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Estimation of Pulse Demand in Ethiopia:

Almost Ideal Demand System Modelling Approach

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ABSTRACT

Estimation of Pulse Demand in Ethiopia:*
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This study estimates pulse demand system using 2018/19 Ethiopian Socioeconomic Survey (ESS) (forth wave) data from which is a joint project between the Ethiopian Statistical Service (ESS) and the World Bank Living Standards Measurement Study – Integrated Surveys on Agriculture (LSMS-ISA). An Almost Ideal Demand System was estimated, and parameters were used to estimate price and expenditure (income) elasticities for three pulse items (horse bean, lentil and chickpea) separately for rural and urban households. In the analysis, demographic variables (such as age, education and household size) were included to capture rural urban differences in preferences. The results disclose that own price, price of others and location of respondents affect expenditure share of pulses. Income elasticity of lentil was 1.02 which is greater than one, implies lentil is luxury goods to the household while horse bean and chickpea are necessity goods. The empirical review result revealed that uncompensated cross-price elasticity of horse bean with lentil was negative which showed that horse bean was consumed complementary with lentil & Chickpea complementary consumed with lentil too. The result of cross-price elasticity, revealed that compensated cross-price elasticity of horse bean with chickpea and lentil had positive signs, which indicate these goods are substitutes to one another at the estimated mean shares. Household consume horse bean and lentil in substitution to chickpea. Similarly, horse bean and chickpea were found to be substitute to lentil.

JEL Classification:
D12, Q11

Keywords:
Pulse Demand; Almost Ideal Demand System Model; Elasticity; Ethiopia

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1. Introduction

Demand studies have various policy implications, particularly in poor and developing economies. The knowledge of how price and income changes affect demand for various foods, respectively, measured by price and income elasticities can help policymakers design careful policies to improve food and nutrition security and alleviate poverty. This significant importance of demand studies has thus resulted in a large amount of empirical literature on the topic during the last three decades (Subir et al., 2020).

The incidence of commodity price increment in the last decades including all food commodities, and how they affect the demand for different food baskets have been studied in Ethiopia (Tafere et al., 2011). Pulses are a staple component of Ethiopian diets and represent the main source of plant protein for a large share of the population, particularly during Orthodox Christian fasting periods (Alemneh et al., 2017; Demelash, 2018). Consequently, changes in pulse prices are likely to have important implications for household food security and nutrition.

Persistent food inflation has substantially increased the cost of staple foods in Ethiopia, raising concerns about its effects on household food consumption and welfare (Vigani et al., 2019). Understanding how consumers adjust their demand in response to price changes has therefore become increasingly important.

Therefore the current study was designed in light of better understanding changes in pulses consumption patterns driven by changes in income levels and relative pulse prices in Ethiopia. The study will contribute to the existing literature first, by modeling the demand for pulses using disaggregated pulse products for the first time in Ethiopia. To the best of our knowledge no previous study has treated pulses in a disaggregated form. Pulses were treated as an aggregate one commodity and entered to the AIDS model as ‘pulse’, ‘pulses and oil seeds’ or ‘pulses and legumes’ (Ulimwengu et al., 2009, Tafere et al., 2011, Yonas Alem, 2011, Shimeles and Delelegn 2013, Tefera, et. Al, 2018 and Vigani et al.,2019). Second, studying the income and price

elasticities for individual pulses will provide a timely, commodity specific area of intervention for policy makers for the inflationary food sector in Ethiopia.

This study estimates pulse demand system using 2018/19 Ethiopian Socioeconomic Survey (ESS) (forth wave) data which is a joint project between the Ethiopian Statistical Service(ESS) and the World Bank Living Standards Measurement Study – Integrated Surveys on Agriculture (LSMS-ISA). An Almost Ideal Demand System was estimated, and parameters were used to estimate price and expenditure (income) elasticities for three pulse items (horse bean, lentil and chickpea) separately for rural and urban households. In the analysis, demographic variables (such as age, education and household size) were included to capture rural urban differences in preferences.

Expenditure elasticity estimates indicate that lentil is already a luxury good for both urban and rural populations. This has suggested that as income increases, households will eventually start consuming more lentil and spend more. On the other hand, the demand for chick pea and horse pea will rise less than proportionally meaning they are necessary goods. The consumption pattern will have a significant impact on the future food system. Therefore, demand oriented and sustainable food systems are needed. Therefore the findings from our study will inform policymakers and researchers about how consumer food demand is evolving and thus help policymakers design an effective food security and nutrition policy for the nation. The remaining of the paper is structured as follows. Section 2 reviews previous literature on the topic, Section 3 discusses on the model and data, Section 4 presents the results, while section 5 concludes.

2. Literatures

In this section we reviewed similar empirical studies from around the world and in Ethiopia as well. Before we dive to the specific studies let us see how different demand estimation methods works in estimating elasticies and what those elasticities refer to. First price elasticity of demand measures how consumers' demand changes due to price changes. Price elasticity of demand values are measured as the ratio of percentage change in demand associated with percentage change in the price of that good (own price elasticity of demand) or another good (cross price elasticity of demand). The sign of own price elasticity of demand is almost always negative, but the sign of cross price elasticity of demand could be positive or negative depending on the substitutability or

complementarity nature of the good (Deaton 2018). Demand is inelastic (price elasticity of demand < 1) if it does not respond much to price changes (necessity good), and elastic (price elasticity of demand > 1) if demand changes a lot when the price changes (luxury good). The size of price elasticities varies widely across various foods and income groups (whether a country is poor or developed). Price elasticities also vary within a food item (Subir et al., 2020).

Second, expenditure (income) elasticity measures how consumers' food demand changes as households income changes. Income elasticity of demand values are measured as the ratio of percentage change in demand associated with percentage change in the income of the consumer. A positive elasticity value means the good is normal, while a negative elasticity means the good is inferior. Income elasticity value which is (> 1) indicates the good is a luxury, whereas if the income elasticity value is (0-1), it indicates the good is a necessary. In literature, like price elasticities, a large heterogeneity in income elasticities is also found. In different literature income elasticity of food vary widely, due to the reasons food items, and methodological attributes (e.g. model type, sample size, types of data) are the major drivers of this large variations. However it is well agreed that income growth will increase food consumption and lead to more nutritionally diverse diets.

A large and well established literatures with roots in demand analysis have been taken place globally. A review of the current literature indicates that the Almost Ideal Demand System (AIDS) model has been applied to the aggregate pulses in combination to other food items, or using disaggregated products in Pakistan (Ghulam Mustafa et al., 2022; Rani, Saima et al., 2020; Hayat et al., 2016), India (Frank W. Agbola, 2000), Sri Lanka (Lokuge and Edirisinghe, 2015), Uganda (Larochelle et al., 2017), Nepal (Kumar et al.,2019) and estimated income elasticiites, uncompensated(Marshalian) and compensated (Hicksian) own price elasticity just to name a few. Among these studies the expenditure elasticity of varied between and were divergent due to culture and related differences in consumption patterns. It is important to keep in mind that the widely varying economic conditions across countries also contributes towards greatly varying estimates of the elasticities of demand (Ramirez, 2013).

The almost ideal demand system estimation modeling has been used for a long time to understand the food demand. Evita and Daniel (2011) applied the Quadratic Almost Ideal Demand System (QAIDS) model to examine the impact of price changes, income and other socio-economic factors on households food demand in Indonesia. The findings indicate that all own price elasticities for

staple food, oils, other foods, vegetables and fruits, meat and fish, alcohol and tobacco, and snack and dried food are negative in line with the law of demand. All food groups have positive expenditure elasticities but the magnitude of those elasticities differs for various food categories. For the staple food, oils and other food are necessities while vegetables, meat and fish, dairy products as well as alcohol and tobacco goods are luxuries.

Linh (2020), investigated the Vetnam's demand for food using modified Almost Ideal Demand System (AIDS) method. The findings indicate that the expenditure elasticity is positive for all 11 commodity groups, which means all the foods are normal goods. Other Meat, fish, pork, poultry, fruits and drinks are luxury, while the others are necessities. The own price elasticity is negative for all commodities. FAFH, poultry, and other foods are relatively price-elastic foods, with Marshallian price elasticities above unity. Meanwhile, rice, other staples, pork, other meats, fish, and fruit have Marshallian price elasticities of less than unity. Cross price elsasticity indicates that all other foods consumption are complement to rice except for vegetables and FAFH. An increase in the price of pork leads to a reduction in the other meat products (poultry and other meats), and a cut in the expenditure on staples other than rice, vegetables, fruits, and FAFH, but leads to an increase in the consumption of rice, fish, and other foods. Therefore, rice, fish, and other foods are substitutes for pork, while all the other food groups are complements.

Mohamud et al. (2021) estimated the food demand system for Somalia by applying Quadratic Almost Ideal Demand System (QUAIDS) method. Their findings shows that, other than fruit/vegetables (-1.063) and pulses (-1.053), all food categories can be classified as own-price inelastic, as their quantities response to change in respective prices is less than one. However, the consumption of more expensive products, such as meat/fish (-0.882) and dairy (-0.749), shows a sizeable response to own-price changes. Turning to the cross-price elasticities, the results reveal some degree of complementarity among the broader food commodity categories. For example, for a one percentage change in dairy prices the associated cereals cross-price elasticity is -0.208, such that an increase in the price of dairy will see an associated decline in quantity of cereal consumed. Oils/fats and vegetables are also found to be complementary (-0.553). Indeed, an increase in meat (and fish) and dairy prices is associated with a fall in fruit/vegetable consumption, suggesting that households fall back to a cereal diet when animal products become unaffordable. In contrast, there are substitution effects between fruit/vegetables and dairy (0.384), and cereals and oils/fat (0.873).

Khalil et al. (2012), examined the demand elasticities for Rice, Wheat, Chicken, Milk, Mutton, Fish and Oil) for rural and urban areas of Pakistan. They used Linear Approximated version of Almost Ideal Demand System (LA-AIDS) in parametric framework. The results show that uncompensated own price elasticities were negative for all included food stuffs and their values were lower than unity except for Mutton (1.108) and Fish (1.775) in rural areas. The cross price substitution effects between Rice and Wheat, Rice and Fish, Rice and Milk and Rice and Oil showed that these were substitutes in nature. While on the other hand the cross price effects between Rice and Chicken and Rice and Mutton showed their complementary relationship. The expenditure elasticities were indicating that Fish (1.20) was luxury good for rural areas and mutton both for urban and rural regions with income elasticities 1.11 and 1.23, respectively.

The AIDS model, specifically the Quadratic Almost Ideal Demand System (QAIDS) model was applied to the Ethiopian food demand analysis by (Shimeles and Delelegn 2013). In their study they included a bunch of food and nonfood items, such as, transport, health, electricity and education, personal care fuel and many more and separate the basket of commodities for rural and urban areas according to the population consumption trends. For the pulses aggregate group the results showed that demand for these commodities in urban and rural areas tend to be necessities seemingly an increase in the relative price of these commodities will have adverse effect more on the poor population than the non-poor.

While Yonas Alem, 2011 applied the quadratic AIDS model for the commodities Teff, maize, wheat, pulses, animal products, fruits and vegetables and other food items groups. The estimation of the results shows beside the household size , which is introduced to capture taste differences across households is negative and significant for food groups such as wheat, pulses, and animal products. The result points that to feed a large household size, for a given level of income, households tend to shift their consumption pattern to basic food items and away from expensive ones such as animal products and pulses. The expenditure elasticities of teff and pulses for all households are less than one. The results show that as income increases, consumers tend to spend proportionately less on teff and pulses and more on animal products and fruits and vegetables.

Tafere et al. (2011), which has investigated of demand for various food and non-food items to change in price and expenditure using the Quadratic Linear Almost Ideal Demand Model (QAIDS). Teff, other cereals, processed cereals, pulses, animal products, and services have income

elastic demands. The expenditure elasticity of demand of pulses is higher in rural areas. Expenditure elasticities for pulses are to be (1.03) while the uncompensated price elasticity is (-0.95). In the works of Ulimwengu et al. (2009), which has applied AIDS the expenditure elasticity of Pulses and legumes are (0.44) while its uncompensated price elasticity is (-0.16). The most recent paper which has applied QAIDS Tefera, et. Al, (2018) the uncompensated (Marshalian) price elasticity is (0.206), while the compensated price elasticity is (0.446), while the expenditure elasticituy is (2.191).

Finally (Vigani et al., 2019), applied QUAIDS to the 2015-2016 Ethiopian Socioeconomic Survey/LSMS-ISA for a total of 15 food groups, such as, manufactured food products, cereals, animal products, pulses. All estimations include socio-demographic variables to control for households heterogeneity. The results showed that, pulses and nuts have a positive but less than 1 expenditure elasticity coefficient, suggesting that they are essential foods for Ethiopian diets, although price elasticity coefficients are not statistically significant.

All the studies discussed here aimed to study the expenditure and price elasticity of food demand by households in Ethiopia, cover different period, different sources of data and different data sets, different in estimation methods hence we observe difference in the estimations.

3. Empirical strategy

Demand models for estimating price and income elasticities can be traced back to the 1950s (Stone1954; Prais and Houthakker 1955). Demand models can broadly be categories such as no demand system (e.g. double log or log-log inverse model) and demand system models, such as the linear expenditure system (LES), the Rotterdam model (Barten 1964); (Theil 1965), the translog model (Christensen et al. 1975), the Almost Ideal Demand System (AIDS) (Deaton and Muellbauer 1980; Dearon 1990) and variants of the AIDS (Banks et al. 1997; Lewbel and Pendakur 2009). To operate a demand system with consistent estimates, the utility function is required to be separable and additives. Additionally, aggregation (Gorman, 1959) and symmetry (Spence 1976; Dixit and Stiglitz 1977) restrictions need to be imposed to mitigate and dimensionality problem that might arise due to the large number of parameters to be estimated in the demand system (Nevo 2010). Today, a complete demand system imposing these restrictions can easily be estimated

because of the tremendous development of programming software and gradual improvement in computing capacity during the previous decades.

3.1. Source of Data

Our source of data for this empirical work was the 2018/2019 Ethiopian Socioeconomic Survey (ESS) which is a joint project between the Ethiopian Statistical Service (ESS) and the World Bank Living Standards Measurement Study – Integrated Surveys on Agriculture (LSMS-ISA). We refer to the forth wave. The sample size of the estimation was 940 households selected based on weekly consumption availability data on pulses namely, horse bean, chickpea, and lentil. The sample covers both urban and rural households to allow for statistical inference to all of Ethiopia and to the population of urban and rural households from nine Ethiopian regions and two city administrates which are Addis Ababa and Dire Dawa.

The households self report their food expenditures along with the consumed physical quantities. We prepare the data for consumption by adopting the method used in the (Vigani et al., 2019), while excluding the households whose socio-demographic data are missing, the consumption or the price are too high or too low compared to the household size.

3.2. Model and Estimation method

The Almost Ideal Demand System (AIDS) modeling approach is a method for estimating demand systems. In 1980, Deaton and Muellbauer suggested the AIDS model as a particular representation of price-independent generalized logarithmic (PILOG) preferences. As Chalfant et al. (1991) notes, the AIDS model is consistent with the aggregation of individual preferences. The Almost Ideal Demand System (AIDS) employed in this study was chosen to estimate the parameters of Ethiopian household demand system. The AIDS model is flexible, consistent with the aggregation of individual preferences and provides an arbitrary first-order approximation of the demand system that satisfies the axioms of choice exactly (Deaton and Mullbauer, 1980). In addition, the AIDS technique is employed in the analysis because of the relative ease of imposition of the theoretical restrictions of homogeneity, Slutsky symmetry and adding up in the estimation of the Ethiopian demand system.

AIDS is a member of the Price-Independent Generalized Logarithmic (PIGLOG) class of demand models (Cranfield et al. 2003), which are derived from indirect utility functions that are themselves

linear in log total expenditure. A better framework to estimate price elasticities for a wide range of commodities , sucha s Chickpea, horsebean and lentil would be flexible functional form such as the Almost Ideal Demand System (AIDS) of Deaton and Mullebauer (1980), which is given as follows. The demand functions are derived in budget share form as follows:

$$w_i = \alpha_i + \sum_{i=1}^{n} \delta_{ij} lnp_j + \beta_i \ln(\frac{X}{P}) \quad (1)$$

Where: *wi* is the i[th] good expenditure share, P_j price of the j[th] good, β_i = expenditure coefficient of demand for commodity i, δ_{ij} is the price coefficient, X is total expenditure on all goods, and P is a price index defined by

$$lnP = \alpha_0 + \sum_{i=1}^{n} \alpha_i \, lnp_i + \frac{1}{2} \sum_{\{i=1\}}^{\{n\}} \sum_{\{j=1\}}^{\{n\}} \delta_{ij} \, lnp_i lnp_j \quad (2)$$

Where: $\alpha_i \; is \; a \; parameter \; to \; be \; estimated; and \; n = 1 - 3$

Deaton and Muellbauer (1980) suggest replacing the expression in equation (2) by the Stone geometric price index defined by:

$$lnP = \sum_{k=1}^{n} w_k \, lnp_k \quad (3)$$

Where: w_k is the mean of the budget share in periods t and t-1

Substituting (3) in (1) gives an expression of budget shares in terms of the Stone geometric index as:

$$w_i = \alpha_i + \sum_{i=1}^{n} \delta_{ij} \, lnp_i + \beta_i \ln\left(\frac{X}{p^*}\right) \quad (4)$$

To ensure that the AIDS model provides a satisfactory approximation of the true demand system that is consistent with the underlying utility maximization it is important to impose the basic demand restrictions of adding-up, homogeneity, and symmetry. The demand restrictions are expressed in terms of the model coefficients as follows:

$$\sum_{i=1}^{n} \alpha_i = 1; \sum_{i=1}^{n} \delta_{ij} = 0; \sum_{i=1}^{n} \beta_i = 0 \quad \text{(Adding up)} \quad (5)$$

$$\sum_{j=1}^{n} \delta_{ij} = 0 \qquad \text{(Homogenity)} \qquad (6)$$

$$\delta_{ij} = \delta_{ji} \qquad \text{(Symettry)} \qquad (7)$$

The expression in equation (5) enables that the sum of individual expenditure is equal to total expenditure, which is the adding up restriction. The second one, which is the homogeneity restriction ensures that the demand equation is homogenous of degree zero in income and prices. The Slutsky symmetry assures consistency of choice on the part of the consumer. Assume that the group prices are fixed, the Marshallian or uncompensated measures of own price and cross price elasticities are computed from the estimated parameters of the AIDS model in equation (4), following Hayes et al. (1989), as follows:

$$\varepsilon_{ii} = \left(\frac{\delta_{ij}}{w_i}\right) - (1 + \beta_i) \qquad \text{(own price elasticity)} \qquad (8)$$

$$\varepsilon_{ij} = \frac{\delta_{ij}}{w_i} - \beta_i \left(\frac{w_j}{w_i}\right) \qquad \text{(cross price elasticity)} \qquad (9)$$

Where; ε denotes the uncompensated price elasticity measure,

$$\eta_i = 1 + \frac{\beta_i}{w_i} \qquad \text{(expenditure elasticity)} \qquad (10)$$

$$\varepsilon_{ij}^{*} = \varepsilon_{ij} + w_j \eta_j \qquad \text{(compensated/Hicksian elasticity)} \qquad (11)$$

4. Results and Discussion

Both descriptive and econometric techniques were used to conduct the analysis. The Descriptive statistics described the household expenditure, each budget share of pulses and the demographic characteristics of the sample households. Econometrics techniques entailed the specification and estimation of pulse demand equations. It also analyzed the influence of various socioeconomic factors on the demand of pulses among households.

4.1. Demographic and descriptive statistics

The result of table 1 indicates that in the surveyed households, the mean value for number of household (household size), age of household heads and education level (school years) of the

household heads were 4, 36.5 years and 5 grade respectively. Out of the 940 sample respondents 24.36% were female and the rest 75.64% were male household headed. The location of the sampled households indicates that 35.64% of the respondents were reside in rural Ethiopia and 64.36% were from urban area. The tabulation result indicates that out of the total female headed households 24.45% located in rural and 75.55% were located in urban area. As for those male headed respondents, 39.24% reside in rural and 60.76% reside in urban area. The average price of haricot bean, chickpea and lentil are 32.42, 38.30 and 66.11 birr respectively. This indicates that lentil is more expensive when compared to the prices of horse bean and chickpea. Horse bean is relatively cheap this is because specially in the urban Ethiopia context, consumers prefer the test of chick pea over the horse bean. This result is consistent with the findings of Nigussie et al.(2018), which explains that the household demand for food consumption pattern depends not only on their income and product prices but also on household preferences as well as socio economic characteristics.

Table.1. Descriptive Statistics

Variable name(Continuous)	**Observation**	**Mean**	**Std. Dev.**	**Min**	**Max**
Wi_HB	940	0.2836999	0.1488058	0.0266667	0.8842105
Wi_CP	940	0.2882726	0.1439988	0.0210526	0.9146341
Wi_Lentil	940	0.4280275	0.1711737	0.0487805	0.9090909
Price_HB	940	32.42314	11.9524	10	100
Price_CP	940	38.30225	14.53199	10	120
Price_Lentil	940	66.11724	15.50592	20	153.8462
Expenditure	940	107.7426	57.03043	21	436
HH_size	940	3.891489	2.086758	1	13
Age	940	36.4734	11.05376	19	80
Education	940	4.804255	1.639496	1	7
Variable name	**Dummies**	**Frequency**	**Percent**		
Sex	Female	229	24.36		
	Male	711	75.64		
Location	Rural	335	35.64		
	urban	605	64.36		

Source: authors' computation

As far as descriptive statistics of expenditure and prices of pulses are concerned, the table above shows that the average expenditure of households for pulses was 107.74 birr/week with a minimum expenditure 21 birr/week and the maximum expenditure of 436 birr/week. On average, out of total expenditure of household for pulses, 28.37% spent on horse bean, 28.83% on chickpea and 42.80% spent on lentil. While implying that horse bean and chickpea earn almost similar budget share

while lentil earns the highest budget share. As shown in table above, the mean price of lentil and its standard deviation is the largest followed by chickpea, while horse bean has the smallest mean and standard deviation.

4.2. Econometrics Result

4.2.1. Estimated Coefficients for AIDS Model of pulses

With the results of AIDS model, Table 2 presents the parameter estimates of the model. As shown in the table below, that the expenditure share of horse bean increased by 3. 13% as the price of horse bean increased by 1%. One percent increase in chickpea price also increases chickpea expenditure share by 6.71% and decrease expenditure of share of lentil by 5. 1%, both are significant at $p < 0.001$. As the same time a 1% increase in lentil price reduces expenditure share of horse bean and chickpea by 7.37% and 4.83% respectively but increase expenditure of lentil by 12.21%.

From the demographic variables entered in to the model, age, education, sex and household size do not affect the expenditure share of pulses. The result is consistent with (Alem and Söderbom 2012), who reported that education level and age have no relationship on household consummation for food. Location of the respondents, i.e. whether they are living in rural and urban is statistically significant for all. This indicates that compared to the rural households (the baseline), urban households decrease the expenditure share of horse bean and chick pea as their respective prices rise. But has positive and significant effect on the expenditure share of lentil, which means compared to the rural households, urban households expenditure share of lentil rises for increase in price of lentil. This shows that urban households for 1% in horse bean and chekpea prices, their expenditure share will reduce by 5.4% and 1.5% respectively. While a 1% increase in percentage in price of lentil, the expenditure share will rise by 12.1%. The results contradicts to the findings of Nigussie et al. (2018), who have investigated an increase real price of wheat, root crops and pulses and oilseeds, has negative impact on the likelihood of consumption of that products. Pulses and oilseeds are more likely used cash crops (to generate cash income), in addition to their use for preparing sauce (consumed with injera). An increase in price of pulses and oilseeds is more likely to increase income than its consumption. But here we argue that For rural households, who are both producers and consumers, an increase in real horse bean and chickepea prices has positive and significant impact on the likelihood of horse bean and chickpea consumption. As rural

households are both producers and consumers, increase in real prices of products appears to increase income, which in turn leads to increase in consumption. In other words, increasing real prices have dual purposes for rural farming households; first it increases income and then increases level of consumption.

Table.2. **Parameter Estimates from the AIDS Model**

Parameters	**Wi_HB**	**Wi_CP**	**Wi_Lentil**
lnprice_HB	0.031303**	-0.0082285	-0.0230745
lnprice_CP	-0.0162533	0.0670865***	-0.0508332***
lnprice_Lentil	-0.0737206***	-0.0483991**	0.1221197***
beta_lnx	-0.0115358	-0.0025141	0.0140498
hh_size	0.0029989	0.0004679	-0.0034667
age	0.0003457	0.0000773	-0.0004231
education	-0.000324	0.0022141	-0.0018902
gender	0.0034649	0.0030655	-0.0065304
loccodes	-0.0536805***	-0.0147447*	0.0684253***
Cons	0.6113973***	0.2835669**	0.1050358

*Notes: Single, d*ouble and triple asterisks (*, **, ***) indicate significance at the 10%, 5% and 1% level. Values in parentheses are standard errors.

4.2.2. Uncompensated price elasticity of demand for pulses

Own price elasticity of pulse demand

Own price elasticity refers to the percentage change in quantity consumed by a household with respect to change in the prices of the commodities in question. As per economic theory, the sign of the own price elasticity is expected to be negative. Table 3 shows that the uncompensated own price elasticity demand of the selected pulses (horse bean, chickpea and lentil) were negative and inelastic (all are between 0 and -1) which satisfies the law of demand. This indicates that the demands of these commodities though parallel to the demand law, and accordingly the demand for the pulses decline following their respective price increment, we can say relatively the demand will not reduce by large. As the price of each crop increases by one unit the quantity demand for each crop would be decreased by proportion. From this result the demand for horse bean was more sensitive to own price change. The demand for pulses remains relatively strong in the dynamic of price fluctuations in Ethiopia, likely due to the limited availability of affordable protein substitutes. One unit increase in price of horse ben leads 0.91 unit decreases in household's quantity demand for horse bean. This finding similar with the finding of (N. Tefera

and Commission 2020 and Kariuki et al., 2025). However, inconsistent with findings of (Nigussie et al. 2018), who reported that the own price demand elasticity for pulses, is positive and significant.

Table 3. Uncompensated and expenditure Elasticity Matrix of Pulses

	price_HB	price_CP	price_Lentil	Expenditure elasticity
Wi_HB	-0.906***	-0.066	-0.240***	0.981***
	(0.049)	(0.047)	(0.071)	(0.036)
Wi_CP	-0.032	-0.770***	-0.162*	0.996***
	(0.047)	(0.045)	(0.068)	(0.034)
Wi_Lentil	-0.041	-0.112**	-0.732***	1.016***
	(0.037)	(0.036)	(0.054)	(0.027)

Notes: Triple asterisks (***) indicate significance at the 1% level. Values in parentheses are standard errors. Elasticities are evaluated at mean of the data

Income (expenditure) elasticity of food demand

Income elasticity refers to percentage change in the quantity consumed of a particular commodity with respect to percent change in the income of the households. Over the income elasticity, we can identify whether the food commodities are inferior or necessity or luxurious to the households. Income elasticity of pulses were presented in Table 3 above. The empirical result showed that the income elasticity of all pulses were positive and significant at 1% level of significance, indicating that these crops are normal goods. As predicted from the result income elasticity of lentil was 1.02 which is greater than one, implies lentil is a luxury goods to the household. The high elasticity of pulses, typically considered a staple, suggests a growing preference for them as an affordable, protein-rich alternative to more expensive animal-based proteins which is consistent of the findings of (Kariuki et al., 2025 and Nigussie et al., 2018). While horse bean and chickpea are necessity goods, the income elasticity of horse bean and chickpea were 0.981 and 0.99 respectively This result in line with the finding of Tefera (2013), he found that lentil considered as luxury goods in most household of South Ethiopia. While (N. Tefera and Commission 2020) reported that pulse food groups are found to be normal goods.

Cross price elasticity of pulses

Cross price elasticity measures the percentage changes in the quantity consumption of commodities with respect to changes in the prices of the other commodities. It shows the

substitutability and complementarily effects of commodities. Zero cross-price elasticity denotes two products are independent products, Positive cross-price elasticity shows substitutability and negative cross-price elasticity indicates complementarily. The empirical review result revealed that uncompensated cross-price elasticity of horse bean with lentil was negative (-0.240) which showed that horse bean was consumed complementary with lentil. Chickpea complementary consumed with lentil (-0.162) and lentil consumed with chick pea complementary too (-0.112).

4.2.3. Estimation of Compensated Price Elasticity of Demand of pulses

Compensated or substitution elasticity indicates that the percentage change in the demand for a good in response to a change in a price that ignores the income effect. In table 4, the empirical results shows that the compensated own price elasticity of demand is (-0.628, -0.483 and -0.298) for horse bean, chickpea and lentil respectively. Which showed that the demand for horse bean, chickpea and lentil was inelastic indicating, the percentage change in quantity demand is lower than the percentage change in price even after removing the income effect. The implication of inelastic demand in horse bean, chickpea and lentil revealed that those crops are necessity goods. Household demand for those crops was less sensitive to own price change. The decrease in quantity change of demand for those crops was less than the quantity change in price of that corps.

The result of cross-price elasticity, revealed that compensated cross-price elasticity of horse bean with chickpea and lentil had positive signs, which indicate these goods are substitutes to one another at the estimated mean shares. Household consume horse bean and lentil in substitution to chickpea. Similarly, horsebean and chickpea were found to be substitute to lentil.

Table 4. Compensated Elasticity Matrix

	Price_HB	price_CP	price_Lentil
Wi_HB	-0.628***	0.217***	0.180*
	(0.050)	(0.048)	(0.072)
Wi_CP	0.250***	-0.483***	0.264***
	(0.048)	(0.046)	(0.068)
Wi_Lentil	0.247***	0.181***	-0.298***
	(0.038)	(0.036)	(0.054)

Notes: Triple asterisks (***) indicate significance at the 1% level. Values in parentheses are standard errors. Elasticities are evaluated at mean of the data

5. Conclusion

The analysis of the determinants of pulses demand and estimation of elasticity especially with respects to income and prices provides vital information regarding the consumption behavior of society in general. In this regard, the author estimated the demand of pulses in Ethiopia based on secondary data obtained from 2018/2019 Ethiopian Socioeconomic Survey (ESS) forth waves with sample size 940 households. Almost Ideal Demand System (AIDS) was employed to estimate the household demand for pulses. Almost Ideal Demand System (AIDS) results showed that the household demand for pulses in Ethiopia was influenced by price and demographic factor such as location of respondents. Uncompensated own-price elasticity result revealed that all the selected pulses were having relatively less elastic demands. Household response to the demand of pulses decreases as the commodity price increase. The most responsive commodity to price change was horse bean followed by chickpea, and lentil. All pulses have inelastic compensated price elasticity result. All the selected pulses were categorized as normal goods, as characterized by an income elasticity value of more than zero. The nature of the commodity determined that chickpea and horsebean were necessity goods, while lentil was categorized to luxury goods due to its income elasticity value, which is greater than one. The compensated cross-price elasticity result showed that all of the sampled pulses were substituted to each other.

The implications drown from this finding were, pulses demand pattern is less likely to be influenced by sex, age, or education. But the result revealed that for the urban households, increase in price of lentil significantly increase their expenditure on it while for urban households, the increase in price of horse bean and chickpea reduces their expenditure on both pulses. Given the price elasticity of both for the compensated and uncompensated estimates results, it can be inferred from these results that price has high impact. Thus, price stablization policy would be effective. The expenditure elasticity of pulses shows that they are necessities which implicates the recent high food prices if continued may lead to household's cut consumption of pulses which are the basic food items and are the sources of protein for majority of poor households in urban area. This will again worsen the food security problem which has already growing in the country and creates a significant imbalances in nutrition insecurity for the poor and urban dwellers. We also encourage further studies to link the parameter elasticities for welfare analysis to capture in measuring long term rising food prices.

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