Improving animal health and incentive of hygiene management: Case study in Vietnam

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Abstract

Incidence of animal diseases, such as Hog Cholera and Pasteurella, was found in our field survey of 100 pig farmers in T.T.Hue province in Vietnam Thirty five (36%) of surveyed farmers are in poverty according to the 2005 poverty standard in Vietnam. Low income farmer has a large income share from pig production. We suggest that the increase of pig deaths in low income farms will raise the risk to fall into poverty. Improvement of animal health service, especially for low income farmers, will be important for poverty reduction in rural area in Vietnam.

Vietnamese pork distribution is in a state of so-called information asymmetry. In order to solve the problem of information asymmetry, it is necessary to fulfill the requirements of incentive compatibility. In Vietnam, the food sanitation inspection system is not in a sufficiently functional state, and it is possible that the principal-agent theory requirements of incentive compatibility are not established. A significant degree of microbial contamination can be mitigated even by washing the carcasses with water using simple machinery; however, at the same time, it is also important that there is improvement in the accuracy of the food sanitation inspection system at the store stage for distinguishing between retailers that are carrying out appropriate hygiene management and those that are not.

Keywords: animal health, incentive, poverty, principal-agent, Vietnam

Introduction

Poverty reduction has attracted much attention internationally since The World Bank set up “Poverty” as a main title in the World Development Report 1990 (The World Bank, 1990). In this trend, the relationship between animal health or animal hygiene and poverty reduction has been focused recently.

Meanwhile, due to recent economic growth, the consumption of pork and the number of pigs have increased dramatically in Vietnam. But, incidents are continually being reported about pork retailers illegally using coloring agents to make unsold pork look fresher or illegally selling pork from dead animals.

In this study, we will first identify the situation of pig disease outbreaks and their impact on the poverty situation through our field survey data. Secondly, we will identify the pork food system in Vietnam, applying the principal-agent theory to determine how hygiene control incentives should be provided.

Methods

We conducted a field survey in T. T. Hue province in November 2005. We selected two villages and surveyed a total of 100 pig farmers with a prepared questionnaire. The distance to the surveyed villages is about 15 km east from Hue city center. The number of pigs in T.T. Hue province increased by 30% from 200,000 head in 2000 to 260,000 head in 2004. Hue city has a famous world heritage site, and more and more foreign tourists are visiting recently. The increased number of pigs in Hue is attributed to the pork consumption increase due to this tourist activity.

Further, we conducted an epidemiological study in August 2007—with Professor Ito (Obihiro University of Agriculture and Veterinary Medicine) and Professor Hosono (Kyoto University)—in which bacterial populations were tested on dressed carcasses shipped from slaughterhouses in Hue City of central Vietnam, following food inspection guidelines. Based on the model of Starbird (2005), we applied the principal-agent (PA) theory to hygiene control during pork distribution in Vietnam. This model has the characteristic of linking together pork safety and pathogen distribution in pork, for incorporation into the analysis of the results of the epidemiological study. That is, we took consumers who purchased pork to be principals and retailers who sell pork to consumers to be agents, and assumed that the national or local government was monitoring hygiene control related to meat transactions between the principals and agents.

Results of 2005 field survey

Sixty-five farms (68%) of the surveyed farms are fattening management and 31 farms (32%) are consistent ones. The average number of pigs per farm is 6.2 head. Forty-five farms (47%) reported outbreaks of pig diseases such as swine fever, *Pasteurella*, *E. coli*, and others (Table 1).

Table 1. Pig diseases and scale of pig farm.

	Scale of pig farm (number of pig owned)					
	1～2	3～5	6～10	11～15	16～37	total
Swine fever	0	2	1	2	2	7
Pasteurella	0	9	3	1	1	14
Erysipelothrix	0	0	2	0	0	2
E.coli	0	0	1	2	0	3
Other(unknown)	7	9	5	2	1	24
subtotal(a)	7(39)	18(47)	11(42)	6(86)	3(43)	45(47)
No disease outbreak(b)	11	20	15	1	4	51
total(a+b)	18	38	26	7	7	96

Note:1)Figure in parenthes is a percent of animal disease outbreak (a/(a+b)).
2)Unit:farm number

Table 2. Farm income structure.

			I	II	III	IV	Average
Farm income	Agri. income	Crops	3,869	6,313	7,449	9,652	6,821
			(52.4)	(47.7)	(35.4)	(25.3)	(33.5)
		Pig farm	3,402	4,153	8,251	13,088	7,223
			(42.8)	(31.1)	(39.1)	(37.6)	(35.4)
		Other livestock	213	2,252	1,503	2,937	1,726
			(3.4)	(14.8)	(7.4)	(7.6)	(8.5)
		Other agriculture	41	695	2,286	1,225	1,062
			(0.4)	(5.5)	(9.2)	(3.2)	(5.2)
	Non-agri. icnome		83	167	2,458	11,519	3,557
			(1.0)	(0.9)	(8.8)	(26.4)	(17.4)
total			7,609	13,579	21,948	38,422	20,389

Note:1)Figure indicats farm income per head.
2)Farm income per head is a average farm income in each four categories, which is classified in the order corresponding to farm income from low to high level. The sample size in each categories is 24.
3)Figure in each parenthes is a percent of farm income (%).
4)Unit:1,000VND

The average farm income is 20,389,000 VND (Table 2). The income per head is 3,756,000 VND, and it is almost the same as the national standard level (3,946,000 VND). We confirmed three points in Table 2. First, the income level in the high income class (IV) is more than five times higher than the low income class (I). The income gap between the classes is very big. Second, the income share of non-agriculture in low income class (I and II) is small (1.0% and 0.9%, respectively), but the share is high (26.4%) in case of high income class (IV). Finally, though the income level of pig farms in the high income class is the highest (13,088,000 VND), the income share in the low income class (I) is the highest (42.8%) of the four income classes. Pig farm income is important for low income class which has limited agricultural land and non-agricultural income opportunity.

The households below the 2005 MOLISA poverty standard are 35 farms (36%), which is higher than the 2005 national average (22%). We can say that the risk to fall into poverty will be high if the number of pig deaths in low income class increases, and the risk to fall into poverty will decrease if a farmer possesses more pigs.

Results of 2007 epidemiological survey

Table 3 shows the results of the epidemiological surveys at two slaughterhouses in Hue. H is the largest slaughterhouse in Hue, established about 10 years ago. F is a slaughterhouse in the suburbs of Hue which slaughters fewer animals than H; its facilities and equipment were less spacious and appeared to be deteriorating with age. The number of bacteria on the surfaces of dressed carcasses produced at slaughterhouse H was 4,660 cfu/cm^2 on the inner surface and 8,200 cfu/cm^2 on the outer body surface; these values were lower than those at slaughterhouse F, which appeared to have a poorer hygienic status.

Table3. Result of viable bacterial counts.

		Average	Std
H	internal surface	4,660	6,525
Slaughterhouse	body surface	8,200	6,893
F	internal surface	5,798	8,383
Slaughterhouse	body surface	9,565	6,754

Note:1)total 368 samples

2)Unit:cfu/cm^2

The fewer number of bacteria on the meat side compared to on the outer side was thought to be the result of lining up the processed carcasses on the floor with their outer sides down in both slaughterhouses H and F. The meat side inside the body had almost no bacteria until the carcass was cut open during processing, when the meat can be contaminated by the contents of the intestines and other internal organs. In contrast, the outer body surface is boiled for about 1 minute in hot water and hair is removed, resulting in a smoother surface.

Data on microorganisms are known to have a normal distribution following logarithmic conversion (Fig. 1). In Fig. 1, M is the standard for the viable bacteria count determined by the government. Retailers cut dressed carcasses purchased from slaughterhouses into sections, containing cuts with a low viable bacterial count (<M) that can be eaten safely and cuts with a high bacterial count (>M) that may lead to such problems as food poisoning when eaten. From our inspection of some cuts (samples) at retailers, we found that when high hygienic control efforts are made (e^H), few samples exceeded M, whereas when low hygienic control efforts (e^L) are made, many samples exceeded M. For analysis, the probability that satisfies hygienic standard M based on e^H is defined as θ^H, and the probability that satisfies hygienic standard M based on e^L is defined as θ^L.

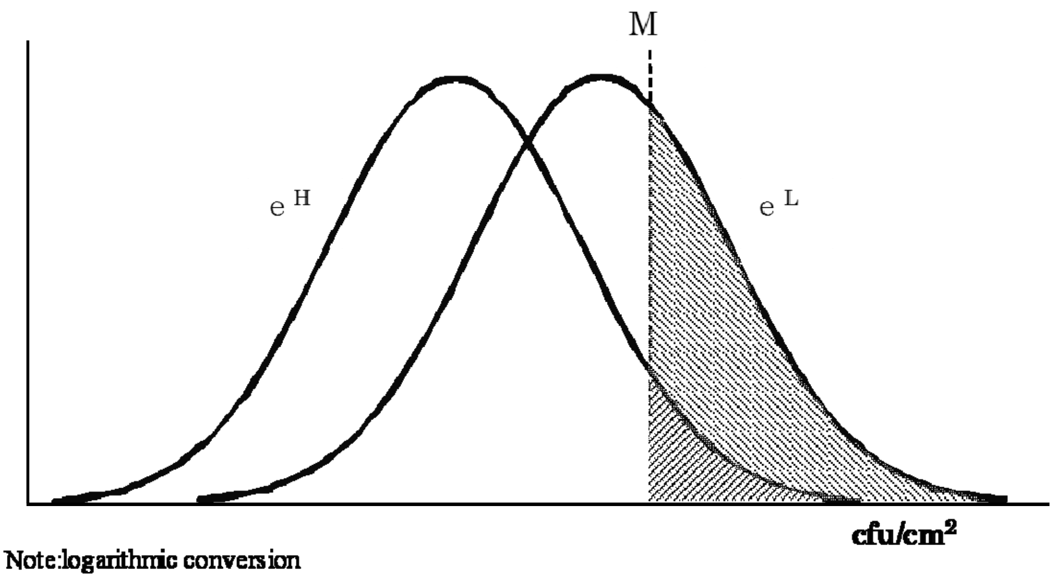

Figure 1. Hypothetical distribution of viable bacterial counts.

Sampling from pork sold by certain retailers was tested according to the government food hygiene inspection policy, and pork with bacterial cell counts below standard M was judged to be safe. The possibility of selling all pork to customers was defined as $P(\theta)$. Thus, it is also possible that although pork bacterial counts tested during sampling are below M, some pork sold to consumers may include bacterial counts above M. $P(\theta)$ is considered to be influenced by factors such as the status of systems and organizations related to food hygiene inspections, status of laboratories where bacterial tests are conducted, sampling methods, and skill level of the people conducting the tests. To distinguish differences in the level of hygiene control effort, we assumed $P(\theta^H)$ and $P(\theta^L)$. If food hygiene inspection systems can be completely distinguished by the level of food hygiene control effort, $P(\theta^H)$ approaches 1, $P(\theta^L)$ approaches 0, and $P(\theta^H) - P(\theta^L)$ approaches 1. Conversely, if food hygiene inspection systems cannot be distinguished, $P(\theta^H) - P(\theta^L)$ becomes a very small value. Thus, $P(\theta^H) - P(\theta^L)$ can be considered the precision of the food hygiene inspection system in distinguishing the level of effort in food hygiene control.

The relationship between principals (consumers) who wish to be supplied pork and agents (retailers) who conduct appropriate food hygiene control and sell pork to consumers is expressed according to the PA model as follows,

$$\text{MAX}_w \quad P(\theta^H)V[I - wN - (1 - \theta^H)rN] + [1 - P(\theta^H)]V(I - b) \qquad \text{eq. (1)}$$

subject to $P(\theta^H)U(wN - \delta) + [1 - P(\theta^H)]U(-sN - \delta) - Nc(\theta^H) \geq K$ eq. (2)

$P(\theta^H)U(wN - \delta) + [1 - P(\theta^H)]U(-sN - \delta) - Nc(\theta^H) \geq P(\theta^L)U(wN - \delta) + [1 - P(\theta^L)]U(-sN - \delta) - Nc(\theta^L)$ eq. (3)

where V and U are utility functions for the principal (consumer) and agent (retailer), respectively. I is the consumers' food expense within a fixed period; w is the price of pork per unit weight paid by consumers to retailers; N is the amount of pork that consumers purchase in a fixed period; r is the expense for treatment when consumers eat pork that has a poor hygiene status and become sick from food poisoning or other conditions; s is the expense for removal of pork that is discovered to have a poor level of hygiene by the hygiene inspection system and the fine paid by retailers; δ is the expense associated with hygiene inspections (in Vietnam paid by retailers); c(θ) is the expense produced per unit based on the respective level of effort for hygiene (H or L); and K is a reservation utility.

Equation (2) is an incentive rationality condition (IR condition) showing that expected utility, when the agent makes a strong hygiene control effort, is a more profitable condition compared to other opportunities. Equation (3) is an incentive compatibility condition (IC condition) showing that expected utility for a strong hygiene control effort is a better condition than the expected utility resulting from a weak effort.

To solve the problem of information asymmetry, the solution must satisfy the IC condition. Equation (4) shows the price (w^o) paid by the consumer for safe pork when the IC condition holds.

$$w^o = \frac{1}{N}U^{-1}\left[\frac{N(c(\theta^H) - c(\theta^L))}{P(\theta^H) - P(\theta^L)} + U(-sN - \delta)\right] \quad \text{eq. (4)}$$

$$P(\theta^H) - P(\theta^L) \geq [N(c(\theta^H) - c(\theta^L))] / [U(wN - \delta) - U(-sN - \delta)] \quad \text{eq. (5)}$$

Equation (4) shows that the price paid by consumers for safe pork is influenced by the precision of the food hygiene inspection system ($P(\theta^H) - P(\theta^L)$). If the right side of equation (3) is greater than K (reservation utility), the consumer pays a higher price for higher hygiene effort e^H.

Equation (5) shows that the IC condition is less likely to hold as the left side becomes smaller and the right side becomes larger. The left side shows the precision ($P(\theta^H) - P(\theta^L)$) of the food hygiene inspection system. If the difference between $P(\theta^H)$ and $P(\theta^L)$ is small, the left side becomes small. This indicates a situation in which the level of hygiene effort cannot be distinguished with the current food hygiene inspection system. In addition, when $c(\theta^H) - c(\theta^L)$ is large and U(wN) − U(-sN) is small, the right side becomes large and the IC condition becomes difficult.

In Vietnam, the food hygiene inspection system appears to be functioning inadequately. There is a very low likelihood of exposing retailers who sell pork with a poor hygiene level through government hygiene inspections, and the actual fines for this are low. Increasing fines in Vietnam from the current level(s) should increase the possibility of producing the IC condition.

In Vietnam, many retailers sell pork not in markets but in simple facilities on roadsides around markets. Compared with production expenses ($c(\theta^H)$) for selling pork inside markets, which entails costs such as a market use fees, production expenses ($c(\theta^L)$) are lower when pork is sold using simple facilities, most likely resulting in a large difference in expenses between the two, $c(\theta^H) - c(\theta^L)$. In this situation the right side of equation (5) becomes more than 1, suggesting that in this situation achieving incentive compatibility is difficult.

In Japan, systems are in place at the national and prefectural levels to recognize, through awards, superior facilities and people who achieve improvements in food hygiene, but there are no such systems currently in Vietnam. The introduction of such systems would increase the reputation in local communities of people and facilities that received the awards, and recipients could expect lower advertising costs for their pork business. An awards mechanism could lower $c(\theta^H)$ in equation (5) and raise the possibility of establishing an IC condition.

Conclusions

We can derive some policy implications for poverty reduction through livestock development from our study. The improvement of animal health service skills in rural areas is important to decrease pig deaths in pig farm management. The risk to fall into poverty will decrease if a farmer possesses more pigs. I would like to emphasize that the improvement of a formal credit system would allow farmers to purchase pigs.

The food hygiene inspection system in Vietnam does not function adequately, suggesting that the IC condition has not been established. If penalties are strengthened in food hygiene inspections, a system that awards facilities and people for superior hygiene control could be used as a mechanism to enable establishment of the IC condition. In addition, improvements in the government or university research institutions to analytically conduct bacterial inspections are also needed.

References

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