ESTIMATING THE COST OF FOOD SAFETY REGULATION TO THE NEW ZEALAND SEAFOOD INDUSTRY

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Abstract

In New Zealand, the Animal Products Act 1999 requires all animal product processing businesses to have a HACCP-based risk management program by the end of 2002. This paper attempts to measure the effects of such regulation on the variable cost of production of the New Zealand seafood industry. Using the framework developed by Antle (2000), a model of quality-adjusted translog cost function is estimated using census of production data from 1929 to 1998. Our results show that variable costs could increase from 2% to 22% or from 2 cents to19 cents per kilogram.

Keywords: HACCP, compliance costs, seafood

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1. Food safety regulation and the seafood industry

The Animal Products Act 1999, which comes into force in November 2002, reforms the New Zealand law that regulates the production and processing of animal products. The purposes of this legislative change are to manage associated risks with food processing and to facilitate overseas market access (NZFSA, 2002).

The new Act requires that all animal products traded and used to be ‘fit for intended purpose’ and that risk management systems to be applied in the food chain from production, through processing, to the market. Risk management systems consist of three main types of controls, as illustrated in Table 1.

Table 1. Risk management system

Types of Controls	Description/Function
Risk Management Programme (RMP)	- A documented programme to identify and manage biological, chemical, and physical hazards, - Based on HACCP principles, - Designed by individual businesses for animal materials used, production processes performed and products produced.
Regulated Control Scheme	- To manage hazards not able to be managed by RMP, or would be more cost effectively managed by this mean, or for overseas market access purposes.
Controls relating to the export of animal materials and animal products	- Related to the issue of official assurances when required by importing countries. For example: + export licensing, + placing duties on exporters, + New Zealand’s interpretation of market access requirements.

Source: Summary of the Animal Products Act 1999 (NZFSA, 2002)

The Animal Products Act 1999 applies to all animal materials and products derived from animals that are traded and used in New Zealand or exported from New Zealand. Industries covered by the Act include the Meat and Seafood industry. The Dairy industry is not yet included as it is still covered under the Dairy Industry Act 1952.

A core requirement of the new Act is that primary animal processing businesses must have a registered risk management programme (RMP) by the end of 2002. As RMPs are based on the principles of Hazards Analysis and Critical Control Points (HACCP), this requirement means that businesses are responsible for the design and development, evaluation, and registration of the RMP. They also have to assure that the RMP is operating as planned and achieving specified outcomes. The inclusion of these duties to the production process means added production costs.

This paper attempts to measure this increase in production costs due to the implementation of RMPs. The paper also focuses on the Seafood industry as it is one of the first industries that are covered under the new Act. An estimation of the costs of RMPs to the Meat industry has been conducted and presented in Cao et al (2002).

The New Zealand Seafood industry is a billion-dollar industry. Seafood export value in 2001 worth a total of $1.4 billion (SeaFIC, 2002), which makes the industry the fourth largest export earner of the country. Having a food safety assurance system such as a HACCP-based RMP means that the industry would be able to retain its overseas markets or to get access to the new ones. However, the RMP will also bring extra costs to the production process. It is the purpose of this paper to measure this cost impacts.

2. Model, data, and estimation of quality-adjusted cost function

Cao et al (2002), following Antle (2000), have discussed the theoretical framework to estimate changes in variable costs of production due to the implementation of a food safety management programme like HACCP. A similar approach will be used in this paper. Firstly, an empirical cost function, which incorporates quality and safety variables as well as other traditional variables such as input prices and output quantity, is specified and then estimated. Secondly, based on the estimates of the cost function, elasticity of cost with respect to safety is calculated, which will subsequently be used to estimate changes in costs.

If we characterised the quality-differentiated product by the triplet (y,s,**q**), where y is output quantity, s is product safety, and **q** is a vector of other non-safety quality attributes, then the variable cost function which depends on both product quantity and quality can be specified as: vc = f(y,s,**q**,**w**,k). Here, **w** is a vector of input prices and k is the value of capital stock.

Assuming input variables as consisting of labour (L) and other materials (M), the empirical cost function written in log-linear form, incorporating a time variable, can be specified as:

$$\begin{aligned}\ln VC = {} & \alpha_0 + \alpha_M \ln w_M + \frac{1}{2}\alpha_{MM}(\ln w_M)^2 + \alpha_L \ln w_L + \frac{1}{2}\alpha_{LL}(\ln w_L)^2 + \beta_y \ln y + \frac{1}{2}\beta_{yy}(\ln y)^2 \\ & + \delta_k \ln k + \frac{1}{2}\delta_{kk}(\ln k)^2 + \alpha_{ML}\ln w_M \ln w_L + \beta_{yM}\ln y \ln w_M + \beta_{yL}\ln y \ln w_L + \beta_{yk}\ln y \ln k + \\ & + \delta_{kM}\ln k \ln w_M + \delta_{kL}\ln k \ln w_L + \gamma_s \ln s + \gamma_{sM}\ln s \ln w_M + \gamma_{sL}\ln s \ln w_L + \gamma_{sy}\ln s \ln y + \\ & + \gamma_{sk}\ln s \ln k + \theta_{man}\ln q_{man} + \theta_{mix}\ln q_{mix} + \beta_{Mt}\ln w_M t + \beta_{Lt}\ln w_L t + \beta_{yt}(\ln y)t + \beta_{kt}(\ln k)t + \\ & + \beta_{st}(\ln s)t + \beta_{mant}(\ln q_{man})t + \beta_{mixt}(\ln q_{mix})t + \beta_t t + \beta_{tt} t^2\end{aligned} \quad (1)$$

where

w_M, w_L are prices of materials and labour respectively,

t is a time variable, which captures change in technology overtime,

q_{man} is a quality variable, which is defined as the ratio on non-production labour to production labour,

q_{mix} is another quality variable, which measures the proportion of processed products in total output,

s is a safety variable, which is unobserved but can be estimated using other observable variables.

Applying Shephard's lemma, the first-order condition for labour input is:

$$C_L = \alpha_L + \alpha_{LL} \ln w_L + \alpha_{ML} \ln w_M + \beta_{yL} \ln y + \delta_{kL} \ln k + \gamma_{sL} \ln s + \beta_{Lt} t \tag{2}$$

where

C_L is the labour cost share.

Following Antle (2000), assuming firms are price-takers in a competitive market, a measure for s can be derived and specified as: s = g(**q**,p,**z**,**w**,k). Here, **z** is a vector of other demand variables. Using the same approach as that of Cao et al (2002), we use New Zealand income per capita as a demand variable for the estimation. Empirically, the safety function can be written in log-liner form as:

$$\ln s = \tau_0 + \tau_{man} \ln q_{man} + \tau_p \ln p + \tau_Z \ln z + \tau_M \ln w_M + \tau_L \ln w_L + \tau_k \ln k \tag{3}$$

Data

Data for the estimation is taken from New Zealand census of production for the seafood industry in the period from 1929 to 1998. CPI deflators are taken from the New Zealand Official Yearbook 2000, and New Zealand per capita income for the period is taken from Maddison (1995) and the Penn World Table (Heston and Summers, 2002). A statistical summary of the variables is presented in Table 2.

Estimation

The translog cost function and cost share equation are estimated with the conditions for linear homogeneity of the cost function imposed. Estimation results are presented in Table 3.

To confirm that food safety regulation does affect productive efficiency in the seafood industry, a test for the hypothesis of safety exogeneity is conducted. For the cost function (1), safety exogeneity holds if and only if γ_S and γ_{Si} (i = y, M, L, k, t) are all equal to zero. Our test results strongly reject this hypothesis (p = 0).

The interaction term of safety and labour price γ_{sL} is negative which means that a higher labour price lowers the marginal cost of safety. On the contrary, as γ_{sM} has an opposite sign from γ_{sL}, a higher material price leads to higher marginal cost of safety. These results are similar to those estimated by Cao et al (2002) for the meat industry. However, in the case of the seafood industry, the interaction term of safety and capital γ_{sk} is negative which means that increasing capital stock leads to decreasing marginal cost of safety. Also, γ_{sy} being negative means higher rates of production are associated with lower marginal cost of safety.

The interaction term of time and material β_{Mt} is positive which shows that, for seafood, technical change is material using. On the contrary, β_{Lt} is negative which implies that technical change is labour saving.

3. Estimation of cost of food safety regulation

To estimate impacts of food safety regulation on variable cost, elasticity of cost with respect to safety is calculated. Calculation of elasticity is done for each observation and the mean is calculated. Results show that food safety cost elasticities lie in the range of 0.67 to 1.37, with a mean of 1.11. The fact that mean safety cost elasticity is positive shows that cost of production rises as the safety level increases.

To estimate the cost of food safety regulation, changes in variable cost of production due to food safety regulation such as HACCP are then calculated as follows:

$$\Delta VC = VC.E.e.(100\text{-}S)/S \qquad (4)$$

where

VC is variable cost of production; here we take the mean of variable costs during the period, mean VC = 120,950,000 (1999 dollars) (see Table 2).

E is the mean of safety cost elasticities, E = 1.11

e is the effectiveness of the regulation in enhancing food safety (or reducing microbial pathogen as in the case of HACCP), following Antle (2000), we assume e = 20 %.

S is the level of product safety before the introduction of the new regulation, here S is defined as the percentage of negative outcomes when product is tested for microbial contamination in a unit of time. ($0 < S \leq 100$)

The change in unit cost can be calculated as:

$$u = \Delta VC/y \quad (5)$$

where

y is output volume, y = mean output = 140,360 (tones) (see Table 2).

We calculate change in variable cost and the resulted unit cost for three scenarios of different base safety levels S = 50%, 70%, and 90%. Results are presented in Table 4.

Estimation results show that for a mean of variable cost of about $120 million, increase in variable cost due to regulation could be in the range of $3 million to $27 million (or 2.5% to 22.5% respectively). Cost per unit could be in the range of 2 cents to 19 cents per kilogram.

4. Conclusion

Using seafood census of production data from 1929 to 1998, we have estimated a model of quality-adjusted translog cost function for the New Zealand seafood industry. Estimation results are then used to measure the increase in variable cost of production due to the implementation of RMP. The elasticity of cost with respect to safety is estimated to be 1.11 for the study period. Hence, for a level of annual variable cost of about $120 million, increase in variable cost is estimated to be in the range of $3 million to $27 million (2.5% to 22.5%). Cost per unit is estimated to be in the range of 2 cents to 19 cents per kilogram. This increase in cost represents the impact of regulation on the operating efficiency of firms. It could be additional variable costs associated with the slowdown of the slaughtering line due to monitoring, sampling and testing. These costs constitute just a part of the total cost of regulation, which includes other items such as costs of plan design, labour training, new investment equipment, and costs of validation and record-keeping.

The study estimates costs of food safety regulation based on time series data. Similar estimations can be done for cross-sectional data or panel data. The advantages of cross-sectional data or panel data are that the effects of data aggregation would be less and impacts on different firm sizes could be revealed. However, plant-level data is required in order to have this detailed study.

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Table 2. Statistical summary of variables (prices in 1999 dollars)

Variable	Unit	Obs.	Mean	Standard Deviation	Minimum	Maximum
w_M	PPI* (base 1982=1000)	63	469.84	536.49	67.00	1,645.00
w_L	$ (000)	63	14.43	7.60	5.95	31.34
y	Tonnes(000)	63	140.36	222.11	14.58	730.00
k	$ (000)	63	65,941	121,610	420.29	533,860
q_{man}	-	63	0.26	0.075	0.09	0.60
q_{mix}	-	63	0.76	0.11	0.44	0.96
P	$ per tonne	63	790.23	844.30	60.57	3451.30
z	1990internl $	63	9,875.90	3,278.40	4,349.00	15,085.00
VC	$ (000)	63	120,950	211,430	957.45	727,460
C_L	-	63	0.23	0.091	0.09	0.57

* Producer Price Index

Table 3. Estimation results (Standard errors in parentheses)

Coefficient	Estimate	Coefficient	Estimate
α_0	2.75	γ_{sy}	-0.17
	(3.30)		(0.18)
α_L	-0.0079	β_{yk}	-0.027
	(0.26)		(0.14)
γ_S	1.27	δ_{kL}	-0.039
	(0.28)		(0.031)
τ_M	-0.79	τ_{man}	0.26
	(0.11)		(0.35)
α_{LL}	0.056	θ_{man}	-0.58
	(0.031)		(0.57)
γ_{SL}	-0.089	τ_z	-0.20
	(0.042)		(0.28)
τ_L	-0.43	β_t	0.023
	(0.10)		(0.069)
β_y	0.61	β_{tt}	-0.00029
	(0.82)		(0.00035)
β_{yy}	-0.57	β_{Mt}	0.0047
	(0.35)		(0.0017)
δ_k	1.17	β_{st}	0.02
	(0.50)		(0.0081)
τ_k	-0.97	β_{Lt}	-0.0047
	(0.25)		(0.0017)
δ_{kk}	-0.11	β_{kt}	0.011
	(0.075)		(0.0085)
γ_{sk}	-0.045	β_{yt}	0.027
	(0.064)		(0.011)
β_{yL}	0.0061	β_{mant}	-0.0035
	(0.075)		(0.0061)
θ_{mix}	0.74	β_{mixt}	0.018
	(0.50)		(0.012)

Table 4. Increases in variable cost and unit cost for a 20% improvement in product safety (in 1999 dollars)

Scenario	Change in costs
Base safety S = 50%	
Increase in cost (ΔVC)	26,965,000
Unit cost (u) ($/kg)	0.19
Base safety S = 70%	
Increase in cost (ΔVC)	11,556,000
Unit cost (u) ($/kg)	0.082
Base safety S = 90%	
Increase in cost (ΔVC)	2,996,000
Unit cost (u) ($/kg)	0.021