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Determinants of vegetables market supply in case of Habru district, North Wollo Zone, Ethiopia

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Abstract

The development of vegetable subsector in Habru district faces various marketing problems to supply their produce to the market. Therefore, this study was aimed to identify the determinants of vegetables market supply in Habru district. Data for the study were collected from primary and secondary sources. Primary data were collected from a randomly selected 147 vegetable producer households. Descriptive statistics and multiple regression econometric methods were used for identifying determinants of vegetable market supply. The test for assumptions of the classical linear regression model showed endogeneity in market supply analysis and hetero skedasticity problem in tomato supply analysis. Two-stage least squares result showed that quantity produced, farming experience and extension contact significantly and positively affected the quantity of onion supplied to the market whereas the age of the household head significantly and negatively affected it. Robust multiple linear regression results showed that quantity produced, education level, family size and extension contact positively and significantly affected the quantity of tomato supplied to the market whereas distance to the market affected it negatively and significantly. The study recommends the need to boost production and provision of market-oriented extension, support technological advancement in production and marketing, enhance farmers experience and education status.

Keywords: Habru district, Market Supply, Multiple Linear Regression, Vegetable

1. INTRODUCTION

Ethiopia is one of the countries in Africa, which has huge potential for the development of different varieties of horticultural crops (EHDA, 2012). Horticulture creates in excess of 180 thousand of employment opportunities, out of which 85% are for women. Nationally, over 130 foreign investors are operating in Ethiopia's horticulture sector, exporting to Netherland, Germany, Saudi Arabia, Norway, Belgium, France, Japan, Italy, and United States, among others.The volume of vegetables and fruits exported was 166 thousand tons (EHPEA, 2013).

Fruit and vegetable production covered about 0.13% and 3.29% of the total area coveredby cereal crops in Amhara region, respectively. The regions' total production of vegetables in 2016/17 *meher*season was

7,003,925Qt produced by 3,417,357 private smallholder farmers on 115,011 hectares of cultivated land. The production of vegetables including root crops in North Wollo zone for the 2016/17*meher* season was 315,719.88Qtwhich produced by234,435 smallholder farmers in 3,787.74 hectares (CSA, 2017).Habru district naturally endowed for vegetable production due to its favorable agroecology and availability of irrigation water. It is mainly for commercial vegetable production in two rounds per year. Even though the district has high potential in vegetable production and its economic role is huge, farmers are unlikely to extract the opportunity due to lack of market linkage, the nature of products and production(OHWARD, 2017).

Vegetables are an integral part of the farming system, which plays a crucial role in the economy of Ethiopia. Vegetable production is increasing due to increased area allocation as well as increased yield per unit area. However, the perishable nature of vegetables aggravated the poor vegetable market performance in Ethiopia (Bezabih *et al*., 2014).The study conducted by Mohammed and Afework (2016) identified the major factors affecting post-harvest loss and quality deterioration of horticultural crops in Dire Dawa region arepoor postharvest handling, distance to the market, low price, poor transportation and conditions of the road.

Vegetable production is a source of income and home consumption for a large proportion of rural households in the district. However, the perishable nature of product, low price and intermediary malpractices, lack of market linkage, price volatility, unidentified market behavior and character altogether impede the potential gains that could have been attained from the existing opportunities in the district (OHWARD, 2016).Mengesha (2015) conducted a study on marketing system analysis of vegetables and fruits in North Wollo zone, the author taken sample respondents jointly supply fruits and vegetables, which ignored only vegetable producers.Therefore, this study attempted to fill the existing research and information gaps by identifying the determinants of vegetable market supply in Habru district.

The objectives of the study wereto identify the determinants of onion and tomato supplied to the market by farm households in the study area.

2. RESEARCH METHODOLOGY

2.1.Description of the Study Area

The study was conducted in Habru district, which is located in North Wollo Administrative zone, Amhara National Regional State of Ethiopia. The district is bordered in the south by the Mille River, which separatesNorth Wollo from the South Wollo zone, on the west by Gubalafto Woreda, on the north by theAlawuha river, which separates Habru from Kobo Woreda and on the east by the Afarregion. The district has 36 rural kebeles and 3 sub-urban kebele administrations, with a totalarea of 1,239.79 km^2 (1, 23979 ha). The town Mersa is the center of the district, which is 491km Northeast of Addis Ababa and 30 km south of Woldia, capital of North Wollo zone (OHWARD, 2016).

According to SARC (2015),the mean annual maximumand minimum temperatures of the district is 28.5 °C and 15 °C,respectively. It has a latitude and longitude of 11°40′N 39°39.5′E/ 11.667°N 39.6583°E, with an elevation of 1600 meters above sea level. The pattern of rainfall is erratic with an annual average of 300mm but sometimes it ranges from 600-1200 mm. The main rainy season (summer) lasts from June to September, while the short rainy season (spring) is between January and April.

According to CSA (2013) population projection, in 2016/17 the district has a total projected population of 235,347, an increase of 22.1% over the 2007 census, of whom 118,088 are men and 117,259 women. The projected total urban residence was 37,659,

which is 16% of the population in the district and an increase of 74.34% of urban population over the 2007 population census (CSA, 2007; CSA, 2013).

The dominant crops produced in the district are sorghum, barley, wheat, and maize, which are the main food crops produced under rain-fed farming. The rain-fed production system is most dominant and is being practiced by the majority of the farmers. Moreover, fruit and vegetable crops are often produced using irrigation and ground water-based drip irrigation scheme has boosted the production of onion andtomato in the district.Major types of vegetable crops grown in the district include onion, tomato, cabbage, watermelon, beetroot, and some leafy vegetables.(OHWARD, 2016).

2.2.*Types, Sources, and Methods of Data Collection*

In this study, both qualitative and quantitative cross-sectional data were collected from primary and secondary sources. Primary data were collected by using pre-testedsemi-structured questionnaires designed for sample producers. Secondary data were collected from different published and unpublished sources, such as Habru District Irrigation and Development Office, CSA, OHWARD, SARC, published and unpublished reports, and bulletins.

2.3.Sampling Procedure and Sample Size

A multi-stage random sampling method was used to select vegetableproducing kebeles and sample farm households. In thefirst stage, from 36 rural kebeles in the district 10 majorvegetables (onion and/or tomato) producing kebeleswere purposively selected. In thesecond stage, four kebeleswere selected randomly from 10 onion and/or tomato producing kebeles.Finally, from the randomly selected kebeles, 147 sample households wereselected randomly using a formula developed by Yamane (1967).

Accordingly, out of 2,312 onion and/or tomato producers in randomly selected kebeles of the district 147 sample producers were determined using simple random sampling method at 95% confidence level with degree of variability of 5% and level of precision equal to 8%.

Table 1. Sample kebeles and vegetables (onion and/or tomato) producers

No	Name of kebelles	Population size	Sample size
1	Girana	960	61
2	Gorarba	750	48
3	Woldia-kurkura	292	18
4	Libso	310	20
Total		2,312	147

Source:Agricultural offices of Habru Woreda and own design (2017)

2.4.Methods of Data Analysis

Both descriptive statistics and econometric models were employed for analyzing the data obtained from producers and traders sample respondents.

The econometric analysis used to estimate the causal relationship between the dependent variable and the explanatory variables. Multiple linear regression was used to analyze the determinants of

vegetables supplied to the market as all sample households supply these vegetables to the market. For the parameter estimates to be efficient, unbiased and consistent assumptions of CLR model should hold true. Hence, multi collinearity, hetero scedasticity, model specification, and endogeneity detection test performed using appropriate test statistics. Test for hetero scedasticity for tomato supply result showed the existence of hetero scedasticity and robust regression was used as a remedial.

Greene (2012) specifies multiple regression model as follows.

$$Y_i = X_i'\beta + \varepsilon_i \quad (6)$$

Where: Y_i = Quantity of tomato supplied to the market

β = Vector of estimated coefficients of the explanatory variables

X_i= Vector of explanatory variables

ε_i= disturbance term

The existence of endogeneity problem in onion supply was resolved by using 2SLS method (Wooldridge, 2016). Quantity produced is suspected to be an endogenous variable as it is simultaneously determined with quantity supplied. A valid instrumental variable ((amount of fertilizer used for onion and improved seed)for quantity produced satisfy two conditions that instruments are relevance and exogeneous.

2.5.Definition of Variables and Working Hypothesis

Dependent Variables

Quantity supplied to market (Qtsold): A continuous variable that represents the actual quantity of onion ortomato supplied by individual farm households to the market during the survey year, measured in quintals (100kg).

Independent Variables

Age of the household head (age): It is a continuous variable measured in years. According to Alemayehu *et al.* (2016),the age of household heads positively affected the amount of onion sold. Aged households are believed to be wise in resource use; on the other hand, young households are active for labor work. Therefore, this variable was expected either to have a negative or positive effect on the quantity of vegetable supply.

Family size (famsz): This is a continuous variable, which refers to the total number of family members in the household measured by man equivalent. Meron (2015) found that family size significantly and positively influences the extent of market participation. Since, vegetable production and marketing is labor-intensive activity the more family members tend to have more labor, which in turn increases vegetable production and market supply.

Distance to the nearest market (dstmkt): It is a continuous variable measured in kilometers that producers travel to sell their product to the nearest market. Melkamu *et al*. (2017) and Almaz (2013) revealed that distance from the nearest market negatively related to potato market supply. Hence, distance to the market expected to influence vegetable market supply negatively due to increase substantial product loss and cost.

Farming experience (exper): Vegetable farming experience is a continuous independent variable measured in the number of years a household has been engaged in vegetable production and marketing. Addisu (2016) and Abraham (2013) revealed that vegetable farming experience of the household has a significant and positive effect on the quantity of onion and potato supplied respectively. Therefore, this variable was hypothesized to positively affect vegetable market supply.

Sex of the household head (sex):A dummy variable that takes a value of one if the household head is male and zero otherwise. Almaz (2013) and Mahlet *et al*. (2015) found that sex of the household heads positively and significantly influences potato marketed supply. Female-headed households might have family burdens than males that decrease production thereby the supply of vegetables to the market. Therefore, sex of the household head was hypothesized to have a positive influence on vegetable market supply.

Quantity produced (Qtprod): It is a continuous variable measured in quintals per year and expected to influence market supply positively. Abraham (2013)result indicated that quantity produced positively affects potato, cabbage and tomato quantity supplied to the market. The perishable nature of vegetable product enforce producers to supply the amount leftover from consumption. Hence, this variable hypothesized to influence the quantity of vegetable supply to the market positively.

Frequency of extension contacts (extcon): It is a continuous variable, which refers to the frequency of contacts that producers have with an extension agent per month. Frequent extension contact provides important information that helps to increase vegetable market supply. Ayelech(2011) found access to extension increase fruits supplied to the market. Therefore, this variable was hypothesized to influence the quantity of vegetables supplied to the market.

Education level of household head (edu)*:*It is a continuous variable measured in years of formal schooling of the household head attended. Yimer (2015) showed that education has s positive effect on quantity offruit supplied to market. Education increases farmers' ability to get and use information. Therefore, this variable was hypothesized to affectthe quantity of vegetables supplied positively.

Land cultivated for vegetable (lancult): It is a continuous variable measured by the total area of land cultivated for vegetable production in hectares. Melkamu*etal*. (2017) indicated that land size allocated for potato productionsignificantly affected potato marketed surplus. The more cultivated area for vegetables increases the quantity of vegetables produced and supplied to the market.Therefore, it is hypothesized that land cultivated for vegetables to affect its supply to the market.

Non/off-farm income (noffarm): It is a dummy variable measured in terms of whether the household obtained income from off and non-farming activities. It is 1 if the household is involved in non/off-farm activities and 0 otherwise. Abraham (2013) and Addisu (2016) showed that non-farm income has a significant and positive influence on the volume of cabbage and potato supplied respectively.The participation of producers in off and non-farm income expected to expand and intensify the production and supply of vegetables to the market.

3. RESULTS AND DISCUSSION

This section presents the results and discussion of descriptive and econometric analyses.

3.1.Characteristics of Sample Households

From a total of 147 sample households, the number of households producing both onion and tomato were 95 and the remaining 32 households produce onion only while 20 households produced tomato only in the survey year. The total number of sample onion producers were 127 and the number of sample tomato producers were 115 households.

The sex composition of the sample household heads showed that 81.1% of onion and 76.5% of tomato producers were male-headed households. Female-headed households, accounting 18.9% and 23.5% of onion and tomato producers respectively, have limited participation in vegetable farming, as they were busy home chores and child care. About 78% onion and 79% tomato sample producer households were married which indicates that married householdsactively participate in vegetable cultivation to generate more income and meet family food requirements more than single households who do not have family-caring burdens.

Farming remains to be a dominant economic activity and source of livelihood for households in the study area with 54% of the sample households rely on only on-farm activities. Non/off-farm income such as income from animal, fruits and vegetable trading, petty trade, free aid from government safety net program, and remittance from abroad in the district managed by 46% of the sample households in addition to farming during the survey year.

Table 2. Demographic and socioeconomic characteristics of respondents (categorical variables)

Variable	Category	Onion		Tomato	
		Frequency	Percent	Frequency	Percent
Sex	Male	103	81.1	88	76.5
	Female	24	18.9	27	23.5
Marital status	Single	6	4.73	6	5.22
	Married	99	77.95	91	79.13
	Divorced	7	5.51	4	3.48
	Windowed	15	11.81	14	12.17
Off/non-farm income	Yes	58	45.67	53	46
	No	69	54.33	62	54

Source: Survey result (2017)

Table 3. Demographic and socio-economic characteristics of respondents (continuous variable)

Variable	Onion (N= 127)				Tomato (N=115)			
	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max
Age	43.67	8.641	26	63	42.62	8.449	26	63
Education	2.12	1.753	0	7	2.14	1.825	0	7
Family size	2.29	0.241	1.8	2.8	2.28	0.237	1.8	2.8
Experience	9.22	2.514	4	15	7.54	2.189	4	11

Source: Survey result (2017)

Table 4. Land ownership and allocation of sample producers in 2016/17 production year (ha)

Description	Mean	Std. Dev.	Minimum	Maximum
Total land owned	0.81	0.32	0.25	1.625
Onion cultivated land	0.32	0.081	0.125	0.5
Tomato cultivated land	0.12	0.052	0.0625	0.25

Source: Survey result (2017)

The survey result showed the age of onion sample producers were on average 43 years old, while sample tomato producer were 42 years old ranged from 26 to 63 years. Education level of the sample respondents in years of schooling ranged from zero to 7 years with mean schooling of 2 years. The survey results further indicated about 26% of the respondents did not attend any formal education. The result revealed that family size in man equivalent ranged from a minimum of 1.8 to a maximum of 2.8, with average family size of 2.28 man-equivalent. The sampled respondents have an average experience of 9 and 7 years in onion and tomato farming, respectively. The survey indicated that onion and tomato producers have a minimum of 4 years of farming experience and a maximum of 15 and 11 years experience in onion and tomato farming, respectively.

The survey results indicate that the size of sample respondents farmland ranged from 0.25 to 1.625 hectares with a mean land size of 0.81 hectares (Table 7). In 2016/17 production year, the maximum size of land cultivated by onion and tomato producers were 0.5 and 0.25 hectares, respectively. The result also showed that the average cultivated land for onion and tomato were 0.32 and 0.12 hectares, respectively.

3.2 Econometric Model Results

Two-stage least square is a poor strategy for estimation and hypothesis testing when instruments are weak and the model is over-identified. If the F-test statistic value is sufficiently large than the F>10 rule of thumb, we reject the hypothesis that the instruments are weak and can proceed with instrumental variables estimation (Hill *et al*., 2011). The F-test statistic result to detect instrument strength for the quantity of onion produced was "46.9". Amount of fertilizer applied for onion production and improved seed were used as instruments for onion quantity produced. The 2SLS results showed that quantity produced, age of household head, onion farming experience and frequency of extension contact) significantly influenced volume of onion supplied to the market. The coefficient of multiple determinations R^2 indicates 89.55% of the variation in onion market supply is explained by the explanatory variables included in the model.

Robust regression results found that five variables (quantity produced, education level, family size, distance to the nearest market and extension contact) significantly determine the quantity of tomato supplied to the market. The result shows that the model was statistically significant at 1% level of significance indicating the goodness of fit of the model to explain the relationships of the hypothesized variables. The coefficient of determination R^2 shows the explanatory variables included in the model explained 90.96% of the variation in the quantity of tomato supplied to the market.

Quantity produced (Qtprod): As hypothesized, the result shows that quantity

produced significantly affected onion and tomato quantity supplied to the market at 1% significance level. The result also implied that a unit increase in the quantity of onion and tomato produced has increase 0.93Qt and 0.82Qt of onion and tomato supply respectively, keeping all other factors constant. The increase in the volume of onion and tomato produced the more likely that farmer's supply to the market due to the reason that products are perishable and have to be supplied to the market in a short period after it has harvested. The result is in line with Almaz (2013) who found that quantity produced positively affected marketed surplus of potato and leafy vegetables. Furthermore, the result of Olowa and Olowa (2017) findings showed that quantity produced positively related to marketed supply of fruit and vegetable.

Table 5. Determinants of onion and tomato supplied to the market

	Onion		Tomato	
Variable	Coefficient	Std. Err.	Coefficient	Robust Std. Err.
Quantity produced	0.93***	0.063	0.82***	0.043
Age	-0.04**	0.018	-0.01	0.014
Education	-0.05	0.101	0.13**	0.063
Sex	0.22	0.374	0.17	0.292
Family size	-0.19	0.601	1.28***	0.462
Farming experience	0.12*	0.062	-0.03	0.054
Land cultivated	-2.41	3.192	-1.41	3.981
Distance to market	0.02	0.027	-0.05***	0.020
Frequency of extension contact	0.27**	0.126	0.19*	0.103
Off/non-farm income	0.03	0.294	0.14	0.225
Constant	0.20	1.675	-1.90	1.217
N		127	N	115
Wald chi2(10)		952.96	F(10, 104)	129.30
Prob > chi2		0.0000***	Prob > F	0.0000***
R-squared		0.8955	R-squared	0.9096

Note: The dependent variable is the quantity of onion and tomato supplied to the market in quintal in 2016/17.

***, ** and * are significant at 1%, 5% and 10% level of probability, respectively.

Source: Survey result (2017)

Age of household head (age): The result of 2SLS regression output showed that the age of household heads negatively affect the quantity of onion supplied to the market at 5% significant level. This implied that one additional year increase in the age of household head decrease the quantity of onion supplied by 0.04Qt, keeping all other factors constant. The possible reason might be due to young household heads are more productive in labor work and active for new information and technology, which enables them to produce thereby supply more than older households. This result is in line with

the Adugna (2009) findings that age of household heads negatively affect onion market supply due to older households may be tradition-bound and reluctant to take up new technologies.

Education level of household head (edu): Education level of household head spositively affected the quantity of tomato supplied to the market at 5% significance level. The result indicated that one additional year schooling of household head increases the quantity of tomato market supply by 0.13Qt, keeping all other factors constant. Education allow the use of new production techniques, technology and market information, which in turn increased tomato supply. This result is congruent with Yimer (2015) who found that education level of household head positively affected fruit market supply. Furthermore, Habtamu (2015) and Yeshitila (2012) found that education increases the quantity of potato supplied to the market.

Family size (famsz): The result showed that family size in man equivalent positively and significantly affected quantity of tomato supplied at 1% significance level. This result implied that an additional unit increase in family size leads to 1.28Qt increase tomato market supply, keeping all other factors constant. This might be as family size increases, more labor utilized for tomato production and hence increase the supply of more product to the market. This is in line with Nega*et al*. (2015) who found that active family labor increases the amount of banana supplied to the market.

Farming experience (exper): The result showed that onion farming experience of household shead positively affects the quantity of onion supplied to the market at 10% significance level. Thus, the result implied that a year increase in farming experience increases the quantity of onion supplied to the market by 0.12Qt, keeping all other factors constant. This means that farmers with more experience in onion production and marketing have the ability to supply more to the market because they have more marketing networks and information. This is in line with Abraham (2013) and Toyiba *et al.* (2014) who illustrated that farming experience positively affected the quantity of potato and papaya market supply, respectively. Furthermore, Addisu (2016) also found that vegetable farming experience of households has a positive effect on the quantity of onion supplied to the market.

Distance to the nearest market (dstmkt): As hypothesized, it affected tomato market supply negatively and significantly at 1% significance level. The result shows that one kilometer increased in distance of households from the nearest market decrease the quantity of tomato supply by 0.05Qt, keeping all other factors constant. This is due to the reason that the longer distance of households from the market increases spoilage and the transaction costs of tomato marketing, which decreases the quantity of tomato supplied to the market. This is in line with the result of Mebrat (2014) who found that distance to market had a significant negative effect on tomato marketed surplus. Olowa and Olowa (2017) found thatas the distance from the production area to market place decrease the quantity of fruit and vegetable supplied to the market. This might be due to the nature of the product (perishability) and costs associated with transportation and handling.

Frequency of extension contact (extcon): Frequency of extension contact affected onion and tomato market supply positively and significantly at 5% and 10% significance level, respectively. The result indicated that an additional unit increase in the frequency of extension contact increases

the quantity of onion and tomato supplied by 0.27Qt and 0.19Qt respectively, keeping all other factors constant. This might be due to frequent extension contact help farmers to have up to date information, awareness and skill on new technologies, which thereby improve production, productivity and then the supply of onion and tomato to the market. This is consistent with the result of Amare (2013) who revealed that access to extension service positively affected the volume of pepper sold to the market as extension service enable households to intensify the production level and eventually the amount of pepper marketed.

4. CONCLUSION AND RECOMMENDATIONS

4.1. Conclusion

Horticultural crops in Ethiopia play a significant role in improving the income and nutrition status of the country in general and a source of income for a large proportion of rural households in Habru district in particular. Habru district is one of naturally endowed area for vegetable production mainly onion, tomato, cabbage, watermelon, beetroot and some leafy vegetables due to its favorable agro-ecology and availability of irrigation water. However, the development of the subsector faces various marketing challenges in the district. Hence, this study analyzed the determinants of vegetable market supply. To meet the objective of the study, primary data were generated from 147 vegetable producers and secondary data from different sources.

Two-stage least square was used for onion market supply analysis due to endogeneity problem and the result showed that quantity produced, farming experience and frequency of extension contact were positively significant whereas the age of household head negatively determines the quantity of onion supplied. Robust regression was used for tomato market supply analysis as remedial for hetero skedasticity problem and the result showed that quantity produced, education level, family size and frequency of extension contact positively significant whereas the distance to the market negatively affected the quantity of tomato supply to the market.

4.2. Recommendations

Based on the empirical findings of the study, the following recommendations are proposed to be considered in the future intervention strategies of policymakers and development actors working for the development of vegetable marketing.

Based on findings, policymakers should focus on enhancing onion and tomato production, which could be achieved through providing improved inputs, new technology, and techniques that enable farmers to produce more than once in a year. In addition, market-oriented extension focuses on the enhancement of knowledge, awareness, and skills of producers on different aspects of agricultural marketing needed to strengthen besides production-focused agricultural extension system. The need to improve roads and road networks to production areas to enhance vegetable supply, provide transport vehicle access that reduce the time spent to reach the market, product damage and transportation costs. The need to improve farmers' experience and education status through enhancing existing farmer training center service to provides education to farmers, continuous training and create favorable discussion environment for farmers to share their experience.

No Conflict of interest

We declare that this manuscript is original and has not been published elsewhere.

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