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Factors Affecting Adoption of Modern Beehive in Saese Tsaeda District of Tigray Ethiopia

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Abstract
This paper evaluates factors that determine adoption of modern hive technology using primary data of 250 households collected in 2015 from four kebelas in Saese'e tsa'eda emba woreda of Tigray, Ethiopia. Both descriptive and econometric methods employed to analyze the demographic, socioeconomic and institutional factors affecting beekeeping households' decisions. Determinant factors of adoption of modern hive were analyzed using logit model. According to the result of descriptive econometric analysis, the difference between adopters and non-adopters in terms of educational level of household head, labor availability in the household, access to extension service, land tenure and access to loan service were statistically significant.
Keywords: Logit, Descriptive analysis, modern hive, adoption,

Background of the Study

In Ethiopia, traditional beekeeping is the oldest and the richest practice, which has been carried out by the people for thousands of years. Several million bee colonies are managed with the same old traditional beekeeping methods in almost all parts of the country (Fichtl and Admasu, 1994). Traditional beekeeping is of two types: forest beekeeping and backyard beekeeping. The traditional types of hives and the way of keeping bees vary from area to area. Based on locally available materials used for construction of hives, environmental conditions and positions used to keep bees, the following variants of basic design are found throughout the country: hollowed logs, bark hive, bamboo or reed grass hive, mud (clay) hive, animal dung (mixed with ash) hive, woven straw hive, gourd hive, earthen pot hive and so on. The beekeepers that are experienced and skilful in using these hives could do many operations with less facility. Gezahegne (2001) reported that under Ethiopian farmers' management condition, the average amount of crude honey produced from traditional hive is estimated to be 5 kg / hive / year. This low productivity of honey per hive was due to the type of hive beekeeping farmers' use. To enhance the low yield of honey per hive different packages was implemented and among them was the introduction of modern hive. Modern beekeeping methods aim to obtain the maximum honey crop, season after season, without harming bees (Nicola, 2002). Modern movable- frame hive consists of precisely made rectangular box hives (hive bodies) superimposed one above the other in a tier. The number of boxes is varied seasonally according to the population size of bees. In Ethiopia, about 5 types of movable frame hives were introduced since 1970 (HBRC, 1997) and the most commonly used are: Zander and Langstroth style hives. Based on the national estimate, the average yield of pure honey from modern hive is 15-20 kg/year, and the amount of beeswax produced is 1-2% of the honey yield (Gezahegne, 2001). However, in potential areas, up to 50-60 kg harvest has been reported (HBRC, 1997). The amount of honey produced from one beehive per year varies from places to places; in most cases, it determined by the existences of pollen and nectar source plants, level of management & input. Movable frame hives allow colony management and use of a higher level of technology, with larger colonies, and can give higher yield and quality honey but are likely require high investment cost and trained man power.

Even if the productivity capacity of modern hive is high and efficient the adoption rate of this technology is found at low level in Ethiopia and Tigray regional state, but in Saese'e tsa'eda emba distric,t the adoption rate was high and encouraging. According the district annual report (2015), it was reported above 50% adoption rate in this district and why this paper was done to see what determinant factors are there and what best experience of adoption works are worked.

Data Source and Sampling System

Based upon their beekeeping potential and number of modern hive introduced, nearest geographical location and accessibility four Kebele were selected purposely from 26 kebels of this district. Based on the criteria, Gumuse ,maymegelta, sinkat,sendada kebeles were selected. Beekeepers were stratified into farmers having modern hive (adopters) and farmers having traditional hive (non adopters). According to Storck *et al*. (1991), the size of the sample depends on the available fund, time and other reasons and not necessarily on the total population. A total 250 sample sizes were randomly drown from the selected four kebeles and each kebele had a proportional size on the sample. Sample size of adopters was 100 and sample size of non adopters 150.

Model Specification

In this section, models that we used in order to address the general objective and the specific objectives are

identified with their appropriate specification. In this paper, both descriptive and econometric analysis approaches are used to investigate the research questions. Logit model was used to analyze factors influencing modern hive adoption and propensity score matching was employed to evaluate the impact of modern hive on households' income gain.

Model Specification for Adoption Decision

Logit Model

Independent Linear Probability Model (LPM), probit or logit models, have been widely used to analyze factors that influence discrete behavior such as the adoption decisions (Greene, 1993; Gujarati, 2004). The linear probability model (LPM) which is expressed as a linear function of the explanatory variables is computationally simple. However, despite its computational simplicity, as indorsed by Pindyck and Rubinfeld (1981), Amemiya and Gujarati (1988), it has a serious defect in that the estimated probability values can lie outside the normal (0-1) range. Hence logit model is advantageous over LPM in that the probabilities are bound between 0 and 1. The logit model assumes cumulative logistic probability function whereas the probit model is associated with the cumulative normal distribution (Gugarati, 2004). Although logit and probit models yield similar parameter estimates, a cumulative logistic regression model is preferred because of easier to compute and interpret than the Probit and Tobit models (Pindyck and Rubinfeld, 1991). The logit model has less restrictive assumptions and a simpler functional form than the probit model (Gujarati & Sangetha, 2009).

The character of adopters and non adopters was essentially a univarate approach where difference between the means of selected characteristics of adopters and non adopters were compared using pair wise statistical test. A binary choice model, using the logit specification, was also used to examine the adoption decision in a multivariate framework.

Logit model used to identify factors affecting farmers' decision whether to adopt modern beehive or not. According to the logit model, the probability of an individual farmer adopting a modern beehive given a well defined set of socio-economic and physical characteristics (X), is represented accordingly. Following Pindyck and Rubinfeld (1981), the cumulative logistic probability function is specified as:

$$P\left(Y_i = 1\right) = \frac{1}{1 + e^{-(\beta_i X_i)}} \quad \text{---------- 1}$$

$$P(Y_i = 1) = \frac{1}{1 + e^{-(Z_i)}} \quad \text{----------2}$$

Where: $P(Y_i = 1)$ is the probability that a farmer adopting modern beehive

Z_i Is the function of a vector of n explanatory variables, e represents the base of natural logarithms and equation (2) is the cumulative distribution function. If $P(Y_i = 1)$ is the probability of farmers adopting modern beehive in that area, then $1 - P(Y_i = 1)$ represents the probability of farmers not adopting modern beehive in the research area and is expressed as:

$$1 - P(Y_i = 1) = 1 - \frac{1}{1 + e^{-(Z_i)}} = \frac{1}{1 + e^{(Z_i)}} \quad \text{---------- 3}$$

Interpretation of coefficients will be easier if the logistic model can be written in terms of the odds and log of odds (Gujarati, 2004). The odd ratio, the ratio of the probability that a farmer adopt modern beehive to the probability of the non-adopter is expressed as:

$$\frac{P(Y_i = 1}{1 - P(Y_i = 1)} = \frac{1 + e^{Z_i}}{1 + e^{-Z_i}} = e^{Z_i} \quad \text{---------- 4}$$

Taking the natural log of equation (4), we obtain

$$L_i = \ln\left(\frac{P(Y_i = 1)}{1 - P(Y_i = 1)}\right) = Z_i \quad \text{---------- 5}$$

Where L_i is the log of the odds ratio which is not only linear in the explanatory variables but in the parameters also.Thus, introducing the stochastic error term, μ_i , the logit model can be written as:

$$Z_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + - - - - - - - + \beta_n X_n + \mu_i \quad \text{---------- 6}$$

Where $X's$ = are explanatory variables, β_0 is the constant term and $\beta`s$ are coefficients to be estimated.

Table 3.1. Description of variables used in the logistic model

Variable name	type	Variable Description	Measurement	Expected effect
Dependent Variables				
Adoption	Dummy	Adoption of modern hive	1 if yes, 0 otherwise	
Honey yield	Continuous	Kg of honey harvest	Kilo gram	
Honey sale	Continuous	Birr gain from honey sale	Ethiopian Birr	
Total hh income	Continuous	Birr gain from all activity	Ethiopian Birr	
Explanatory variables (independent variables)				
fasize	Continuous	family size	No. of HH members	+
basiceduca	Dummy	Education status of household head	Literate =1, 0 otherwise	+
Age	Continuous	Age of household head	years completed	+/-
Maritalsta	Dummy	Marital status of household head	1 if married, 0 otherwise	+/-
Sex	Dummy	sex of household head	1 if male, 0 otherwise	+
Laborav	Continuous	Labor availability in the HH	adult equivalents	+
totalandhold	Continuous	Total land owned by the household	hectare	+
own aradio	Dummy	Owning a mobile phone	1 if yes, 0 otherwise	+
Own a radio	Dummy	Owning a radio	1 if yes, 0 otherwise	+
livestockhol	Continuous	Livestock holding	tropical livestock units	+
landtenure	Dummy	certified & own Land	1 if yes, 0 otherwise	+/-
access topriceinfor,	Dummy	access to price information	1 if yes, 0 otherwise	+
accesstoloan	Dummy	access credit service	1 if yes, 0 otherwise	+
acctoexteserv,	Dummy	access extension services	1 if yes, 0 otherwise	+
disttoveicroad	Continuous	Home distance to vehicular road	kilo meters	_
distancetoinput market	Continuous	Distance to input market	kilo meters	+/-
distopromarket	Continuous	Distance to product market	kilo meters	+/-

Result and Discussion

Descriptive Statistics

In this part, descriptive statistics and econometric model results are presented and discussed.

Under descriptive statistics important determinant characteristics of households and outcome variables are displayed with appropriate statistical tools like mean, standard deviation and percentages. Based on descriptive results household characters and socio-economic factors are presented as fellow.

Household Demographic Character

Age of household head: As shown in many empirical literatures, the role of age in explaining adoption decision of new technology is somewhat controversial. In most adoption studies older people have more farming experience that helps them to adopt new technologies. According to Mignouna et al, 2011; Kariyasa and Dewi 2011, older farmers are assumed to have gained knowledge and experience over time and are better able to evaluate technology information than younger farmers. On the other hand, a study by Abatania(2005) and Rahmeto(2007) shows that age and adoption decision are inversely associated. As farmers age increases, the likelihood of new technology adoption tends to decline. Because of risk averting nature aged farmers is high; they need to minimize risk taking action of newly introduced technology and they become more conservative (not ready to accept the new one) than the youngest one to adopt new technology. The survey result depicts that the average age of household head for adopters and non-adopters is 44.95 and 46.73 years, respectively. From t-test statistics result (table 4.1), the average age difference between adopters and non-adopters is not statistically significant.

Family size: in this study family size is considered as the number of individual who resides in the respondent's household. Large family size assumed to be an indicator of better labor availability in the household. Beliyu, Tewodros and Edward 2010 works, indicates that as a household size increases, adoption also expected to increases and correlate positively. The average family size of adopters and non-adopters is 5.29 and 4.83 respectively. Even if there is no statistically significant difference between adopters and non-adopters with respect to their average family size, still adopters have relatively high number of family size and they are also in better position of adoption status.

Education of the household head: household head farmers who can read and write are more advantageous in understanding new technology and apiculture practices when compared with those who cannot read and write. Literate farmers can manage and interpret production instructions themselves any time with what they had written and printed materials. Moreover, household heads that have better education level are more likely to adopt modern hive than those who are illiterate. Literate beekeepers are more ready to understand new idea and concepts provided by extension workers and other informants.

The availability education Level of family member's household head was categorized into two levels; literate (can read and write) and illiterate (can't read and write). The statistical test indicates that there is statistically significant difference between adopters and non-adopters.

Household Economic factors

Total land holding

Land is the single most important endowment, as it is a base for any economic activity especially in rural and agricultural sector. Farm size influences household's decision to adopt or not to adopt new technologies. It is expected that more land holding and adoption decision are positively correlated, Nzomoi *et al.(*2007), Beliyu, Tewodros and Edward(2010) and Kaguongo(2010). The survey result showed that, the average land holding of sample households was found to be 0.707 hectare with a standard deviation of 0.04. This figure is lower than the national figure, which is 1.5 hectare implying in the study area land holding is low. The average land holding of adopter and non-adopter was 0.7448 and 0.68 hectare respectively. The t-test indicates that, the mean difference of farm size between adopters and non-adopters is not statistically significant. But it important to see the advantage of having the most constraints to agricultural technology adoption is, the availability of cultivable land (de Janvry et al, 2011; Carletto et al, 2007; Pingali et al, 1987).

Livestock Size

In rural context, livestock holding is an important indicator of household wealth. In addition, livestock is considered to be a source of income, food and drafting power for crop cultivations. The number of livestock owned by farmers was hypothesized to be positively associated with adoption decision in most adoption literature. The average livestock holding of adopter sample households was 4.1269 TLU with standard deviation of 2.46. It ranges from 0 to 14 TLU within groups. On the other hand non adopters hold 3.89 TLU with standard deviation of 2.74. The range was from 0 to 18.5TLU within the group. Within adoption categories the result of this study shows that, there was high variation in livestock holding. Even if the t-test shows that the mean difference in livestock holding among adopters and non-adopters is not statistically significant it was positive relation with adoption and it is consistent with some study. Having more units of livestock hypothesized is to be positively related to the adoption of agricultural technologies because it serve as proxy for wealth status B.Kafle and P.Shah(2012)

Own farm Land

Land ownership status is the legal right to have and own the natural land entity to use for production and to benefit from its outputs without any difficulty which is stated by low. Farm households have relatively different Land ownership status because of many reasons. The statistical test indicates that, adopter households was found statistically significant differ from non adopters with respect to their land owning status. From (table 4.1) we can see that adopters have had 82 percent certified and own land but non adopters had have certified and own land only 71.3percent.

Different Access & Institutional Factors

Access to loan

Feder *et al.* (1985) observed that credit programs enable farmers to purchase inputs or acquire physical capital needed for technology adoption.

Credit may be essential to acquire farm technologies like modern beekeeping which the farmers perceive to be a costly activity to engage in (Workneh, 2007).

Adopters and non adopters of beekeeping farmers on the research area have an access to loan and 36 percent of adopters used the advantage of credit but non adopters benefited only 18.33 percent of the credit advantage. The t-test indicates that, the mean difference of access to loan between adopters and non-adopters is statistically significant.

Access to extension service:

Extension is as major sources of agricultural information for adoption process is seen as the main important service to farmers. The adoption of agricultural technologies primarily depends on access to information and on the willingness and ability of farmers to use information provided by extension agents. Information helps decision-making process is to reduce risk and uncertainty and enable farm households to made right choices from available technologies. Out of the total sample households 46.8 percent of them had got extension service; whereas the remaining 53.2 percent had not got extension service. As indicated (Table 4.1), 56 and 37.3 percent of adopter and non-adopter had access to extension service respectively. This implies that majority of the adopters had access to extension service which enable them to have more information about new technologies. The t test result shows that, there is statistically significant difference between adopters and non-adopters with respect to access to extension services.

Table 4.1 Descriptive Characteristic
Household character and socio economic factors of adoption for adopters and non adopters in research kebleas based on sample survey on 2015.

Characteristic	Adopters (N=100) (adoption =1,0 otherwise)		Non adopters (N=150)		
	Mean	Standard deviation	Mean	Standard deviation	t-test
Household demographic character					
Age	44.95	10.915	46.733	-2.27	-1.24
Sex	0.76	0.429	.8400	0.61	-1.57
fasize	5.29	2.425	4.8333	2.95	1.49
basiceduca	0.60	0.492	0.4000	0.27	3.15***
maritalsta	0.83	0.377	0.8400	2.99	-0.21
Household economic factors					
Laborav	3.248	1.773	2.6060	0.26	2.9***
totalandhold	0.7448	0.689	0.6820	0.36	0.77
own mo phone(yes)	0.60	0.492	0.6006	0.84	-0.11
own aradio (yes)	0.56	0.498	0.4730	2.20	1.34
livestockhol (tlu)	4.127	2.460	3.6880	1.26	1.29
landtenure	0.82	0.386	0.7130	3.62	1.93*
Market Access & Institutional factors					
access topriceinfor	0.60	0.492	0.5600	3.68	0.62
accesstoloan	0.36	0.482	0.1860	-4.81	3.1***
disttoveicroad	4.43	3.306	3.9730	2.76	1.16
acctoexteserv	0.61	0.490	0.3730	-1.80	3.76**
Distance to input market	6.17	3.333	6.9000	-2.64	-1.58
Distance to product market	6.85	3.870	6.8530	-2.27	-0.01

Source: model output based on primary collected data,2015. **HH=household, . N=number of sample population. ***,**, * significant levels at 1%, 5% &10% respectively**

Econometric Analysis

Determinants of Modern Hive Adoption

With descriptive statistics of sample households we test of the existence of relationship between the dependant and independent variables to identify factors affecting adoption of modern beehive technology. Identifications of these factors alone are however not enough unless the relative influence of each factor is statistically determined. In this section, logit model was used to see the relative influence of demographic, socio-economic and institutional variables on adoption of modern hive.

Out of the total hypothesized variables, 10 of them were found to be statistically significant in affecting modern hive adoption. Thus, age, sex, education status of household head, Labor availability, Land tenure, access to loan, access to extension service and distance to vehicle road, input market, product market. Others determinant factors like total land hold owning phone and radio, lives stock, family size, marital status and access to price information which was not significant to determine between adopters and non-adopters were excluded from further explanations.

Age of household

Depending on the nature of the technology, age of farmer is likely to play different roles in technology adoption. Age had a negative and significance influence on adoption of modern hive technology at 1percent level of significance.

As farmers get old they are likely to be risk (probable loss of production or other benefit due to new technology) avert and they become none adopters of beekeeping technologies. Other things being constant beekeepers are reluctant to new technology as they get older. The marginal effect indicates that probability of adoption of improved modern hive technologies decreases by 0.9 percent as the house hold increase its age by one year. (Table, 4.2). The result in line with Yohannis (1992) and; Shiferaw and Holden (1998) who also indicated

that age of the household head negatively influenced adoption of farm technology.

Access to loan

As a liquidity factor, the more farmers have access to source of finance, the more likely to adopt agricultural technologies that could possibly increase honey yield. Access to loan was positive and significant influence on adoption of modern hive at 1percent significance level. Farmers, who had access to loan, keeping other things constant, had 35.8% higher probability of adopting modern beehive unlike non-adopter farmers. This finding is consistent with Kassie *et al.* (2012).

Access to extension service

Access to extension service has positive influence on the probability of modern hive adoption at 1 percent significance level. From this result it is possible to state that those household who have access to extension service like training and demonstration are more likely to adopt modern hive than those who have not. The marginal effect result also shows that the estimated increase in the probability of adoption improved of modern hive technologies due to access to extension service was 28.2 percent. In addition to offering information and creating awareness, extension service also includes advices, training, demonstrations and timely distribution of inputs. Farmers who are frequently visited by extension agents tend to be more progressive and more likely to experiment with modern hive technology. The result is consistent with Shiferaw et al.(2008) for improved pigeon pea varieties in Tanzania, Kristjanson et al. (2005) for cowpea varieties, Kaliba et al.(2000) for maize varieties and Gebreselassie and Sanders (2008) for sorghum in Ethiopia. Similarly, this finding is also match with the finding of Rahimeto (2007), Beliyu, Tewodros and Edward(2010).

Household head education

Educational level of the household head is important to note as determinant of adoption to farm technologies. The possible reasons for more adoption of modern hives by beekeepers with higher educational backgrounds, could be that education may increases access to information and their knowledge to understand the technology. Beekeepers, who can read and write, can have simple and diversified communication ways to extension services. As the logit estimation result indicates (table 4.2), education status of house hold head is positive and significantly correlated with adoption at 1percent level of significance. Farmers, those who can read and write, keeping other things constant, have 22.2% higher probability of adopting, modern beehive unlike illiterate farmers. The result is also supported by earlier studies (Workneh et. al., 2008);Workneh, 2011).

Labor availability

Agriculture needs labor as an input in order to perform activities. Having large working labor force in a family increases the chance of doing any practice by themselves and they may not need to hire more additional labor from the market. On the other hand the money saved due to use of own labor force can be used to buy modern inputs and facilitate adoption of modern hive technology.

From our logit result (table 4.2), Labor availability has positive and significant influence on adoption of modern bee hive at 1percent level of significance. Availability of labor in a household is associated with an increase in the probability of adopting modern hive technology; by 8.3percent*, ceteris paribus.*

Our result is consistent with findings of Bekele *et.al***,** (2000) and Million (2004).It is also observed that the availability of adult family members within households may facilitate technology adoption because most farming households suffer from offering hired labor due to liquidity constraints (Carletto et al, 2007).

Own farm land

Ownership of large tracts of land can facilitate experimentation with new agricultural technologies, and also determine the pace of adoption as large land owners are more likely to be the early adopters (de Janvry et al, 2011). Farmers those who are certified and have secured land ownership status (having land usage certificate) accept new technologies. Such legal rights of land use, assures and motivate continuous investment of beekeeping society on their own land by using new inputs and technology practices.

Being a rational decision makers, while incurring a cost for technologies(bee forage development), farmers want totally to employ technologies within their own land where the final yield could not be shared and sub-divided by others, which is too common in sharecropping system.(honey share production is common in Ttigray).

Land ownership status of farm households was found to be statistically significant in determining adoption decision of modern hive at 5 percent level of significance. Keeping other things constant, adopters had 21.1percent higher probability of adopting modern beehive, unlike their counterparts.

Distance to vehicle road

Beekeepers living in the research area were influenced positively and significantly by distance from vehicle road infrastructure at one percent level of significance. The model marginal effect result indicates that (table 4.2), as 1 KM move far away to vehicle road 7.7 percent higher adopting probability of modern hive was resulted.

Distance to input market

Modern beekeeping use newly introduced technology inputs. Among these inputs modern bee hive, protection materials, honey extractor, swarm bee and others are available important inputs which are found at different market locations.

As expected, the farthest input market has a negative and significance influence on the adoption decision of modern hive at one percent significance level (p=0.000). From this result it can be stated that those households who are near to input market are more likely to adopt modern hive than those who are live far away from input market. The marginal effect in the model with regard to distance to input market implies that, other thing held constant, the probability of adoption modern hive was decrease by 13.9 percent as one beekeeping farmer move far away one KM from the input market. Results indicate that farm households that are located in remote areas are less likely to adopt modern hive technology. This is not surprising because in such areas, access to extension services, field visits by agricultural staff and interactions with farmers (human capital inputs) is usually limited due to poor road infrastructure.

Distance to product market

Distance from farmers' house to product market was positively related to the adoption of modern hive technology. The probability adoption of technology was significantly affected by market distance at 1percent significance level (Table 4.2). Product market result indicated that as market distance increase, the probability of adoption of modern hive technology increase by 8.6 percent. The market gain of honey sale is positively increased as farmers were sale their product at reasonable market price if they are travel far away from their local market. Beekeepers can sale their honey bee product at home to locale traders at low price which is inconvenience to motivate them for farther honey production and farmers always travel to search the right price and place even if it has travel cost. These all honey producers are most likely motivated by big cities honey price to adopt new bee technology. But the finding is inconsistent with finding was identified by (Hailu, 2008), as market distance increases adoption and intensity of adoption decreased.

Conclusion

The main conclusions can be drawn from the results of this study on factors of adoption was that; the group of farm households that did adopt modern hive had different characteristics than the group of farm households that did not adopt. These differences represent sources of variation between the two groups that the estimation of a logit model including of all variable for adoption can take in to consideration.

Recommendation

Based on the result every extension worker should be consider physical and socio economic factor that facilitate any acceptance of new technology and there is a need of prioritized and ranking of factors according their influence on adoption .

The presence of loan access, strong extension services and being literate(can write and read) are among the strong determinate factors for adoption of modern hive technology and any provision of extension service should be analyze the influence of these factors as an important focus.

Table: 4.2 Logit estimation result for determinants of modern hive adoption

Explanatory variables	Coefficients	Odds ratio	Marginal effect	Robust Std. Err	Z	P>|z|
age	-0.037	0.963	-0.009	0.0141	-2.64	0.008***
sex †	-1.099	0.333	-0.266	0.4850	-2.27	0.023**
fasize	0.044	1.045	0.010	0.0720	0.61	0.5390
basiceduca†	0 .967	2.631	0.222	0 .3281	2.95	0.003***
maritalsta†	0.167	1.182	0.038	0.6092	0.27	0.783
Laborav	0.359	1.432	0.083	0.1200	2.99	0.003***
totalandhold	0.154	1.167	0.036	0.2834	0.54	0.586
own mo phone†	0.089	1.093	0.021	0.3400	0.26	0.793
own aradio†	0.112	1.119	0.026	0.3152	0.36	0.722
livestockhol	0.053	1.054	0.012	0.0635	0.84	0.403
landtenure†	0.995	2.707	0.211	0.4532	2.20	0.028**
access topriceinfor†	0.454	1.574	0.104	0.3590	1.26	0.206
accesstoloan†	1.512	4.537	0.358	0.4174	3.62	0.000***
disttoveicroad	0.331	3.431	0.077	0.1188	2.79	0.005***
acctoexteserv†	1.233	1.393	0.282	0.3351	3.68	0.000***
distancetoinput market	-0.601	0.548	-0.139	0.1250	-4.81	0.000***
distopromarket	0.370	1.448	0.086	0.1342	2.76	0.006***
_ cons	-2.137	0.118	-0.008	1.1862	-1.80	0.072

Log pseudo Likelihood		= 122.12078
Number Of observation	=	250
Wald chi2(17)	=	52.13
Prob > chi2	=	0.0000
Pseudo R2	=	0.2742

Source: model output based on own survey 2015
**** Significant at 1 percent ** significant at 5 percent * significant at 10 percent*
(†) Dummy variable; marginal effect (dy/dx) is for discrete change of dummy variable from 0 to 1

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