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Determinants of Pepper Market Supply Among Small Holder Farmer in Wenberma District, West Gojjam Zone of Amhara Region, Ethiopia

Gizachew Wosene[1], Mengistu Ketema[2], Alelign Ademe[2]

[1]Agribusiness and Value Chain Management Department, Debre Markos University, Bure Campus, Ethiopia
[2]School of Agricultural Economics, Haramaya University, Dire Dawa, Ethiopia

Email address:
gizachew11wesene@gmail.com (G. Wosene), mengistuket@gmail.com (M. Ketema), alexs2003@yahoo.com (A. Ademe)

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Abstract: Pepper is an important cash crop for its contribution to income generating and employment opportunity to majority of the rural household. However, enhancing pepper producers to reach market chain is a key issue needed in the study area. This study intended to analyze determinants of market supply of pepper among smallholder farmers in Wonberma district of west Gojjam zone of Amhara region. Both primary and secondary source of data were used to collect qualitative and quantitative data. Two stage sampling method were used and data was collected from 130 pepper producers. Multiple linear regression (2SLS) model was used to analyze factors affecting market supply of small holder pepper producers. The result of Two Stage Least Square (2SLS) indicated that market supply of pepper was significantly affected by quantity of pepper produced; pepper farming experience, one year lagged price and family size. Therefore, this study underscores enhancing farmers bargaining power through cooperative; strengthen institutional services and infrastructure development for policy implication.

Keywords: Pepper, Wonberma, Market Supply, 2SLS

1. Introduction

Pepper is the world's most important vegetable next to tomato and by virtue of its versatile use in the modern world, earned a reputation as king of spices [22]. This crop is a vital cash crop for farmers in many developing countries such as Ethiopia, Nigeria, Ghana, India, Pakistan, Bhutan, Indonesia, Cambodia and Thailand [14]. Investment in chilli pepper production is viable enterprise for income generation, poverty alleviation, job creation and improvement of food security to every household [17]. Pepper has various purposes in food, feed and cosmetic industries. For instance, the color and flavor extracted from pepper are used in both food and feed industries like poultry feed, sauces and ginger beer [20]. In addition, it also plays a crucial role in cosmetic production, condiment, food preservation and medical and ornamental purpose in the garden [8].

Currently, Vietnam is by far the world largest producer and exporter of pepper, producing 34 per cent of the world's pepper crop in 2008. Indonesia is in 2nd position in pepper production followed by India, Brazil, China, Malaysia, Srilanka, Thailand and other countries which have recorded less production in pepper [25]. Likewise, the major world exporter of pepper is Vietnam, Indonesia, Brazil, India, Malaysia, Srilank, followed by Thailand, China, Madagascar and other countries.

Green pepper sauce, ground pepper; pepper oil and pepper oleoresins are the major products of pepper. Ethiopia is the one among the few countries producing Paprinka and capsicum oleoresins from red pepper for export purpose and considers as home of many spices [16]. Pepper grows under various environmental and climate condition. Ethiopia has good climatic and soil conditions for growing pepper. The most commonly grown type is the Mareko Fana variety, a pungent long chilli of dark-red appearance (pungency is at least twice as high as required for Western food processors)

[13].

In 2015/16 production year, the total cultivated land and production of pepper at national level were 147,216.20 hectare and 2,696,053 quintals [6]. This means that 18.31qt/ha was harvested. In addition, in 2016/17 production year, Ethiopia's pepper production was 3,298,042.9 quintal harvested on 180,701.46 hectares [7]. In Amhara region, the total cultivated land and productions were 69,020.08 hectare and 1,116,185.52 quintal [7]. Therefore the contribution of the Amhara region for the country production was 35.21%.

Wenberma which is located in North West part of Ethiopia is one of the potential districts in pepper production due to its favorable Agro-ecology in West Gojjam zone. As *Woreda* office of agriculture reported, in 2015/16 production season total production of pepper in Wenberma district was estimated to be 215,280 quintals on 8970 hectares of land while in 2016/17 production season it was about 200,658 quintals on 8143 hectares of land [18].

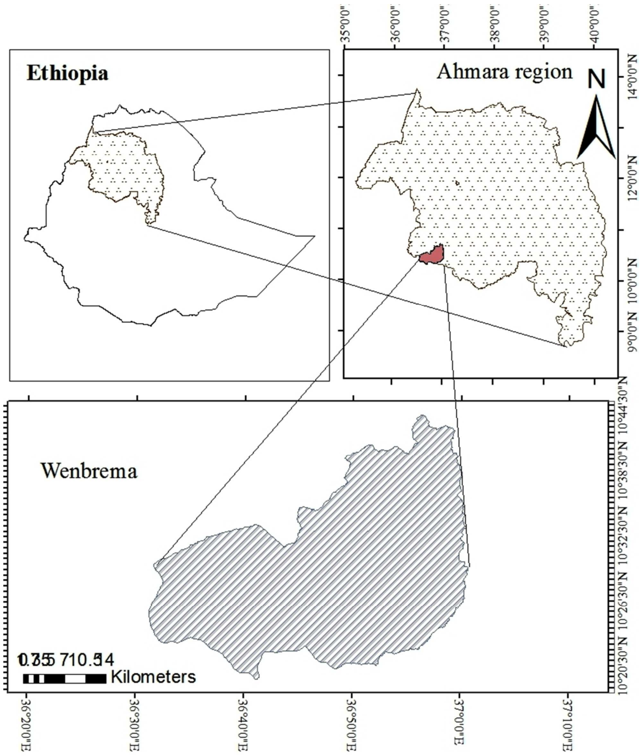
Pepper makes significant contribution to the Ethiopian households and national economy. However, production and marketing of pepper is constrained by different factors. The main constraints that contributed for low productivity of pepper in Ethiopia includes lack of proper and adequate inputs, traditional production methods and lack of research outputs on production techniques [15]. As a result, the variation in market supply to rural and urban market will be expected. Likewise, marketing problem like Storage facilities, transportation, linkages with traders; quality controlling mechanisms, market information and price settings are weak in the region and need to be further investigated [4]. Such constraints are aggravated by underdeveloped infrastructure and weak transport facilities.

Farmers in Ethiopia in general and in Amhara region in particular are affected by low producer's price, on one hand, and high consumer's price, on the other hand [4]. Therefore, to solve production and marketing problems and increase the contribution of pepper to generate additional income for producers and traders it was important to undertake this study. In addition, factor affecting market supply of pepper were not done in Wenberma district. Since there is no research conducted so far to address existing problems in study area, the motivation behind this study was to provide information for intervention that would be useful to pepper producer, traders, GO, NGOs (AGPs), researchers and other stakeholders.

2. Research Methodology

2.1. Description of the Study Area

The study was conducted in Wenberma District, West Gojjam Zone of Amhara region, North West Ethiopia, approximately mid-way between Debremarkos and Bahir Dar. It is located at about 165 km Southwest of Bahir Dar and 426 km from Addis Ababa. Wenberma district is bordered on the South by river Abay which separates it from Oromia Regional State, on the West by Bure district, on the North and Northeast by Ankesha district and on the East by Guanga district.



Source: Wenberma District Office of Agriculture (2017)

Figure 1. *Location of Wenberma District.*

According to Population and Housing Census of Ethiopian Central Statistic Authority projection, the total population of Wenberma District is about 182,212 in which the total male population comprises 91,540 and remaining 90,672 are females [7] with an area of 1356.75 square kilometer. This District has an estimated population density of 134.3 people per square kilometer, which is the Zone average of 174.47 [18].

2.2. Data Type, Sample Size and Sampling Procedure

Both quantitative and qualitative data were collected from primary and secondary data source to deal with objectives. Primary data was collected directly from respondents through structured and semi-structured questionnaire. Focus group discussion, key informants and field observation were also undertaken during primary data collection in the study area. Secondary data were collected from office of agriculture, input suppliers, *Woreda* trade office, survey report, bulletins, annual report, CSA and websites. Both published and unpublished document were comprehensively reviewed to support interpretation of the primary data. Cross sectional data were collected from 130 pepper producing farmers in the study area. A two-stage sampling procedure was applied to select sample respondent. In the first stage, four *kebeles* were selected from 19 potential peppers producing rural *kebeles* randomly. In the second stage, 130 sample respondents were selected randomly from the list of households who produce pepper in the sample *kebeles* and the sample households were drawn randomly from each *kebele* based on probability proportional to size sampling techniques.

2.3. Methods of Data Analysis

Descriptive statistics and econometric analysis were used to analyze the data obtained from sample respondents. Descriptive analysis of data mainly uses frequency, percentage, mean and standard deviations and range. Econometric analysis was used to estimate the causal relationship between the dependent variable and regressors. It is pertinent to understand the effect of different regressors on market supply by smallholder pepper producers.

Multiple linear regression models: was used to analyze the determinants of market supply of pepper by taking in to consideration that all farmers are participated in pepper market. This model was selected for its simplicity and practical applicability [9].

$$Y=B_0+\sum_{i=1}^{n} BiXi + e_i \quad i=1, 2, 3\ldots n \tag{1}$$

Where Yi = marketed supply of pepper (dependent variable)

B_0 = an intercept

B_i = vector of coefficients for i^{th} independent variable

X_i = vector of independent variable and 'i' is 1, 2, 3 …n

e_i = unobserved disturbance term

Test of multicollinearity, heteroscedasticity and endogeneity problems

When some of the assumptions of the classical linear regression (CLR) model are violated, the parameter estimate of the above model may not be best linear unbiased estimators (BLUE). Therefore, it is better to check the presence of multicollinearity, heteroscedasticity and endogeneity problems after model estimation.

The problems of multicollinearity occur when there is a linear correlation among the explanatory variables and become difficult to identify the separate effect of independent variables on the dependent variables [11]. Multicollinearity problem among explanatory variables had been checked using the Variance Inflation Factor (VIF). As a rule of thumb, if the VIF is greater than 10 (this will happen if R^2 is greater than 0.90), the variable is said to be highly collinear. Variance Inflation Factors can be used as a measure of multicollinearity [11], and computed as:

$$VIF(Xj)=\frac{1}{1-Rj2} \tag{2}$$

Where, Rj^2 is the multiple correlation coefficients between *Xj* and other explanatory variables.

Further, test for heteroscedasticity had been undertaken for this study. Even though there are a number of test statistics for detecting heteroscedasticity such as HCCM: robust standard error, Generalized (weighted) least squares (WLS) and Feasible generalized least squares (FGLS); robust standard error method was employed for correcting the problem in this study. It is *Heteroscedasticity consistent covariance matrix" (HCCM)* estimators which corrects standard errors for heteroscedasticity.

Lastly, it is very crucial to test the presence of endogeneity problem in OLS regression model. Endogeneity is most commonly described in the context of ordinary least squares (OLS) estimation, and refers to a situation in which an explanatory variable correlated with the structural error term in the model during population data generating process [23]. In such situation, the error term is not random and the estimation is inconsistent, which implies that the coefficient estimates of the independent variable fail to converge to the true value of the coefficient in the population as sample size increases. Literature emphasizes three primary instances where the condition of exogeniety becomes violated and therefore endogeneity occurs: omission of variables, measurement error in variables and simultaneous causality [23]. Therefore, to address endogeneity issue, instrumental variable techniques are recommended [5] & [21].

The researcher used both Hausman test and Durbin-Wu-Hausman (DWH) test to check the presence of endogeneity problem. In this study, quantity produced of pepper which was included as an explanatory variable was identified as endogenieous variable when OLS is applied. Therefore, 2SLS model was used instead of OLS in order to identify factors determining the market supply of pepper. Two-stage least square is similar to OLS except that uses two completely separate stages during the analysis phase in order to avoid problems of endogeneity [24].

Consider a population model (Structural equation):

$$Y_{i1} = \alpha Y_{i2} + \beta_0 + \beta 1\ X_{i1} + \beta_2\ X_{i2} + \ldots + \beta_k X_{ik} + U \tag{3}$$

Where Y_{i1} is dependent variable which is market supply, Y_{i2} is an endogenous variable which is quantity of pepper produced, X is set of explanatory variables, α β_0, β_1 and β_2 are a vector of parameter to be estimated, and *U* is a vector of disturbance term.

In order to obtain consistent estimators in this case, we need to apply instrumental variables (IV) estimation because instrumental variables are used to cut correlation between the error term and independent variables. To conduct IV estimation, we need to have instrumental variables (instruments in short) which must fulfill two requirements; uncorrelated with U, also called orthogonal to the error process (exogeneity condition i.e. Cov (Z, U) =0) and strongly correlated with Y_2 the endogenous regressors (relevance condition i.e. Cov (Y_2, Z) ≠ 0) once the other independent variables are controlled for [24]. This means Z is a variable directly affecting the endogenous regressors (Y_2) and may not directly be related to the dependent variable Y_{i1}. However, it is very difficult to find proper instruments. To test the second requirements, we need to express a reduced form of equation of Y_2 with all of exogenous variables (both independent variables and instrumental variables).

The reduced form of the structural equation is as follow:

$$Y_2 = \delta_0 Z + \delta_1 + \delta_2 X_2 + \dots + \delta_{K-1} X_{K-1} + U \quad (4)$$

Where, Y_2 is endogenous regressors (quantity of pepper produced); X *is* vector of exogenous variables, Z is a vector of excluded instruments (credit amount and land allocated to pepper production); δ is the coefficients to be estimated; and U is the errors terms, symmetrically distributed around zero. Here, both X and Z are called included and excluded instrument, respectively. For the identification of the above equation, there must be at least as many excluded instruments as there are endogenous regressors. This is called order condition for identifications.

When we have more instrumental variables than endogenous variables, we say the endogenous variables are over-identified. In this case, we need to use "two stage least squares" (2SLS) estimation. In 2SLS regression model, first we have to regress endogenous variable, in this case quantity of pepper production, on all exogenous variables (first-stage regression model) and used in the second stage estimation as independent variables.

Two basic tests in IV estimation include relevancy test and exogeneity (overidentification restriction) test. First, it is necessary to test whether the excluded instrumental variable is weak or not i.e. we need to know the degree of correlation between these instrument and endogenous variables. If the degree of correlation between them is zero, the instrument is said to be irrelevant. In this study, relevance of instrument is tested by comparing the calculated value (minimum eigenvalue) with the critical value in the table of first stage regression of 2SLS. If the calculated value is greater than the critical vale then the instrument is said to be relevant. Test of exogeneity condition of instruments is another important test in IV estimation. It also called overidentification restrictions. Very pertinent to check whether the instruments are correlated to the error term in the structural equation. It can be performed if and only if the number of instruments greater than number of endogenous variable. It can be tested using both Sargan and Basmann $\chi 2$ test. Failure to reject Sargan and Basmann χ^2 means that the instrument can be considered as exogenous. In this study, the instrument are valid (relevant and exogenous) so that the IV estimator is a consistent estimator of the true population parameter (Table A4).

2.4. Hypothesis and Definition of Working Variables

Pepper market supply is continuous dependent variable which represent the actual supply of pepper per year by the producer to the market and it was measured in quintal.

Table 1 indicates the summary of hypothesized independent variables which was used in the econometric analysis.

Table 1. *Description of independent variables used in 2SLS estimation.*

Variables	Measurement	Expected outcome on market supply
Quantity pepper produced	Continuous (in quintal)	Positive
Farming experience	Continuous (in years)	Positive
Market distance	Continuous (in walking hours)	Negative
Lagged year price	Continuous (in Birr/qt)	Positive
Family size	Continuous (in man equivalent)	Positive /negative
Quantity of fertilizer used	Continuous (in quintal)	Positive
year of schooling	Continuous (in grade)	Positive
Sex of the households	Dummy, 1 if male, 0 otherwise	Positive
Market information	Dummy, 1 if yes, 0 otherwise	Positive
Livestock owned	Continuous (in number)	Positive /negative

3. Result and Discussion

3.1. Demographic and Socioeconomic Characteristics of Sampled Respondents

Demographic characteristics of sample households (such as sex, family size, year of schooling, farming experience, livestock owned, distance from FTCs and distance from market) play crucial role in either promoting or impeding market supply of pepper in Wonberma district.

As shown in table 2, out of the total households interviewed, 90% were male headed households and 10 % were female headed households. On average, sampled household's year of schooling were found to be 5 years in the study area. Measure of central tendency is not always a good measure of mean of demographic characteristics of households hence it affected by outliers. So, it does not imply all households are educated. Educational backgrounds of the sampled households are believed to be important features that determine the readiness of household heads to accept new innovations and improve their market participation.

To assess the livestock holding of sample respondents, tropical livestock unit (TLU) per household was calculated (Table A5). The average livestock holding of pepper producers was 9.85 TLU in the study area. It is the farmers' one of sources of income, food and traction power for cultivation of land. Hence, households with larger livestock holding have better access to draft power than those with less. Livestock holding is also one of the main cash sources to purchase agricultural inputs. It means that, the one with large livestock ownership would be able to purchase input for pepper production so as to increase market supply of pepper. The mean farming experience of the total sample respondents was found to be 16.88 years in Wenberma district which implied that sampled households had good experience in the production of pepper. Another important factor which affects pepper market supply was distance to the nearest market. The average distance needed for producers to travel to nearest market place was 1.35 walking hours. The mean family size of the sample households was 5.92 ranging from 3 to 10 (Table 2).

The major village market by which farmers uses to supply pepper were Shindi, Wogedad and Gommer Dond. The average quantity production of pepper per sampled households was 12.47 quintal in Wenberma district.

Table 2. *Characteristics of pepper producers (continuous and dummy variables).*

Variables		Mean	Standard deviation	Minimum	Maximum
Year of Schooling		5.00	2.59	0	12
Farming experience		16.88	6.81	5	35
Livestock owned		9.85	4.20	4	28
Quantity of pepper produced		12.47	6.17	7.20	18
Distance from market		1.35	0.69	0.54	3.84
Quantity of fertilizer used					
	Urea/Qt	0.76	0.42	0	1.75
	DAP/Qt	1.02	0.34	0	1.5
Family size		5.92	1.65	3	10
	Item	Frequency	Percent		
Sex of households					
	Male	117	90.00		
	Female	13	10.00		
Had access to market information					
	Yes	115	88.46		
	No	15	11.54		

Source: Own computation from survey result, 2017.

Modern agricultural input like inorganic fertilizer was also used by majority of sampled households. Fertilizer application is one of the most important agricultural practices that are used by pepper producers. To obtain the required production and market supply, proper application of recommended fertilizer rate is pertinent. Regarding the amount of fertilizer applied, on average farmers applied 1.02 quintal of DAP which is near to the recommended rate (100 kg DAP per hectare) and 0.76 quintal of Urea per hectare which is below the recommended rate (100 kg Urea per hectare). The average use of DAP and UREA in [4]was 0.45 quintal and 0.34 quintal in Bure district which was below the recommended rate. The average use of DAP and Urea in Wenberma district is greater than Bure district. This is because the extension education on application of fertilizer in Wenberma district was better as compared to Bure district even though the application of Urea was below the recommended rate. Therefore, there is a need to strengthen an extension education on the application of recommended rate of Urea so as to increase the market supply of pepper.

Up-to-date market information is one of the institutional service which enable farmers to make good market decision on production and marketing of pepper. It enables farmers to negotiate with traders on prices, quality and quantity required. Access to reliable market information on the prevailing market condition would help farmers to sale their surplus of pepper. The survey result reveals that 88.46 % of the sampled households had access to market information from different sources and only 11.54% of sampled households had no access to market information. The type of market information provided were price and buyer information (25.22%), market place information (21.74%), input and output price information (18.26%), post-harvest handling information (18.26%) and demand information and other combination of those (16.52%). The sampled households suggested that the major source of information were radio and DAs (40%), friends and neighbors (32.17%) and district and *kebeles* administration (27.83%) (Table A2).

3.2. Factors Affecting Market Supply of Pepper

Analysis of factors affecting market supply of pepper was found to be important to identify factors constraining pepper supplied to market. For the analysis, two stages least square (2SLS) method was applied. The proposed explanatory variables were checked for the existence of some econometric problems like multicollinearity, heteroscedasticity and endogeneity problems.

Multicollinearity test: Multicollinearity is a situation where explanatory variables are highly correlated each other. The existence of multicollinearity among the explanatory variables was checked by using VIF. The results indicated that there was no serious problem of multicollinearity because the result of VIF is less than 5 for all variables (Table A1).

Heteroscedasticity test: The problem of heteroscedasticity is always common and expected when analyzing cross-sectional data [10]. Presence of heteroscedasticity problem has been checked using Breusch-Pagan / Cook-Weisberg test. The Breusch-Pagan test indicate that, the researcher was failing to reject the null hypothesis of constant variance at P-value = 0.07. This implied that, there was heteroscedasticity problem in the data set. Therefore, the parameter estimates of the coefficients of the independent variables cannot be BLUE. To overcome the problem IV estimator with robust standard error and GMM need to be used. However, GMM estimator is more efficient than the simple IV estimator with robust standard error whenever heteroscedasticity is happened. Nevertheless, the use of GMM does come with a price. The problem, is that the optimal weighting matrix Sˆ at the core of efficient GMM is a function of fourth moments and obtaining reasonable estimates of fourth moments may require very large sample sizes [12]. To overcome the problem, IV estimate with robust standard error was estimated.

Endogeneity test: When a variable is endogenous, it will be correlated with the disturbance term, hence violating the OLS assumptions and making our OLS estimate biased. Endogeneity is a problem in case our explanatory variables are correlated to the error term and we can solve this problem with the help of including instrumental variables. So, if we get endogeneity problem in the model, running OLS is not a better choice. In this case we prefer 2SLS which is an econometric technique and a good choice in case of endogeneity problem [23].

Testing for endogeneity of quantity production of pepper were carried out in the model using both Durbin-Wu-Hausman (DWH) and Hausman test and endogeneity problem was found in quantity production variable in pepper. Hausman test result indicated that, the predicted quantity production was statistically significant ($p = 0.02$) when included as additional explanatory variable in structural model which implies hypothesized quantity production variable is endogenous due to the fact that it is correlated with error term. Durbin Wu-Hausman test results also shows that the null hypothesis of exogeniety of the quantity production of pepper rejected at 5% probability level ($\chi 2 = 5.4$ and P-value = 0.02) using estat endogenous STATA command after ivregress. Therefore, two stages least square (2SLS) method was used to address the endogeneity problem.

2SLS is appropriate if we have valid instrumental variables which must fulfill two requirements; uncorrelated with error term (U) (i.e. Cov (Z, U) =0) and strongly correlated with the endogenous regressors (Y_2) once the other independent variables are controlled for [24]. Land allocated to pepper and amount of credit taken for pepper production were used as instruments for quantity production. Therefore, for this study relevance tests of excluded variables were made using F statistic from the first stage regression using estat first-stage STATA command. The F test result and minimum eigenvalue statistic for quantity production of pepper was "32.56" and 52, respectively which is greatly exceed the critical values (Table A4). So we should reject the null hypothesis presence of weak instruments. Over identifying restrictions test was also tested using Sargan test and Basmann test using estat overid command to test the correlation between instrumental variables and error term. The results of Sargan and Basmann test show a P-value of 0.31 and 0.34, respectively, which indicated the model is correctly specified and the instruments are valid.

Two stages least square (2SLS) method was used to identify factors affecting market supply of pepper to the market. In the first stage, quantity of pepper produced was regressed over eleven independent variables including instrumental variables. The result shows that, experience in pepper production, year of schooling, land allocated to pepper production and credit taken affected positively and significantly quantity of pepper produced). On contrary, distance from the nearest market influence pepper production negatively and significantly (Table A3). The predicted value of quantity of pepper produced was saved to be used as independent variable in the second stage of 2SLS method.

In the second stage of 2SLS method, quantity of pepper supplied to the market was regressed over predicted value of quantity of pepper produced and hypothesized independent variables excluding instrumental variables. The result shows that four variables namely, quantity of pepper produced, farming experience, one year lagged price and family size influence market supply of pepper positively and significantly

Table 3. *Determinants of pepper quantity supplied to the market (2SLS estimate).*

Variables	Coefficients	Robust standard errors	Z
Quantity produced	0.835***	0.293	2.85
Farming experience	0.087**	0.044	1.98
Market distance	0.139	0.220	0.63
Sex	-0.518	0.527	-0.98
Market information	1.227	0.807	1.52
Lagged price	0.037***	0.012	3.08
year of schooling	0.136	0.108	1.26
Total livestock owned	-0.077	0.071	-1.08
Family size	0.294*	0.172	1.71
Fertilizer applied	0.327	0.203	1.61
Frequency of extension contact	0.021	0.423	0.049
Constant	-12.093	2.404	-5.03
Number of observation		130	
Wald chi2(10)		314	
Prob>chi2		0.00	
R-squared		0.70	

Source: Own computation from survey result, 2017

Note: ***, ** and * show the values statistically significant at 1%, 5% and 10% significance level, respectively.

As depicted in Table 3 the model was statistically significant at 1% probability level indicating the goodness of fit of the model to explain the relationships of the hypothesized variables. Coefficient of multiple determinations (R^2) was used to check goodness of fit for the regression model. Hence, R^2 indicates that 70 percent of the variation in the quantity of pepper supplied to market was explained by the variables included in the model. The explanation on the effect of the significant explanatory variables is discussed below.

Quantity produced: As hypothesized, the regression coefficient of quantity produced was positively and significantly related with pepper quantity supplied to market at 1% significance level. The positive and significant relationships between the two variables indicate that the quantity produced was very important variable affecting the household heads volume of pepper supply. The coefficient for the quantity produced of pepper implies that an increase in quantity produced of pepper by one quintal resulted in an increase in farm level market supply of pepper by 0.8 quintals, keeping other factors constant. This is in line with a study by [4] and [19] who found that the quantity produced influenced the amount of market supply of pepper positively. The finding also agreed with the case that quantity produced significantly affected potato, cabbage and tomato quantity supplied to the market [2].

Farming experience: Farming experience of the household significantly and positively affected market supply of pepper at 1% significant level. At ceteris paribus, the result implies that as the farmers' experience increased by one year the pepper supplied to market increased by 0.087 quintals. The implication is that the one with more experience in pepper production leads to increase market supply of pepper. This is in line with the findings by [4], [3] and [2] who revealed that as farmer experience increased the market supply of red pepper, onion and potato to the market increased, respectively.

Lagged year price: This variable was found to be positive and statistically significant influence on quantity supply of pepper to the market at 1% significant level. This relationship indicates that when one year lagged price increased in one Birr per kilogram, the market supply of pepper increased by 0.037 quintal. Similar study by [4] found that lagged market price of pepper positively and significantly affected quantity supply of red pepper. The finding also agreed that lagged price affected positively market participation of tomato in *Fogera* district of Amhara region [1]. This may be because prices stimulate production, and thus market surplus.

Family size: previously it was hypothesized that family size affect market supply of pepper either positively or negatively. However, the model result shows a contrary to the hypothesis that family size has a positive impact on market supply of pepper and it was significant at 10% significant level. As pepper production is labor intensive activities, pepper production in general and market supply of pepper in particular is a function of labor. Accordingly, household with more family member tend to have more labor which in turn increase pepper production thereby making them more willing to participate in marketing. On the other hand, because of the nature of the commodity that only small proportion of it is consumed at home and the remaining large proportion of it is supplied to the market. The positive and significant relationship indicates that households with a greater number of family members supply more amount of pepper to the market than those households with relatively a smaller number of family members. The coefficient confirms that when the family size increases by one unit, the market supply of pepper increased by about 0.3 units.

4. Conclusions and Recommendation

The aim of this study was to identify determinants of quantity of pepper supply to the market among small holder farmers in Wonberma district. The data were generated from both primary and secondary sources. The primary data were collected through personal interviews form a total of 130 respondents using structured and semi-structured questionnaires. Qualitative data were also collected through focus group discussions, key informants' interviews and field observations. Both published and unpublished document were comprehensively reviewed to support interpretation of the primary data. Secondary data were collected from office of agriculture, input suppliers, *Woreda* trade office, survey report, bulletins, annual report, CSA and websites.

Descriptive statistical tool like mean, standard deviation, range and percentage were used to characterized the sample households. Two stage least square regression (2SLS) estimator was adopted to understand the determinants of pepper supply to market. Econometric result of the two stage least (2SLS) regression model indicated that quantity produced of pepper, farming experience, one year lagged price and family size significantly determined the quantity of pepper supplied to market.

Therefore, the study recommended that those significant explanatory variables need to be promoted to boost the amount of pepper market supply except family size. In order to increase the productivities of pepper, there is a need of public, private, research center and farmers themselves working together so as to increase access to improved and disease resistance seed variety. There is a need to build the capacity of producer to increase their knowledge and technical skill trough extension education in order to increase delivery of pepper produce to the market. Even though, lagged price is used as a signal in agricultural marketing, the extension education needs also build the capacity of the producers to predict the future market demand based on the current price movement through training. Relying on the past year price and deciding to produce pepper might not guarantee the producer to become profitable.

Appendix

Table A1. *Test of multicollinearity of explanatory variables*

Variables	VIF	1/VIF
Quantity produced	2.20	0.45
Fertilizer	1.70	0.59
Market distance	1.30	0.77
Farming experience	1.24	0.80
Year of schooling	1.21	0.82
Family size	1.21	0.83
Livestock owned	1.17	0.86
One year lagged price	1.11	0.90
Market information	1.07	0.93
Sex	1.07	0.94
Mean VIF	1.33	

Source: Own computation from survey result, 2017

Table A2. *Type and source of information sampled households provided during survey year.*

Variables	Items	Frequency	Percent
Type of information			
	Price and buyer information	29	25.22
	Market place information	25	21.74
	Input and output price info	21	18.26
	Postharvest handling info	21	18.26
	Demand and other combination info	19	16.52
Source of information			
	Radio and Das	46	40
	District and *kebele* administration	37	32.17
	Friends and neighbors	32	27.83

Source: Own computation from survey result, 2017

Table A3. *Factor affecting production of pepper.*

Variables	Coefficients	Robust Standard error	t-value
Farming experience	.200**	.092	2.17
Market distance	-.753*	.392	-1.92
Sex	.374	.966	0.39
Market information	2.026	1.315	1.54
One year lagged price	-.032	.026	-1.23
Year schooling	.423**	.173	2.45
Livestock owned	.063	.126	0.50
Family size	.030	.359	0.08
Amount of fertilizer applied	.796	.512	1.56
Land allocated to pepper production	3.487**	1.751	1.99
Credit amount	1.396***	.202	6.92
Constant	-5.488	4.107	-1.34

Source: Own computation from survey result, 2017

Table A4. *First-stage regression summary statistics, endogeneity and over identification test for pepper production.*

		Adjusted	Partial	Robust	
Variable	R-sq	R-sq	R-sq	F (2,118)	Prob > F
Quantity produced	0.7584	0.7359	0.4685	32.5556	0.0000

Minimum eigenvalue statistic = 52.0132
Critical Values # of endogenous regressors: 1
Ho: Instruments are weak # of excluded instruments: 2

	5%	10%	20%	30%
2SLS relative bias	(not available)			
	10%	15%	20%	25%
2SLS Size of nominal 5% Wald test	19.93	11.59	8.75	7.25
LIML Size of nominal 5% Wald test	8.68	5.33	4.42	3.92
Test of endogeneity for pepper produced	Test of over identification restriction			
(Ho: variables are exogenous)				
Durbin (score) chi2 (1) = 5.65839 (p = 0.0174)	Sargan chi2 (1) = 1.01371 (p = 0.3140)			
Wu-Hausman F (1,104) = 5.3698 (p = 0.0222)	Basmann chi2(1) =.916852 (p = 0.3383)			

Source: Own computation from survey result, 2017

Table A5. *Conversion factor used to compute tropical livestock unit.*

Animal type	Conversion factor
Calf	0.25
Weaned calf	0.34
Heifer	0.75
Cow and Oxen	1.00
Horse	1.10
Donkey (adult)	0.70
Donkey (young)	0.35
Camel	1.25
Sheep and goat (adult)	0.13
Sheep and goat (young)	0.06
Chicken	0.01

Source: Storck *et al*., 1991

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