

## **Original Research Article**

### **Animal Insurance and Farmer's Behavior in Vietnam**

#### **ABSTRACT**

Most poor people in developing countries make their living from agriculture; hence, their livelihood is subject to various risks such as livestock disease, flooding, drought, and fluctuations in the price of agricultural products. One method of dealing with risk is insurance. However insurance markets in developing countries are seriously impacted by adverse selection and moral hazard, derived from information asymmetry. Livestock insurance was introduced in Vietnam as a pilot project in 2011–2013. We examine the factors behind the decision to take out insurance, from the viewpoint of moral hazard or adverse selection in Vietnam. The results suggest that, if there are few trustworthy people locally, the rate of time discounting is lower and farmer will respond to the insurance. Further, the higher the number of calvings, and therefore the older the cows owned by a farmer, the more likely he/she is to take out livestock insurance. The analysis of results also reveals a low level of existence of adverse selection and moral hazard with respect to livestock insurance in the surveyed areas. The incidence of livestock diseases covered by insurance is currently low. Many dairy farmers expressed their wish for insurance coverage to be expanded to include other diseases such as mastitis and hoof disease. Expanding the range of diseases covered by insurance would introduce an additional financial burden.

**Comment [A1]:** farmers

**Comment [A2]:** unclear what this means; do you mean “will purchase insurance coverage”?

20 As a consequence, the system of surveillance and penalties would need to be strengthened.

21 *Key words: Moral hazard, adverse selection, Asymmetric information, risk, insurance, Vietnam*

22

## 23 1. INTRODUCTION

24 Most poor people in developing countries make their living from agriculture; hence, their livelihood is  
25 subject to various risks such as livestock disease, flooding, drought, and fluctuations in the price of  
26 agricultural products. To mitigate such risks, various strategies can be adopted, such as growing  
27 produce that has a stable yield, limiting the impact of insect damage by cultivating a number of different  
28 plots, and varying planting times.

29 In developing countries in Asia, the expansion in the consumption of livestock products has been  
30 accompanied by an increase in the number of reared animals, and, consequently, many outbreaks of  
31 livestock diseases such as porcine reproductive and respiratory syndrome, Foot and Mouth Disease  
32 (FMD), and avian influenza. The majority of livestock producers are small-scale farmers, and the  
33 economic impact of a disease outbreak on such farmers is immense. It is therefore necessary to devise  
34 ways of dealing with the risk.

35 One method of dealing with risk is insurance. However, insurance systems in developing countries are  
36 by no means mature, and the proportion of farmers taking out insurance is also low. In particular,  
37 insurance markets in developing countries are seriously impacted by adverse selection and moral  
38 hazard, derived from information asymmetry. For example, Banerjee and Duflo (2011) described cases

39 of moral hazard in India – a development of a market for cows' ears. As cows' ears were needed to  
40 provide proof of the death of livestock covered by insurance against death, fraud involving purchased  
41 ears was reported. Also, Miwa and Fukui (2014); Ito and Kono (2010) reported examples of adverse  
42 selection in the health insurance markets of Cambodia and India, respectively. They observed a  
43 tendency among households with poor health to purchase health insurance.

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44 In order to combat adverse selection and moral hazard, a new type of insurance known as index  
45 based-insurance has emerged in recent years (Hill et al., 2011; Gine et al., 2007). The insurance payout  
46 is based on indicators (indexes) that can be publically confirmed such as rainfall or hours of sunshine,  
47 alleviating the problems of adverse selection and moral hazard.

48 Research on insurance in developing countries has frequently addressed people's health insurance  
49 and crop insurance. The findings often relate to factors that influence the decision to purchase  
50 insurance, focusing on people's tendency to avoid risk, moral hazard, the level of insurance premiums,  
51 time preference, and education about insurance products. Studies on livestock insurance in developing  
52 countries by the DHAN Foundation (2012) and Dalal et al. (2012), focused on India and of the workings

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53 of livestock insurance there, but did not analyze farmers' behavior in the context of moral hazard and  
54 adverse selection, the key factors that must be considered when examining the insurance in developing  
55 countries.

56 However, even if asked directly about their behavior, arising from moral hazard or adverse selection,  
57 few farmers are likely to answer honestly. When sensitive questions are asked directly and an honest

58 answer cannot be expected (for instance, questions relating to homosexuality or use of hard drugs such  
59 as heroin), the proportion of people engaging in the relevant behavior can be indirectly estimated using  
60 the item count technique (ICT), a method has been applied in the field of livestock health.  
61 Randrianantoandro et al. (2015) used ICT to calculate the likelihood that pigs infected with African  
62 swine fever (ASF) were sold in Madagascar by farmers who mistakenly believed that “ASF can be  
63 passed to humans.” Further, Gunaratne et al. (2016) used ICT to examine the likelihood that cows  
64 infected with FMD were sold in Sri Lanka by farmers with extensive knowledge about the disease. With  
65 ICT, it is possible to provide indirect evidence of behavior surrounding sensitive issues that people are  
66 reluctant to discuss. It has not, however, been applied to farmer's behaviors stemming from adverse  
67 selection or moral hazard regarding agricultural insurance.  
68 Agricultural insurance was introduced in Vietnam as a pilot project in 2011–2013. It was introduced on a  
69 trial basis in 20 provinces in Vietnam and featured special characteristics including limited disease  
70 coverage and subsidies for poor farmers. The project has, however, never been analyzed from the point  
71 of view of participating farmers' behavior in the context of moral hazard and adverse selection.<sup>1</sup>  
72 In this report, we examine the factors behind the decision to take out insurance, from the viewpoint of  
73 moral hazard or adverse selection, with particularly focusing on dairy farm. Our survey was carried out  
74 in Ba Vi District, Hanoi Province, Vietnam. In particular, our analysis of the factors behind farmers'  
75 insurance decisions takes account of the impact of the endogeneity in the farmers' attitude to risk.  
76 Further, we use ICT to present evidence of adverse selection and moral hazard at the time of farmers'

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77 insurance participation.

78 We emphasize the possibility of government role on livestock insurance to mitigate the problems

79 associated with asymmetric information, not depending on index-based insurance which has elicited

80 considerable attention recently. The Vietnamese government has used the results of their pilot project

81 to deliberate over the future of the livestock insurance business. An analysis of farmer behavior when

82 participating in livestock insurance is likely to provide beneficial suggestions for the future

83 livestock-insurance strategy in Vietnam.

84

## 85 **2. AGRICULTURAL INSURANCE IN VIETNAM<sup>2</sup>**

86 Agricultural (crop, livestock) insurance was first introduced into Vietnam between 1985 and 1987

87 (Phase 1). In Phase 1 of agricultural insurance, there was no government support. There was,

88 however, behavior pertaining to moral hazard, such as replacing dead livestock, the value of paid out

89 claims soared, and agricultural insurance, except for crude-rubber insurance, was withdrawn in 1987.

90 Later, in 2011, aiming to stabilize agricultural production, the Vietnamese prime minister Nguyen Tan

91 Dung ordered the introduction of agricultural insurance, launching Phase 2 of agricultural insurance as

92 a three-year trial from 2011 to 2013. This phase involved agricultural crop insurance, livestock

93 insurance, and aquaculture insurance.

94 Phase 2 of agricultural insurance included government support for insurance premiums, with the very

95 poorest farmers receiving a subsidy of 100%, the next tier of poor farmers, 90%, ordinary farmers, 60%,

96 and agricultural groups, 20%. Such subsidies cost the government 3 trillion VND over the three-year  
97 period (GlobalAgRisk (2009)).

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98 Policy design and underwriting were carried out by two large local insurers, Boa Viet and Boa Minh.  
99 Reinsurance was carried out by a local reinsurance company, Vietnam National Reinsurance  
100 Corporation, and reinsurance giant Swiss Re provided technical support, centering on premium  
101 calculation using actuarial methods<sup>3</sup>.

102 With the support of the Ministry of Agriculture and Rural Development (MARD), the insurance was  
103 marketed to, and claims were paid out to, whole communes as a means to reach small-scale farmers in  
104 rural areas. A trial of Phase 2 agricultural insurance was conducted in 20 provinces and 5 centrally  
105 controlled municipalities. As of June 2013, a total of 315,341 policies had been taken out, the majority of  
106 which (257,110) related to agricultural crops; 42,607 were livestock policies, and 15,624 cultivation  
107 policies. Direct premiums were 324.1 billion VND. The loss ratio was low for agricultural produce and  
108 livestock insurance, but, at 315%, high for cultivation insurance, hence, the underwriting of cultivation  
109 insurance was suspended in the first half of 2013.

110 The subject of our research is livestock insurance, with a particular focus on dairy cattle. With the  
111 economic development of Vietnam in recent years, the consumption of cow's milk has increased. In line  
112 with this, cow's milk production has expanded sharply, from 63,400 tons in 1993 to 487,400 tons in 2013  
113 (FAO, 2015). There are some large farms owned by major Vietnamese milk producers such as Vinamilk  
114 and TH True milk, but most dairy farmers are small-scale farmers with a small number of cows.

115 Meanwhile, there are frequent outbreaks of infectious diseases such as FMD, and the small-scale dairy  
116 farmers had to take action against this risk.

117 The only insured events under livestock (dairy cattle) insurance in Vietnam are three death causes,  
118 such as a result of FMD, Anthrax, or Pasteurella infection. Diseases associated with milk production  
119 such as mastitis and hoof disease are not covered. The market price of a dairy cattle insurance policy of  
120 one-year duration is VND 30 million, VND 40 million, VND, 50 million, or VND 60 million, depending on  
121 which of the four available packages is chosen. The cost of insurance is equivalent to 3.6% of the  
122 market price of milk. However, for the poorest farmers who receive the aforementioned 100% insurance  
123 premium subsidy, the cost of insurance is zero.

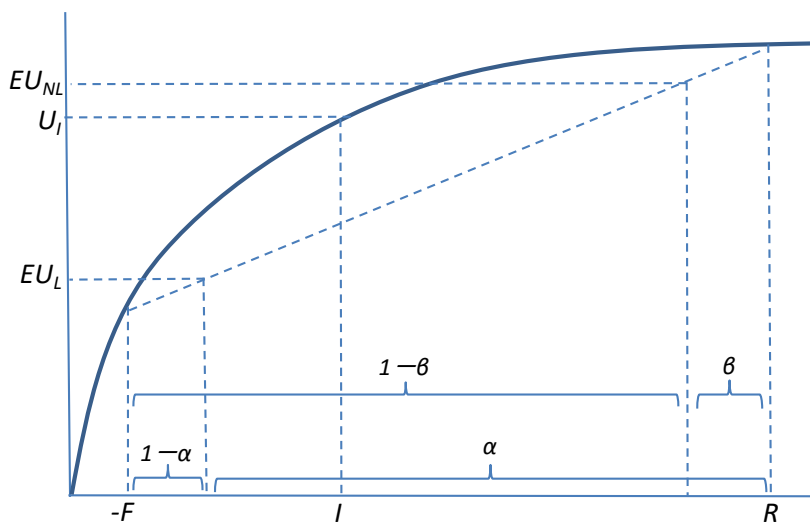
124

### 125 3. THEORETICAL FRAMEWORK OF FARMER'S BEHAVIOR TOWARD LIVESTOCK

#### 126 INSURANCE

127 The relationship between farmer's behavior and livestock insurance is illustrated in Figure 1, using  
128 expected utility theory<sup>4</sup>. We hypothesis the utility curve for farmers taking out livestock insurance are  
129 risk-averse, that is, farmers are trying to reduce their overall risk. Small-scale farmers in developing  
130 countries are particularly risk averse as exposure to an uninsured shock can have devastating  
131 consequences on survival (Janvry & Sadoulet, 2015). When there is an outbreak of disease that the  
132 insured farmer thinks is covered, the farmer has three hypothetical courses of action. The first is to  
133 report the outbreak to the government veterinarian and set an insurance claim in motion, with the

134 insurance payout to be received denoted as  $I$  (net sum received after deduction of premiums paid). The  
 135 second hypothetical course of action is to attempt to sell the animal without reporting the outbreak to the  
 136 government veterinarian, with the probability  $\alpha$  of discovery by the authorities. In this case, the fines and  
 137 the cost of social sanctions are denoted as  $F$ . The third hypothetical course of action is not to report the  
 138 outbreak to the government veterinarian and manage to sell the animal without being discovered by the  
 139 authorities, with a probability of  $(1 - \alpha)$ . The revenue for the sale of the animal is denoted  $R$  ( $R > I$ ).<sup>5</sup> If we  
 140 assume that more than the three diseases are covered by the livestock insurance, the probability of  
 141 discovery of the disease animal by the authorities in the second hypothetical course of action is  $\beta$  and in  
 142 the third hypothetical course of action, the probability of not being discovered is  $(1 - \beta)$ , with no change  
 143 to  $I$ ,  $F$ , and  $R$ .



146 **Fig.1. The relationship between expected utility and farmers' behavior**

147 Under these circumstances, the expected utility for the farmer from being insured if there is an incidence  
148 of livestock disease is denoted  $EU_{NL}$ . Where the insured diseases are not limited within three diseases  
149 (numerous), the probability  $(1 - \beta)$  of being able to sell the animal and obtain R without being discovered  
150 by the authorities led by one specified local official (the government veterinarian) rises. As a result, the  
151 farmers' expected utility  $EU_{NL}$  is likely to grow.

152 However, when the insurance coverage disease is limited, the probability  $(1 - \alpha)$  of being able to sell the  
153 animal without being discovered by the authorities is likely to be lower. As a result, the expected utility  
154  $EU_L$  in this situation is lower than  $EU_{NL}$  and  $U_I$  (utility of insurance payment,  $I$ ). Consequently the  
155 possibility of moral hazard among farmers is reduced.

156

157 **4. METHODS**

158 **4.1 Research methods**

159 We carried out field research using a questionnaire in Ba Vi District in North-West Hanoi in January  
160 2015. Having received dairy-related technical support from Japan in recent years, Ba Vi District has  
161 some of Vietnam's most advanced dairy production. Of the 19 villages in Ba Vi, dairy production is  
162 prevalent in Tan Linh, Van Hoa, and Yen Bai, and about 80% of the approximately 7,500 dairy cows in  
163 Ba Vi are in dairy farms in those 3 villages, which have 2,264, 2,472, and 1,259 dairy cows, respectively.  
164 We carried out our field research in Van Hoa and Yen Bai, where farmers' cooperation was forthcoming.

165 In Ba Vi District, as of October 2013, 260 farmers had taken out livestock insurance, 54 in Van Hoa and  
166 60 in Yen Bai. We surveyed 97 farmers chosen randomly from the farmers' registration book, 38 of  
167 whom were insured and 59 uninsured. Of the 38 insured farmers, 22 were in Van Hoa and 16 in Yen Bai.  
168 Of the 59 uninsured farmers, 26 were in Van Hoa and 33 in Yen Bai. Of the 97 farmers surveyed, 48  
169 were in Van Hoa and 49 in Yen Bai.

170 The research was carried out with a questionnaire covering several topics: details of the farm  
171 environment such as the number of dairy cows reared by the farmer, milk production, occurrence of  
172 disease, and welfare management; details on the household's composition such as age, duration of  
173 education, and scale of the family labor force; risk avoidance; and the situation regarding insurance.

**Comment [A12]:** Change to a period.

174 To provide an overview of the surveyed farmers' details, the average age of the main farmer was 47.2  
175 years in Van Hoa and 43.0 years in Yen Bai; the average household size was 4.3 people in Van Hoa and  
176 4.1 people in Yen Bai; and the average education level of the main farmer was 3.2 in Van Hoa and 3.3 in  
177 Yen Bai.<sup>6</sup> Thus, there was no significant difference between the two villages. The average number of  
178 dairy cows was 4.8 in Van Hoa and 5.5 in Yen Bai, with both villages having small-scale farmers with  
179 around five cows. The average number of dairy-cow calvings was 3.0 in Yen Bai and 2.6 in Van Hoa,  
180 reflecting a slightly older herd age. Productivity was a little higher in Yen Bai, with daily milk production  
181 volume per cow of 20.3 liters, compared to 18.5 liters in Van Hoa. Although milk production in the two  
182 villages is at a low level when compared to the average milk production (around 27 liters per cow per  
183 day) at a large advanced dairy farm (15,000 cows) run by TH true Milk in Nghe An Province, their milk

184 production represents an average for Vietnam's small-scale dairy farmers with a small number of cows.<sup>7</sup>

185

## 186 4.2 Methods of analysis

187 We used two methods to analyze the behavior of farmers when taking out insurance: the instrumental  
188 variable (IV) method and the item count technique (ICT).

189 In analyzing the factors affecting decision-making concerning insurance, we consider the impact of the  
190 farmer's appetite for risk on insurance participation. Hence, it becomes necessary to investigate the

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191 endogeneity of appetite for risk, estimated using the IV method (Rivers & Vuong, 1998; Sannabe &

192 Saito, 2007). Following Miwa and Fukui (2014), we present the model below. In the first stage (Equation

193 2), we estimate the degree of risk avoidance (Risk) and the rate of time discounting (Time) with ordinary

194 least square (OLS) method. Next, using the residual obtained from that estimation, in stage 2 (Equation

195 1), we investigated endogeneity using the probit model. Following existing research, we employed

196 several explanatory variables: a village dummy (Village), characteristics of the household (Age,

197 Knowledge, Off-farm), and characteristics of the farm (Cow, Disease, Calving, Labor) that were made

198 available through our field research.<sup>8</sup> Trust in Equation (2) is an instrumental variable, capturing the

199 endogeneity of the degree of avoidance of risk (Risk) and the rate of time discounting (Time) in Equation

200 (1). Details and definitions of the variables used in Equations (1) and (2) are summarized in Table 1.

201

202

$$Insurance = \alpha_0 + \alpha_1 \cdot Time + \alpha_2 \cdot Risk + \alpha_3 \cdot Cow + \alpha_4 \cdot Disease + \alpha_5 \cdot Calving + \alpha_6 \cdot Labor + \alpha_7 \cdot Knowledge + \alpha_8 \cdot Off-farm + \alpha_9 \cdot Village + \sigma \quad (1)$$

$$Risk \text{ or } Time = \beta_0 + \beta_1 \cdot Cow + \beta_2 \cdot Disease + \beta_3 \cdot Calving + \beta_4 \cdot Labor + \beta_5 \cdot Knowledge + \beta_6 \cdot Off-farm + \beta_7 \cdot Village + \beta_8 \cdot Trust + \delta \quad (2)$$

**Table 1. Definition of variables for IV and Probit method**

| Variables        | Definition                                      | All sample   | VanHoa        | YenBai        |
|------------------|-------------------------------------------------|--------------|---------------|---------------|
| <i>Cow</i>       | Total number of cattle                          | 5.15 (1.89)  | 4.84 (1.89)   | 5.49 (1.84)   |
| <i>Disease</i>   | Ratio (%) of disease prevalence to total cattle | 0.17 (0.20)  | 0.16 (0.19)   | 0.18 (0.21)   |
| <i>Parity</i>    | Average parity number of dairy cattle per farm  | 2.84 (1.46)  | 2.62 (0.99)   | 3.04 (1.82)   |
| <i>Labour</i>    | Number of family labor                          | 2.54 (1.03)  | 2.50 (1.09)   | 2.57 (0.98)   |
| <i>Age</i>       | Age of head farmer                              | 45.07 (9.91) | 47.22 (10.28) | 42.96 (9.15)  |
| <i>Non-agri</i>  | Number of Non-agri. worker in family member     | 0.35 (0.58)  | 0.49 (0.65)   | 0.27 (0.46)   |
| <i>Knowledge</i> | Knowledge of animal disease                     | 1.31 (1.15)  | 1.40 (1.27)   | 1.22 (1.03)   |
| <i>Time</i>      | Rate of time discounting                        | 0.21 (0.40)  | 0.26 (0.43)   | 0.17 (0.37)   |
| <i>Risk</i>      | Risk preference                                 | 2.57 (2.06)  | 2.67 (2.13)   | 2.47 (2.01)   |
| <i>Trust</i>     | Number of trustworthy persons                   | 30.28(48.98) | 41.43 (59.12) | 18.56 (33.05) |
| <i>Village</i>   | Village dummy ( VanHoa=1, YenBai=0 )            | -            | 1.00          | 0.00          |

**Comment [A14]:** doesn't need a capital letter

**Comment [A15]:** move up to align with the word Average to the right

**Comment [A16]:** move up opposite the word "number"

Note: Figure is average and standard deviation in parenthesis

Here, *Insurance*, the explained variable in Equation (1), is a dummy variable. It equals 1 if a farmer took out any livestock insurance during the three-year period from 2011 to 2013, and 0 otherwise.

Equation (2) expresses time and risk preference. The rate of time discounting, *Time*, which is an

214 indicator of time preference, was obtained based on answers to the following question (Kirby et al.,  
215 2002) in the questionnaire: "If you won VND 500,000 on the lottery, but were offered VND 1 million  
216 instead if you waited a number of years, how many years would you wait?" If the time they are willing to  
217 wait is longer, the rate of time discounting is lower; as the number of days decreases, the rate of time  
218 discounting rises.<sup>9</sup> Phomtavong and Fukui (2014) demonstrated that, if the rate of time discounting is  
219 low, there is a high tendency to adopt new technology, and it is conceivable that, in Equation (1),  
220 farmers with a low rate of time discounting will take out livestock insurance and the expected sign is  
221 positive.

222 Following Gine et al. (2008), Risk, indicates the degree of risk avoidance. The degree of risk avoidance  
223 reflects the farmer's selection of one of six combinations of sums of money received for "heads" and for  
224 "tails" in an imagined coin-tossing game.<sup>10</sup>

225 In Equation (1), if a farmer is more risk-averse, the likelihood of the farmer opting for insurance  
226 increases. The expected sign is, hence, negative. All calculations were performed using STATA (STATA  
227 CORPS).

228 People usually do not provide honest answers to sensitive questions (for example, questions about the  
229 use of hard drugs such as heroin or questions regarding homophobia or risky sexual behavior  
230 (Randrianantoandro et al (2015))). However, the ICT method allows for an indirect estimate of the

231 proportion of people engaging in behavior that is not be reflected in people's answers. In the ICT  
232 method, the surveyed farmers who have, and have not, taken out insurance were divided into

Comment [A17]: al.,2015)

233 subsample A and subsample B, as shown in Table 2. Each subsample was asked to say whether four  
 234 basic statements concerning various dairy production practices, known as the baseline list, apply to  
 235 them.<sup>11</sup> For subsample B, the sensitive statement (SS) “I have, on occasion, not sought treatment from  
 236 a veterinarian even though a cow has shown signs of Pasteurella infection” is added to the baseline list,  
 237 making a total of five statements. The farmers being interviewed were not asked to directly indicate  
 238 which statements applied to them, but to use only the numbers assigned to the statements to answer  
 239 indirectly.  $\bar{X}_{4A}$  is the average answer number for the baseline list, and  $\bar{X}_{5B}$  is the average answer  
 240 number for the baseline list + SS; the difference between the two is  $\hat{P}_1$  (Equation 3).

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241

242 **Table 2. ICT survey structure**

| Questionnaire | Subsample A              | Subsample B              |
|---------------|--------------------------|--------------------------|
|               | Baseline list            | Baseline list + SS       |
| Sample size   | Insurance farmer = 16    | Insurance farmer = 22    |
|               | No insurance farmer = 33 | No insurance farmer = 26 |

243 Meanwhile, all farmers, both in subsample A and subsample B, were asked to answer “yes” or “no” to  
 244 the statement “I have on occasion not sought treatment from a veterinarian even though a cow has  
 245 shown signs of Pasteurella infection,” posed directly at the end of the questionnaire. The proportion of  
 246 farmers who answered “yes” to the directly posed statement is  $\hat{P}_2$ . If Equation (4) is true, this suggests  
 247 that some farmers “have on occasion not sought treatment from a veterinarian even though a cow has  
 248 shown signs of Pasteurella infection.” In particular, if the proportion of these farmers among insured  
 249 farmers is high, it is likely that moral hazard exists among insured farmers.<sup>12</sup>

250

251

$$\hat{P}_1 = \bar{X}_{5B} - \bar{X}_{4A} \quad (3)$$

252

253

$$\hat{P}_1 = \hat{P}_2 \quad (4)$$

254

255 **5. RESULTS AND DISCUSSION**

256 **5.1 The occurrence of livestock disease and the use of insurance**

257

Table 3 presents the occurrence of different livestock diseases. Looking at diseases covered by

258

insurance, there are a total of 13 cases, comprising seven cases of Pasteurella infection, 4 cases of

259

FMD, and 2 cases of anthrax. Meanwhile, the diseases occurring frequently in the surveyed farmers'

260

farms are those not covered by insurance: 24 cases of mastitis, 17 cases of hoof disease, and 4 cases

261

each of milk fever and peritarsitis. Disorders surrounding pregnancy and calving and disorders of the

262

digestive system also occurred.

263

264 **Table 3. Disease prevalence in sample farmers**

|                                           | Disease      |       |        |        |
|-------------------------------------------|--------------|-------|--------|--------|
|                                           |              | Total | VanHoa | YenBai |
| Insurance covered                         | Pasteurella  | 7(0)  | 1(0)   | 6(4)   |
|                                           | FMD          | 4(0)  | 0(0)   | 4(0)   |
|                                           | Anthrax      | 2(2)  | 0(0)   | 2(0)   |
| Insurance not covered<br>(Top four ranked | Mastitis     | 24    | 10     | 14     |
|                                           | Foot disease | 17    | 8      | 9      |
|                                           | Milk fever   | 4     | 0      | 4      |

|           |              |   |   |   |
|-----------|--------------|---|---|---|
| diseases) | Peritarsitis | 4 | 0 | 4 |
|-----------|--------------|---|---|---|

265 Note: Figure is based on field survey. Multiple responses.

266 Figure in parenthesis are number farms who could obtain insurance payment because the animal  
 267 was died after the occurrence of a disease covered by insurance.

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268

269 Only two farmers (for three cows) were able to obtain an insurance payout after the occurrence of a  
 270 disease covered by insurance; hence, the number of cows for which a payout could be obtained was  
 271 extremely low when compared to the 13 cows suffering from the insured diseases. This is because,  
 272 even when there is an incidence of an insured disease, there is no payout unless the animal dies. If the  
 273 animal recovers following treatment (and does not die), it is not covered by the insurance.

274

## 275 5.2 Analysis of factors involved in the purchase of livestock insurance

276 Table 4 shows the results from estimation using Equations (1) and (2). When using Equation (2), the  
 277 instrumental variable (trust) could not adequately explain *Risk*. Hence, when using Formula (1), we took  
 278 the risk-aversion and time-discounting variables separately as explanatory variables, and estimated the  
 279 impact of risk avoidance (Risk) on the taking-out of insurance (Insurance) using a probit model.

280 A Wald test of the exogeneity of the discount rate is significant at the 1%. Hence, we may view the  
 281 discount rate as an endogenous variable and demonstrate the validity of the estimation using the IV  
 282 method<sup>13</sup>.

283 The results from the first stage of the estimation using the IV method suggest that, if there are few  
284 trustworthy people locally, the rate of time discounting is low and, if there are many trustworthy people,  
285 the rate of time discounting is higher. The results from the second-stage estimation show that the higher  
286 a farmer's rate of time discounting, the less likely he/she is to take out livestock insurance; the lower a  
287 farmer's rate of time discounting the more likely he/she is to take out livestock insurance. Further, the  
288 higher the number of calvings, and therefore the older the cows owned by a farmer, the more likely  
289 he/she is to take out livestock insurance. The village dummy was also significant, reflecting a higher  
290 tendency to take out livestock insurance in Yen Bai.

291 The probit model estimation showed a high tendency for risk-averse farmers to take out insurance. This  
292 is consistent with the findings of Ito and Kono (2010) and Harms (2011), but differs from the findings of  
293 Miwa and Fukui (2014) and Phomtavong and Fukui (2014). In addition, knowledge is also significant:  
294 farmers with a high level of knowledge about livestock diseases opt for livestock insurance. Farmers  
295 with off-farm revenue opportunities also showed a tendency to take out livestock insurance. This  
296 suggests that farmers with the opportunity to earn money off the farm perceive the new system of  
297 livestock insurance positively.

298 Disease showed no statistical significance. This suggests low likelihood for the existence of adverse  
299 selection; that is, farmers with a high incidence of livestock diseases taking out insurance and low  
300 likelihood for the existence of moral hazard may lead to farmers who take out insurance and then fail to  
301 manage their herds properly. These results differ from those of Miwa and Fukui (2014).

The results above show that it is not only the characteristics of the farmers and their farms, but the main farmer's perception of time discounting and of risk that have a significant impacts on the taking-out of livestock insurance.

Comment [A22]: remove

**Table 4. Result of factors affected to animal insurance**

|                       | IV method |            |           |             | Probit method |           |
|-----------------------|-----------|------------|-----------|-------------|---------------|-----------|
|                       | Time      |            | Insurance |             | Insurance     |           |
| Cow                   | 0.024     | (0.020)    | 0.018     | (0.055)     | -0.038        | (0.083)   |
| Disease               | 0.097     | (0.195)    | -0.331    | (0.666)     | -0.811        | (0.755)   |
| Parity                | 0.019     | (0.021)    | 0.168     | (0.085) **  | 0.172         | (0.108)   |
| Age                   | 0.002     | (0.005)    | -0.009    | (0.011)     | -0.024        | (0.016)   |
| Knowledge             | -0.037    | (0.029)    | 0.047     | (0.114)     | 0.258         | (0.125)** |
| Labour                | 0.027     | (0.048)    | -0.041    | (0.125)     | -0.148        | (0.165)   |
| Non-agri              | 0.051     | (0.098)    | 0.382     | (0.255)     | 0.488         | (0.266)*  |
| Village               | 0.054     | (0.089)    | 0.397     | (0.214)*    | 0.342         | (0.301)   |
| Trust                 | 0.001     | (0.001) ** |           |             |               |           |
| Time                  |           |            | -2.195    | (0.326) *** |               |           |
| Risk                  |           |            |           |             | -0.139        | (0.070)** |
| Wald $\chi^2(9)$      | 157.76    | ***        |           |             | 20.3          | **        |
| Exogeneity test       | 9.36      | ***        |           |             |               |           |
| Pseudo R <sup>2</sup> |           |            |           |             | 0.148         |           |

Note: Figure in parenthesis indicates robust standard errors. Sample=95.

\*\*\*, \*\* and \* are statistically significant at 1%, 5% and 10% level respectively.

Exogeneity test indicate the result of "Wald test of exogeneity  $\chi^2(1)$ ".

### 5.3 Item Count Technique

The whole-sample (97 farms) analysis showed that 1.03% of farmers directly acknowledged that they

313 "have on occasion not sought treatment from a veterinarian even though a cow has shown signs of  
 314 Pasteurella infection," (acknowledging behavior pertaining to moral hazard), while 12.88% indirectly  
 315 acknowledged such action (Table 5). There is a statistically significant difference between the two  
 316 values, suggesting that farmers' behavior reflects moral hazard tendencies.  
 317 When separating these results according to farmers who have taken out livestock insurance and those  
 318 who have not, no farmers with insurance directly acknowledged such behavior and 16.48% indirectly  
 319 acknowledged it. The difference is statistically significant. Further, 1.69% of farmers without insurance  
 320 directly acknowledged such behavior and 14.22% indirectly acknowledged it. Again, the difference is  
 321 statistically significant. The results suggest that behavior pertaining to moral hazard exists among both  
 322 insured and uninsured farmers.  
 323 However, there is no statistical difference between the insured and the uninsured farmers with regard to  
 324 indirect acknowledgement. This implies that there is no particular tendency for moral hazard among  
 325 insured farmers. This is consistent with the results obtained using the IV method. The results differ from  
 326 the findings of Miwa and Fukui (2014), who find insured farmers frequently engaging in behavior  
 327 pertaining to moral hazard.

328 **Table 5. Result of ICT**

|                                   | $\hat{P}_1(\%)$ | $\hat{P}_2(\%)$ | Binominal test (p-value) |
|-----------------------------------|-----------------|-----------------|--------------------------|
| Total sample (n=97)               | 12.88           | 1.03            | 0.001***                 |
| Farmers who join insurance (n=38) | 16.48           | 0               | 0.007***                 |
| Farmers who do not join insurance | 14.22           | 1.69            | 0.011**                  |

**Comment [A23]:** align this across the columns of the table

(n=59)

329

#### 330 5.4 Discussion

331 With respect to time preference and the taking-out of livestock insurance, it is possible to interpret the  
332 findings as the higher a farmer's rate of time discounting (that is, the more impatient the farmer), the less  
333 likely he/she is to respond to a future income opportunity that may arise under livestock insurance.

334 Conversely, it is conceivable that farmers with a low rate of time discounting are able to consider the  
335 dairy business from a long-term perspective and, hence, respond to the new system (livestock  
336 insurance) positively. These findings are similar to those of Phomtavong and Fukui (2014).

337 However, there was a tendency for farmers to have a lower rate of time discounting and be more likely  
338 to adopt the new system (livestock insurance), if there were less trustworthy people around them. Why  
339 is the rate of time discounting high when there are many trustworthy people around? Taking into  
340 account the number of cattle owned, as a variable showing ownership of assets by people who were  
341 surrounded by many trustworthy people (at least 100), farmers able to trust at least 100 people owned,  
342 on average, 5.26 cows. Farmers able to trust fewer than 100 people owned, on average, 4.73 cows.

343 Thus, the less people farmers are able to trust, the less cows (assets) they own, though the difference is  
344 not statistically significant. Further the correlation between a farmer's earnings opportunities off the farm

345 and he or she being able to trust as least 100 people is 0.32, whereas that between a farmer's earnings  
346 opportunities off the farm and he or she being able to trust fewer than 100 people is 0.009, which is a

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347 difference of statistical significant. In other words, farmers able to trust a small number of people are  
348 relatively poor. Because of that, as shown by Tanaka, Colin & Nguyen (2010), the rate of time  
349 discounting among people with low incomes tends to be high (and, conversely, the rate tends to be low  
350 among people with high incomes).

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351 The findings thus suggest that farmers take out insurance because there are few acquaintances to turn  
352 to in hard times, such as when natural disasters occur. Conversely, it is conceivable that farmers able to  
353 trust a large number of people have many acquaintances to turn to in times of trouble and have little  
354 need to take out insurance. Further research is needed to examine the relationship between the number  
355 of people farmers are able to trust and their rate of time discounting.

356 The analysis of results also reveals a low level of existence of adverse selection and moral hazard with  
357 respect to livestock insurance in the surveyed areas. It is conceivable that the fact, farmers suffering  
358 high incidence of livestock disease are unlikely to engage in adverse selection, is attributable to the  
359 proper cooperation between Boa Vet (the private company implementing livestock insurance in  
360 Vietnam) and the local administrative bodies (local government veterinarian and ministry committees).

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361 This allows the insurance company to obtain information about the farmers and eliminate the problems  
362 associated with information asymmetry. Tackling the problem of asymmetric information by making full  
363 use of regional institutions with a great deal of information about the villages, resembles the set-up at  
364 micro-credit providers operating in Bangladesh and elsewhere (Armendariz & Morduch, 2007). The  
365 micro-credit providers normally live in community and they know who is who, what reputation each

366 person has for hard work and honesty, and who is connected with whom. This allows them to defeat the  
367 problems of asymmetric information (Janvry & Sadoulet, 2015). These results in Vietnam suggest the  
368 problem associated with asymmetric information can mitigate under the condition of cooperation  
369 between government and private sector.

370 The fact that insurance coverage is limited to fatal outbreaks of three diseases could also be seen as  
371 working against behavior originating from moral hazard. We explain this point using Figure 1. Where the  
372 insured diseases are limited (numerous), even if a farmer anticipating that  $R > I$  engages in moral  
373 hazard, the probability  $(1 - \beta)$  of being able to sell the animal and obtain  $R$  without being discovered by  
374 the authorities rises. As a result, the farmers' expected utility  $EU_{NL}$  is likely to grow. However, when the  
375 insurance coverage is limited, even if we assume that a farmer who expects  $R > I$  engages in moral  
376 hazard, as mentioned earlier, there is an insurance payout for only three diseases and the probability  $(1$   
377  $-\alpha)$  of being able to sell the animal without being discovered by the authorities is likely to be lower. In  
378 other words, limiting the diseases covered reduces expected utility and, as shown by the results of our  
379 ICT analysis, we expect that the possibility of moral hazard among farmers is also reduced.

380 In Vietnam's system of livestock insurance, the poorest farmers receive a 100% subsidy of their  
381 premiums when taking out insurance; the poorest farmers do not make any payment, raising the value  
382 of  $I$ , the net payout figure after deduction of premiums. It is conceivable that raising the value of  $I$  will  
383 have the effect of preventing moral hazard. The inequality  $U_I > EU_L$  in Figure 1 reflects positive utility and  
384 the inequality  $U_I < EU_{NL}$  reflects negative utility. This suggests that the system of subsidies in

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385 Vietnamese government livestock insurance has a significant impact on whether farmers opt for  
386 insurance.

## 387 6. CONCLUSIONS

388 In this paper, we have studied the factors behind the decision to take out insurance, from the viewpoint  
389 of moral hazard or adverse selection. We summarize the contributions of this article into three ways

390 First, the analysis reveals a low level of existence of adverse selection and moral hazard with respect to  
391 livestock insurance in the surveyed areas. It is conceivable that the fact that farmers suffering high  
392 incidence of livestock disease are unlikely to engage in adverse selection and take out insurance is  
393 attributable to the proper cooperation between the company implementing livestock insurance in  
394 Vietnam and the local administrative bodies. This allows the insurance company to obtain information  
395 about the farmers and eliminate the problems associated with information asymmetry. The livestock  
396 insurance in Vietnam as a public-private risk-management is evaluated to mitigate the asymmetric  
397 information problems.

398 Second, the results show that the higher a farmer's rate of time discounting, the less likely the farmer is  
399 to take out livestock insurance; the lower a farmer's rate of time discounting the more likely the farmer is  
400 to take out livestock insurance. It is possible to interpret the findings as the higher a farmer's rate of time  
401 discounting (that is, the more impatient the farmer), the less likely the farmer is to respond to a future  
402 earnings opportunity that may arise under the new system. Conversely, it is conceivable that farmers  
403 with a low rate of time discounting are able to consider the dairy business from a long-term perspective

404 and, hence, respond to the new system positively.

405 **Third**, the fact that insurance coverage is limited to fatal outbreaks of three diseases could also be seen  
406 as working against behavior originating from moral hazard. The incidence of livestock diseases covered  
407 by insurance is currently low. Many dairy farmers expressed their wish for insurance coverage to be  
408 expanded to include other diseases such as mastitis and hoof disease. Expanding the insured diseases  
409 increases the probability of farmers being able to sell an animal without the authorities knowing and it is  
410 likely that farmers' expected **utility of insurance claims** will rise. Expanding the range of diseases  
411 covered by insurance would introduce an additional financial burden. As a consequence, the system of  
412 surveillance and penalties would need to be strengthened.

413 **Many governments in developing countries have prioritized the creation and strengthening of the**  
414 **agricultural insurance and index-based insurance has elicited considerable attention recently,**  
415 **especially since it is free from information asymmetric problems. Our work showed that "conventional"**  
416 **insurance can mitigate the problems associated with asymmetric information under the situations we**  
417 **have identified, not depending index based-insurance. It would be meaningful implication for policy**  
418 **makers to enhance agricultural insurance in developing countries.**

419

## 420 **ENDNOTES**

421 <sup>1</sup>GlobalAgRisk (2009) produced a report explaining agricultural insurance in Vietnam. However, it  
422 focuses on the basic insurance mechanism and contains no analysis of the behavior of farmers

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423 choosing agricultural insurance.

424 <sup>2</sup>These comments on agricultural insurance are based on the results from field research and studies  
425 by Kada (2014).

426 <sup>3</sup>Agricultural insurance in Vietnam has also attracted attention as a public-private risk-management  
427 system (ENESA-CEIGRAM-Agroseguro, 2015).

428 <sup>4</sup>Here, we present an expected-utility analysis following Kono (2011).

429 <sup>5</sup>In our survey, there were farmers who did not receive a payout for an animal that died from an  
430 uninsured disease and farmers that were dissatisfied by the fact that the payout was lower than the  
431 contracted sum. The assumption  $R > I$  is, thus, rather realistic.

432 <sup>6</sup>Education level is the education level of each main farmer measured against five levels (no education,  
433 finished elementary school, finished middle- school, graduated from high school, graduated from  
434 university or higher). The average education level is the average value of these.

435 <sup>7</sup>Average milk production volume in Nghe An province was taken from the JICA page below (accessed  
436 Aug 31, 2015).

437 <http://www.jica.go.jp/project/Vietnam/0601775/news/news/20100922.html>

438 <sup>8</sup>Knowledge quantifies the level of knowledge about livestock disease based on the accuracy of yes/no  
439 answers to the following four questions: 1) "Chickens can be infected with FMD." 2) "Pigs can be  
440 infected with the mastitis virus." 3) "Cows can be infected with avian influenza." 4) "Cows become blind  
441 when infected with pasteurellosis."

442 <sup>9</sup>We calculate the rate of time discounting using the formula  $X=Y/(1+kT)$ . In this formula, X is the  
443 current value of the winning lottery ticket (VND 500,000), Y is the value of the delayed ticket paying out  
444 after T days (VND 1,000,000), and k is the rate of time discounting.

445 <sup>10</sup>The following six combinations are listed in the questionnaire. 1) Heads: VND 100,000; Tails VND  
446 100,000. 2) Heads: VND 80,000; Tails VND 200,000. 3) Heads: VND 60,000; Tails VND 260,000. 4)  
447 Heads: VND 40,000; Tails VND 320,000. 5) Heads: VND 20,000; Tails VND 380,000. 6) Heads: VND 0;  
448 Tails VND 400,000. Farmers who select option 1 are considered to have a strong tendency to avoid risk,  
449 and those who select option 6 have a strong tendency to seek risk.

450 <sup>11</sup>The following four statements were included: 1) "I use only artificial insemination." 2) "For fertilization,  
451 I use only stud bulls." 3) "I sell raw milk to local restaurants." 4) "I give vitamins to my cows."

452 <sup>12</sup>For details, see Randrianantoandro et al. (2015).

453 <sup>13</sup> For more details, see Gujarati (2015).

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#### 508 **ABBREVIATION**

509 ASF: African swine fever;

510 FAO: Food and Agricultural Organization;

511 FMD: foot and mouth disease;

512 ICT: Item count technique;

513 IV: Instrumental variable;

514 MARD: Ministry of Agriculture and Rural Development;

515 OLS: Ordinary Least Square;

516 SS: Sensitive statement;

517 VND: Vietnamese Dong;