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# Commodity Future Trading and Cointegration of Turmeric Markets in India

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***Authors' contributions***

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

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## ABSTRACT

The government has reduced its direct market intervention in order to promote private sector engagement based on market forces, Farmers in an agriculture-dominated economy like India suffer not only yield risk but also pricing risk. As a result, agricultural products are now more vulnerable to market risks related to pricing and other factors. The futures market has to decide the prices of a commodity on the basis of demand and supply. It is important to know about the bi-directional and unidirectional relationship between different market's the prices and future and Spot

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markets in India, price discovery process and price forecasting in Indian agricultural commodities. Knowing about different market's price Integration will help us to know the prevailing prices in various markets and also the impact of one market's price on another. It will help the farmers to know the different pricing statuses in different markets. The study analyses the efficiency of commodity futures of turmeric traded in NCDEX for 2016-2022 and the cointegration of theNizamabad, Erode, Sangli and Cuddapah Markets of India. In agriculture, commodity futures and derivatives are essential to the process of managing price risk.

*Keywords: Commodity futures; cointegration; spot price and future price; turmeric.*

## 1. INTRODUCTION

Commodity Market is a market where commodities will be exchanged. A Commodity futures market is the market where an agreement or contract will be done before the trading of the commodities. It is further divided into Forward market and Future Market. Forward Market is the market where the contract is done before the transactions of the commodity but the trading happens based on the price prevailing at the time of the contract. Unlike Future market is the market where the contract is done before the transaction of commodities but the trading will be based on the price at the time of buying or selling the commodities. It may be a spot market or a derivatives market. In the spot market commodities are bought and sold for immediate delivery, whereas in the derivatives market various financial instruments based on commodities are traded. The Commodity futures market was very much there in earlier times in India. In fact, it was one of the most vibrant markets till the early 70s. But due to numerous restrictions, the market could not develop further. Now that most of these restrictions have been removed, there is enormous scope for the development and growth of the commodity futures market in the country. A nation's financial market includes the commodity market as a significant component. For individuals who desire to invest in anything other than stocks, bonds, real estate, etc., the commodity market provides an alternative investment option. India is a nation where agriculture plays a significant role in the overall economy, hence price fluctuations during the harvesting season have always been of great concern to the farming community.

Commodities can be categorized into major groups like agricultural produce, metals etc. In India, they are further broken into the following categories:

1) Agriculture: Grains: Basmati Rice, Rice, Maize, Wheat. Oil And Oilseeds: Soy Seeds, Castor Oil, Castor Seeds, Soymeal, Refined Soy Oil, Crude Palm Oil, Mustard Seed, Groundnut Oil, Cottonseed, Etc. Spices: Red Chilli, Pepper, Turmeric, Jeera and Cardamom. Pulses: Urad, Chana, Yellow Peas, Tur Dal.

2) Metals and Materials: Base Metals: Copper, Aluminum, Zinc, Nickel, Tin. Bulk Commodities: Coking Coal, Iron Ore, Steel, Bauxite.

3) Precious Metals: Silver, Gold, Platinum and Palladium.

4) Energy: Natural Gas, Crude Oil, Brent Crude, Thermal Coal.

This type of Commodity Markets were under the control of Forward Market Commission in the past but at the time of September 2015, Forward Market Commission (FMC) was merged with (SEBI)Security Exchange Board of India and monitoring this Exchanges. For the study, the commodity exchange NCDEX is chosen Turmeric is considered for the study.

As a result, on April 1, 2003, the Government of India issued notifications allowing futures trading (apart from options trading) for a variety of agricultural commodities. India currently has four national-level commodity exchanges and 21 regional-level commodity exchanges that are authorised to trade agricultural commodities in derivatives.

**TURMERIC:**

India produces 78% of world Turmeric Production.

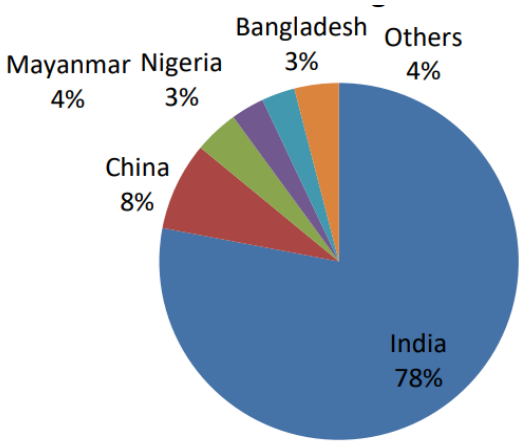


**Fig . 1. Turmeric Production in different countries**
*Source: Spices board of India*

**Table 1. Top 10 Turmeric Producing States in India**

| Top 10 Turmeric Producing States in India | | |
|---|---|---|
| **States** | **Previous FY(2020-21)** | **Current FY(2021-22)** |
| Telangana | 3.87 | 3.13 |
| Karnataka | 1.33 | 1.31 |
| TamilNadu | 0.96 | 0.87 |
| Andra Pradesh | 0.71 | 0.73 |
| West Bengal | 0.46 | 0.46 |
| Orissa | 0.44 | 0.44 |
| Maharastra | 2.19 | 2.27 |
| Mizoram | 0.30 | 0.30 |
| Assam | 0.23 | 0.21 |
| Gujarat | 0.18 | 0.30 |
| Others | 1.13 | 1.02 |
| All India | 11.79 | 11.02 |

Curcuma longa, the botanical name of turmeric, is a member of the Zingiberaceae family and is grown in red soils at temperatures between 20 and 30 degrees. Turmeric is utilised in cosmetics, medications, and cuisine as a colour and flavouring. India, which provides 80-85% of the global population and produces 6.0 lakh MT to 7.0 lakh MT of turmeric annually, is the world's largest producer. There are about 30 varieties of turmeric and the most popular varieties in India are Alleppey finger (Kerala), Erode and Salem turmeric (Tamil Nadu), Rajapore and Sangli turmeric (Maharashtra), Nizamabad Bulb (Telangana). The country's turmeric production in 2021-22 is estimated at 13.31 lakh tonnes (lt) against 11.24 lt the year before, up by over 18 per cent.

Turmeric is produced, consumed, and exported mostly in India. Given its high curcumin content, Indian turmeric is regarded as the best on the global market. About 80% of the world's production of turmeric and 60% of its exports come from India. Haiti, Jamaica, Peru, Taiwan, Pakistan, China, and Haiti are additional top producers. A large portion of the production of turmeric is used in Asia.

The major turmeric-growing states in India are Andhra Pradesh, Telangana, Tamil Nadu, Maharashtra, Assam, Kerala, Karnataka, and West Bengal . Orissa, Tamil Nadu, and Andhra Pradesh make up the next three states in terms of land devoted to growing turmeric, each with 17%. 60 percent of India's entire production of turmeric is produced in Andhra Pradesh followed by Tamil Nadu (13%). The Area occupied was Andra Pradesh(40%), Orissa (17%) and Tamil Nadu (13%). The dried, powdered form of turmeric is a common food additive that gives food both flavour and colour. Turmeric oleoresin, which is made by extracting

pulverised spice with a solvent, is used in the production of pickles, mayonnaise, relish, non-alcoholic beverages, butter, and cheese, among other things. Alleppey Finger (Kerala) and Erode and Salem turmeric (Tamil Nadu), Rajapore and Sangli turmeric(Maharashtra) and Nizamabad Bulb (Andhra Pradesh) in Tamil Nadu. Tamil Nadu, a 100kg bag of turmeric now costs more than 8 gm of gold. Erode, the world's largest producer and most important trading centre of turmeric in Asia, has seen its turmeric trading prices shoot up 30 per cent in value over the past few months.

## 2. REVIEW OF THE LITERATURE

Gouri Prava Samal [1] The paper evaluates the efficiency of Indian cotton futures prices in predicting future spot prices in the period January 2013 to December 2015 using Vector Auto Regression model and Granger causality tests. To check stationarity in futures and spot prices ADF test is applied. The results show that both the variables are stationary at the level. The VAR model suggests that the lag value of futures has more influence on the spot price of cotton. The causality test has further indicated that futures markets have negligible ability to predict subsequent spot prices for cotton.

Nazlioglu et al. [2] this study explore the dynamic link between global oil prices and 24 global agricultural commodity prices while taking relative US dollar strength fluctuations into account. For a panel of twenty-four agricultural items with monthly prices ranging from January 1980 to February 2010, we use panel cointegration and Granger causality approaches. He found that how variations in the price of oil affect the prices of agricultural commodities. Contrary to the findings of numerous studies in the literature, which claim that fluctuations in oil prices have no effect on agricultural prices, we discover compelling evidence that the price of various agricultural commodities is influenced by global oil prices.

Lokare [3] found that although the Indian commodity market is yet to achieve minimum critical liquidity in some commodities (sugar, pepper, turmeric), almost all the commodities show ~~a~~ evidence of co-integration between spot and future prices revealing the right direction of achieving the improved operational efficiency, though at a slower rate. Further hedging proves to be effective in respect of some commodities. However, for a few commodities, the volatility in future price has been substantially lower than the spot prices indicating an inefficient utilization of information.

Natarajan, P., and Nirupama, E. [4] investigated the relationship between Cardamom futures and spot pricing on the MCX from 2006 to 2012. The results of the Co-integration test indicated that the spot and futures emporiums have a close relationship because information spread between the two emporiums affects the oscillation in one emporium, causing it to shift. These findings support the price detection practise of futures emporiums and suggest that the information flow from futures to spot emporiums may be due to an increase in the relative prominence of electronic exchange of futures agreements over open auction dealing, which leads to widely accessible apparent prices in the emporiums.

Qiu Mengyuan, Ocean University of China [5], The futures prices of Chinese agricultural products are generally followed by the Chicago commodity exchange futures prices. The objective is to find the relationship between corn futures prices in China and corn future price United States. The Johansen Co-integration test is used to test the long run co-integration and found that there is a long run co-integration between two variables By comparison, the information in the corn market of America transfers faster and the U.S. corn futures market plays a leading role. This research also suggested how to promote the development of China's corn Future Market.

Sahi et al. [6], finds that the nature of volatility did not change with the introduction of futures trading in wheat, turmeric, sugar, cotton, raw jute and soya oil. Nevertheless, a weak destabilizing effect of futures on spot prices was found in the case of wheat and raw jute. Further, the results of Granger causality tests indicated that the unexpected increase in futures activity in terms of rise in. volumes and open interest caused an increase in the cash price volatilities in all the commodities listed.

Shakeel, M., and Purankar, S. [7] examined the lead-lag relationship between Selected Agri-Commodities futures and spot prices on the NCDEX platform from 2009 to 2014. The results of the cointegration test indicated that the presence of long-tenured

Futures and spot series of respective Agri-Commodities are linked. Furthermore, examination of the vector error correction model

reveals a bidirectional connection between futures and spot series of respective Agri-Commodities, indicating that both emporiums of the sampled underlying assets play a prominent role in price detection practise in India, as well as being very informationally effective and responding more quickly to each other.

Samal, G. P., and Swain, A. K. [8] used the 'Granger Causality test' to give early evidence for the dynamic linkage between turmeric futures and spot series from NCDEX in their work. The results of the 'Granger Causality test' demonstrated a unidirectional flow of news in the majority of the agreements over the studied period. This demonstrates that the turmeric futures exchange is responsible for the price detection method. Furthermore, Fstatistics defines a strong migration of news from futures emporiums to spot emporiums rather than the opposite. Turmeric's 'unidirectional causal nexus' reveals that futures emporiums help to determine prices in spot emporiums and that the emporiums are effective.

Shekhawat, SR., et al. [9] provided early evidence for the cointegration of Refined Soy Oil cash and futures prices from the NCDEX from 2004 to 2012. The empirical results of the 'cointegration test' revealed that the futures and cash rate sequences were significantly cointegrated. Furthermore, a study of the 'vector error correction model' reveals that the causativeness of the sampled underlying asset was bidirectional, i.e. both cash and futures series affected each other similarly, and therefore successful rate detection happened in the market.

## 3. OBJECTIVES

1) To determine the relationship between the selected markets in commodity futures
2) To determine the relationship between spot and future price of the Commodity markets
3) To identify the arbitrage opportunities in the futures market.

## 4. HYPOTHESES

Ho: Time series data is non Stationery
Ha: Time series data is Stationery
Ho: There is no significant long-run and short-run association between commodity markets
Ha: There is a significant long-run and short-run association between commodity markets
Ho: Spot price does not granger cause future
Ha: Spot price does granger cause future
Ho: Future does not granger cause spot
Ha: Future does granger cause the spot price

## 5. METHOD

Secondary data was collected for the study. The data was collected from the NCDEX website from the years 2016 to 2022. Turmeric was choosed and price-related data was collected. Agmarknet website used to collect price data from different markets like Nizamabad (Telangana), Erode (Tamil Nadu), Sangli (Maharastra) and cuddapah (Andra Pradesh) from the year 2013-2023. The data was collected on a daily basis and modified by adding 0 in the no trading days.

## 6. RESULTS AND DISCUSSION

Relationship between different Turmeric Market prices of Commodity Futures:

**Stationarity Test:**

Regressing a non-stationary series on another without performing a stationarity test could result in creating some erroneous outcomes. As a result, the variables that will be included in the regression model should be stationary. Even when it is discovered that the majority of the underlying price series are non-stationary, i.e.

$$\Delta Yt = b0 + \beta Yt\text{-}1 + \mu 1Yt\text{-}1 + \mu 2Yt\text{-}2 + \ldots\ldots\ldots + \mu pYt\text{-}p + \varepsilon t$$

where,

Yt represents a time series to be tested
b0 is the intercept term,
β is the coefficient of interest in the unit root test
μi is the parameter of the augmented lagged first difference of Yt to represent the path order autoregressive process,
εt is the white noise error term. In carrying out the unit root test, it is required to test the following hypothesis:
H0: α=0 (non-stationary)
H1: α≠0 (stationary)

The time series data are stationary if the null hypothesis is rejected. Comparing the computed values of the Augmented Dickey-Fuller "T" statistic with the crucial values for the rejection of a hypothesis for a unit root is one of the deciding criteria. The null hypothesis of non-stationarity in time series variables cannot be rejected if the

estimated ADF statistic is smaller than the critical values.

**Johansen Cointegration Test:**

The Cointegration approach can be used to estimate whether there is a long-term equilibrium between the markets. For estimating, the maximum Likelihood approach developed by Johansen and Juselius is utilised, which explains the cointegration between the selected markets. Two tests are included in the cointegration analysis: the trace statistic and the maximum Eigenvalue test statistic.

At maximum rank 0, the null hypothesis states that there is no co-integration and the alternate hypothesis is the presence of co-integration. Here, the trace statistics (65.2505) exceed the critical value (46.8361).

Therefore, reject the null hypothesis, hence the markets are cointegrated. Similarly, the maximum Eigen statistics (39.7003) is greater than the critical value (27.5843) at 0.05 levels. Thus, the markets are co-integrated at maximum rank. In maximum rank 1, the null hypothesis states that there is co-integration of equation 1. It is inferred from the table that in Atmost3 the trace statistics (1.6618) do not exceed the critical value (3.8414). Therefore, accepting the null hypothesis showed the co-integration of equation 1. A similar condition is observed for the maximum Eigen statistics. Therefore, Vector Error Correction models can be applied based on the result of Johansen co-integration test.

**Granger Casuality Test:**

The cointegration test demonstrated the existence of a long-term connection between the Turmeric markets. The Granger-Causality test is used to determine the direction of the relationship between the markets in the long-run equilibrium. The null hypothesis, according to which there is no granger source for price variations between marketplaces, form the basis of the test. The null hypothesis is disproved due to the significance of the probability value, indicating that a change in one market's price affected other market pricing.

The Table 6 shows the Bidirectional and unidirectional relationship between different markets. If the probability value is significant i.e. less than 0.05 . there is a presence of granger caused by one market and another. One market's price is influenced by another market's price. If the probability value is non-significant there is no Granger Cause between two Market prices.

Here, There is a Bidirectional Relationship between Erode and Cuddapah Market. Cuddapah Market granger cause Erode market i.e Erode Market price was influenced by the Cuddapah market's price. The probability value between Nizamabad and Cuddapah markets is 0.2275 i.e Non Significant so there is no relationship between one market's price with another. Likewise, Sangli and Cuddapah market prices has no influence on each other. The probability value of Nizamabad and Erode market was 0.6122 , so Nizamabad's Market price doesn't influence Erode Market's prices. But Erode Market's prices were influenced by Nizamabad Market's prices because of the Probability value of 0.0548. Erode Market price was influenced by Sangli Market's prices because of the significant probability value of 0.0262 but sangli Market's price doesn't influence Erode Market price because of Non-significant probability value of 0.9287.

The Table 7 shows that a close price granger causes spot price. The Spot price was influenced by the future price of the commodity. The probability value between the close price and the spot price was 0.0021. Here we come to know that Today's closing price will have impact on Tommorrow's Spot Price.

**Scope of Arbitrage:**

To study the scope of arbitrage standard deviation between future open and close prices was calculated. The Table 8 indicates that there is not much difference between the mean and standard deviation in the opening and closing price of future contracts therefore, not much arbitrage opportunity exists. The low arbitrage opportunity is nullified by the transaction cost.

**Table 2. Regression analysis results**

| Market | Level statistic | probability** | stationarity | First difference statistics | probability** | stationarity | Critical Value (1%) |
|---|---|---|---|---|---|---|---|
| Erode (TamilNadu) | -2.8467 | 0.1744 | Non-Stationary | -20.1564 | 0.0000 | stationary | |
| Nizamabad (Telangana) | -2.7766 | 0.2062 | Non-Stationary | -14.3884 | 0.0000 | Stationary | -2.4532 |
| Sangli (Maharastra) | -4.4664 | 0.5017 | Non-Stationary | -16.723 | 0.0000 | Stationary | |
| Cuddapah (Andra Pradesh) | -2.0864 | 0.5524 | Non-Stationary | -9.7882 | 0.0000 | Stationary | |

** Significance at 1 per cent level and**MacKinnon (1996) one-sided p-values*

**Table 3. Unrestricted Cointegration test using Trace Statistic**

| Hypothesized No. of CE(s) | Eigen value | Trace Statistic | Critical Value (5 %) | Probability** |
|---|---|---|---|---|
| None * | 0.01753 | 65.2505 | 46.8361 | 0.0005 |
| Atmost1* | 0.01341 | 37.3522 | 29.7970 | 0.0056 |
| Atmost2* | 0.0090 | 16.0488 | 15.4947 | 0.0412 |
| Atmost3 | 0.0010 | 1.6618 | 3.84146 | 0.1974 |

*Trace test indicates 3 cointegrating eqn(s) at the 0.05 leve*
** denotes rejection of the hypothesis at the 0.05 level*
***MacKinnon-Haug-Michelis (1999) p-values*

**Table 4. Unrestricted cointegration rank test (Maximum Eigenvalue)**

| Hypothesized No. of CE(s) | Eigen value | Maximum Eigen statistic | Critical Value(5%) | Probability** |
|---|---|---|---|---|
| None * | 0.01753 | 27.898 | 27.5843 | 0.0456 |
| Atmost1* | 0.01341 | 21.3034 | 21.1316 | 0.0473 |
| Atmost2* | 0.00908 | 14.3870 | 14.2640 | 0.0478 |
| Atmost3 | 0.00105 | 1.6618 | 3.8414 | 0.1974 |

*Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level; * denotes rejection of the hypothesis at the 0.05 level; **MacKinnon et.al (1999) p-values*

**Table 5. Granger-causality test**

| NULL HYPOTHESIS | Observations | F-Statistic | probability | Relation |
|---|---|---|---|---|
| ERODE_MODAL_PRICE_RS_QUINTAL__does not granger cause CUDDAPAH_MODAL_PRICE_RS_QUINTAL | 1580 | 8.66481 | 0.0002 | E → C |
| CUDDAPAH_MODAL_PRICE_RS_QUINTAL dose not granger cause ERODE_MODAL_PRICE_RS_QUINTAl | | 8.47448 | 0.0002 | C → E |
| NIZAMABAD_MODAL_PRICE_RS_QUINTAL_ dose not granger cause CUDDAPAH_MODAL_PRICE_RS_QUINTAL | 1580 | 1.48193 | 0.2275 | NS |
| CUDDAPAH_MODAL_PRICE_RS_QUINTAL _ dose not granger cause NIZAMABAD_MODAL_PRICE_RS_QUINTAL | | 3.31538 | 0.0366 | C → N |
| SANGLI_MODAL _PRICE_RS_QUINTAL_ dose not granger cause CUDDAPAH_MODAL_PRICE_RS_QUINTAL | 1580 | 0.02504 | 0.9753 | NS |
| CUDDAPAH_MODAL_PRICE_RS_QUINTAL _dose not granger cause SANGLI_MODAL _PRICE_RS_QUINTAL | | 0.54014 | 0.5828 | NS |
| NIZAMABAD_MODAL_PRICE_RS_QUINTAL_ dose not granger cause ERODE_MODAL_PRICE_RS_QUINTAL | 1580 | 0.49080 | 0.6122 | NS |
| ERODE_MODAL_PRICE_RS_QUINTAL__does not granger cause NIZAMABAD_MODAL_PRICE_RS_QUINTAL | | 2.91030 | 0.0548 | E → N |
| SANGLI_MODAL _PRICE_RS_QUINTAL_ dose not granger cause ERODE_MODAL_PRICE_RS_QUINTAL | 1580 | 3.65105 | 0.0262 | S → E |
| ERODE_MODAL_PRICE_RS_QUINTAL__does not granger cause SANGLI_MODAL _PRICE_RS_QUINTAL | | 0.07398 | 0.9287 | NS |
| SANGLI_MODAL _PRICE_RS_QUINTAL_ dose not granger cause NIZAMABAD_MODAL_PRICE_RS_QUINTAL | 1580 | 0.23227 | 0.7928 | NS |
| NIZAMABAD_MODAL_PRICE_RS_QUINTAL_ dose not granger cause SANGLI_MODAL _PRICE_RS_QUINTAL | | 0.58708 | 0.5561 | NS |

*NS: Non significant*

**Table 6. National Market**

| National Market |
|---|
| Erode ⟷ Cuddapah |
| Cuddapah → Nizamabad |
| Cuddapah → Sangli |
| Erode → Nizamabad |
| Sangli → Erode |
| Nizamabad → Sangli |

**Table 7. Relationship between Spot and Future Price of the Commodity market**

| Null Hypothesis | Observation | F-Statistic | probability | Relation |
|---|---|---|---|---|
| CLOSE_PRICE_IN_RS_dose not granger cause SPOT_PRICE_BASIS_VARIETY_RS_ | 3703 | 3.77369 | 0.0021 | CP → SP |
| SPOT_PRICE_FOR_BASIS_VARIETY_RS_dose not granger cause CLOSE_PRICE_IN_RS | | 47.8289 | 4.E-48 | NS |

**Table 8. Descriptive statistics**

| | LN Close price | LN Future Price |
|---|---|---|
| Mean | 8.876198 | 8.867471 |
| Median | 8.870663 | 8.891051 |
| Maximum | 9.319015 | 9.168612 |
| Minimum | 8.252446 | 8.287365 |
| Std.Dev | 0.0145180 | 0.142786 |
| Skewness | 0.351745 | -0.150647 |
| Kurtosis | 3.108955 | 2.528876 |
| Jarque-Bera | 97.41019 | 60.11044 |
| Probability | 0.000000 | 0.000000 |
| Sum | 40945.90 | 40905.64 |
| Sum Sq.Dev | 97.20805 | 94.02923 |

## 7. CONCLUSION

There is a Dynamic relationship between the spot and the future prices of the Commodity Futures and also between different markets. One Market prices granger cause Another Market's price. Some Markets will have no influence on other market's price.

Arbitrage opportunity: Underpricing of Future contracts lends scope for arbitrage opportunity, but it depends on the type of commodity, timing and the magnitude of underpricing.

## 8. LIMITATIONS OF THE STUDY

1. This work only examines the Turmeric product. Other commodities can be the subject of research, with results that can be applied to the entire commodity market.
2. Although the prospect of arbitrage is not present in the case of turmeric, it cannot be extrapolated to other commodities.

## 9. SCOPE FOR FUTURE RESEARCH

1. Further research on major agricultural a commodities can be done.
2. Other issues like if commodity future market is fairly priced or not can be studied.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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