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Analysis of rural–urban vegetable market dynamics in Central Gondar Zone, Ethiopia

Marelign Adugna[1*], Assefa Tilahun[1], Tigist Petros[2] and Kibrom Adino[2]

Abstract

Background Vegetable crops are among most perishable agricultural products which require efficient marketing system to reach them fresh to consumers. Weak market integration and sluggish price transmission of such perishable products can lead to suboptimal allocation of resources. This study was aimed to identify the degree of vegetable price integration and speed of price transmission between urban and rural vegetable markets.

Methods Two rural markets (Maksegnit and Koladiba) and one central urban market (Gondar) were selected for the purpose of the analysis based on their strong relationship as supply and destination market for vegetable crops. Price data of vegetable crops were collected from September 2013 to December 2018 from each market areas trade and revenue department offices. Augmented Dickey-Fuller test, Granger causality test and error correction model were utilized in the process of the analysis.

Results The result shows that both rural markets were integrated with urban market for garlic crop. In addition, the rural markets caused the urban market to change not in the reverse direction. Moreover, urban market is adjusted by about 30% per month when there were a 1% price shock in rural markets for garlic crop. This speed of price transmission is sluggish for perishable crops and seasonally flexible prices.

Conclusion This study concluded that vegetable prices are determined from demand side and it should be the target for any planned policy modification.

Keywords Cointegration, ECM, Market, Price, Rural, Urban, Vegetables

Introduction

Inefficiency of domestic agricultural markets is mentioned as one of the factors held responsible for the reduced productivity of farmers and for the poor performance of the agricultural sector in the developing countries [1]. Effective coordination of different markets is critical to increase the opportunities for exchange and interdependence that underlie growing and expanding economies. Spatially efficient markets increase supply and decrease price of goods and services in deficit areas, and decrease supply and increase price of goods and services in surplus areas [2]. This increases the benefit of both producers in surplus areas and consumers in deficit areas to generate a positive net effect on social welfare which is a very important social function of spatial arbitrage [2].

Prices are a measure of availability because they tend to rise as the supply of food falls in relation to demand (e.g., poor production, constrained imports of food), and they tend to fall when supply expands in relation to demand (e.g., a bumper harvest). Agricultural prices contribute significantly to the pace and direction of agricultural

*Correspondence:
Marelign Adugna
marlynk3@gmail.com
[1] Department of Agricultural Economics, College of Agriculture and Environmental Science, University of Gondar, P.O.Box 196, Gondar, Ethiopia
[2] Department of Rural Development, College of Agriculture and Environmental Science, University of Gondar, P.O.Box 196, Gondar, Ethiopia

development. They serve as market signals of the relative scarcity or abundance of a given product [3]. Prices also serve as a stimulus to direct the allocation of economic resources, and to a large extent, they decide the structure and rate of economic growth. Moreover, prices in efficient markets are relatively stable and they can be forecasted [3].

Instability in commodity prices among markets could be detrimental to the marketing system and the economy as a whole. It could cause inefficiency in resources allocation among sellers and consumers depending on the source of variability (that is, whether it is induced by supply or demand side or both). If markets are not spatially or inter-temporally integrated, it could be indicative that market inefficiencies exist as a result of, among others, collusion and market concentration which result in price fixing and distortions in the market [4].

In Ethiopia studies indicated that there is market inefficiency, lack of competitiveness, and flexibility of the agricultural marketing system in the country. According to [1] wheat inter-market price transmission in Ethiopia was sluggish with the problems of pricing conduct. Another study by Samuel [5] on vegetable marketing also indicated that some of the problems associated with vegetables growers in the study area include imbalance-marketing power, inadequate marketing outlets, low price, high and sudden price fluctuation, seasonality, and unpredictability of demand.

In the study area, particularly in rural districts there are a good potential for horticultural production in terms of agroecology, soil nutrient, land, and labor availability. However, low product price in the production areas and relatively high price in urban areas discourage both producers and consumers to utilize the potential. In some cases, price variation between surplus and deficit areas may be observed among the crop types. Study by Getachew et al. [6] indicated that some cereal prices are slightly higher in deficit areas than in the surplus areas, while pulses, like chickpeas and haricot beans, do not show significant difference in prices between deficit and surplus areas. Of the reasons, the perishable nature of crops and effective demand in deficit areas could be mentioned [6]. It is confirmed that price variability between surplus and deficit areas would remain low due to lack of consumer purchasing power especially among the rural poor in deficit areas. A study by Zewudie [7] also found that speed of price transmission for papaya was very fast for some markets, while slowest for others may be due to asymmetric price information and difference in infrastructure.

As fruits and vegetables are perishable goods, it requires even more coordination between the actors within the chain, where transportation and logistics are the key elements [8]. Hence, understanding market integration and price diffusion between rural and urban markets where variability in terms of effective demand is expected enables decision-makers to design cost-effective policy intervention and evaluation of policy effects. This is the prime research gap this study attempts to bridge the divide in rural and urban vegetable markets in the study area. In addition to information on market integration, policy makers also need to be informed about the direction of causal relationships between price dynamics. Although integration and causality are related concepts, knowledge about market integration does not by itself inform about the direction of causality. Hence, this study aimed to investigate market integration, speed of price transmission, and causal relationship between rural and urban vegetable markets. The analysis was focused on four vegetable crops: onion, tomato, garlic, and potato. This is because sufficient price data were found for these mainly produced and marketed vegetable crops in the study area.

Literature review

Market integration is considered an important determinant of food flow, availability, accessibility, and price stability. As Nyange [9] puts it, the extent to which markets make food available and accessible, and keep price stable, depends on the degree of market integration across a region. According to Goletti and Christina-Tsigas [10], integrated markets are defined as markets in which price of comparable goods does not move independently. According to the Law of One Price (LOP), if two markets are integrated, change in price in one market due to excess demand or supply shocks will have an equal impact in the related market price. If this equilibrium condition holds, the two spatially separated markets are said to be integrated. In other words, the Law of One Price prevails between the two markets [11, 12] or the two markets are spatially price efficient [13]. Otherwise, markets may have some constraints on efficient arbitrage, such as barriers to entry and information asymmetry [14] or imperfection competition in one or more markets [15]. Hence, the study of spatial market relationships provides the extent to which markets are related and efficient in pricing.

The notion of market integration is often associated with the degree of price transmission, which measures the speed of traders' response in moving foods to deficit zones when there is an emergency, or some catastrophe that leads to hunger in deficit zones. A number of factors that lead to market integration have been identified [16, 17]. Among the key factors, weak infrastructure and large market margins that arise due to high transfer costs have been asserted as the main factors that partly insulate domestic market integration. Especially in developing countries, poor infrastructure, transport, and communication services gives rise to large marketing margins due to high costs of delivering locally produced commodities to the reference market for consumption. High transfer cost and marketing margins hinder the transmission of price signals, as they may prohibit it [11, 18]. As a result, change in reference market price is not fully transmitted to local prices, resulting in economic agents adjusting partially to shift in supply and demand.

Material and methods

Study area

Data for this study were collected from Gondar city, and Maksegnit and Koladiba rural towns. *Gondar city* is the capital of Central Gondar Zone of Amhara Region. Gondar city is found north of Lake Tana and southwest of the Simien Mountains. It is surrounded by the Gondar Zuria woreda. It has an elevation of 2133 m above sea level. Gondar had been served as a strong Christian kingdom for many years. At this time, it is considered as a capital of Central Gondar Zone. According to Ethiopian Statistics Service population projection [19], Gondar had a total population of 443,156, of whom 217,102 were men and 226,054 were women. *Koladiba* is the capital city of Dembiya district which is one of the districts in the Central Gondar Zone, Amhara Region of Ethiopia. It is 20 km far to the south west of Gondar city. Based on Ethiopian Statistics Service (ESS) [19], the population of the town is estimated to be 25,926. *Maksegnit* is a capital city of Gondar Zuria district located to the south east of Gondar city. It is 26 km far from Gondar city. Based on Ethiopian Statistics Service (ESS) [19], the town had a population of 24,512. In the present study area, the market for vegetable is characterized by traditional one in which selling and buying are heavily influenced by information asymmetry and traditional transportation and with fragmented characteristics.

Data and sampling procedure

In the Central Gondar Zone two rural districts (Gondar Zuria and Koladiba) where vegetables are relatively better produced are selected purposively, and the largest nearby consumer market (Gondar) was also selected purposively to compare the rural and urban price integration of vegetable crops. These two districts are considered as supply market and Gondar city is as destination market for vegetable crops. The respective rural districts capital city, namely, Maksegnit, and Koladiba, and Gondar city monthly price data were taken for the selected vegetable crops.

Data sources and type

The data used in this analysis are secondary data obtained from each district trade and revenue department office. Each of the four vegetables crops, namely, onion, tomato, garlic, and potato retail prices series based on monthly prices that are extended from September 2013 to December 2018 were taken. The retail price data were measured and entered into the analysis as Ethiopian Birr per kilogram of each crop.

Analytical model specification

To answer the objectives of this paper econometric analysis was used. Specifically, to analyze the long-run relationship between rural and urban markets Johansen cointegration test was used [20]. In addition, to capture the short-run relationship and long-run dynamics, the error correction model (ECM) that is derived from the Johansen test was used. These models show whether the short-run reaction goes to the long-run equilibrium path or not in the cases of shock.

In conducting an analysis of time series data by using an econometrics model, checking the stationary of the data is crucial before running the regression or any other tasks. Results derived from the regression models would produce spurious results if nonstationary data are used. Therefore, the first task is to check for the existence of stationary property in the series of retail prices of both vegetable crops. To check the stationary of the data the Augmented Dickey-Fuller test is applied. Moreover, after the stationary test the paper employs two econometric models to achieve the empirical results: the first one examines the short-run and long-run relationships between pairs of rural and urban markets by applying the Johansen test for cointegration and the associated error correction model (ECM). Moreover, to identify which market price causes the other to change, Granger causality test for each pair of the market was employed.

Stationarity test

If time series data are nonstationary, one can study its behavior only for the time period under consideration. Each set of time series data will therefore be for a particular episode. Consequently, it is not possible to generalize it to other times. Therefore, for forecasting, such (nonstationary) time series may be of little practical value [21]. The classical regression model requires that the dependent and independent variables in a regression be stationary in order to avoid the problem of what Granger and Newbold called 'spurious regression.' A test of stationarity (or nonstationarity) that has become widely popular over the past several years is the unit root test. There are several methods to test for unit root in the series. In our analysis, we used the Augmented Dickey-Fuller (ADF) test specified as follows:

$$\Delta P_{i,t} = \beta_1 + \delta\ P_{i,t-1} + \sum_{k=1}^{m} \alpha_k \Delta P_{i,t-k} + \varepsilon_{t}, \tag{1}$$

where $\Delta P_{i,t}$ = the change in retail prices of each vegetable crop in market i at time t, $P_{i,t-1}$ = one period lagged retail price of respective crop in market i, $\Delta P_{i,t-k}$ = the change in retail price in market i with k period lagged, ε_t = is the random term, and β_1, δ, and α_k are coefficients to be estimated and tested.

Test statistic

$H_o: \delta = 0$: Price change in market i has a unit root (nonstationary).

Rejecting the null hypothesis (has unit root) indicates the series is stationary. If the test confirms that the series is nonstationary one technique to transform nonstationary, time series to stationary is to take the difference of the time series. The number of lagged difference terms to include is often determined empirically, the idea being to include enough terms so that the error term in Eq. (1) is serially uncorrelated [21].

Cointegration and error correction model (ECM)

Cointegration can be regarded as the empirical counterpart of the theoretical notion of long-run equilibrium relationship. The concept of cointegration was first introduced by Granger [22] and developed by Engle and Granger [23], giving it a foundation for representation, estimation, testing, and modeling of cointegrated nonstationary time series variables. Two or more variables are said to be cointegrated if each is individually nonstationary, but there exists linear combination of the variables that are stationary. Economically speaking, two variables will be cointegrated if they have a long-term, or equilibrium, relationship between them.

Engle and Granger cointegration test and Johansen cointegration test are two basic approaches that are commonly used to test for cointegration. Engle-Granger test for cointegration is also called a residual-based cointegration test. Because it is based on the residuals of the linear combination of variables that cointegrated test can be done. There are three major steps to undertake Engle-Granger (Residual based) test for cointegration. The first step to undertake cointegration test between two time series is to test the variables for their order of integration. This can be done by differencing the series until it becomes stationary. A series is said to be integrated of order 'd,' I(d), if it has to be differenced 'd' times to produce a stationary series. If two series are integrated of order one I(1), the second step in estimating the long-run equilibrium relation is regressing the dependent variable on independent one. In this paper retail price of each vegetable crop market was regressed on each of other rural markets price, and rural markets price was regressed on Gondar city market price since no priori information was given about independent and dependent variables. The last step is testing the residuals of each regression for stationarity. If the residuals from linear combination of nonstationary series are found to be integrated at level I(0), it is said to be the time series variables are cointegrated. The basic long-run model is

$$P_{i,t} = \alpha + \gamma P_{j,t} + \nu_t, \tag{2}$$

where $P_{i.t}$ = Retail price of each crop in market i at time t, $P_{j.t}$ = Retail price of each crop in market j at time t, ν_t = Random error, and α *and* γ are coefficients to be estimated.

In each case, an ADF test [24] on the residuals was performed to determine whether the OLS results adequately describe the cointegrating relationship among these categories. After getting cointegrated relationship, the residuals from the equilibrium regression can be used to estimate the error correction model.

The error correction model (ECM) of Engle and Granger [23] has received important recognition for the specification and estimations of dynamic economic models. Unlike the static framework, the ECM includes a dynamic component that captures the effect of adjustment of the dependent variable when it deviates from its long-term equilibrium level. Hence, in this analysis an ECM is specified to account for the dynamic nature of price adjustment. The equation is specified as follows:

$$\Delta P_{i,t} = \beta + \delta \Delta P_{j,t} + \theta \nu_{t-1} + \varepsilon_t, \tag{3}$$

where δ = captures the immediate responsiveness of price at market i to changes in the price at market j, θ = is an error correction term, which measures the speed of adjustment of Pi,t to the long-run equilibrium $\gamma P_{j,t}$, $\nu_{t-1} = P_{i,t-1} - \alpha - \gamma P_{j,t-1}$, that is, the one period lagged value of the residuals from the cointegrating regression Eq. (2), and ε_t = is a random error term.

Equation (3) describes the variation of price at market i in terms of its reaction to fluctuations in the price of market j and adjustment to own long-term equilibrium.

For the ECM to be valid, first it is needed to ensure that the time series used in the estimation is stationary. The stationary properties of the price time series (both levels and first differences) are tested using the augmented Dickey-Fuller (ADF) procedure. In each case, the hypothesis tested is that the time series follows stationary processes with the unit root. Rejecting the null hypothesis allows the time series to be tested as stationary. In addition, the existence of a long-term cointegration relationship between prices at market *i* and *j* is tested in order to check the validity of the error correction part.

Granger causality test

The causality test is used to identify the direction of causal relationship between pairs of markets. This test enables to select market pairs with significant causal relationships and identification of the major markets.

When two price series are cointegrated and stationary, one may proceed to carry out the Granger causality test to determine the direction of causality. To conduct the test for causality, the market pairs of market *i* and *j* were considered. The Granger causality test assumes that the information relevant to the prediction of the respective variables, P_i and P_j, is contained solely in the time series data on these variables. The test involves estimating the following pair of regressions:

$$P_{i,t} = \sum_{h=1}^{n} \alpha_h P_{j,t-h} + \sum_{k=1}^{m} \beta_k P_{i,t-k} + u_{1t}, \tag{4}$$

$$P_{j,t} = \sum_{k=1}^{m} \lambda_k P_{i,t-k} + \sum_{h=1}^{n} \delta_h P_{j,t-h} + u_{2t}.$$

The estimation of causality test is based on the residuals sum of squares of Eq. (4). Taking the residual sum of squares of restricted regression (regression of price at market *i* on its own lagged price), and unrestricted regression (regression of price at market *i* on its own lag and price of market *j*), and testing the null hypothesis that H_0: $\sum \alpha_h = 0$, prices at market *j* do not cause prices at market *i* and $\sum \lambda_k = 0$, i.e., prices at market *i* do not cause price at market *j*. It will be tested by the following F-statistic:

$$F = \frac{(\mathrm{RSS_R} - \mathrm{RSS_{UR}})/m}{\mathrm{RSS_{UR}}/(n-k)}, \tag{5}$$

where RSS_R = residuals sum of squares from restricted regression, RSS_{UR} = residuals sum of squares from unrestricted regression, m = number of linear restrictions (explanatory variables omitted in the restricted regression), k = the number of parameters to be estimated in the unrestricted regression, and n = total number of observations.

Results and discussion

The descriptive results of four vegetable crops retail prices of two rural markets and one urban market, Gondar, are depicted in Table 1. The maximum, minimum, and mean price of individual vegetable crop follow different pattern. The maximum as well as the highest mean price of onion was observed in rural markets. Onion average price of about Birr 14.5 and 11.5/kg are found in Maksegnit and Koladiba rural markets, while Birr 11.2/kg in urban market, Gondar. The implication of the result is that Gondar market mainly traded in with other markets which supply large volume of onion with relatively low price.

Table 1 Summary statistics of vegetable retail prices (in Birr) of sampled markets. Source: Each district trade and revenue department office price data

Crop type	Name of market	Statistics (obs. 64 months data)			
		Mean	Std. dev.	Minimum	maximum
Onion	Gondar	11.22	2.74	7	17
	Maksegnit	14.52	3.63	7.31	22.87
	Koladiba	11.53	3.402	5.75	23.83
Tomato	Gondar	11.91	3.77	5.58	25
	Maksegnit	10.04	4.61	4.25	22.66
	Koladiba	8.31	3.57	3.83	18.39
Garlic	Gondar	34.16	13.83	11	63.88
	Maksegnit	38.14	14.85	11.16	59.17
	Koladiba	33.76	12.69	3.6	58.75
Potato	Gondar	6.34	1.03	4	9
	Maksegnit	5.84	1.40	3.16	9.12
	Koladiba	5.72	1.08	3.99	8.2

Tomato and potato prices were lower at rural markets indicating that these rural markets are supplier of tomato and potato crops to Gondar market. Looking into Garlic market, although the rural markets, Maksegnit and Koladiba, are involved in garlic production, the mean price of garlic was higher in Maksegnit market than the urban market. The reason might be that producers in rural markets prefer to sell large volume of their product directly to the wholesalers of urban market. When producers sell most of their produce to the wholesalers, there could be shortage of the produce in the rural market during slack season which in turn caused high retail price than the destination market. The minimum price of garlic was attained in Koladiba market in December 2016 of Birr 3.83/kg, peak production season, while the price at Gondar market was Birr 43/kg during the same month. The marketing margin, Birr 39.17/kg, was too high, indicating possibly the very sluggish transmission of price to urban market. The highest price of the same crop, Birr 63.9/kg, was observed in Gondar market in September 2015 and it was Birr 57.6 and 56/kg in Maksegnit and Koladiba rural markets for the same month, respectively. The result indicated that high rural market price promptly transmits to urban markets, while low rural market price is slow to be transmitted to urban market. It can also be said from result that the lowest price variation was observed for potato crops, meaning that the price seems more stable and perhaps it is less marketable crop relative to other vegetable crops.

The variation of retail price of vegetables in rural and urban markets through the period considered can also be detected by plotting price series of each market indicated in Fig. 1. By looking the graphs, retail price of onion in Maksegnit rural market and potato in all the three markets seem in general increasing within the time period taken. Tomato and garlic retail prices and onion price in Gondar and Koladiba look stationary throughout the given time although variations were observed among months. This pattern has some implications on how vegetable prices in different markets were moving together over time and the degree to which prices and spatial margins were unstable.

Stationary and cointegration test

The graphs shown above can be used as an informal detection of the price pattern and stationary of the price series at different markets. Formal test about the stationary of price series can be done using ADF test. The results of the stationary test conducted for each crop price at each sampled market are reported in Table 2. The ADF test rejects the null hypothesis that the price series follows a unit root process or is found stationary at level for onion and potato at Gondar and Koladiba markets and for tomato at Gondar and Maksegnit markets. Garlic price is found nonstationary at all the three markers at level. However, testing the same hypothesis for first differences for garlic allows the rejection of the unit root hypothesis at 1% level of significance for all market prices. This leads to the conclusion that only garlic price differentials can be used in the error correction model and Granger causality tests because these models require the prices to be nonstationary at level and stationary at first difference.

Cointegration between the rural markets and urban market for garlic crop was estimated for two pair of markets. Market pairs were developed based on the assumption that price relationship is more relevant in supply–destination markets or rural–urban market than supply–supply or destination–destination markets. Hence, Gondar-Maksegnit and Gondar-Koladiba pairs of markets were tested for long-term relationship of garlic prices. The Johansen test for cointegration between Gondar-Maksegnit pair, Table 3, indicated that the trace statistics at $r=0$ of 26.3764 exceeds its critical value of 25.32, which indicates the rejection of the null hypothesis of no cointegrating equations. However, the trace statistics at $r=1$ of 7.0807 is less than the critical value of 12.25 which indicates the null hypothesis cannot be rejected meaning that there is one cointegration relationship between Gondar and Maksegnit garlic prices.

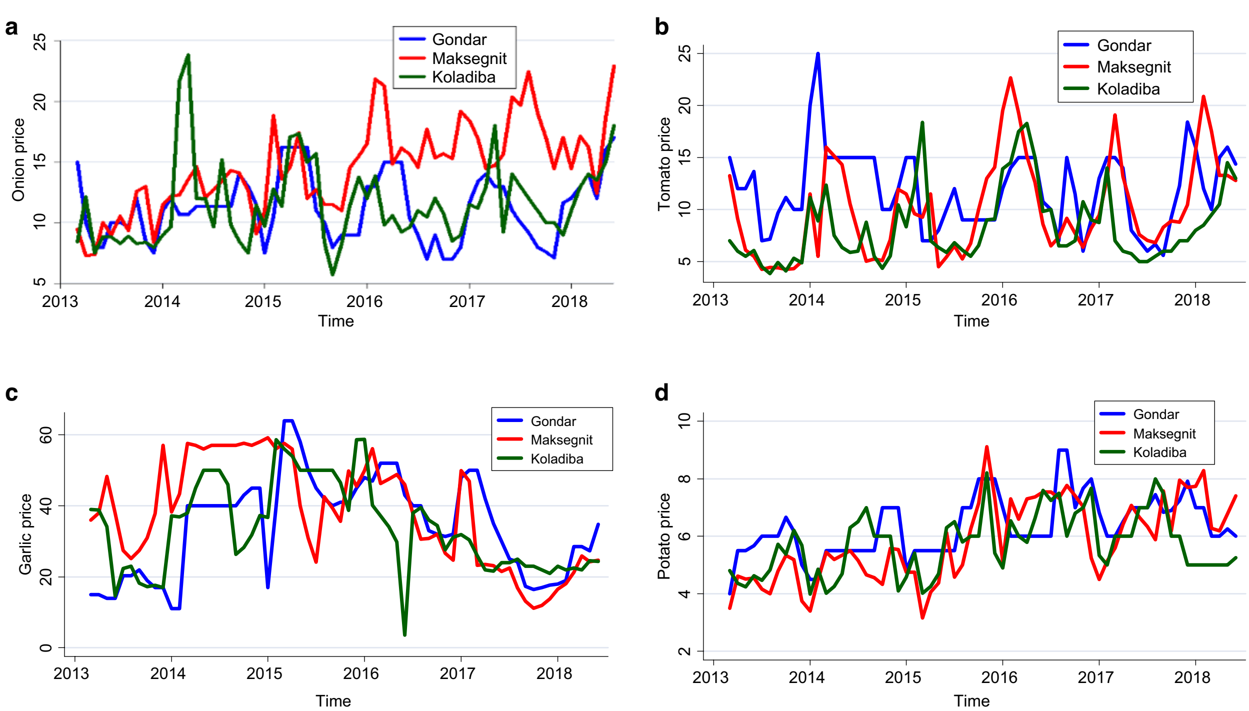

Fig. 1 Retail price pattern of vegetable crops of sampled markets (Source: Each district trade and revenue department office price data)

Table 2 Stationarity test results for vegetable crops retail prices of sampled markets. Source: Model result

Name of market	Crop type	Lag	ADF test statistics (without trend)			
			At level		First difference	
			ADF statistic	Critical value (1%)	ADF statistic	Critical value (1%)
Gondar	Onion	2	− 3.862**	− 3.565	–	–
	Tomato	2	− 3.504*	− 3.565	–	–
	Garlic	1	− 2.786	− 3.563	− 6.582**	− − 3.565
	Potato	1	− 3.406*	− 3.563	–	–
Maksegnit	Onion	1	− 2.784	− 3.563	− 7.492**	− 3.565
	Tomato	1	− 3.247*	− 3.563	–	–
	Garlic	3	− 1.592	− 3.566	− 4.478**	− 3.567
	Potato	1	− 2.526	− 3.563	− 6.684**	− 3.565
Koladiba	Onion	1	− 3.960**	− 3.563	–	–
	Tomato	1	− 2.890	− 3.563	− 6.118**	− 3.565
	Garlic	1	− 2.464	− 3.563	− 6.880**	− 3.565
	Potato	1	− 3.405*	− 3.563	–	–

*, **Null of unit root rejected at 5% and 1%, respectively

Table 3 Johansen tests for cointegration between pairs of market prices. Source: Model result

Market pairs	Lag	Trend specification	Rank	Trace statistic	5% critical value
Gondar → Maksegnit	1	Rtrend	0	26.3764	25.32
			1	7.0807[a]	12.25
Gondar → Koladiba	1	Rtrend	0	25.3632	25.32
			1	5.6663[a]	12.25

[a] Null of at least one cointegrated equation not rejected at 5%

Likewise, Gondar-Koladiba garlic price has also one cointegration equation according to the Johansen cointegration test result shown in Table 3.

Causal relationship between markets

After determining that there is indeed a long-run cointegration relationship between the prices of garlic in urban and rural markets, the next step is to check the causal relationship between these markets. Two rural markets and one urban market pairs that are found cointegrated in the previous test were investigated for evidence of granger causality in both directions (Table 4). Both rural markets cause the urban market, Gondar at 5% significant level indicating that rural markets play significant role in price formation. On the other hand, Gondar market do not have significant role to determine the rural market prices, Maksegnit and Koladiba. The result implies that the price of garlic is determined by supply rather than demand side. This is in line with Worako [25] that Addis Ababa market does not cause other retail markets for vegetable and fruit crops.

Table 4 Granger causality test result between rural and urban garlic markets. Source: Model result

Market pairs	Lag length	Causality $F = \frac{(RSS_R - RSS_{UR})/m}{RSS_{UR}/(n-k)}$	p-value
Gondar causes Maksegnit	1	0.9882	0.3242
Maksegnit causes Gondar	1	4.7785**	0.0327
Gondar causes Koladiba	1	0.08374	0.7733
Koladiba causes Gondar	1	6.6896**	0.0121

**Significant at 5% level

Long-run price relationship and speed of adjustment

Long-run rural–urban price relationship and speed of adjustment toward equilibrium when there is price shock in a given market are modeled by error correction model (ECM). The results of the ECM are reported in Table 5. The adjustment parameters are summarized in the right column of Table 5. When there is a price shock in Maksegnit, speed of price adjustment toward equilibrium for Gondar market is almost equivalent to the price shock occurred in Koladiba market. That means a 100% price

Table 5 Error correction model result. Source: Model result

Crop type	Market pairs	Long-run relationship	Adjustment parameters
Garlic	Maksegnit causes Gondar	− 0.524*	− 0.2868**
	Koladiba causes Gondar	− 1.044**	− 0.3054**

**, *Significant at 1% and 5% level, respectively

change in Maksegnit market is adjusted at a speed of 29% in Gondar per month to sustain its equilibrium position. Likewise, a 100% price change in Koladiba market is adjusted at a speed of 30% in Gondar market per month. It indicates that both Maksegnit and Koladiba markets are similar effect on Gondar market in terms of price adjustment because both are rural markets with similar distance and rural infrastructure development. In fact, considering the nearness of these rural markets to Gondar market, the speed of adjustment is not reasonably large meaning that Gondar garlic price adjusts slowly to changes in the prices of rural market. As Goshu et al. [1] indicated not only distance but also other factors, such as the prevalent marketing system, population density, per capita income, and road density, also affected the speed of price transmission. However, in both cases whether the change in price is a decrease or an increase is not identified.

The long-run relationship between rural and urban garlic prices relationship is unexpected. Both the two rural market prices have negative long-run relationship with urban market. The model predicts that a 1% increase in the price of garlic in Maksegnit is associated with a 0.524% decrease in the garlic price of Gondar market in the long run. Similarly, a 1% increase in the price of garlic in Koladiba is associated with a 1.044% decrease in the garlic price of Gondar market in the long run. This unexpected result may arise due to the effect of significant seasonal price fluctuation of perishable crops, like vegetables, which can mislead the speed of price adjustment and long-run relationship between market prices. To better understand the relationship, seasonal price fluctuation has to be taken into account.

Conclusion

The estimated market integration measures and their tests indicated that the two rural markets found cointegrated with urban market. The result of the granger causality test confirmed that rural market caused the urban market to change. The urban market did not cause the rural market. The implication is that the vegetable price is determined from demand side and it should be the target for any planned policy modification. However, price adjustment for urban market is sluggish, may be due to wholesaler's power in price formation in urban market. Attention should be given to make urban vegetable market more competitive to create strong price integration between rural and urban markets.

Abbreviations

ADF Augmented Dickey-Fuller test
ECM Error correction model
OLS Ordinary least square

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Author contributions

All the authors read and approved the final manuscript. Their specific contributions are stated as follows. MA has achieved the statistical analysis and written the first draft of the paper, KA has contributed to the survey instrument development and data collection process, TP has supervised the field work, and AT has contributed to the interpretation of the results and to the final writing of the paper.

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Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

All survey participants obtained clear oral informed consent prior to the survey.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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