won/kg)	5,507	4,466	-18.9%
Imported pork (won/kg)	3,342	2,798	-16.3%
Imported chicken (won/kg)	2,853	2,415	-15.4%

Note: Prices of imported products are obtained by multiplying the imported cif price by exchange rate.

Source: The imported cif prices are from Korea Agro-Fisheries Trade Corporation and exchange rate is from Korea Statistical Information System.

TABLE 8. Change of Income Before and After the Law of Cattle and Beef Traceability

	Before the law ('08.7～'09.3)	After the law ('09.7～'10.3)	Rate of change (%)
	trillion won	trillion won	
Gross National Income	683.8	724.9	6.0%

Source: Korea Development Institute (April 2010), "KDI Economy Briefing"

2. Simulation Results[4]

2.1. Net impacts of the law

This study measures the impacts of the Law of Cattle and Beef Traceability in the domestic Hanwoo beef industry. The impacts are measured as the rate of changes of demand and supply of Hanwoo beef that are Ez_{beef} and Ew_{beef} in equations (1)' and (4)' respectively.

Given the values in Tables 5-8, the shocks caused by the law are 46.2 percent increase in demand side (Ez_{beef}) and 2.1 percent decrease in supply side (Ew_{beef}) (see Table 9).[5] Those are equivalent to 19.2 percent increase in quantity and 43.5 percent increase in price (Table 10). These net impacts in quantity and price are much bigger than the total rate of changes of quantity and price before and after the law that are 2.4 percent and 27.3 percent respectively (Table 10).

The measured impacts in terms of quantity and price in Table 10 show that if we do not consider the explanatory variables as specified in the model above, the impacts caused by the law would be underestimated. After controlling the impacts of the substitution effects among beef, pork, chicken, and imported meat, the impacts of the law become larger as shown above.

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[4] The simulation results are obtained by using the computer program Eviews 6.

[5] In measuring the supply side impacts, we net out the natural change of Hanwoo herds during the two periods, which is 15.9 percent. Precisely, the number of Hanwoo herds that is supposed to be slaughtered during the period from July, 2009 to March, 2010 increased 15.9 percent compared with that during the period from of July, 2008 to March, 2009. All the values in Tables 9-11 are under this consideration.

TABLE 9. Impacts of the Law of Cattle and Beef Traceability on Demands and Supplies of Meat

	Demand	Supply
Hanwoo beef	46.2%	-2.1%
Pork	-5.5%	3.3%
Chicken	7.2%	4.2%

TABLE 10. Net Impacts of the Law of Cattle and Beef Traceability on Price and Quantity of Hanwoo Beef

	Total changes between before and after the law		Net changes between before and after the law	
	Quantity	Price	Quantity	Price
Hanwoo beef	2.4%	27.3%	19.2%	43.5%

2.2. Sensitivity analysis

In the EDM model as specified above through various parameters, the impacts of the law depend on the values of parameters. Hence, this study checks the robustness of the simulation results under several scenarios for key parameters. Table 11 shows the simulation results of seven scenarios. The first scenario S0 (S, D) is the base scenario which shows the same results in Tables 9-10. Additionally, this study considers six scenarios from S1 to S6. Each of them assumes different values for supply and demand elasticities in order.

Compared with S0(base scenario), S1 shows that supply elasticities are the same as those in S0, but demand elasticities are half of those in S0. As demand elasticities become inelastic, the net impacts of the law become larger in terms of quantity and price: from 19.2 percent to 21.7 percent in quantity increase and from 43.5 percent to 48.5 percent in price increase. Under S2 scenario in which supply elasticities are half of those in S0 and demand elasticities are the same as those in S0, quantity change becomes smaller but price change becomes larger: from 19.2 percent to 16.4 percent in quantity increase and from 43.5 percent to 48.1 percent in price increase. The other simulation results can be understood similarly.

The results of the sensitivity analysis show that the quantity effect of

the law lies in the range of 16.4-21.7 percent under the values given in Table 11. The price effect of the law lies in the range of 38.7-57.8 percent which is larger than the quantity effect of the law. The price effect responds more sensitively to elasticities. Conclusively, the total effect of the law in terms of sales lies in the range of 58.4-76.6 percent. This finding indicates that as elasticities become more elastic, the net impact of the law in terms of sales becomes smaller.

TABLE 11. Net Impacts of the Law of Cattle and Beef Traceability on Hanwoo Beef Under Various Parameters of Elasticities

Scenarios on Elasticities	Net changes in		Net changes between before and after the law		Net changes of sales* (EPQ)
	Demand (Ez_{beef})	Supply (Ew_{beef})	Quantity (EQ)	Price (EP)	
S0(S=1, D=1)	46.2%	-2.1%	19.2%	43.5%	62.7%
S1(1, 1/2)	36.7%	-2.1%	21.7%	48.5%	70.2%
S2(1/2, 1)	46.2%	4.6%	16.4%	48.1%	64.5%
S3(1/2, 1/2)	36.7%	4.6%	18.8%	57.8%	76.6%
S4(1, 3/2)	55.7%	-2.1%	17.8%	40.7%	58.5%
S5(3/2, 1)	46.2%	-8.8%	21.0%	40.6%	61.6%
S6(3/2, 3/2)	55.7%	-8.8%	19.7%	38.7%	58.4%

* Net change of sales (EPQ) is the sum of price change (EP) and quantity change (EQ).

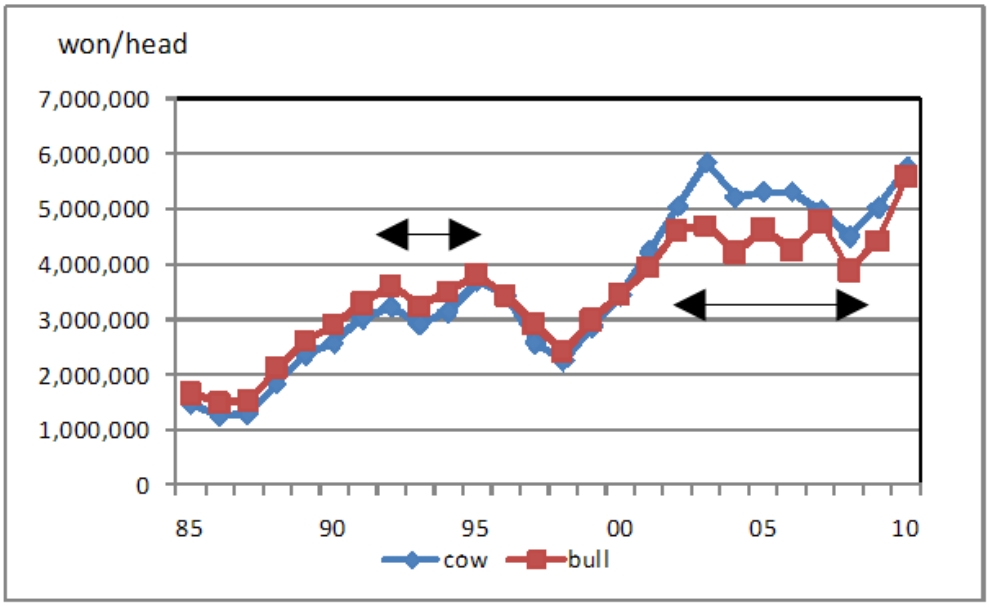
Note: The first number in the parenthesis is the value that is multiplied to the price elasticity of supply in Table 5 and the second number in the parenthesis is the value that is multiplied to all the demand elasticities in Table 5. For example, the scenario S2(1/2, 1) implies that the price elasticities of supply of the three products are 1/2 times of those values in Table 5 and the demand elasticities are one times of those values in Table 5.

2.3. Interpretations

Much concerns have to be paid in interpreting the results in Tables 9 and 10. Most of all, there are some other alternative hypotheses for the reasons of price increase after executing the law. First, the 10-12 years cycle of Hanwoo price pattern may result in Hanwoo price increase. As Figure 4 shows, opening the domestic beef market with the tariff rates of 2000 changes the price

patterns of Hanwoo. Generally, the past cycle of Hanwoo price shows that the price increases for 8 years and decreases for 3 years. But, after the market opening in 2000, the price of Hanwoo stayed relatively constant compared with the past pattern. Also, the price decreased only once in 2008 and bounced back in 2009. So the sharp price increase after 2008 is hard to explain with the past price cycle of Hanwoo, which is explained by the law in this study.

FIGURE 4. Cycle of Hanwoo Price Change



Source: National Agricultural Cooperative Federation.

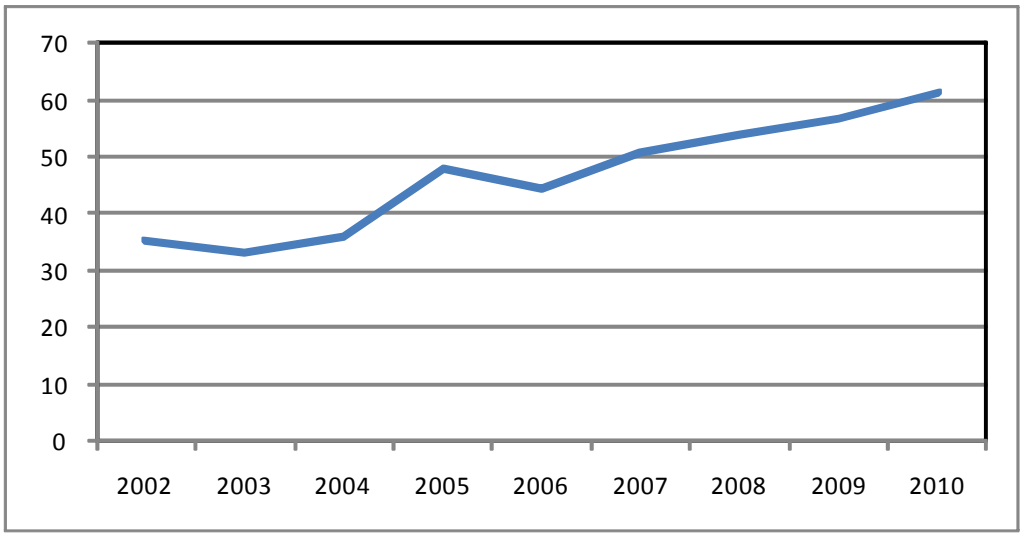
Second, the price increase may reflect the cost increase caused by the law. The major factor of cost increase can be attributed to variable cost such as labor.[6] There is no data for this cost change but almost 50 percent cost increase in labor is detected by interviewing several marketers. According to the cost survey of Korea Agro-Fisheries Trade Corporation in 2008, the final price of bull (castrated, 1+) that is delivered to the final domestic consumers is almost 9,500,000 won and the indirect cost including labor for handling the carcass meat is 1,000,000 won. Fifty percent increase in labor cost may not exceed 500,000 won in the indirect cost, which is almost 5 percent increase in total cost. Therefore, the price increase of 43.5 percent in Table 10 includes

[6] Fixed cost of new facilities does not affect the market equilibrium.

the cost increase necessary for executing the law, but the transfer of the cost changes may not be great. For the precise cost change, a broad and extensive cost survey has to be done later.

Third, the price increase can be interpreted as a result of grade improvement. Figure 5 shows the pattern of share of grades above 1+ in Hanwoo beef. Before and after the law (from 2007 to 2010), the share of good quality graded beef above 1+ increases with stable pattern. As explained in the section of identification above, this stable impacts of grade improvement is controlled by subtracting through the semi-natural experiment.

FIGURE 5. The Pattern of Share of Grades Above 1+ in Hanwoo



Source: Animal Products Grading Service

Ⅳ. Conclusion

The purpose of the Law of Cattle and Beef Traceability is to respond quickly to sanitation or safety problems through marketing channels from the birthing of a cow to the final consumption of beef. Enacting this law makes marketing of beef more transparent, prevents mislabelling of beef, and gives more confidence to domestic consumers for their beef consumption.

This study measures the impacts of the Law of Cattle and Beef

Traceability in marketing channels on the domestic Hanwoo beef industry. To do this, the livestock model is developed and modified using an EDM technique for a comparative statics. To capture the net impacts of the Law of Cattle and Beef Traceability in marketing channels, this study controls all the effects other than the law. The developed generalized livestock structural model nets out the substitution effects between meats. To separate pure impacts of the Law of Cattle and Beef Traceability in marketing channels from the impacts of the law in farming level and the impacts of the Rule of Labelling the Origin of Beef in Restaurants, this study executes a semi-natural experiment by carefully choosing the periods for the comparative statics.

The simulation results can be summarized as below. First, the net impact of the Law of Cattle and Beef Traceability in marketing channels on price of Hanwoo beef lies in 38.7-57.8 percent increase and that on quantity lies in 16.4-21.7. Second, the price effect outweighs the quantity effect. Price effect is counter-proportional to elasticities and quantity effect is proportional to elasticities. Third, the total effect of the law in terms of sales lies in 58.4-76.6, which is a tremendous increase in sales.

Although the impacts of the Law of Cattle and Beef Traceability in marketing channels are measured by controlling other variables, there are some caveats in the methodology and interpretation of simulation results. The terms Ez_{beef} in demand side and Ew_{beef} in supply side are similar to dummy variables in an econometric equation. These two terms might be contaminated by the variables that are not included in the system equations above, which is supposed to be not great. The impacts of the law measured in this study are calculated based on the two periods. The results show only the changes between the two periods. They do not have information about how long and how much the impacts will be sustained in the future. Finally, for the semi-natural experiment, this study assumes that the impacts of the Rule of Labelling the Origin of Beef in Restaurants and the Law of Cattle and Beef Traceability in farming level are constant in the two Groups. The accumulating effects of the rule and the law may not be zero, which is a limitation of this study.

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Appendix

To see whether the Law of Cattle and Beef Traceability in farming level is significant or not, this study estimates a demand equation for Hanwoo including a dummy variable that stands for the impact of the Law of Cattle and Beef Traceability in farming level. The term DUM_TR in the estimated equation captures the impact of the law in farming level. The estimated equation is below. The t-value for each variable is in the parenthesis below. Several monthly dummy variables are used to capture the seasonality in beef consumption.

From this estimated equation, the coefficient of the dummy DUM_TR is not statistically significant. The t-value for that variable is only 0.85. Hence, we can not conclude that the impact of the Law of Cattle and Beef Traceability in farming level is significant.

LOG(D51) = -20.63117C-0.45415 LOG(NWP51)+2.899186LOG(INCOME)+0.175842LOG(MP51)
(-4.82) (-1.73) (6.06) (1.18)

+**0.035571DUM_TR**+0.415779 DUM0701+0.500308(DUM0708+DUM0712)
(0.85) (4.51) (8.22)

+0.540661(DUM0812+DUM0908)-0.300749(DUM0909+DUM0801)
(8.69) (-4.63)

-0.231396(DUM0805+DUM0901-DUM0808)
(-4.77)

Variables and definitions

variable	meaning	variable	meaning
D51	beef consumption	DUM0801	dummy variable of Jan. 2008
NWP51	domestic beef whole price	DUM0805	dummy variable of May. 2008
INCOME	desirable income	DUM0808	dummy variable of Aug. 2008
MP51	imported beef unit cost	DUM0812	dummy variable of Dec. 2008
DUM_TR	dummy variable of traceability in farming level	DUM0901	dummy variable of Jan. 2009
DUM0701	dummy variable of Jan. 2007	DUM0908	dummy variable of Aug. 2009
DUM0708	dummy variable of Aug. 2007	DUM0909	dummy variable of Sep. 2009
DUM0712	dummy variable of Dec. 2007		

Note: The used data period is from January 2007 to December 2009 in monthly basis.