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# Price Index: Agricultural Commodities in Ethiopia

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***Abstract:***

***Purpose:*** *This study aimed to construct a price index for agricultural commodities in Ethiopia. Retail price data of agricultural commodities in five categories, cereals, pulses, oilseeds, root crops, and spices from 2010-2020 from three regions and one city administration were collected from the central statistics agency of Ethiopia (CSA).*
***Design/Methodology/Approach:*** *The Laspeyres average production quantity weighting index approach was used to construct the index. The findings show that prices of agricultural commodities revealed an ever increasing trend in all the three regional states and the Addis Ababa city administration despite the fact that there were variations across the areas.*
***Findings:*** *This persistent and continuing trend of agricultural commodity prices is highly likely to worsen consumers' lives and would generally boost the cost of living in Ethiopia. If this trend continues, it would be difficult for the majority of the people of Ethiopia to afford to pay for food items. Once the price of a specific crop has increased, its possibility of declining below its previous average is unlikely.*
***Practical Implications:*** *Although the Ethiopian government is engaged in a process of modernization and making major financial reforms, there is no solid financial tool that could assist market participants to analyze risk and return in the agricultural commodity market.*
***Originality/Value:*** *Agricultural policy lacks instruments to shield neither farmers against potential losses induced by a reduction in the price of the crops they produce nor consumers against the increase in the cost of living induced by food price inflation.*

***Keywords:***

***JEL codes:***

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## 1. Introduction

The market, by its nature, is dynamic and fluctuating (Pindyck, 2001), and it can be impacted by several forces, such as human emotions, the behaviors of producers, and consumer prices. To understand how the market performs, it is important to have key information to succeed in one's investment decision. Price indices are one of the tools that help to measure the movement and performance of the market, such as a stock or commodity market that is offered and which facilitates investors' decisions.

A market index is a measurement of the value of a section of the market that serves as a benchmark for the economy or some sectors of the economy (Afriat, 2015). Lo (2016), by giving a historical perspective of the market performance, says that market indexes can provide investors with more insight about the market so that they can easily make their investment decisions.

An index number is an instrument that is used to compute a change in the level of a set of variables beginning with a certain reference (base) period. Coelli *et al.* (2005) defined an index number as a device that is employed to compare prices over time, space, or both; indeed, it is an instrument that is used to measure changes in a variable or group of variables with common features, for example, time and geography.

Furthermore, according to Allen (1976), Balk (2008), and Afriat (2015), an index number is a tool of measurement which can fairly combine either similar or different types of data and helps to bring about a single summary value which helps to make an accurate comparison between the given periods, namely time series. Therefore, a market index is a figure over which investors rely on and make investment decisions given their risk appetite, and it is used as a forecasting tool.

There are different types of commonly employed indices, such as price indexes, which can be used to measure percentage changes in price; quantity indexes that are used to measure percentage changes in quantity produced or consumed, and a value index that is employed to measure the percentage change in values.

Of these, a price index is characterized as a time series index. A time series index, according to Allen (1976) and Allen *et al.* (1981), helps to make the degree of change easily understandable in the process of constructing values. Underlying an index number conception is a theory that promotes the aggregation of quantity and prices over commodities (Coyle, 2007). This is termed the "index number theory." In 1936, Frisch distinguished two main schools in the theory of index numbers, namely the atomistic and the functional approaches.

In the process of constructing an index, other important issues to be considered are the selection of the items to be included in the index and the determination of the

appropriate weight to be applied. Based on the weighting approach, researchers can categorize an index as either weighted or un-weighted. Several organizations develop indexes across the globe, both in stock markets and commodity markets, for which they have been used as a barometer of the market's condition. Just to list some, the S&P 500, Dow Jones, NASDAQ, Russell 2000, EGX 30, NIFTY and Bloomberg can be mentioned, as examples.

Investors, traders, speculators, governments, and others rely on the information provided by index numbers to understand market characteristics such as relative changes, risk, and return in order to make their own decisions.

Generally, the markets in developing countries, including Ethiopia, are often characterized by small trading volumes, lack of competition, and high price volatility (Teshome, 2020). Low trading volume implies that the quantity and quality of information that buyers receive are limited, and thus the price prediction process could be affected.

As a change in prices of agricultural products has become a global phenomenon (Shiferaw, 2009), price volatility in markets for major crops remains high in Ethiopia too (Rashid *et al.*, 2010). In line with this, although agricultural product market policies in the country have tried to make dramatic changes over the past number of years.

Indeed, an accurate evaluation of agricultural commodity price movements is important for inflation control, market prediction and production planning, and it is particularly relevant to developing countries, like Ethiopia, which is in the process of promoting investment in the agriculture sector, and which is required to work hard for poverty reduction (Chen *et al.*, 2010).

Thus, this researcher first tried to develop a market index for agricultural commodities prices in Ethiopia.

## 1.2 Statement of the Problem

Due to the increasing nature of international investments and the globalization of the market, the demand for getting timely, valid, and reliable information regarding a given market is increasing dramatically. Many equity and commodity indices around the world have been providing information based on risk-adjusted returns analysis and asset pricing models that provide strong theoretical support in finance to meet this demand (Bringham and Houston, 2012; Damodaran, 2020; Pogue and Gerald, 1973).

The stock market index is the most dominant and established, which was developed by various index developers such as Dow Jones, S&P 500, NASDAQ, and others for the US stock market; the Nairobi Securities Exchange, Ghana Stock Exchange, and

Egyptian exchanges with an African context are also among the organizations that construct indexes. Apart from these, others build price indexes for distinct market segments and specific commodities. For example, for the real estate and housing segment, price indexes are assembled by applying approaches such as the hedonic approach (Rosen, 1974), repeated sales (Bailey *et al.*, 1963), Case and Shiller (1987), hybrid approaches (Case *et al.*, 1991), and the autoregressive index introduced by Nagaraja *et al.* (2011).

Moreover, price indexes are developed for specific commodities as well. Recently, Tuo and Zhang (2020) modeled the iron ore price index for China, which was used to explore the price risk and fluctuation correlations between China's iron ore futures and spot markets and forecast the price index series of the country's and international iron ore spot markets from the futures market.

Another study by Yang *et al.* (2020) was conducted with the aim to construct the natural gas price index (NGPI). All of these signify the necessity of index construction for different sectors of the economy. It is not surprising that there is no stock price index and no index developer in Ethiopia, as there is no stock market in the country.

Specifically, agricultural commodity indices can serve as representative indicators of the commodity markets, measuring the aggregate direction of prices across various commodity sectors. While construction of the agricultural commodity price index plays a paramount role for the economy's participants, including the government, currently, there is no organization other than Central Statistics Agency (CSA) and FAO somehow providing information related to commodity prices in the agricultural commodity markets of Ethiopia. Even the CSA and FAO's limited indexes could not independently represent domestic agricultural commodity prices.

The former is aimed to measure the average price change of certain consumer goods and services and can give information about inflation and the cost of living over a given period, and it is highly influenced by commodities other than agricultural products (CSA, 2016). The FAO Food Price Index (FPI), its purpose is not just to be used as an indicator on its own to assess the domestic agricultural commodity market; it is based on the export share of a commodity in the international market.

Moreover, methodologically, the CSA, CPI, and FAO FPI indexes make use of different weighting approaches to reflect the relative importance of goods and services, where the former is a base year quantity consumed weighted index and the latter is weighted with an average export share of each of the five groups over 2014-2016 (FAO).

Nonetheless, neither of these indexes takes the quantity of production into account when constructing their indexes. That is, it is both supply and demand that mainly determine the price of goods and services. Unlike the stock price, the price of

agricultural commodities is subjected to the size of areas covered with that specific commodity and the quantity produced in any given particular year. So, one need to take into accounts those factors while constructing a price index for agricultural commodities as an indicator of relative importance.

Therefore, it is worth establishing a solid price index for the agricultural commodities market, which could be used to measure the economic performance of the sector and provide investors with summarized, comprehensive, and reliable sectorial information.

In line with this, the objectives of this study is to construct price index for agricultural commodities in Ethiopia.

## 2. Review of Related Literature

### 2.1 Index Number Theory

An index number is a measure of changes (Ralph *et al.*, 2015) of magnitudes from one situation to another (Allen, 1976), which may be two time periods (e.g., two years), two situations in a spatial sense (e.g., two regions of a country), or two groups of individuals. Since index numbers measure changes, there should be a reference or base required to compare with, which usually is the period taken at a level of 100.

Traditional index number theory organizes a value ratio into the product of a price index and a quantity index. The price (quantity) index is interpreted as an aggregate price (quantity) ratio. According to Hill (1988), there are two fundamental approaches to index number theory; axiomatic approach and the economic approach. Diewert (2005) takes an alternative approach to index number theory, started by Bennet and Montgomery in the 1920s, which decomposes a value difference into the sum of a price difference plus a quantity difference.

Hence axiomatic and economic approaches to this alternative branch of index theory are considered in his paper. The analysis presented has some relevance to accounting theory in which revenue, cost, or profit changes need to be decomposed into price quantity components. In axiomatic price index theory, "tests" or "axioms" indicate numerical properties that are fundamental or necessary for a price record equation, and equations are looked for that show those properties (Reinsdorf, 2007).

The term "test" was used by Irving Fisher in two books that viably enforced this field of investigation in the early twentieth century, whereas "axiom" is utilized by later scholars to indicate the core properties that are fundamental for any price index. Two options to the axiomatic approach are too often used to plan or to assess price indexes. The stochastic approach, also called the statistical approach

considers the individual person's price changes as appealing from a statistical distribution whose central tendency is to be evaluated.

The axiomatic approach is one in which the theoretical foundations of index numbers are built on certain postulates, or axioms, which any index must satisfy. For Reinsdorf (2007), the axiomatic approach is adequately versatile to be all around appropriate, but the applicability of the elective approaches, for the most part, depends on the level of accumulation.

At the lowest level of accumulation, the presumptions of the stochastic approach are well-suited for the problem of combining price quotes from different venders into an index for a single product. Most index number issues include higher levels of accumulation, be that as it may. A basic example of one of these problems is weighting of different commodities to reflect their economic significance.

Fisher (1922) is the one who required indices to satisfy certain conditions called axioms, or tests, such as the Monotonicity Axiom or the Linear Homogeneity Axiom, which states the linear homogeneity of a price index with respect to the comparison price, the identity axiom, which states that if all prices remain constant, the value of P equals unity, and so on.

The dimensionality axiom states that a dimensional change in the unit of the currency does not change the value of the function P. In other words, if two economies are identical except for the definition of the unit of money, then the values of the respective price indices are the same just to explain some.

The economic theoretic approach, which seeks to define price or volume indices with reference to underlying utility functions with the consumer preference context or production functions in the context of producers.

Konus (1924) cited in Diewert (2005) says that an aggregator function is neoclassical if these functions are continuous, positive, and linearly homogeneous, in which the cost function or expenditure function is the solution to the minimization problem. That is, the economic approach models quantities as a function of price and income as a description to solve an optimization problem.

A price index, according to (Diewer, 2007), is a measure or function that summarizes the change in the prices of many commodities from one situation (a time or place) to another; to determine a price index, it is necessary to know the types of commodities or items to be included in the index, the method used to determine the item prices, the types of transactions that involve the items to be included in the index, the type of technique used to determine the weight, and the sources from which the weights are drawn, and the type of formula or mean that should be employed to compute the average value of the selected items relative prices.

## 2.2 Index Number Construction

In the process of constructing an index number, it is necessary to decide on six factors: they are the purpose of the index, availability of data, selection of items, choice of the base period, selection of the weights, and methods of construction (Tysoe, 1981). In brief, in the process of developing an index number, the first step is to state the purpose for which the index is intended to be used; it is crucial to specify the purpose of an index before any attempt is made to construct it, for stating the purpose helps to influence other factors involved in the construction process of the index.

The second step is to ensure the availability of the required data. In other words, it is essential to be sure that the data is continually available and accessible in the right format for the index number construction process. The reason for this is that lack of access to the required data could create a serious problem years after an index number series has been started. If the needed data is not available at the right time and in the right format from the beginning, and if its inaccessibility continues, the index number's future usefulness and reliability will be distorted.

The third step is the selection of the items to be included in the index. Meaning, in the process of constructing a general-purpose index, for example, a consumer price index, it is difficult to include all consumer goods. The only feasible alternative is to take samples in such a way that it may reasonably be presumed that the items that are included adequately reflect, represent, or indicate the overall picture. The fourth step is the choice of the base period.

The year or period with which one wants to compare is called 'given year' or 'given period' while the year or period relative to which the comparison is made is called 'base year' or 'base period'. The index number for the base year is taken as 100. Ideally, in the choice of a base year, it is generally desirable to base comparisons on a period of relative economic stability (a period of average steady inflation without any unusual occurrences) as well as a period not too distant in the past.

An index based on a period of abnormal economic conditions tends to give the wrong impression of the phenomenon being observed. When the base period is too remote, data related to such a period could be very difficult to collect. The fifth step is the choice of the weights that account for the significance of individual items in the overall that the index is supposed to describe.

Choice of the weights, therefore, becomes very important when items being considered in an index are not of equal importance. The weights assigned to the various items must, therefore, be measures of their relative importance and should be carefully chosen to avoid biased and misleading results.

Based on the weighting approach, an index can be categorized as weighted or unweight, and while the latter does not apply a weight to the index, the former applies different bases as a weight, such as equally weighted, price-weighted, market capitalization-weighted and float-adjusted market capitalization-weighted. For example, Laspeyres (1971) and Paasche (1974) developed indexes that use base year quantity and current year quantity as weighting methods.

To begin with, an equal-weighted index is the type of weighting index that is used to assign equal value to all the stocks in the index, and therefore, all of the constituent stocks carry equal relative importance or weight in the construction of the index. To create a price-weighted-index, first the average price is computed, and then the percentage change in the average price is calculated.

In the price weighted-index method, the highest-priced stocks have the highest weightings within the portfolio regardless of their total market capitalization; price-weighted indices are easy to calculate but generally have arbitrary index weightings (Zeng and Luo, 2013). The Dow Jones industrial average is one of the well-known indexes that use a price.

The third weighting method, namely the market capitalization-weighted index, is a weighting approach in which a company's shares outstanding are multiplied by its per-share market value, and the weight is computed as a proportion of the total market capitalization; the market cap index method is dominantly employed by many index providers, such as the S&P 50, the NASDAQ 100, and the Russell 2000 (Zeng and Luo, 2013).

Finally, float-adjusted market-capitalization weighting is another weighting approach by which the weight of each constituent security is determined by adjusting market capitalization for its market float, i.e., the regular shares a company has issued to the public that are available for investors to trade.

The last step is the methods of construction, which is about the choice of appropriate formulas that describe relative changes. The particular formulas that provide the required index numbers could be chosen based on practical considerations. That is, there are different formulas, and some of the most commonly used are the Laspeyres price index and the Paasche price index.

The Laspeyres price index was developed by German economist Etienne Laspeyres as a base period quantity index in which the Laspeyres price index is used to measure the change in the prices of a basket of goods and services relative to a specified base period weighting. The Paasche Price Index is another price index method developed by German economist Hermann Paasche to measure the change in the price and quantity of a basket of goods and services relative to a current period price and observation year quantity). The Paasche Price Index is commonly confused with the Laspeyres Price Index.

The key distinguishing factor between the Paasche Index and the Laspeyres Price Index is that the Paasche Index uses current-period quantity weightings while the Laspeyres Price Index uses base-period quantity weightings.

## 3. Empirical Literature

Some studies that focused on price index construction, asset pricing, and price volatility have been conducted. To begin with the first one, a variety of price indexes for real estate and housing have been developed at different times and by different scholars; for example, the repeated sales index by Bailey *et al.* (1963), hedonic regression by Rosen (1974), weighted repeated sales by Case and Shiller (1987), hybrid approaches by Case *et al.* (1991), Quigley (1995), and Hill *et al.* (1997), autoregressive index by Nagaraja *et al.* (2011), and a spatial cost index of housing by Paredes (2011) are citable.

In brief, a study by Bailey *et al.* (1963) focused on the construction of a real estate price index employing the regression method. According to these researchers, quality differences can help estimate price indexes for real properties difficult. In other words, for them, it is challenging to construct index numbers for the prices of real properties, and the difficulty can result from the high differences in quality among the properties.

As a result, index numbers constructed relying on the average sales prices of all properties of certain specific types sold in a given period are likely to be inefficient in two ways: (1) the variation observed in the quality of properties sold from time to time can make the index vary widely more than the value of any given property; and (2) it is the event of a progressive change in the quality of properties which are sold at different times, the index number will be biased over time.

One technique that could be employed to avoid these problems is to eradicate the apparently observed quality differences by employing regression analysis. Indeed, the difficulty of merging price relations of repeat sales of properties to get a price index can be converted into a standard regression method, which, in turn, can be used to estimate the index; the regression approach of estimation is more effective than other methods for merging price relations.

Furthermore, the regression approach can help one to easily compute standard errors of the estimated index, and it can help to eradicate certain effects on the value of real properties from the index (Bailey *et al.*, 1963).

Rosen (1974) conducted a study that attempted to develop an index using hedonic regression methods; hedonic models indicate that shifts in the quality of one attribute of a product may prompt a shift in the composition of buyers of that product, and a hedonic regression model describes how a product price could be explained by its characteristics; that is to say, it permits various attributes.

Indeed, the main idea behind the hedonic model is to decompose the characteristics. It is worth noting that the repeated sales method, which was introduced by Bailey *et al.* (1963) and further extended by Case and Shiller (1987) as the weighted repeated sales model (WRS), is a type of model that is used as quality control for a property, and it requires very limited data in comparison to hedonic or hybrid methods.

The WRS index could be constructed based on non-random samples selected from a population of house sales that could be sold more frequently during a given time interval. Yet, the WRS model is criticized for its failure to address depreciation and normal maintenance as well as problems concerning interpretation and sample selection.

Considering the weakness of the WRS, the hedonic, and repeated sales models, Case *et al.* (1991), Quigley (1995), and Hill *et al.* (1997) developed a hybrid model by combining hedonic and repeated sales, which was found to avoid most of the sources of biases and inefficiency, and the autoregressive index model was introduced by Nagaraja, Brown, and Zhao (2011).

Paredes (2011) proposes a methodology for a spatial cost index of housing in consideration of spatial heterogeneity in properties across regions by combining quasi-experimental methods, hedonic prices, and Fisher spatial price index techniques to reduce the spatial heterogeneity in housing. In a study he conducted, Paredes (2011) found the existence of a price variation for similar houses in Chilem and he concluded in such a way that, firstly, houses were matched, followed by a hedonic price model computation and the creation of a regional housing price matrix using Fisher spatial price indices.

The aforementioned studies, however, relied on price index construction methodologies that were focused on the real estate sector; they cannot be directly traced to agricultural commodities price indexes, which are fundamentally different from real estate and housing sector prices. Thus, Fernandez (2019) proposed a price index that is an extended version of Grilli and Yang's (1988) non-fuel commodity price index (GYCPI) for the period of 1900-2016 that included thirty-six commodities which were classified into seven categories: beverages, cereals, other foods, agricultural raw materials, energy, metals and minerals, and precious metals.

He used the Divisia-based commodity price index and the Divisia-version of the Grilli-Yang non-fuel commodity price index. Each commodity's average export share is taken as weights during the base period of 1977-1979. He presented two Divisia commodity indices that can track well-known indices, such as the World Bank and S&P GSCI non-energy indices on annual and monthly bases, both of which can be easily computed and updated using publicly available data. Fernandez (2019) extended index displays strong co-movement with a Divisia-version of GYC; both indices are capable of tracking well-known indices, such as the World Bank and S&P GSCI non-energy indices.

To summarize, in both the international and local studies conducted on price indexes, application of CAPM and volatility modeling, certain gaps have been apparently observed. Firstly, it has been hardly attempted to develop an index that can serve as a reliable quantitative measure that could show the overall performance of the agricultural commodities market in Ethiopia, which is useful for investment and policy-making decisions.

To begin with the CSA CPI, firstly, its purpose has been to measure the overall inflation level in the country. As a result, it was based on a basket of commodities which consisted of both agricultural and non-agricultural commodities.

Furthermore, the weighting strategy was based on the relative importance of each commodity in household consumption. That is, it was a base year quantity weighted index (CSA). Therefore, it has failed to demonstrate the quantity produced to signify the performance of the agricultural commodities market.

The FAO Food Price Index (FFPI) was introduced in 1996 as a public good to help the development of the global agricultural commodities market. The purpose of the index was not to use it as an indicator on its own to assess the domestic agricultural commodities market. In addition, it has focused on the export share of a commodity in the international market. In other words, the FAO FPI have been used as a measure of the monthly change in international prices of a basket of food commodities weighted by the average export shares of each of the groups.

By implication, the FAO FPI has relied on commodities that could be exported from the country and imported into the country (FAO, 2021). But there are many agricultural commodities that are dominantly produced and consumed in the local market that the FAO FPI could not address because the indexes were based on global export share and the actual price paid by individuals is quite differences. Therefore, this study tried to fill the aforementioned gaps. That is, it attempted to develop price indexes for agricultural commodities.

## 4. Research Methodology

Purposeful sampling techniques were used to collect the data. Ten years data on the retail prices of the agricultural commodities which were recorded from 2010-2020 were chosen. The reasons for selecting these years were that these years were considered as the most recent periods which could help the researcher be in a position to reflect the current situation and forecast the future market better.

That is, if the data included the long past, it might be far in time and could not reflect the current market conditions due to the dynamic nature of the market. Secondly, only major market areas which were supposed to represent the market in the country were chosen purposefully. Out of the nine regions and two city administrations, three regions, and one city administration that share at least ten percent of the overall

Ethiopian major markets were selected. Specifically, of the nine regions, three regional states, namely Amhara National Regional State, Oromia National Regional State, South Nations Nationalities and Peoples Regional State were chosen, and of the two city administrations, Addis Ababa was selected. Thirdly, the index's consists of ten crops from five categories based on its relative importance in the country's crop production share such as cereal (80%), root crop (5%), pulse (5%), spice (5%), and oilseeds (5%) (CSA, 2016).

To construct the index for the selected agricultural commodities, the Laspeyres production quantity weighting index approach was used because it was found to be appropriate for the nature of the data and the objective of the index construction process in the current study.

The first elementary item indexes are calculated as follows:

$$p_{i,j}^{t} = \frac{p_i^t}{p_i^0} \, x100$$

Where:
$p_{i,j}^{t}$ is the price index for item i in region j at period t;
$p_i^t$ is average monthly price of a commodity i in region j at period t;
$p_i^0$ is the price of item i in region j as an average monthly price over the three-year base period 2014-2016.

The elementary item indexes were then aggregated via their region weights to derive the overall national item index. After the elementary indices were computed, indices at the upper level were calculated as weighted averages of the elementary indices by using the Laspeyres formula where the weights were the share of the average of the quantity produced.

The formula for aggregation of items in areas to derive a national item index is:

$$p_I^t = \sum_{j=1}^{4} w_i\left(p_{i,j}^{t}\right) / \sum_{j=4}^{4} w_j$$

Where:
$P_I^t$ is national index for item i in period t;
$w_j$ is the national weight of region j weighted as a an overall share of Ethiopian major markets.

The overall country levels all items index compiled by aggregation of items across areas using national item weight as follows:

$$p_n^t = \sum_{i=1}^{10} w_i(p_I^t) / \sum_{i=1}^{10} w_i$$

Where:
$p_n^t$ - is the national all items index at period t;
$w_i$ - is the weight for item i as an average over the three-year base period 2014–2016 quantity produced.

## 5. Results and Discussion

The purpose of this study was to develop a price index for agricultural commodities in Ethiopia. Agricultural commodities from five categories, namely Cereal, Pulses, Oilseed, Root crop and Spices were taken. From the five categories, a total of ten crops were chosen and included in the index based on their proportionate share in the overall agricultural commodity as weight.

The result revealed that the price of agricultural commodities exhibited an ever increasing trend in all of the regions of the country and in Addis Ababa city administration during the study periods between 2010 and 2020. Some special sudden increases were also recorded in some years as compared to the past, specifically in the year 2017.

While providing similarity in the ever increasing trend of crop prices throughout the country, there were some differences in prices of crops across the regional states and the Addis Ababa city administration over the study periods. That is, the price of a specific commodity was relatively low in one region as compared with others, and it might be higher in another crop in comparison to other regional states and the national average. For example, prices of Teff and Wheat were relatively the lowest in ANRS and of the lowest prices for maize and sorghum were observed in SNNP, while the lowest average price of barley was witnessed in ONRS.

Specifically, in the Amhara Region, the index of Teff prices is relatively lower than the national average, while the Sorghum and Wheat indices are a bit higher than the national average. During 2017, price indexes for most of the crops suddenly increased. For example, the sorghum price index dramatically increased to a point of 395, up from 104 points in the previous periods.

The same sudden rise in the index was recorded at the national level, which rose from 104 to 192 in the price of sorghum. The price index of maize in most of the

periods, especially from 2010 up to 2017, was lower in the region than the national average. After the year 2017, in which the highest ever index level was recorded, the increase in its price at ANRS was far greater than the increases in other regions and the national average comparatively. Starting from mid-2018 up to the end of 2020, the ANRS price index for maize was above the national average.

Concerning barley, a slight decline in the first eight months was recorded both at the national level and at the ANRS level, while a rapid increase followed from June 2011 until November 2013. From 2014 up to the beginning of 2017, lower and relatively stable prices were recorded, followed by a sharp increase in late 2017. In most of the periods, the ANRS barley price index is above the national average, with the highest ever index point of 215 recorded in 2020 at ANRS, where the national average for a similar period was 185.

The price of cereals at an index level moves in a similar pattern to the national average in Oromia national regional state, a region which accounts for 27.66% of the weightings in the Ethiopian agricultural commodities price index. With the exception of the last few months, the price of cereals in this regional state, at an index level, was slightly lower than the national average. Since 2017, the index of sorghum, wheat, and barley has been rising rapidly.

A similar sudden rise in the index was recorded at the national level too for the same crops. With respect to teff, its price was declining at the beginning of the study period, but it began to rise between the periods from 2011 to late 2013. Relatively, price stability was observed in the price of Teff in the years from 2014 up to the beginning of 2017, followed by a subsequent rise.

In most of the study periods, specifically from 2010 up to 2016, the price of maize in ONRS at index level was lower than the national average. After that, it was higher than the national average. This implies that the increase in prices in the region was higher in magnitude than the increases recorded at the national level on an average.

In September 2019, the ONRS maize price reached its highest ever index point of 220. The Southern Nation Nationalities and Peoples region (SNNP) accounts for 35.66% of the weightings in the Ethiopian agricultural commodities price index. The SNNP price of cereals at an index level moves in a similar pattern to the price movements at the national level. Except for a few months in the study periods, the prices of most cereal crops in SNNP were above the national average at index levels.

The year 2017 was a period wherein special increments were observed in most of the commodities in SNNP, the same as in ANRS, ONRS and Addis Ababa too. As compared to other crops, the price indexes of barley and wheat in SNNP were relatively stable from the end of 2011 up to 2016, while the sustainable rise was exhibited following the 2017 increment. In particular, the price of sorghum was found to be the most volatile compared to the prices of other cereal crops in the

SNNP markets during the study periods. This might result from the lack of market integration in agricultural commodities and the production quantity of this particular crop in the region.

That is, the weak market integration and poor supply chain in the marketing of agricultural commodities across regions can result in the variations in price volatility of agricultural commodities. According to the report of FAO (2015), in Ethiopia, sorghum is the single most important staple in drought-prone areas in which the majority of its imports take the form of food aid, and the sorghum value chain is long and involves too many small operators.

In line with this, the main sorghum producing regions are Oromia National Regional State and Amhara National Regional State are the main sorghum producing regions, accounting for nearly 80 percent of total production according to the reports of the Central Statistics Agency. As a result, sorghum from surplus areas is transported to deficit areas, among which SNNP is the one that is considered as deficit area specifically for sorghum as recorded by Famine Early Warning Systems Network (FEWSNET, 2014).

In short, it is likely that SNNP's high price volatility of sorghum as compared to other cereal crops can result from a lack of adequate production in the region.

As mentioned above, like SNNP, special increments in price indexes of most agricultural commodities were seen in Addis Ababa in 2017. There might be different reasons for these unique increments. For example, Addis Ababa is the capital city of the country and accounts for 10% of the country's major market areas wherein agricultural commodities from all corners of the country are bought and sold at large.

In most of the study periods, the price index of Addis Ababa was found to be above each of the regional states and the national average too. This is because it is receiving city rather than a producing one. Many of the crops under study that were traded in Addis Ababa came from ANRS, ONRS, and SNNP.

Hence, the price in Addis Ababa is highly impacted by the prices in those nearby regions, which are major producers of the commodities. Moreover, transportation costs were other factors that impacted its price. The finding of this study shows that the indexes of cereals in Addis Ababa were more volatile than the national averages except for sorghum.

That is, as the price volatility is associated with different factors, the marketing system is one of them. That is, in market areas that are major producers of a specific crop, its price tends to be relatively lower and less volatile than the national average. The Addis Ababa city administration is the one wherein the studied crops are traded but is not a major producer of any of them. That means crops sold in the 12 Addis

Ababa market were transported from other regions, hence the prices for almost all crops were high and volatile, with an exception to sorghum.

According to the central statistics agency agricultural sample survey data, sorghum is one of the major staple crops and drought-tolerant crops grown in the poorest and most food insecure regions of Ethiopia. Besides, the consumption of sorghum has increased in areas affected by adverse climate conditions, which favor the production of sorghum over other cereals.

According to a USAID (2012) report, sorghum accounts for 10% of the daily caloric intake of households Ethiopia's eastern and north-western parts. That is, where teff is used to make injera (the traditional food) in more productive areas, sorghum grain is used for making injera in these areas as a substitute for teff. Therefore, when teff prices decline, the consumption of sorghum also declines, and when teff prices rise, the consumption of sorghum also rises, in areas affected by adverse climate conditions. However, its consumption in Addis Ababa is insignificant, and so its price volatility is not as high as other cereal crops.

Coming to root crops, they are more volatile than other groups of crops included in this study. From July 2010 to January 2017, Addis Ababa's root crop price index tracked the national root crop price index. The price of onions in Addis Ababa was highly volatile throughout this period. A rapid rise in onion prices has been recorded in March 2017, from an index point of 74 in January 2017 to 220 in March 2017.

Following this rise, the index rests within a range of 220 to 264 points, up to the 2019 January index level. Prices have been dramatically rising since November 2019, reaching their peak point of 585 on an index level in February 2020. With the exception of a few months, the price of potatoes in Addis Ababa moves at nearly the same rate as the national average over the study period. The frequent fluctuation and volatility in root crops is not exhibited only in the Addis Ababa city administration but also in other regional states and the national average too.

At the national level, the price indices of pulses and oilseeds initially showed declines for certain months, and then they rose, followed by another decline in the periods between October 2011 and March 2015, specifically for pulses. The price of pulses was in an increasing pattern during the periods between April 2015 and September 2016, and then went back to declining and continued fluctuating at a smaller rate until January 2019; after that, it increased considerably and reached its peak (231) in June 2020.

The lowest point in the price of Niger was reached in February 2014; after that, it steadily increased in the rest of the periods; the highest ever level of the price index for Niger was recorded in 2017, which was 204, and that was its peak.

The year 2017 was the period in which special increases in prices were observed in almost all of the crops used for this study. The major reason behind this occurrence might be the currency devaluation that the Ethiopian government has made since 2017. The National Bank of Ethiopia (NBE) has announced a devaluation of the country's currency by 15% effective Wednesday, October 11, 2017.

The government of Ethiopia has been implementing a "managed float" exchange rate system for a long period of time. This is because the exchange rate does not have a given path and is, therefore, allowed to fluctuate every day through the authorities' occasional intervention in the foreign exchange market by means of buying and selling currency. However, in all of the previous years,

Ethiopia's official exchange rate was fairly stable with a nominal devaluation of 5% per year, with the exception of some significant devaluation but no single instance of appreciation. Countries devalue their currencies for different reasons, such as to boost exports, to improve their balance of payments, or to reduce sovereign debt burdens.

The main argument behind the currency devaluation by the Ethiopian government rests on the first one; that is, devaluation would empower exporters to make more money in the local currency for a given amount of sales abroad, thereby encouraging them to export more. This argument, however, assumes that Ethiopia could earn much more hard currency by exporting more when export prices rise in local currency and that imports would significantly decline when their prices increase in local currency (NBE, 2017).

That is, it is based on the assumption that supply of export and demand of import are quite flexible. In addition, to be successful, the devaluation needs to be accompanied by tight monetary and fiscal policy, which the NBE should implement.

Theoretically, the devaluation of one currency has both advantages and disadvantages. There is valid evidence which shows the positive impacts of devaluations. Brazil, for example, devalued its currency by 64% in 1999, South Korea devalued its currency gradually in the 1970s, and Egypt devalued Egypt's pounds by approximately 200 % between November 2016 and May 2017.

The devaluations of these countries were successful for the reason that they were supported by restrictive monetary and fiscal policies to curb inflation. However, the results of the present study showed that the devaluation is followed by an immediate rise in the prices of major cereal crops in the country, except Teff.

This finding is confirmed by the report of the monthly update on the Ethiopian economy (UN, 2020) that stated, in any episodes of significant devaluation in Ethiopia, a significant increase in export earnings and a decline in imports were never witnessed because its exports are still limited to agricultural commodities.

In principle, inflation is likely to occur after devaluation due to rising import prices and increased demand for exports. Immediately after the Birr devaluation on October 10, 2017, the prices of almost all commodities and services increased significantly, leading to an increase in the overall price level.

Thus, it is in line with the finding of Korsa *et al.* (2018) and Rajan (2018) that the rise in inflation in Ethiopia following the devaluation once again confirms that there is a direct link between devaluation and inflation. One of the important factors in keeping inflation high in Ethiopia is the frequent devaluation.

In general, despite the differences in its magnitude, the price index of agricultural commodities in Ethiopia has been steadily rising in the three regional states and Addis Ababa City Administration.

There were some ups and downs in the patterns, that is, there were periods when declines in prices were recorded, but the declines were still above what they had been in the previous period's average. It is implied that once the price of a commodity rises, its probability of declining is very low as it becomes the norm to continue rising. Even the seasonal decline at harvest time was not as high in magnitude to offset the previous period's increment.

The regional and national price indices constructed in this research offer advantages for in-depth price monitoring and analysis, and provide a basis for forecasting. In addition, it provides researchers and interested parties, such as producers, traders, cooperatives, consumers, and the government, with a thorough breakdown of price changes that allows them to better understand recent market developments.

## 6. Conclusion

Price indexes of ten agricultural commodities were developed, and the constructed indexes demonstrated a substantial rise in prices since 2010, reaching their highest levels in 2020, taking the 2014-2016 average production quantity as a base; the findings revealed that once the price of a specific crop has increased, its possibility of declining below its previous average is unlikely.

Thus, the persistent and continuing trend of agricultural commodity prices is highly likely to worsen consumers' lives and would generally boost the cost of living in Ethiopia. If this trend continues, it would be difficult for the majority of the people of Ethiopia to afford to pay for food items.

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