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Research

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Market integration and price transmission in Ethiopian banana supply chain

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Abstract

Local banana market prices in surplus areas are asymmetrically integrated and transmitted with that in central banana market prices or deficit areas due to geographic distance between markets, market power, and high transportation costs. As the result, the banana marketing margin is high due to high transport costs and transaction costs. Although the policy relevance of degree of vertical and spatial price transmission in banana supply chain, in Ethiopia is largely unknown, and this study assists to bridge the existing gap. The study investigates degree of spatial and vertical market integration and price transmission of banana supply chain in Ethiopia. ARDL co-integration bound tests and Granger causality tests are employed to examine vertical and horizontal price transmissions in banana supply chain using 10 years average monthly banana prices. The study finds relatively a higher degree of price transmission from central wholesale banana market to surplus banana market. Central wholesaler price has a significant effect on both banana producer and retailer prices in both long-run and short-run. The result indicates that Granger causality is running from central wholesale market to local markets. There may be high transaction cost may reflect the vertical and spatial asymmetric price transmissions in banana supply chain. Policy interventions in banana supply chains could facilitate a faster and substantial degree of price transmission between actors in banana supply chain.

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1. Introduction

The theory concentrates on the demand and supply-side effects on the speed or magnitude of price transmission, empirical analysis and research is largely focused on identifying whether the existing price transmission is asymmetric or not. High market integration and price transmission could improve aggregate food availability and efficiency of food distribution in urban areas. Market integration and price transmission have a positive impact on the welfare of both

producers and consumers. Food security is highly associated with a high degree of market integration. Better market integration leads to faster transmission of price signals and encourages producers to specialize according to comparative advantage and thereby enjoy welfare gains from trade (Baulch, 1997). Efficient market integration is very important to increase producers' benefit in the long-run from technological change (Barrett, 2008). Market integration stimulates producers to use superior technologies that have a great impact on productivity. A perfectly competitive market is completely integrated and transmitted (Knetter and Goldberey, 1996). A closely related concept involves the degree to which price shocks tend to be transmitted across spatially separated markets. High transaction costs are a responsible factor for asymmetry in price transmission between markets (Balke and Fomby, 1997; Balcombe et al., 2007). Prices transfer signals about food deficit and food surplus in different areas (Habte, 2016). Changes in prices at different points along the marketing chain may have essential implication for the welfare of consumers and/or producers and are thus of concern to policy-makers (Sexton and Lavoie, 2001; von Cramon-Taubadel, 2017). Meyer and von Cramon-Taubadel (2004) observe that a possible implication of asymmetric price transmission is that consumers are not benefiting from price reduction at the producers' level, or producers might not benefit from price increase at the retail level.

Market power and concentration at various stages of supply chains can be the causes of asymmetric price transmission (Meyer and von Cramon-Taubadel, 2004). Product perishability (Ward, 1982), high transaction costs (Balke and Fomby, 1997; Balcombe et al., 2007), and public intervention in producer prices (Habte, 2016) are also the causes of asymmetric price transmission. Asymmetric price transmission has been studied by using different econometric methods, from the classical specification to cointegration (von Cramon-Taubadel, 1998) and threshold models (Balke and Fomby, 1997). Kuiper et al. (2003) pointed out that high transaction costs impede market integration and as a consequence, not all spot markets perform equally well. This implies that with the high transaction costs, actors in surplus areas cannot be informed on time about price changes in deficit areas. This paper tries to identify the presence of price symmetries across banana supply chains.

The paper contributes to the literature by further attempting to link the presence/absence of price transmission asymmetries in a banana supply chain. This paper contributes to the existing literature on asymmetric price transmission in the supply chain. Studying price transmission

along the banana supply chain is very expedient to understand the functioning of food production, processing and distribution. Vertical price transmission analyses can help to identify market failures. A better understanding of price transmission in banana supply chain in Ethiopia can simulate banana production, and encourage actors to produce more and to participate in the supply chain to enhance their income levels. Therefore, the relationship between different prices in different stages of banana supply chain is an important research topic in Ethiopia. In addition, the knowledge about the behavior of the spatial markets and the relationship between the local producer, central wholesale and retail market prices and the local market prices can be employed as an information source for targeting potential policy interventions to improve the performance of banana markets, and alleviate fluctuation in producer prices to stabilize their income. The study investigates whether there is a long run and short run vertical price transmission in banana supply chain using time series data observed from 2009 to 2018 at monthly frequency. Since, there is limited empirical research that explores actors' price transmissions, and explains supply and demand dynamics and drivers of equilibrium price in banana supply chain in Ethiopia. Thus, this paper examines market integration, and vertical and spatial price transmission between producer, wholesaler, and retailer prices in banana supply chain of Ethiopia. This paper is organized as follows. The second section reviews about spatial and vertical price transmissions. The third section presents the methodological approach. The fourth section discusses the empirical results that evaluate dependence between producer, wholesaler, and retailer prices in banana supply chain. The last section provides concluding remarks and policy implications.

2. Literature review

2.1. Market Integration

Market integration is explained as the extent of price transmission between two, either vertically or spatially, related markets. From an alternative perspective, commodity market integration can exist spatially and vertically. In the spatial integration, inter-linkages exist between surplus and deficit commodity markets, while vertical integration exists between local markets in different stages market. Local market integration involves spatial links of various regional markets. The concept of market integration refers to the tradability of products between spatially distinct markets, irrespective of the presence or absence of spatial market equilibrium and efficiency (Barrett and Li, 2002). The operational definition of market integration is identified as the law of

one price. Homogeneous commodities follow the law of one price (Monke and Petzel, 1984). That is homogeneous commodities are sold at a uniform price across different markets. If the identical commodities are sold at a uniform price in all markets, then it could be regarded as an integrated market. In the local economy, if identical commodities follow the law of one price there will be local market integration.

Spatial integration may imply perfect price transmission (i.e., that a price change in one market causes an identical adjustment in another market) (Fackler and Goodwin, 2001). The commodity market integration is very useful to improve producer profit. If goods and information flow freely among spatially separated markets, the effects of price changes in one market are transmitted to another market. The consequence of spatial arbitrage is the Law of One Price (LOP), as already derived by Fackler and Goodwin (2001) in markets linked by trade and arbitrage, homogeneous goods will have a unique price, when expressed in the same currency, net of transaction costs. In this context, market efficiency indicates the capacity of markets to minimize costs when they match supply and demand. In a competitive market with perfect information, arbitrage will ensure that price differentials will reflect all marketing costs.

2.2. Basic concepts and methods for the study of price transmission

Price transmission is a change in one price that causes a change in another price (Meyer and Cramon-Taubadel, 2004). Generally, it is measured in terms of the transmission elasticity, explained as the percentage change in the price in one market given a 1% change in the price in another market. Price changes are transmitted along the spatial and vertical food supply chains (Lloyd, 2017). The price transmissions are divided into three – vertical, spatial and cross-commodity transmissions. Vertical price transmission exists when there is an interaction between prices in different stages. It is described by degree (of completeness of pass-through of price change), speed, and type of price adjustments through the supply chain. Such changes are usually represented as responses to shocks at some points in the chain. Horizontal price transmission refers to the existing linkage among different markets at the same position in the supply chain. The notion of horizontal price transmission usually refers to price linkages across market places (spatial price transmission).

The asymmetric price transmission exists when the adjustment of prices is not homogeneous with respect to characteristics, external or internal to the system. In economic literature,

asymmetric price transmission caught attention because of two reasons. First, its presence is not in line with predictions of the canonical economics theory (e.g., perfect competition and monopoly), which expects that under some regularity assumptions (such as non-kinked), convex/concave demand function) downstream responses to upstream changes should be asymmetric in terms of absolute size and timing. Secondly, asymmetric price transmission is important from the welfare point of view, which means, welfare redistribution from downstream actors to upstream actors and it has serious political and social implications (Wlazlowski, 2003). In theory, spatial price determination models suggest that if two markets are linked by trade in a free market regime, excessive demand or supply shocks in one market will have an equal impact on price in both markets. High transfer costs and marketing margins hinder the transmission of price signals as they prohibit arbitrage. As a result, changes in international market prices are not fully transmitted to domestic prices, resulting in economic agents adjusting (if at all) partly to shifts in international supply and demand (Sexton et al., 1991).

Most of the analyses focusing on asymmetric price transmission refer to non-competitive market structures as an explanation for asymmetry (Abdulai, 2000). Evidence of asymmetric price transmission has been considered as a manifestation of market failure (Meyer and von Cramon-Taubadel, 2004) and thus provides justification for regulatory public interventions. The literature indicates that asymmetric price transmission can be caused by several factors, such as transport and transaction costs, market power, adjustment costs and domestic policies (Meyer and von Cramon-Taubadel 2004; Ghosh and Rajan 2006). Abdulai (2000), Kuiper et al. (2003) found that non-competitive behavior among intermediaries in supply chains has an adverse effect on producers. The imperfect completion provides an opportunity for intermediaries to exercise market power.

Markets are perfectly integrated with each other in the long-run due to better and direct road and rail links, common socio-economic cultures, better flow of information between those markets (Zahid et al., 2007). Bakucs et al. (2013) found that there is asymmetric price transmission in both long-run and short-run. Generally, earlier studies concentrated on inter-regional spatial grain and fruit market integration in Ethiopia (Negassa et al. 2004; Getnet et al. 2005; Jaleta and Gebremedhin, 2009; Tamru, 2013; Wondemu, 2015; Habte, 2016; Haile et al., 2017; Yami et al., 2017), analytical research on vertically banana price transmission is largely limited in Ethiopia.

Therefore, this paper makes an attempt to empirically investigate the market integration and price transmission banana supply chain in Ethiopia.

3. Methodology

3.1. Data

The study is going to analyze the degree of market integration and price adjustment of banana prices in the supply chain in Ethiopia. Data on monthly average banana producer, retail and wholesale prices are compiled over a total period of 120 months (2008:1 to 2018:12). Average monthly producers and wholesaler and retailer prices with 120 total observations are used, which are gathered from CSA databases from September 2008 to September 2018. Prices of producers, wholesalers and retailers in three banana markets are selected for this study based on the availability of data, surplus and deficit markets. The central wholesaler and retailer prices of banana are collected from CSA databases of Ethiopia. Wholesaler and retailer prices of banana in Addis Ababa are considered as an explanatory variable for the local producer prices of banana. Arbaminch and Tepi are chosen as local surplus banana markets in this analysis. These major banana producing areas supply banana to central wholesale markets or deficit banana markets. Therefore, the wholesaler and retailer prices of banana in the Addis Ababa market, Arbaminch and Tepi retailer prices are modeled as explanatory variables for the producer prices of banana at the supply markets. Arbaminch and Tepi are located at a distance of about 500 kilometers south of Addis Ababa and 565 Kilometers southwest of Addis Ababa, respectively the capital city of Ethiopia since it can be anticipated to fairly characterize the banana production of Ethiopia, where most of the banana production is concentrated in these areas.

3.2 ARDL Bounds tests for cointegration

In view of this, the ARDL model employed here to study the spatial price behaviors of banana is used to check for the forcing variables in order to avoid uncertainty about causality and finds evidence that central wholesale prices are forcing variables for local prices. Market integration and price transmission are examined by employing the time series techniques of ARDL Bounds test, and Granger causality test. Before identifying any relationship between variables, the non-stationarity of selected data series at first difference has been checked by using the unit root test. I run an Augmented Dickey–Fuller (ADF) test to check the existence of I(2) variables and exclude the probability of dealing with, I(2) variables. The results in Table 1 indicate that there

are no variables with I (2). In particular, the variables appear to be I (0), and I (1). Pesaran and Shin (1999) and Pesaran et al. (2001) developed the ARDL approach which has advantages over conventional cointegration analyses. For instance, ARDL approach to cointegration has some advantages over the other cointegration approach, such as: Engle and Granger (1987), Johansen (1988), Johansen-Juselius (1990). ARDL approach to cointegration is not only capable of differentiating between dependent and independent variables (i.e. it overcomes the effect of endogeneity) but can also estimate the long-run relationships and short-run dynamic relationships elements of the model at the same time. ARDL provides unbiased estimates of the long-run model (Harris and Sollis, 2003). The ARDL model to co-integration testing in this study is specified as:

$$\Delta PPB_t = \alpha_{01} + \gamma_{12} PPB_{t-1} + \gamma_{21} PW_{t-1} + \gamma_{31} PR_{t-1} + \sum_{i=1}^p \beta_{1i} \Delta PPB_{t-i} + \sum_{i=0}^q \beta_{2i} \Delta PW_{t-i} + \sum_{i=0}^r \beta_{3i} \Delta PR_{t-i} + \varepsilon_{1t} \quad (1)$$

Where P_t is the vector and the other variables (X_t , Z_t , and E_t) are allowed to be purely I(0) or I (1) or co-integrated, β , δ , λ , and φ are coefficients, α is constant, p, q, r, and t are optimal lag orders, the lengths for p, q, r, and t are not the same, ε_{jt} captures the disturbance term. PPB_t is the price of banana in a period t and PW_t is the central wholesale market price in period t, PR_t is the central retail market price in period t.

The next step of the ARDL bounds test procedure is to test for a long-run relationship among the variables using F-statistic. The procedure specifies the null hypothesis in Equations 1-4 as $H_0: \beta_1 = \beta_2 = \beta_3 = \beta_4 = 0$ suggesting absence of a long-run relationship and an alternative hypothesis (i.e. presence of co-integration) of $H_1: \beta_1 \neq \beta_2 \neq \beta_3 \neq \beta_4 \neq 0$. The calculated F-statistics are compared with tabulated F-statistics (95% bounds and 99% bounds) values estimated by Pesaran et al. (2001) which are split into lower critical bounds (I(0)) and upper critical value bounds (I(1)) that result incorrect conclusion about co-integration. If the calculated F-statistic value is greater than the upper tabulated value, the null hypothesis of no cointegration is rejected independent of the order of integration of the series, otherwise the null is accepted.

ARDL Bounds test for cointegration is used to estimate the long-run relationships and short-run dynamic relationships among the variables of interest. The present study utilizes the autoregressive distributed lag model (ARDL) of Pesaran et al. (2001) to evaluate the existence of a long-run relationship among prices. The ARDL long-run model for surplus banana market and deficit banana market can be expressed as:

$$PPB_t = \alpha_{01} + \sum_{i=1}^p \beta_{1i} PPB_{t-i} + \sum_{i=0}^q \beta_{2i} PW_{t-i} + \sum_{i=0}^r \beta_{3i} PR_{t-i} + \varepsilon_t \quad (2)$$

Where all variables are as earlier defined, $\beta_1, \beta_2, \beta_3, \beta_4$ are ARDL long-run coefficients, and ε_t is the white noise error term.

Following Pesaran and Shin (1999), and Pesaran and Smith (2001), the error-correction version of ARDL model is specified as follows:

$$\Delta PPB_t = \alpha_{0j} + \theta ECT_{t-1} + \sum_{i=1}^p \gamma_{1i} \Delta PPB_{t-i} + \sum_{i=0}^q \gamma_{2i} \Delta PW_{t-i} + \sum_{i=0}^r \gamma_{3i} \Delta PR_{t-i} + \varepsilon_t \quad (3)$$

Where all variables are as earlier defined, θ is the speed of adjustment, ECT_t is the coefficient of error correction term which is obtained as residual from the long-run relationship in equation 2, γ_1, γ_2 , and γ_3 are the short-run dynamic coefficients of the model's convergence to equilibrium, and ε_t is the white noise error term. The sign Δ denotes the difference operator.

Granger (1969) suggested Granger causality analysis to examine causal interactions between two time-series data. The presence of long run and short run relationships between two variables implies the presence of causality in at least one direction (Granger, 1988). However, co-integration test and error correction model are not sufficient to determine the direction of causality between two time series data. Thus, the Granger causality test can be used to decide the direction of interconnection (Gupta and Mueller, 1982). To test whether institutional credit does Granger causes agricultural real GDP or not, this paper uses the Granger causality test suggested by Granger (1969). This Granger causality test consists of two variables, institutional credit and agricultural real GDP is written as:

$$PPB_t = \alpha_1 + \sum_{j=1}^k \beta_j \Delta PPB_{t-j} + \sum_{i=1}^k \beta_i PW_{t-i} + u_{1t} \quad (4)$$

$$PW_t = \alpha_2 + \sum_{i=1}^k \beta_i PW_{t-i} + \sum_{j=1}^k \beta_j PPB_{t-j} + u_{2t} \quad (5)$$

Where, PPB_t and PW_t are banana producer price and banana wholesaler price, respectively.

Both null and alternative hypotheses are derived from the literature review. Based on β_j and coefficients for the equations (4) and (5) four hypotheses about the relationship between producer price and wholesale price are specified:

1. Unidirectional Granger-causality: Causality is running from banana producer price from banana wholesaler price. In this case, banana producer price dominates price formation in banana wholesaler price but not vice versa. Thus $H_0: \beta_i \neq 0$ and $H_A: \beta_j = 0$.
2. Unidirectional Granger-causality: Granger causality is running from banana wholesaler price to banana producer price. In this case, banana wholesaler price dominates price formation in banana producer price but not vice versa. Thus $H_0: \beta_i = 0$ and $H_A: \beta_j \neq 0$
3. There is bidirectional causality between two pair markets. In this case banana producer price dominates price formation in banana wholesaler price and vice versa. Thus $H_0: \beta_i \neq 0$ and $H_A: \beta_j \neq 0$.
4. Independence. In this case, there is no feedback in any direction between banana producer price and banana wholesaler price. Thus $H_0: \beta_i = 0$ and $H_A: \beta_j = 0$.

4. Results and Discussions

4.1. Results of the stationarity test and ARDL bounds tests for co-integration

By using the unit root test, each variable over the period of 2009-2018 is tested with constant and trend at level and first difference. The results in Table 1 show that null hypothesis of no unit roots for the time series is rejected for banana prices for Arbaminch prices and accepted for Addis Ababa and Tepi banana prices at level. On the other hand, all variables are found to be stationary at first difference with constant and without constant, which means that unit roots in the first differences were rejected at the 1% level of significance. Therefore, the results allow us to use ARDL model to examine the short run and long run equilibrium relationship. In the next step, ARDL bounds tests are run to examine the existence of long run relationships among time series data.

Table 1. Augmented Dickey-Fuller test for following variables with constant and trend (H_0 : unit root)

Variable	Constant		without constant	
	T value		T value	
	Level	FDF	Level	FDF
Arbaminch producer price (APP)	-4.30*** (0.00)	11.97*** (0.00)	-5.35 (0.00)	-10.01*** (0.00)

Tepi producer price (TPP)	-2.29 (0.18)	6.23*** (0.00)	-0.46 (0.59)	-4.11*** (0.00)
Addis Ababa wholesale price (AAWP)	-2.78 (0.02)	-6.76*** (0.00)	-1.02 (0.75)	-5.57*** (0.00)
Arbaminch retail price (ARP)	-3.80*** (0.20)	-6.76*** (0.00)	-3.92** (0.04)	-6.00*** (0.00)
Tepi retail price (TRP)	-1.6 (0.48)	8.89*** (0.00)	-0.46 (0.59)	-7.31*** (0.00)
Addis Ababa retail price (AARP)	-0.61 (0.98)	4.89*** (0.00)	-0.76 (0.49)	-4.55*** (0.00)

Notes: Values of probabilities are in parenthesis. The T value is the test statistic from the Augmented Dickey-Fuller test; an optimal lag length is determined with the help of the Akiake Information Criteria and F-test assuming a maximum lag of four; ***, **, *, denotes rejection of the null hypothesis of non-stationarity at the 1%, 5%, and 10% levels.

Source: Computed from data in Central Statistic Agency (CSA) of Ethiopia (2020).

Table 2. Results of ARDL bounds test for co-integration

Dependent variable	F-statistic	Decision
APP/TPP, ARP, TRP, AAWP, AARP	4.56***	Co-integration
TPP/APP, ARP, TRP, AAWP, AARP	3.75**	Co-integration
ARP/APP, TPP, AWP, TWP, TRP, AAWP, AARP	2.21	No
TRP/APP, TPP, AWP, TWP, ARP, AAWP, AARP	3.35**	Co-integration
AAWP/APP, TPP, AWP, TWP, ARP, TRP, AAP	2.11	No

Source: Author's computation from the CSA database (2020). **Notes:** **, *** significant at 5% and 1 % levels, respectively. Lower-bound critical value and upper-bound critical value are 3.23 and 4.35 at 5%, respectively. Lower-bound critical value and upper-bound critical value are 4.29 and 5.61 at 1%, respectively. Regarding lower critical bound, it is assumed that all the variables are I (0) (i.e., no cointegration among variables) and regarding upper critical bound, it is assumed all the variables are I (1) (i.e., cointegration among variables).

4.2. Long-run and short run relationship in banana supply chains

The error correction model takes into account the adjustment of short-run and long-run disequilibrium in markets and time to remove disequilibrium in each period. In terms of efficiency, prices are transmitted fully and completely given efficient market conditions. The coefficient of price adjustment with negative sign showing a movement back towards equilibrium; a positive sign reflects a movement away from equilibrium. The coefficient should lie between 0 and 1, 0 suggesting no adjustment one time period later, 1 indicates full adjustment. The coefficients of the error correction term show the speed of convergence to the long run equilibrium as a result of shock of their own prices. Coefficients of the ECT (Table 3) have the right sign for each regressor variable and the equilibrium error correction coefficient is statistically significant implying that there is an adjustment in the producer price of banana back to the long-run (equilibrium) position once there is disturbance due to shocks. The coefficients of adjustment vector for retailer markets have a negative sign and significant at 1% level of significance indicates that the short run price movements along the long run equilibrium path are stable. The Arbaminch and Addis Ababa retail prices have positive and significant effect on Tepi retail price in short run and long run, respectively. The estimate of the error correction coefficients for the banana retail markets indicates that the banana market is significant at 1% level with a right sign signifying disequilibrium in the long run retailer prices could be corrected about 60% in Arbaminch retail market and 35% in Tepi retail market in the short run; thus, the short run price movements along the long run equilibrium path is stable (Table 3).

Table 3 The results of ARDL and error correction model for spatial markets

Variable	Arbaminch	Tepi
	Coefficient	Coefficient
Arbaminch/Tepi retail price (LR)	0.93**(0.43)	-0.16 (0.22)
Addis Ababa retail price (LR)	-0.25 (0.18)	0.38*** (0.08)
Arbaminch/Tepi retail price (SR) (D1)	-0.13 (0.30)	0.15**(0.06)
Addis Ababa retail price (SR) (D1)	-0.01 (0.26)	0.09 (0.12)
Adjustment (ECT)	-0.60*** (0.12)	-0.35*** (0.11)
Constant	2.52*** (0.83)	-0.01 (0.42)

Notes: Values of standard errors are in parenthesis. ***, **, *, denotes significant at the 1%, 5%, and 10% levels. Source: Computed from data in Central Statistic Agency (CSA) of Ethiopia (2020).

The results of the speeds of price adjustment vectors in banana supply chains are displayed in Table 4. Addis Ababa banana wholesale price has a positive and significant impact on surplus banana market in both short run and long run (Table 4). The findings indicate that there are significant vertical price transmissions in banana supply chain. The magnitude of the coefficient indicates the speed of adjustment back to the equilibrium position once the system is in disequilibrium. The magnitude of equilibrium error correction coefficient (-0.71) indicates that 71 percent of the previous month's deviation from the equilibrium position is corrected in a particular month. The dynamic speed of adjustment for Tepi banana producer price is relatively slower (-0.36), in absolute value, than Arbaminch banana producer price and it is a reflection of asymmetric price transmission with respect to speed. Arbaminch price relatively adjusts more quickly, and it is more flexible than Tepi producer price to restoration in the long-run equilibrium. The result proves the presence of short-run adjustment between the variables. Overall, a higher level of central banana wholesale price is associated with surplus banana market prices.

Table 4. The results of ARDL and error correction model for vertical price transmission

Variable	Arbaminch	Tepi
	Coefficient	Coefficient
Arbaminch/Tepi retail price (LR)	-0.05 (0.09)	0.36 (0.37)
Addis Ababa retail price (LR)	0.10 (0.14)	0.03(0.15)
Addis Ababa wholesale price (LR)	0.62*** (0.08)	0.10** (0.04)
Arbaminch/Tepi retail price (SR) (D1)	0.03 (0.06)	-0.29 (0.13)
Addis Ababa retail price (SR) (D1)	-0.10 (0.11)	0.13 (0.23)
Addis Ababa wholesale price (SR) (D1)	0.43** (0.21)	0.29** (0.11)
Adjustment (ECT)	-0.71*** (0.18)	-0.33*** (0.10)
Constant	1.79***(0.51)	0.42 (0.37)

Notes: The lag length is selected based on the Akiake Information Criteria and F-test considering a maximum lag of four. The values of standard errors are in parentheses.

Source: Author's estimations from the CSA database, 2020.

The empirical analysis is also extended further to investigate vertical price transmission among all market. This analysis considers both surplus banana markets (Arbaminch and Tepi producer prices) together. The results indicate that there is the existence of vertical price transmission between central wholesale price and local producer prices. The price transmission process in the Ethiopian banana market is determined by the forces in the central wholesale market. The result shows that wholesaler with the central market dominates local price formation in the Ethiopian banana market and local producer prices as a dependent variable on central wholesale and retail market prices, and local retail prices. Wholesale banana price plays a leadership role in vertical market channels. The geographic distance between central market and local market creates a difference in the magnitude of equilibrium error correction coefficient, the higher the possibility of adjusting price in shorter geographic distance becomes, probably due to lower transportation costs incurred in such shorter distance marketing activities.

Table 5. Price transmission in banana supply chain

Variable	Arbaminch	Tepi
	Coefficient	Coefficient
Arbaminch/Tepi producer price (LR)	-0.16 (0.17)	-0.23 (0.47)
Arbaminch retail price (LR)	-0.37 (0.11)	0.14 (0.20)
Tepi retail price (LR)	0.14 (0.17)	0.33 (0.36)
Addis Ababa retail price (LR)	0.07 (0.07)	0.05 (0.15)
Addis Ababa wholesale price (LR)	0.34**(0.13)	0.39**(0.15)
Arbaminch/Tepi producer price (SR) (D1)	0.09 (0.14)	-0.14 (0.13)
Arbaminch retail price (SR) (D1)	0.01 (0.07)	-0.06(0.07)
Tepi retail price (SR) (D1)	-0.05 (0.15)	-0.22 (0.15)
Addis Ababa retail price (SR) (D1)	-0.07(0.13)	0.18 (0.13)
Addis Ababa wholesale price (SR) (D1)	0.17* (0.09)	0.37**(0.14)
Adjustment (ECT)	-0.70***(0.14)	-0.37**(0.11)
Constant	1.93***(0.57)	0.48 (0.57)

Notes: Values of standard errors are in parenthesis. ***, **, *, denotes significant at the 1%, 5%, and 10% levels.

4.3. Results of Granger causality tests

The existence of Granger causality is tested between pairs of banana market prices. Granger causality refers to the direction of price formation between pair markets and related spatial arbitrage, i.e., physical movement of the commodity to adjust these price differences. The finding in Table 6 indicates that there is bidirectional causality between Arbaminch banana producer price and central wholesaler price. That is, Addis Ababa market Granger caused price formation in Arbaminch market which in turn provided feedback to the Addis Ababa base market. There also is a feedback causal relationship between Tepi producer price and Addis Ababa wholesaler price. Addis Ababa wholesale market had also unidirectional relationships with Tepi base markets. This implies that the Tepi retail market relied on central wholesale market price's information to set its own price. But, Addis Ababa banana retail market did not depend on Arbaminch and Tepi retail prices to fix its prices. Granger causality runs from wholesale price to retail price in all localities. There is no causality between wholesale price in central market and retail price in Arbaminch.

Table 6. Results of Granger causality tests

Variable	F-statistics
Arbaminch producer price leading Addis Ababa wholesale price	3.10* (0.08)
Addis Ababa wholesale price leading Arbaminch producer price	4.93** (0.05)
Arbaminch retail price leading Addis Ababa wholesale price	0.13 (0.73)
Addis Ababa wholesale price leading Arbaminch retail price	0.11 (0.78)
Tepi producer price leading Addis Ababa wholesale price	3.90** (0.04)
Addis Ababa wholesale price leading Tepi producer price	7.05*** (0.00)
Addis Ababa wholesale price leading Tepi retail price	5.36** (0.02)
Tepi retail price leading Addis Ababa wholesale price	0.05 (0.81)
Arbaminch retail price leading Tepi retail price	3.10 (0.08)
Tepi retail price leading Arbaminch retail price	3.43* (0.06)
Arbaminch retail price leading Addis Ababa retail price	0.78 (0.53)
Addis Ababa retail price leading Arbaminch retail price	0.65 (0.67)

Tepi retail price leading Addis Ababa retail price	0.60 (0.81)
Addis Ababa retail price leading Tepi retail price	7.60*** (0.00)

Notes: The values of probability are in parentheses. ***, **, *, denotes significant at the 1%, 5%, and 10% levels. The lag length is selected based on the Akiake Information Criteria and F-test considering a maximum lag of four.

5. Conclusions and Policy Implications

The results show the existence of market integration, price transmission, and causality between wholesaler price in Addis Ababa and producer and retailer prices in surplus banana markets. The result indicates that wholesale traders in the central market have more power in price formation than the retailer and producer. This implies that there is more concentration of market power at the level of wholesalers than retailers. Wholesale traders determine market prices when purchasing from producers in local markets and when selling to retailers in the central market. It can be possible to conclude that wholesale prices are important determinants of the retail prices in the consumer market and of the producer prices in the local markets. Wholesalers are the most useful information sources for local markets; these markets use information from central market to fix prices in the local markets.

The result indicates that the speeds of price adjustment are not the same in different markets. The significance of the elasticity coefficient of the central wholesale price (0.71) suggests that there is a considerable degree of price transmission from the central wholesale market to the local producer markets, indicating market integration. Banana price for wholesale and retail markets removed 71% and 36% of disequilibrium, and the remaining is corrected by the external and internal forces. Together with the information from the ECM (i.e., a statistically significant short-run dynamic from the central wholesale market to the local market), adequate evidence is detected to conclude that the wholesale price in the central market plays a great role as a short- and long-run determinant of the banana producer prices in the local supply chain. In general, speeds of price transmission were slower for Tepi producer price, which may be for various reasons such as transportation costs, imprecise price information, the longer the geographic distance from central market, and logistics infrastructure. One of the possible explanations for slower price transmission in Tepi local market might be the relatively longer geographic distance from the central market (Addis Ababa), which is about 565 kms. This is advisable especially

during periods of positive supply shocks that threaten producer prices in the local markets. There are asymmetries in both magnitude and times of responses are found in the wholesale and retail prices of banana in Ethiopia. The study finds asymmetries for the banana market reflecting the existence of non-competitive banana markets due to distinctive market characteristics such as excessive government intervention, geographic distance, deficient infrastructures etc. Price adjustment information is important for economic agents, policymakers, and regulatory authorities to make the right economic decisions. The study suggests poor physical infrastructure, longer geographic distance, search costs, and imperfect competition as causes of price information asymmetries in banana supply chains.

The study suggested the possibility of rationalizing government intervention at the wholesale market level since it could provide the possibility of raising and stabilizing producer prices at the local markets through price transmission effects. Policy interventions, such as delivery of inputs at subsidized prices, or the promotion of adoption of superior technologies in the production of banana, may lower production costs. These interventions are useful to increase food availability in a country, and improve the competitive behavior, and increase smooth price transmission in banana supply chain. The existence of non-competitive behavior between wholesaler and retailer reflects a lower degree of dependence between these two market levels. Private sectors and GOs should work jointly to improve the competitive behavior in the banana supply chain, by the implementation of forward contracts to maintain a more significant mutual cooperation, coordination and short-term credit between producer–wholesaler and wholesaler–retailer (Shikur et al., 2020) that facilitate faster price transmission along the banana supply chain, which could also maintain banana price lower at retail level to save consumers against significant price rises. Improved market infrastructures would also enable actors along the supply chains to benefit from better information and goods flow and linkages between markets. The interventions would improve access to markets and institutions as well as access to information, increase the income of actors, and favor food availability for urban consumers.

Competing interests

There are no conflicts of interest to declare.

Author's contributions

Author analyzed the data and generated the quantitative results. He also wrote the results.

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References

- Abdulai, A. (2000). Spatial price transmission and asymmetry in the Ghanaian maize market. *Journal of Development Economics*, 63: 327–349.
- Alexander, C. (2001). *Market models: A guide to financial data analysis*. John Wiley Chichester.
- Alexander, C. and Wyeth, J. (1994). Co-integration and market integration: An application to the Indonesian rice market. *The Journal of Development Studies*, 30: 303-328.
- Asfaw, N. (1998). Vertical and spatial integration of grain markets in Ethiopia: Implications for grain markets and food security policies', Grain Market Research Project, Working Paper No. 9, Addis Ababa, Ethiopia.
- Balcombe, K., Bailey, A. and Brooks, J. (2007). Threshold effects in price transmission: The case of Brazilian wheat, maize and soya prices. *Am. J. Agr. Econ.*, 89: 308–323.
- Balke, N.S. and Fomby, T.B. (1997). Threshold cointegration. *Int. Econ. Rev.*, 38:627–645.
- Barrett, C.B. and Li, J.R. 2002. Distinguishing between equilibrium and integration in spatial price analysis. *American Journal of Agricultural Economics*, 84: 292–307.
- Barrett, C.B., 2001. Measuring integration and efficiency in international agricultural markets. *Rev. Agr. Econ.* 23, 19–32.
- Bakucs, Z., Falkowski, J. and Ferto, I. (2013). What causes asymmetric price transmission in agro-agriculture sector? Meta-analysis perspective. *Muhelytanulmanyok Discussion Paper*, MT-DP- 2013/3.
- Dickey, D. and Fuller, W. (1979). Distribution of the estimators for autoregressive time series with a Unit Root. *The American Statistical Association*, 74: 427-431.
- Dadi, L., Negassa, A. and Franzel, S. (1992). Marketing of maize and Tef in western Ethiopia, implications for policy following liberalization. *Food Policy*, 17: 201-213.
- Enders, W. and Siklos, P.L. (2001). Co integration and threshold adjustment. *Journal of business and Economics Statistics*, 20: 166-176.

- Engle, R.F. and Granger, C.W.J. (1987). Cointegration and error correction: Representation, estimation and testing. *Econometrica*, 55: 251-276.
- Fackler, P.L. and Goodwin, B.K. (2001). Spatial price analysis. In *Handbook of Agricultural Economics*, ed. Gardner, B.L. and Rausser, G.C., 971–1024. Amsterdam: Elsevier Science.
- Getnet, K., Verbeke, W. and Viaene, J. (2005). Modeling price transmission in the grain markets of Ethiopia with application of ARDL approach to White Teff. *Agricultural Economics*, 33 (3): 493–501.
- Getnet, K. (2007). Spatial equilibrium of wheat markets in Ethiopia. *African Development Review*, 19(2): 281–303.
- Granger, C.W.J. (1988). Some recent developments in the concept of causality. *Journal of Econometrics*, 39: 199-211.
- Gupta, S. and Mueller, R.A. (1982). Analysing the pricing efficiency: Concepts and application. *European Review of Agricultural Economics*, 9:301-312.
- Habte, Z. (2016). Spatial market integration and price transmission for papaya markets in Ethiopia: In *Proceedings of the 8th Multi-Disciplinary Seminar. Research and Knowledge Management of St. Mary's University, Addis Ababa, Ethiopia.*
- Haile, M.G., Kalkuhl, M., Algeria, B. and Gebreselassie, S. (2017). Price shock transmission: Evidence from the wheat-bread market value chain in Ethiopia. *Agricultural Economics*, 48 (2017): 769–780.
- Harris, H. and Sollis, R. (2003). *Applied time series modelling and forecasting*. Wiley, West Sussex.
- Jaleta, M. and Gebermedhin, B. (2009). Price co-integration analyses of food crop markets: The case of wheat and teff commodities in Northern Ethiopia. *The International Association of Agricultural Economists Conference*, Beijing, China; August 16-22, 2009.
- Johansen, S. (1988). Statistical analysis of cointegration vectors. *Journal of Economic Dynamics and Control*, 12: 231-54.
- Johansen, S. and Juselius, K. (1990). Maximum likelihood estimation and inference on cointegration with application to the demand for money. *Oxford Bulletin of Economics and Statistics*, 52: 169-210.
- Kuiper, W.E., Lutz, C. and van Tilburg, A. (2003). Vertical price leadership on local maize markets in Benin. *Journal of Development Economics*, 71(2): 417–33.

- Lloyd, T. (2017). Presidential Address forty years of price transmission research in the food industry: Insights, challenges and prospects. *Journal of Agricultural Economics*, 68 (1): 3–21.
- Meyer, J. and von Cramon-Taubadel, S. (2002). Asymmetric price transmission: A survey. In: *Proceedings of the Xth EAAE Conference, Zaragoza*.
- Monke, E. and Petzel, T. (1984). Market integration: An application to international trade in cotton. *American Journal of Agricultural Economics*, 66(4): 481-487.
- Negassa, A., Myers, R. and Gabre-Madhin, E. (2004). Grain marketing policy changes and spatial efficiency of maize and wheat markets in Ethiopia. *International Food Policy Research Institute (IFPRI), MTDI Discussion Paper 66*.
- Pesaran, M.H. and Shin, Y. (1999). An autoregressive distributed lag modelling approach to cointegration analysis. *Econometrics and Economic Theory in the 20th Century: The Ragnar Frisch Centennial Symposium*, Strom, S. (ed.) Cambridge University Press.
- Pesaran, M.H., Shin, Y. and Smith, R.J. (2001). Bounds testing approaches to the analysis of level relationships. *Journal of Applied Econometrics*, 16: 289–326.
- Phillips, P.C. and Perron, P. (1988). Testing for a unit root in time series regression. *Biometrika*, 75: 335-346.
- Seneshaw, T. (2013). Spatial integration of cereal markets in Ethiopia, Ethiopia Strategy Support Program, Ethiopian Development Research Institute, ESSP Working Paper 56.
- Sexton, R., Kling, C. and Carman, H. (1991). Market integration, efficiency of arbitrage and imperfect competition: methodology and application to US celery. *American Journal of Agricultural Economics*, 73:568-580.
- Serra, T., Gil, J.M. and Goodwin, B.K. (2006). Local polynomial fitting and spatial price relationships: Price transmission in EU pork markets. *European Review of Agricultural Economics*, 33: 415–436.
- Shikur, H.Z., Legesse, B., Haji, J. and Jaleta, M. (2020). Governance structures and incentives in the wheat value chain in Ethiopia.
- Ward, R.W. (1982). Asymmetry in retail, wholesale and shipping point pricing for fresh vegetables. *American Journal of Agricultural Economics*, 62: 205–212.
- Wlazlowski, S. (2003). Petrol and crude oil prices: Asymmetric price transmission. *Ekonomia*, 11: 1-25.

- Wondemu, K. (2015). Price transmission asymmetry in spatial grain markets in Ethiopia. *African Development Review*, 27(2): 106–116.
- Yami, M., Meyer, F. and Hassan, R. (2017). Modelling price formation and dynamics in the Ethiopian maize market. *J. Agr. Sci. Tech.*, 19: 1439-1452.
- Zahid, S., Qayyum A. and Shahid, W., 2007. Dynamics of Wheat Market Integration in Northern Punjab, Pakistan. *The Pakistan Development Review*, 46(4), pp. 817-830.
- Zakari, S., Ying, L. and Song, B. (2014). Market Integration and Spatial Price Transmission in Niger Grain Markets. *African Development Review*, 26(2), 264–273.
- Von Cramon-Taubadel, S. (2017). The analysis of market integration and price transmission – results and implications in an African context. *Agrekon*, 56(2): 83–96.