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Testing for asymmetric cointegration of Italian agricultural commodities prices: Evidence from the futures-spot market relationship

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Abstract: The volatility of food prices still raises concerns among agricultural market players, increasing interest in the futures markets, thus calling for a better understanding of the connection between the futures and the Italian spot prices. This study uses symmetric and asymmetric vector error correction models to investigate the relationship between futures and spot prices for the Italian agricultural markets of soybean, corn, and milling wheat. The results confirm the leading role of the futures contract prices for all the considered commodities. Moreover, the non-linear cointegration analysis results suggest price transmission's asymmetries for all the agricultural commodity prices. This research provides critical insight into the shape of the futures-spot price transmission.

Keywords: hedging; price discovery; price transmission; threshold vector error correction model; vector error correction model

The relationship between futures and spot markets is the premise for the efficient use of futures contracts to hedge against price risk (Goodwin and Schnepf 2000). Price risk affects all economic activities, including the agricultural sector that is increasingly vulnerable to the high variability in output prices (Santeramo et al. 2018). Following this, it is expected that in these uncertain environments in which farmers operate, they are incentivized to adopt risk management strategies and tools (Coletta et al. 2018). Futures contracts may represent a viable alternative for farmers and operators to lock in delivery prices in advance, thus reducing price risk (Penone et al. 2021). The increasing interest in futures contracts calls for a better understanding of the Italian spot prices connection to the futures market.

The effectiveness of the hedging activities is sensitive to the spread between the futures and the spot prices, i.e. the basis. According to the no-arbitrage price theory, prices in two different markets should tend to converge (Lence et al. 2018). Past studies have documented the existence of a stationary basis between futures and spot prices, among others, within the Canadian and the Brazilian agri-commodity futures and spot markets (respectively: Brockman and Tse 1995; Mattos and Garcia 2004). Also, the relationship between spot and futures prices for European agri-commodities has been tested, confirming the presence of a cointegrating relationship and the leading role of cereals futures prices (Kuiper et al. 2002; Adämmer and Bohl 2018). Thus, the literature confirms the existence of a cointegration relationship between futures and spot prices using error correction models to test for cointegration. However, it is typically assumed asymmetric adjustment toward equilibrium.

The issue of price transmission asymmetries has attracted considerable research interest among agricultural economists (von Cramon-Taubadel 1998; Enders and Siklos 2001; Meyer and von Cramon-Taubadel 2004; Santeramo and von Cramon-Taubadel 2016). A positive (negative) price asymmetry occurs when a decrease (increase) in prices is not fully or imme-

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diately transmitted, but an increase (decrease) passes on more quickly or thoroughly. However, to the best of our knowledge, there is little evidence regarding asymmetric price transmission (APT) in the relationship between agricultural commodity futures-spot prices. The degree and shape with which shocks are transmitted between the futures and spot markets can have important implications for hedging activities, agricultural commodities pricing and, policy implications. The presence of APT has been confirmed for the US and Canadian grain markets, implying the most profitable opportunities for traders when the basis is narrowing (Chang et al. 2012). Similarly, Wu et al. (2018), confirmed the presence of negative APT between the Chicago futures market and the Ontario spot market for soybean while the corn markets showed positive APT. Their finding suggests that operators of assorted commodities must resort to different trading strategies in response to shock.

The purpose of this paper is to examine the relationship between futures and spot prices and testing for the presence of an asymmetric price transmission for soybean, corn, and milling wheat (hereafter wheat) in Italy. This study contributes to the literature by examining the non-linear dynamic relationship between futures and Italian spot prices, using error correction methods. While the methodology has been applied, to a limited extent, to the futures-spot transmission studies, to the best of our knowledge, this is the first analysis regarding countries that do not have access to a domestic derivatives exchange. Indeed, like others within the European Union, Italian agricultural commodities' operators must operate in foreign futures exchanges. Therefore, this analysis will show insight into the use of futures markets within multiple settings in which a local derivatives exchange is absent.

MATERIAL AND METHODS

The soybean corn and milling wheat production account for more than 60% of all cereals and oilseed produced in Italy in 2019, representing a holistic picture of the Italian arable crop sector. The sample period of this study runs from January 2008 to December 2019. The Italian spot prices are weekly wholesale prices listed on the Bologna market every Thursday (AGER 2021). The futures markets investigated in this analysis are the Chicago Board of Trade (CBOT), the world reference market for agricultural trading, and Euronext, the main agri-commodity European futures market (AHDB 2021).

Figure 1 illustrates the joint movement of the Italian spot prices for soybean, corn, and milling wheat with the counterpart futures contract prices of CBOT and Euronext. Even if futures and spot prices move together, it is possible to observe how the basis is not precisely constant. Summary statistics are reported in Table 1.

The equilibrium relationship between futures and spot prices is based on the following equation:

$$F_{tT} = S_t e^{\left(r_t + u_t + c_t\right) \times \left(t - T\right)} \quad (1)$$

where: F, S – futures contract and spot price of a commodity; t – current date; T – futures contract expiration date; r – interest rate due for holding the commodity; u – marginal storage cost rate; c – marginal convenience yield (Fama and French 1987).

This implies:

$$b_t = S_t - F_t = -\left(r_t + u_t + c_t\right) \times \left(T - t\right) \quad (2)$$

where: b_t – basis, i.e. the difference between stop and futures prices.

The law of one price (LOP) implies a decline in the international dispersion of prices which tend to converge as a result of arbitrage (von Cramon-Taubadel and Goodwin 2021). Indeed, if $b_t < 0$, arbitrageurs will buy the spot commodity and sell futures contracts to profit from the difference. Alternatively, if $b_t > 0$, arbitrageurs would profit by selling the spot commodity and buying the futures contracts. The LOP abstract from trade and transportation costs which may have a significant impact on the market efficiency. If futures and spot prices are linearly cointegrated, i.e. the basis is stationary with zero mean, futures contracts can be used as an efficient price risk management instrument (Penone et al. 2021). However, as stated in the literature, deviations from arbitrage equilibrium can influence price transmission throughout the markets (Goodwin et al. 2021).

Preliminary steps are needed to test for the presence of asymmetric price transmission. Firstly, the time series are tested to identify the order of integration through the augmented Dickey-Fuller (Dickey-Fuller 1979), and the non-parametric Phillips-Perron (1988) approaches. Then, the application of error correction models implies a stationary combination of the futures spot price sets. The futures spot price pairs for the same commodities are tested with the Engle-Granger (EG) two-step procedure (Engle and Granger 1987). Moreover, given the linearity of the EG procedure, to include

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threshold types of effect and therefore testing for the presence of APT, we applied Enders and Siklos (2001) threshold autoregressive model (TAR).

After the testing for symmetric and asymmetric behaviour of the basis, both symmetric and asymmetric error correction models (ECM) are applied to the

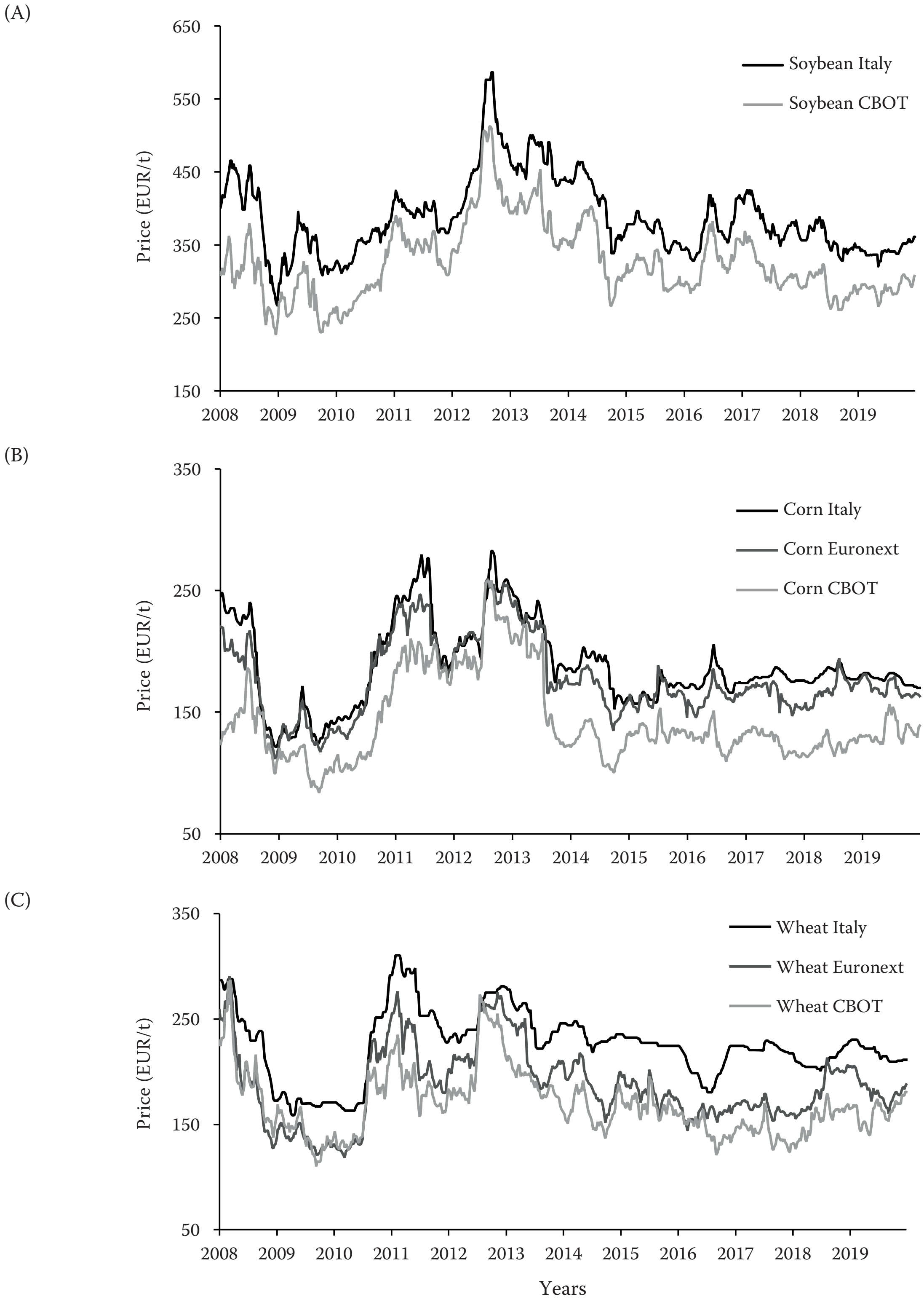

Figure 1. The futures prices (CBOT and Euronext) and Italian spot prices: (A) soybean, (B) corn, and (C) wheat
Source: AHDB (2021), AGER (2021)

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Table 1. Summary statistics of the futures and spot prices (No. of observations = 626)

Commodities	Prices	Mean	SD	Minimum	Maximum
Soybean	Italian spot	387.49	53.12	267.50	586.50
	CBOT futures	325.82	51.50	226.64	512.73
Corn	Italian spot	187.75	34.04	121.50	282.50
	Euronext futures	177.06	32.10	111.65	259.75
	CBOT futures	143.10	35.48	83.68	258.58
Milling wheat	Italian spot	225.42	32.88	158.50	310.50
	Euronext futures	186.28	36.39	118.35	290.65
	CBOT futures	168.71	30.78	109.97	287.17

Prices are expressed in EUR/t
Source: AGER (2021), AHDB (2021)

futures-spot price pairs. Firstly, a symmetric ECM, as in Equation (3), was performed.

$$\Delta y_t = \beta_0 + \sum_{i=1}^{l} \beta_1 \Delta x_{t-i} + \sum_{i=1}^{l} \beta_2 \Delta y_{t-j} + \beta_3 ECT_{t-1} + \varepsilon_t \qquad (3)$$

where: Δy_t, Δx_t – lagged log differences of spot (futures) and futures (spot) prices from the time interval (i) 1 to l (the number of selected lags); β_0 – intercept terms; β_1 – coefficient of the lagged differenced futures (spot) representing the short-run transmission; β_2 – autoregressive coefficient of the spot (futures) prices; ECT, defined as $ECT_{t-1} = y_{t-1} - b_1 - b_2 x_{t-1}$ – error correction term corresponding to the speed at which the cointegrated series converges (Santeramo and von Cramon-Taubadel 2016).

As previously stated, prices may show APT, thus calling for the examination of threshold types of effects in the ECM model of the utmost importance. The threshold vector error correction model (TVECM) specification can be computed according to Equations (4–5).

$$\Delta y_t = \gamma_0 + \sum_{i=1}^{l} \gamma_1 \Delta x_{t-i} + \sum_{i=1}^{l} \gamma_2 \Delta y_{t-i} + I_t \gamma_3 ECT_{t-1} + (1 - I_t)\gamma_4 ECT_{t-1} + \varepsilon_{st} \qquad (4)$$

$$I_t = \begin{cases} 1 & if \;\; ECT_{t-1} \geq \tau \\ 0 & if \;\; ECT_{t-1} < \tau \end{cases} \qquad (5)$$

where: Δy_t; Δx_t – lagged log differences of spot (futures) and futures (spot) prices from the time interval (i) 1 to l (the number of selected lags); α_0 – intercept terms; γ_1 – coefficient of the lagged differenced futures (spot) representing the short-run transmission; and γ_2 – autoregressive coefficient of the spot (futures) prices; ECT – error correction term; γ_3, γ_4 – adjustment coefficients calculated according to the Heaviside indicator (I_t) setting; $\tau = 0$ (Wu et al. 2018).

In summary, the empirical analysis of price transmission from futures to spot prices for Italian commodities involves the following steps. First, the price series under investigation are examined through a unit root test (Dickey-Fuller 1979; Philipp-Perron 1988). Second, the standard Engle-Granger procedure to test the cointegration is applied to the futures-spot and spot-futures price pairs (Engle-Granger 1987). Third, a TAR model for the analysis of asymmetries is implemented (Enders and Siklos 2001). Lastly, both vector error correction model (VECM) and TVECM are estimated (Wu et al. 2018).

RESULTS AND DISCUSSION

The preliminary tests results confirm stationarity for all prices' first differences (Table 2).

The results of the EG cointegration methodology are presented in the first part of Table 3. The results show a long-run cointegrating relationship, confirming literature on futures-spot price analysis (among others: Kuiper et al. 2002; Beckmann and Czudaj 2014).

The results for the threshold cointegration tests present some interesting relations (Table 3). For all the considered futures markets and commodities, the TAR models suggest convergence given the negative α_2 and α_3 coefficients. The null hypothesis of symmetric adjustment ($\alpha_2 - \alpha_3 = 0$) cannot be accepted for future-spot price pairs. These results align with the agricultural commodity literature regarding price transmission and asymmetric tests in futures markets (Chang et al. 2012; Wu et al. 2018). The estimated adjustment parameters for positive and negative basis changes (α_2 = positive basis changes, α_3 = nega-

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Table 2. Unit root test on spot and futures prices of designated agricultural commodities

Commodities	Prices	Augmented Dickey-Fuller		Phillips-Perron	
		levels	first differences	levels	first differences
Soybean	Italian spot[3]	–3.360*	–10.660***	–3.203*	–21.712***
	CBOT futures[2]	–3.102	–14.417***	–3.197*	–22.329***
Corn	Italian spot[2]	–2.410	–13.186***	–2.143	–20.643***
	CBOT futures[2]	–2.370	–13.911***	–2.341	–21.034***
	Euronext futures[2]	–2.350	–13.797***	–2.329	–21.569***
Milling wheat	Italian spot[4]	–2.919	–8.169***	–2.146	–19.548***
	CBOT futures[2]	–3.530**	–13.956***	–3.326*	–20.880***
	Euronext futures[4]	–2.854	–10.518***	–2.582	–19.127***

*, **, ***Significance at 10, 5, 1%, respectively; based on series characteristics both tests allow for both the constant and linear trend; the optimal lag length was chosen according to the Akaike information criterion; numbers in square brackets indicates the selected lags; augmented Dickey-Fuller and Phillips-Perron test critical values at 1, 5 and 10% are –3.960, –3.410 and –3.120, respectively

Source: Authors' elaboration according to AGER (2021) and AHDB (2021) data

tive basis changes) show, overall, a faster adjustment when the basis changes are below the threshold value and a slower adjustment when the basis changes are above the threshold value. For all the considered prices pairs, the model suggests the strongest adjustment occur during the narrowing of the futures-spot basis. Therefore, a shock that results in the narrowing of corn basis (decline in futures contract prices relative to spot

Table 3. Cointegration and threshold cointegration of designated agricultural commodities

Methods	Commodities	Prices (Italian spot)		Coefficients	$\alpha_2 - \alpha_3 = 0$	R^2	AIC	LM	Q
EG	soybean	CBOT	α_1	–0.075*** (0.015)	–	–	–	0.045	0.014
	corn	CBOT	α_1	–0.028*** (0.009)	–	–	–	0.028	0.440
		Euronext	α_1	–0.126*** (0.021)	–	–	–	0.084	0.216
	wheat	CBOT	α_1	–0.044*** (0.012)	–	–	–	0.036	0.335
		Euronext	α_1	–0.060*** (0.013)	–	–	–	0.054	0.234
TAR	soybean	CBOT	α_2	–0.056** (0.024)	0.505	0.045	–5.000	0.016	0.215
			α_3	–0.088*** (0.033)					
	corn	CBOT	α_2	–0.033** (0.014)	0.647	0.028	–4.344	0.705	0.444
			α_3	–0.021 (0.017)					
		Euronext	α_2	–0.090*** (0.035)	0.237	0.099	–4.291	0.004	0.046
			α_3	–0.164*** (0.040)					
	wheat	CBOT	α_2	–0.036 (0.023)	0.832	0.036	–4.459	0.645	0.339
			α_3	–0.044** (0.020)					
		Euronext	α_2	–0.055** (0.025)	0.832	0.058	–4.908	0.246	0.734
			α_3	–0.064** (0.025)					

*, **, ***Significance at 10, 5, 1%, respectively; standard error in parenthesis; EG – Engle-Granger two-step procedure; TAR – threshold autoregressive; LM – Lagrange multiplier test; Q – Portmanteau test; AIC – Akaike information criterion; EG and TAR are the results coefficients from an ADF-type test on the residuals: Δz_t, of $S_t = a_0 + a_1 F_t + z_t$, where: S_t – spot prices at time t; F – futures prices at time t; the coefficients are calculated according to:

$$\text{EG} \rightarrow \Delta z_t = \alpha_0 + \alpha_1 z_{t-1} + \sum_{i=1}^{n} \sigma_i \Delta z_{t-i} + \varepsilon_t \text{ , TAR} \rightarrow \Delta z_t = \alpha_0 + \alpha_2 z_{t-1}^{+} + \alpha_3 z_{t-1}^{-} + \sum_{i=1}^{n} \sigma_i \Delta z_{t-i} + \varepsilon_t$$

Source: Authors' elaboration according to AGER (2021) and AHDB (2021) data

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price) will tend to revert faster back toward the equilibrium. Contrariwise, a shock that results in widening of corn basis (rise in futures price relative to spot price) will tend to revert faster back toward the equilibrium. Surprisingly, the CBOT-Italian spot prices for corn show $|\alpha_2| > |\alpha_3|$, thus suggesting positive APT between the two prices. A shock in the CBOT futures prices will tend to persist if futures prices increase relative to the spot prices. Similar conflicting results are shown in the literature for some commodities (Chang et al. 2012; Wu et al. 2018).

The VECM and TVECM analysis results are reported in Tables 4 and 5. Overall, the results are consistent across methods (EG – TAR – VECM – TVECM), confirming the presence of significant a long-run cointegrating relationship and an asymmetric adjustment between futures and spot prices. Consistency of results supports the application of error correction-based inference (von Cramon-Taubadel 1998).

The symmetric vector error correction model (Table 4) shows for the spot price equation (Δs_t) a positive and significant short-run effect from both the Euronext and the CBOT futures prices (Δf_t). In contrast, the futures prices equation (Δf_t) shows that the spot prices only have a significant adjustment effect for Euronext corn contracts. This implies that the causality of the relationship runs from futures to spot prices, confirming the existing literature (Brockman and Tse 1995). Therefore, the Euronext futures contract and Italian spot prices pair show signs of bidirectional causality. The lagged coefficient of the spot prices on the futures prices equation (Δf_t) is significant, implying a feedback system (Ali and Gupta 2011). Moreover, comparing the CBOT and Euronext short-run price transmission coefficients (corn and wheat commodity) shows a higher percentage of short-run transmission from the European futures prices. These findings are consistent with a highly liquid European futures mar-

Table 4. Vector error correction model of designated agricultural commodities

Δy	Δx	Soybean spot – CBOT	Corn		Wheat	
			spot – CBOT	spot – Euronext	spot – CBOT	spot – Euronext
Δs_t	ECT_{t-1}	–0.056*** (0.015)	–0.018** (0.007)	–0.112*** (0.016)	–0.017*** (0.006)	–0.044*** (0.009)
	Δs_{t-1}	ns	0.206*** (0.038)	0.170*** (0.037)	0.185*** (0.038)	0.100*** (0.039)
	Δs_{t-2}	–	–	–	0.172*** (0.037)	0.096** (0.038)
	Δs_{t-3}	–	–	–	–	0.106*** (0.037)
	Δf_{t-1}	0.156*** (0.033)	0.094*** (0.026)	0.152*** (0.035)	0.088*** (0.016)	0.118*** (0.021)
	Δf_{t-2}	–	–	–	0.028* (0.016)	ns
	Δf_{t-3}	–	–	–	–	0.051** (0.022)
	c	ns	ns	ns	ns	ns
	AdjR^2	0.095	0.075	0.166	0.185	0.250
	$P > \chi^2$	0.000	0.000	0.000	0.000	0.000
	Q	0.0744	0.2874	0.2632	0.0486	0.8178
Δf_t	ECT_{t-1}	ns	0.020* (0.011)	0.033* (0.020)	0.032** (0.015)	0.049** (0.024)
	Δs_{t-1}	ns	ns	0.110** (0.045)	ns	ns
	Δs_{t-2}	–	–	–	ns	ns
	Δs_{t-3}	–	–	–	–	0.166* (0.095)
	Δf_{t-1}	0.152*** (0.049)	0.201*** (0.039)	0.171*** (0.042)	0.226*** (0.040)	0.364*** (0.054)
	Δf_{t-2}	–	–	–	ns	ns
	Δf_{t-3}	–	–	–	–	ns
	c	ns	ns	ns	ns	ns
	AdjR^2	0.020	0.045	0.042	0.050	0.070
	$P > \chi^2$	0.000	0.000	0.000	0.000	0.000
	Q	0.409	0.164	0.443	0.035	0.015

*, **, ***Significance at 10, 5, 1%, respectively; standard errors are reported within parenthesis; the optimal lag length was determined using the modified Akaike information criterion; Q – Portmanteau test; ns – not significant; abbreviations are explained under the Equation (4)

Source: Authors' elaboration according to AGER (2021) and AHDB (2021) data

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ket for the two commodities, with Euronext playing a leading role in Italian spot prices (Wu et al. 2018).

Within VECM and TVECM analysis framework, the analysis of the ECT allows for the investigation of the speed of the adjustment between the two prices. Moreover, the ECT coefficients allow for examining which price moves to restore the long run cointegrating relationship. Within the VECM framework, the ECT for the soybean spot equation is negative and statistically significant, while the counterpart ECT in the future's equation is not significantly different from zero. This confirms that the spot prices react to restore the long-run equilibrium in the soybean markets (von Cramon-Tabaudel 1998). These results align with the literature highlighting the leading role of the CBOT soybean futures prices (Mattos and Garcia 2004). Instead, the corn and wheat ECT coefficients for both the CBOT and the Euronext exchanges show that both futures and spot prices move to restore the long-run equilibrium.

The asymmetric TVECM model confirms the presence of a significant short-run effect (Δs_t in the futures price equation) from futures to spot prices for all the considered prices and commodity pairs. Throughout the interpretation of positive and negative ECT coefficients, the model confirmed the presence of APT between the CBOT and Italian prices for soybean and wheat and the Euronext and Italian prices for corn and wheat. These findings provide further support to the TAR model results. TVECM results show that the negative ECT has a higher coefficient for corn and wheat prices (Euronext-Italian spot for corn and wheat and CBOT-Italian spot for wheat). In contrast, in soybean CBOT-Italian prices pairs, the positive ECT coefficient is higher (Wu et al. 2018). Therefore, based

Table 5. Treshold vector error correction model of designated agricultural commodities

Δy	Δx	Soybean	Corn		Wheat	
		spot – CBOT	spot – CBOT	spot – Euronext	spot – CBOT	spot – Euronext
Δs_t	ECT^+_{t-1}	−0.059** (0.024)	ns	−0.082*** (0.028)	ns	−0.029* (0.017)
	ECT^-_{t-1}	ns	ns	−0.150*** (0.032)	−0.030*** (0.011)	−0.059*** (0.017)
	Δs_{t-1}	ns	0.188*** (0.038)	ns	0.167*** (0.039)	ns
	Δs_{t-2}	–	–	–	0.172*** (0.037)	0.096** (0.038)
	Δs_{t-3}	–	–	–	–	0.106*** (0.037)
	Δf_{t-1}	0.201*** (0.033)	0.104*** (0.026)	0.259*** (0.033)	0.099*** (0.016)	0.148*** (0.020)
	Δf_{t-2}	–	–	–	0.028* (0.016)	ns
	Δf_{t-3}	–	–	–	–	0.051** (0.022)
	c	ns	ns	ns	ns	ns
	AdjR^2	0.093	0.073	0.167	0.187	0.250
	$P > \chi^2$	0.000	0.000	0.000	0.000	0.000
	Q	0.071	0.287	0.208	0.030	0.823
Δf_t	ECT^+_{t-1}	ns	ns	ns	0.055* (0.032)	ns
	ECT^-_{t-1}	ns	ns	0.078** (0.038)	ns	0.081* (0.044)
	Δs_{t-1}	ns	ns	0.149*** (0.047)	ns	ns
	Δs_{t-2}	ns	ns	–	ns	ns
	Δs_{t-3}	–	–	–	–	0.164* (0.095)
	Δf_{t-1}	0.138*** (0.048)	0.190*** (0.039)	0.140*** (0.040)	0.204*** (0.039)	0.330*** (0.052)
	Δf_{t-2}	–	–	–	ns	ns
	Δf_{t-3}	–	–	–	–	ns
	c	n.s	n.s	n.s	n.s	ns
	AdjR^2	0.018	0.0438	0.043	0.049	0.069
	$P > \chi^2$	0.002	0.000	0.000	0.000	0.000
	Q	0.415	0.160	0.406	0.036	0.015

*, **, ***Significance at 10, 5, 1%, respectively; standard errors are reported within parenthesis; the optimal lag length was determined using the modified Akaike information criterion; Q – Portmanteau test; ns – not significant; abbreviations are explained under the Equation (4)

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on the TAR and TVECM model, a narrowing of the Euronext and Italian corn and wheat spot basis will revert faster and more fully back toward the equilibrium than an increase. Conversely, the CBOT and Italian spot basis showed positive APT. Thus, after a positive shock in the basis, prices tend to revert to equilibrium more quickly.

The preponderant theory explaining the presence of negative vertical APT refers to imperfect competition, adjustment costs, inventory management, political interventions, or asymmetric information (Meyer and von Cramon-Taubadel 2004; Santeramo and von Cramon-Taubadel 2016). However, the asymmetric link between futures and spot prices may require a different interpretation compared to vertical asymmetric price transmission. Assuming lower futures prices with respect to the local spot prices, the narrowing of the basis of the futures-spot price would benefit short positions seeking to protect the selling prices for the physical commodity. Our results show that for corn (Euronext-Italian spot) and wheat (Euronext-Italian spot and CBOT-Italian spot), the spot prices react more fully to a negative ECT movement than to a positive one. Therefore, given the leading role of futures markets (Kuiper et al. 2002; Adämmer and Bohl 2018), an increase in the futures prices, which will strengthen the local basis, would imply a faster transmission of the shock with respect to an increase. Contrariwise, given the positive APT shown for the soybean commodity's CBOT-Italian spot prices, strengthening the local basis would imply a slower transmission of the shock with respect to an increase, thus allowing farmers to benefit more from the movement. Therefore, spot commodities pricing agents and hedgers should consider that, after a shock, corn and wheat spot prices respond more to negative variation in the basis than to an increase.

CONCLUSION

This paper explores the price transmission dynamics between the futures spot prices for the Italian soybean, corn, and wheat markets. The analysis confirmed a significant long-run relationship and a significant short-run effect of the futures prices on the spot prices and provided strong evidence supporting the asymmetric behaviour for all the considered commodities and markets. Furthermore, this asymmetric behaviour has been tested and confirmed in the context of an ECM, which assessed the response in the spot and futures prices to a shock to the basis. As a result, negative APT was confirmed from corn (Euronext-Italian spot) and wheat (Euronext-Italian spot and CBOT-Italian spot) markets. On the other hand, soybean price transmission (CBOT-Italian spot) showed positive APT.

The agricultural spot-futures price relationship analysis has important implications for producers and buyers. The presence of negative (positive) APT will call for different strategies and timing in opening and closing the contract for negative or positive movements. The asymmetric nature of price transmission of futures contracts prices to Italian spot prices will affect the cost-effectiveness of hedging for all operators. Indeed, negative (positive) APT implies faster (slower) adjustment after a negative ECT shock, thus implying a faster (slower) transmission of a strong basis, making it less (more) beneficial for farmers.

The present analysis reinforces the findings of recent literature on the presence of asymmetric price transmission in the agricultural derivatives exchange, signalling the increasing importance of the adoption of price risk management tools. In addition to existing evidence, we show that for Italian farmers who, similarly to others within the EU, do not have access to a national derivatives exchange, futures-spot prices are cointegrated but show asymmetric behaviour. These results are of prominent importance for farmers and other operators along the agricultural commodities supply chain by providing a better assessment of the futures markets as possible instruments for Italian farmers aiming to manage price risk.

We recognize the limitation of the present study, which lies in the local nature of the spot prices, making the results specific to the Italian agricultural sector. However, given that many other European countries do not have access to a domestic derivatives market, this research is of general explorative interest for all market sharing situations. Under this point of view, further research should aim to test the presence of APT within the broader context of the European Union spot prices, helping the understanding of EU futures-spot prices transmission.

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