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Price transmission for natural rubber: India integration with world markets

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Abstract. *This paper, using daily price series during the period 2004-2017, analyses the price integration between global and national rubber markets in India. The study ultimately aims at producing evidence based claims on the effects of 2008 financial crisis in horizontal price transmission efficiency from global market to domestic rubber markets, for which we carry out our estimation procedure separately for two distinct, no overlapping time slots - pre-recession and post-recession periods. The cointegration procedure administered in the research finds higher degree of price integration between markets until recession. The rubber price elasticity coefficient is almost halved during the resilient phase which could partially due to the increased use of low cost synthetic substitute to natural rubber. The disruption of arrival of new stocks as a result of the recently initiated reforms like demonetisation and GST in India could also have affected the degree of market integration. The study concludes with a suggestion that the emerging markets like India should encourage their domestic agriculture production and limit dependency on world markets to develop an environment encouraging equity in sustainable economic growth.*

Keywords: natural rubber; price transmission; cointegration.

JEL Classification: C58; G01; G17.

1. Introduction

The growing integration of national markets into global market through trade and investment liberalisation has been observed phenomenon for the past two to three decades. Countries with close trade and investment ties should have closely integrated markets (Cheng and Zhang, 1997). Globalisation transforms the traditional market structures of world economy into timeless, space less, free and open (Kose et al., 2006). Integration into the world economy is not an end itself, rather should be regarded as means in the course of development (Sesrtcic, 2005). Advances in communication and transport technology, drift in consumer tastes and changes in public policies significantly influenced the nature and pace of integration (Mussa, 2000).

An efficient market is well integrated one. Increasing complexity of integration makes it hard and difficult to measure efficiency. However, among many performance measures, price is the main tool to assess the efficiency of market integration at different levels (Kharin, 2015). Technological innovations in countries improve products and processes, and reduce costs which stimulate import demand by trade partners and subside price pressures for trade partners. Hence, increasing market integration should analyse through the lenses of commodity prices (Bolling, 2003). For that reason price convergence is the best measure of commodity market integration (Findlay and O'Rourke, 2003). In other sense, an integrated commodity price volatility is the key source of economic shocks, particularly in developing and least developed economies, which is much depressing for their long run economic growth. Consequently, commodity market integration and price transmission effect receive significant interest recent times.

Research investigating the price transmission is not recent origin in economic literature (Meyer and von Cramon-Taubadel, 2004). In fact, the studies explaining the price transmission mechanism in domestic agriculture is splendid in commodity research. Many literature on this issue embrace to the conventional wisdom that agriculture is one of the sectors which is more vulnerable to the global price volatility. Agriculture is a shining light in many declining economies. Still, it is a complex activity in the light of dynamism and innovations registered by global economy (Loto, 2012). Globalisation and trade liberalisation have exposed agricultural sector of many developing countries to sudden disturbances caused by demand supply conditions and volatility in commodity prices (Bathla, 2014). Opening up to world markets and constant adjustment of agricultural policies in response to changing conditions of global markets cause price transmission effect in agricultural commodity markets (Arnade et al., 2017). Hence, issue of price volatility has assumed critical importance in the context of agricultural trade liberalisation that lead to the transmission of international price volatility in domestic markets (Sekhar, 2003). However, the short price transmission of prices are much lower than long run price transmissions which impels the effectiveness of stabilisation policies in delaying the transmission of price shocks in many commodities (Arnade et al., 2017).

Economic cycle changes affect the market integration and price transmission process in commodity markets. The trend towards greater market integration in agriculture commodities is not monotonic and is continuously interrupted by wars and economic recessions (Findlay and O'Rourke, 2001). Economic recession caused a drop in demand for basic products and lead to sharp decline in agriculture prices that had repercussions for farmers (Pouch, 2018).Contrary to these literature, Greb et al. (2016) claim that local factors are more significant in impacting the price volatility of commodity prices even for markets where domestic prices are cointegrated with global prices. Moreover their study observes commodity specific as well as region specific heterogeneity in price volatility in domestic markets.

Spatial or horizontal price dissemination model suggests that if two markets are linked by trade in a free market regime, the demand supply gap in one market causes price volatility in other market. Identical commodities follow the law of one price (Monke and Petzel, 1984). Minot (2010) argues that domestic prices are unlikely to have noticeable impact on world prices despite world prices can exert substantial influence on domestic prices. Based on the food prices in 58 countries, Mundlak and Larson (1992) find that 95 per cent of the price change in world market was transmitted to domestic markets.

The extent of price transmission varies substantially from market to market (Kalkuhi, 2016). In a study investigating the asymmetry of price transmission from global groundnut markets to national markets, Tankari (2012) shows that groundnut national central market is not integrated to the international markets and transmission from the global markets to the domestic market is symmetric. Jha et al. (2005) reveals that market integration was much distant in India due to the over governmental interventions. JENA (2016) finds no relationship between domestic agriculture index and global agriculture index prices in India. However, his study reveals that the change in commodity index, more specifically, energy and metal index prices are due to the global commodity index. In an open market setting, the price fluctuations in global markets get easily transmitted to the domestic markets (Rajmal and Mishra, 2009). However, their research finds the agriculture prices in India are much lower than the domestic prices both in absolute and relative terms. In his study on price integration of rice and wheat markets, Acharya et al. (2012) find lack of integration between domestic and global rice prices. However, the wheat prices appeared to be cointegrated with global market prices.

India is one of the leaders in natural rubber production (Goswami and Challa, 2007). Like other commodities, natural rubber faced serious price volatility during the time of economic crisis 2008 (Goh et al., 2016). Moreover, the lagged effects of recession continued for the next few years.From the above literature reviewed, it is quite obvious that the research investigating market integration and price transmission are rich indeed. However, most of the studies on this issue are commodity specific. To be precise, they concentrate more on commodities like cereals, wheat, rice and similar commodities. Moreover, the studies examining the price transmission and market integration of agriculture commodities meant for industrial needs are really scanty, particularly in emerging market context. Hence, this paper empirically examines the integration of Indian rubber markets with global markets, thereby the price transmission effect. Alternately, the research investigates the effects of economic downturn on horizontal price transmission for natural rubber markets in India.

2. Empirical methodology

Basically, this research aims to empirically calibrate the price transmission effects of global rubber markets to Indian rubber markets. Today's market is unquestionably global and the national market for goods and services have become increasingly integrated with other markets (Berg et al., 2016). The relationship between market prices is either long term or short term and the intention of this kind of research is to capture and examine the dynamics of such market integration in terms of prices. The empirical methodology for the study is designed under time series econometric framework which extracts as much information as possible from the past history of price series to explore causal relations between markets. Accordingly, our estimation procedure involves two stage processes – a Causality test under Vector Autoregressive (VAR) modelling suggested by Granger (1969) to detect the direction of short run causality and an OLS (Ordinary Least Square) based cointegration methodology proposed by Engle and Granger (1987) to investigate the asymmetry of price transmission between markets.

2.1. Causality test

VAR model allows us to test for the direction of causality and enables characterization of dynamic interaction between variables, without any restrictions on the structure of the system. Granger (1969) developed a relatively simple procedure that predicts the values of endogenous variable with greater accuracy by using its own past values along with the past values of exogenous variables.

The study estimates VAR to capture short run causality between global rubber prices and domestic rubber prices. Despite the causality test is able to diagnose the bi-directional causality between two price series, the study hypotheses only one-dimensional causality from global rubber prices to domestic rubber prices under the impression that the impact of domestic prices on world prices are implausible in most market conditions. Consequently, the Granger causality test for the case of two stationary variables, domestic rubber prices and world rubber prices, involves as a first step estimation of the following VAR model:

$$Y_t = \alpha_t + \sum_{i=1}^{n} A_i Y_{t-i} + \sum_{i=1}^{m} \beta_i \, \chi_{t-i} + \varepsilon_t \qquad (1)$$

Where Y_t is the transformed variables vector of domestic rubber prices, Y_{t-i} are the lagged variables vectors, X_t are the explanatory variable of global rubber prices, matrices A_i and β are to be estimated and ε_t is uncorrelated white-noise error terms.

The study set the null and the alternative hypotheses as below:

H_0: $\sum_{i=1}^{n} \beta_i = 0$ or Y_t (global rubber prices) does not cause X_t (Indian rubber prices)

H_1: $\sum_{i=1}^{n} \beta_i \neq 0$ or Y_t (global rubber prices) does cause X_t (Indian rubber prices)

2.2. Engle–Granger cointegration analysis

Cointegration is a prime requisite for judging the utility of any economic model using non-stationary time series data. Conventional Granger causality test is not valid as two integrated series cannot cause each other in the long run unless they are cointegrated (Granger and Lin, 1995). If the variables do not cointegrate, we have the problems of spurious regression. Thus, we test for causality between the variables which, are found to be cointegrated.

Granger (1981) introduced the concept of cointegration and studies like Engle and Granger (1987); Engle and Yoo (1987) and Johansen, 1991, 1995) later elaborated the thought. From the mathematical point of view, the idea of cointegration emerges from the notion of transformations. When the original data exhibit certain non-stationary behaviour, we should convert the same into stationary. Non-stationary data series are subject to cumulated error processes revealed by the presence of stochastic trends (Asteriou and Hall, 2005). Once these stochastic trends cancelled then we have cointegration and the coefficients in the estimation process constitute parameters denoting the long run relationship between the observed variables.

The theory of cointegration assumes the general behaviour of a multiple time series. Engle and Granger (1987) is the pioneering work that formalised this concept by introducing a simple test for the existence of cointegrating relationship. The approach suggested by them we often called EG approach, the standard procedure of which includes carry out Augmented Dickey Fuller (ADF) tests on the null hypothesis that each of the variables listed has a unit root; estimating the cointegrating regression; and perform ADF test on the residuals from the cointegrating regression.

By definition, cointegration pre supposes that the variables are at same order of integration (Brooks, 2008). Hence, the first step is to examine each variable to find out its order of integration. The ADF test checks the number of unit roots (if any) in each of the variables.

ADF is a parametric method for controlling higher order correlation by assuming that the series follows an AR (p) process (Dickey and Fuller 1979, 1981). Augmented Dickey-Fuller test procedure needs to run a regression of the first difference of the series against the series lagged once, lagged difference terms and a constant with a time trend such as:

$$\Delta Y_t = a_0 + \lambda Y_{t\text{-}i} + A_2 t + \sum_{i=1}^{m} \beta_i \Delta Y_{t\text{-}i} + \varepsilon_t \qquad (2)$$

Where Δ is the first difference operator, $\mathbf{e_t}$ is an error term, and **m** is the number of lagged first differenced term and is determined such that $\mathbf{e_t}$ is approaching white noise.

We can differentiate two cases, which either will lead us to the next step or will suggest stopping:

a) If variables integrate at different order, it is possible to conclude that there is no evidence of cointegration.
b) If the variables integrate at the same order then we proceed to estimate the possible cointegrating regression

If unit root test results indicate that all variables are integrated of the same order (usually in I(1) form), the next step is to estimate the long run equilibrium relationship of the form

$$y_t = \beta_1 + \beta_2 x_{1t} + e_t \qquad (3)$$

and obtain the residual of this equation.

Since our cointegration vector consists of two variables (domestic and global rubber prices), there should have been two regression equations. Since the prime intention of the research is to examine the asymmetry of price transmission from global rubber market to domestic rubber market in India we construct only one regression equation taking domestic rubber prices as endogenous variable 'y_t' and global rubber prices 'x_t'. However, the research performs regression separately for two observation periods.

If there is no cointegration, the results obtained will be spurious. However, if the variables are cointegrated, then OLS regression yields "super consistent" estimators for the cointegrating parameter β_2.

We should estimate the residual sequence, denoted by $\hat{e}_t$, from cointegrating regression equation to decide whether the variables are really cointegrated or not. In other way, $\hat{e}_t$ is the series of the estimated residuals of the long run relationship. Once these deviations from long run equilibrium found stationary, then variables are said to be cointegrated. The DF or ADF test can be used on $\hat{e}_t$ series, using the regression of the form

$$\Delta\hat{e}_t = a_1\hat{e}_{t-1} + \sum_{i=1}^{m} \delta_i \Delta\hat{e}_{t-1} + v_t \qquad (4)$$

with v_t an error term.

Since $\hat{e}_t$ is a residual, we include neither a constant nor a time trend. Moreover, the critical values compare with a DF or an ADF test on a series of raw data. Unlike other co-integration tests, Engle and Granger (1987), in their seminal work, performed their own Monte Carlo simulation in order to construct critical values for co integration tests (Enders, 1995).

The residuals have constructed from a particular set of coefficient estimates, and the sampling estimation error in those coefficients will change the distribution of the test statistic. If we find that $\hat{e}_t \sim I(0)$ then we can reject the null that the variables are not cointegrated.

3. Data and empirical results

3.1. Data

This part devotes to discuss the data and results of the empirical analysis made. The research perform price transmission analysis at global and Indian rubber prices using daily price data for a period of fourteen years from 1st January 2004 to 31st December 2017. We divide the study period into two distinct sample periods- pre recession (2004-2008) and post recession (2009-2017) to verify the presence of structural break, if any, caused by the global recession in the price transmission effect from global markets. The observations relate to nominal prices for rubber per ton as the level data and the Rubber Board, Government of India constitutes the sources of data. We transform the base level data in to the daily changes in the rubber prices, the first-differenced data, that permits the outcome of the research to be construed in change terms. The probability of stationarity will be improved after first differencing (Hamilton, 1994). The research arbitrarily divides the study period into pre-recession period (2004-2008) and post-recession period (2009-17) for making valuable judgment of the findings on objectives specified.

Natural rubber: Global supply and demand

Classical economic literature assume supply and demand as an economic model of determining prices and also the changes therein. Hence we should look into the data about world production and consumption of rubber during the period we observed. Thailand is the world's largest producer of natural rubber and it produced 4.473 million tons of rubber in 2015 (Table 1). India is the sixth largest producer of Natural Rubber in 2015 with a share of 4.7 per cent of total world production. Natural Rubber production increased by 38.28 per cent to 12.314 million tons in 2015, compared to 8.904 million tons in 2014. During the year 2015, the output in major producing countries like Thailand, Indonesia, Malaysia and Vietnam have increased, while production in China and India have decreased. In fact, from the year 2013 onwards natural rubber production in India was in downtrend which can be attributed to the production curtail practices of Indian rubber growers due to the drop in prices in domestic and global markets.

Table 1.*Country wise Production of Natural Rubber (in million tons)*

Country / Year	Thailand	Indonesia	Malaysia	India	Vietnam	China	Others	Total
2004	2.984	2.271	1.126	0.772	0.482	0.510	0.806	8.904
2005	2.937	2.271	1.126	0.772	0.482	0.510	0.806	8.904
2006	3.137	2.637	1.284	0.853	0.555	0.533	0.792	9.791
2007	3.056	2.755	1.200	0.811	0.606	0.590	0.783	9.801
2008	3.090	2.751	1.072	0.881	0.660	0.560	0.102	10.036
2009	3.164	2.440	0.856	0.820	0.724	0.644	0.1054	9.702
2010	3.252	2..736	0.939	0.851	0.752	0.665	1.204	10.399
2011	3.394	2.982	0.996	0.890	0.812	0.707	1.193	10.974
2012	3.778	3.040	0.923	0.919	0.864	0.795	1.008	11.327
2013	4.170	3.237	0.826	0.796	0.949	0.865	1.408	12.251
2014	4.323	3.153	0.669	0.705	0.954	0.857	1.409	12.070
2015	4.473	3.175	0.722	0.575	1.017	0.794	1.558	12.314

Source: Rubber Board, Government of India, 2017.

China is the largest consumer of rubber in the world and it consumed 4.680 tons of natural rubber which is more than double of its rubber consumption in 2004. India ranked second with regard to natural rubber consumption during the period of observation with a share of 8 to 9 per cent of world consumption. India's natural rubber consumption was in uptrend until 2014 and before occurring mild insignificant contractions in 2015. Global natural rubber consumption increased to 12.167 million tons in 2015 registering a growth of 46.44 per cent relative to 8.718 million tons in 2004. Consumption of natural rubber in most countries increased during the period, while Japan reduced their demand considerably.

Table 2. *Country wise Consumption of Natural Rubber (in million tons)*

Year \ Country	Thailand	Indonesia	Malaysia	India	Japan	China	Others	Total
2004	0.319	0.196	0.403	0.745	0.815	2	0.806	8.718
2005	0.335	0.221	0.387	0.789	0.857	2.266	0.806	9.2
2006	0.321	0.355	0.383	0.815	0.874	2.743	0.792	9.677
2007	0.374	0.391	0.45	0.851	0.887	2.812	0.783	10.144
2008	0.398	0.414	0.469	0.881	0.878	2.94	1.022	10.173
2009	0.399	0.422	0.47	0.905	0.636	3.46	1.054	9.39
2010	0.42	0.421	0.458	0.944	0.739	3.634	1.204	10.671
2011	0.48	0.441	0.402	0.957	0.772	3.622	1.193	10.963
2012	0.49	0.488	0.441	0.988	0.733	3.853	1.008	11.005
2013	0.521	0.509	0.434	0.962	0.71	4.21	1.408	11.388
2014	0.541	0.54	0.447	1.015	0.709	4.76	1.409	12.137
2015	0.601	0.58	0.475	0.993	0.691	4.68	1.558	12.167

Source: Rubber Board, Government of India, 2017.

Summary statistics

Higher growth in consumption compared to the growth in production of natural rubber has driven its prices up in both domestic and world markets, particularly after recession (Table 3). Until the global recession of 2008, the average price of rubber in international market was much higher than the domestic market prices. Domestic prices found less volatile and price movement in the market was almost normal while global market prices were slightly positively skewed in its distribution. However, the recession brought in sweeping changes and the domestic rubber prices in India went ahead of global prices, but with fewer amount of volatility. None of the markets were strictly normal, despite spot market prices were found approximately normal.

Table 3. *Summary statistics*

Period	Variable	Mean	Standard deviation	CV	Skewness	Kurtosis
Pre Recession	Global	8253.85	2029.03	0.245	0.176	-1.023
	India	7778.23	1783.81	0.229	0.016	-1.230
Post Recession	Global	14693.20	4630.40	0.315	0.504	-0.180
	India	15297.00	3884.62	0.253	0.131	-0.662

Augmented Dickey-Fuller Test for Unit Roots

Since causality tests assume stationary or the presence of random behaviour of the series, the study checked the order of integration at first with ADF estimates, which we reported in Table 4. The test results of unit root indicate that both price series are stationary after being first differenced and the null hypothesis of non-stationary is clearly rejected at one per cent level, suggesting that our rubber price series are integrated of order one i.e. I(1). Since the variables are integrated of the same order then we proceed to the next step, estimating the causality between series.

Table 4. *ADF Statistics for Rubber Price data*

Period	Rubber Prices	With constant		With constant and trend	
		Test statistic	P value	Test statistic	P value
Pre Recession	Global	-12.6281	0.0000*	-12.5845	0.0000*
	India	-12.6805	0.0000*	-12.6472	0.0000*
Post Recession	Global	-15.0845	0.0000*	-15.0232	0.0000*
	India	-15.1851	0.0000*	-15.0642	0.0000*

*significant at one per cent level.

Table 5. *Test statistics and choice criteria for selecting the order of the VAR model*

Period	Lags	LL	P(LR)	AIC	BIC	HQC
Pre recession	1	-6703.367		12.9092	12.9235	12.9146
	2	-6697.878	0.0009	12.9006*	12.9196*	12.9078*
	3	-6697.873	0.9212	12.9025	12.9263	12.9115
	4	-6697.161	0.2329	12.9031	12.9316	12.9139
	5	-6696.275	0.1831	12.9033	12.9366	12.9159
	6	-6696.013	0.4692	12.9047	12.9428	12.9191
	7	-6695.665	0.4044	12.9059	12.9488	12.9222
	8	-6694.988	0.2446	12.9066	12.9542	12.9246
Post recession	1	-10167.821		13.1956*	13.2106*	13.2041*
	2	-10166.543	0.1045	13.1998	13.2137	13.205
	3	-10166.519	0.9152	13.2011	13.2184	13.2075
	4	-10165.492	0.1501	13.2023	13.2218	13.2088
	5	-10165.438	0.7756	13.2034	13.2266	13.2113
	6	-10165.388	0.6003	13.2045	13.2311	13.2137
	7	-10165.183	0.5482	13.2045	13.2357	13.2161
	8	-10165.113	0.8899	13.2058	13.2404	13.2186

Note: AIC – Akaike Information Criterion BIC – Bayesian Information Criterion HQC – Hannan-Quinn criterion.

The study tests the presence of both short run and long run causality between Global rubber prices and the Indian rubber prices. The econometric techniques estimating causality between time variables are known to be sensitive to the lag length (Banerjee et al., 1993). Hence, we estimate the VAR system comprising global and domestic prices in India for various lag lengths and calculate the respective Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC) and Hannan-Quinn criterion (HQC) for determining the appropriate lag length for the causality tests. Eight alternative VAR (P), p=1, 2, 3, ..., 8 models were separately estimated for each of the sample periods and the maximized values of the Log-Likelihood decrease with p. All the criteria indicated that the optimal lag length is one both for pre recession and post recession periods (Table 5). Accordingly, we test causality and cointegration using one lag in the VAR system.

Table 6. *Short run Causality between Global and Indian Rubber prices: Granger Causality Results*

Period	Causality	Coefficient	F	P value
Pre recession	International rubber prices Granger cause Indian rubber prices	0.7401(34.457)	2.9463	0.0120**
Post recession	International rubber prices Granger cause Indian rubber prices	0.3443 (16.953)	4.0977	0.0011*

*significant at one per cent level.
** significant at 5 per cent level. (Figures given in parentheses indicate t ratio)

Price transmission effect in rubber markets implies that international prices must Granger cause domestic prices. In other sense, dividing the sample period into pre recession and post recession for resolving the issues of parameter instabilities, we should reject the null hypothesis that $\beta_i = 0$ or global rubber prices do not cause Indian rubber prices. To test this hypothesis we use standard Granger causality test separately for two sample periods on first differenced price data that are serial correlation consistent. Table 6 reports the results of the causality test that indicates stronger evidence in favour of the validity of global market leading hypothesis in the emerging markets, like India. To be precise the results suggest the causality direction runs from the global rubber markets to Indian market during both period of analysis. Also we observe, in both sample periods, that the coefficients of the equations are statistically significant (at least at five per cent level). F tests reject the hypothesis of the coefficients in the VAR system are equal to zero thereby suggesting short run causal relationship between international rubber prices and Indian rubber prices. The international rubber prices are likely to embody vital information content about future rubber price movements in India. Thus, the results of the causality test eventually motivate us to subscribe to the theory of price transmission effects in Indian rubber markets during recessionary as well as resilience days. In sum, we obtain robust, but theoretically sensible finding that the global rubber prices which are connected to many market forces can forecast the domestic rubber price movements in India

Cointegration test results

The study uses Engle Granger (EG) approach to confirm cointegrating relationship of Indian rubber prices with global prices. Once series are cointegrated, Indian rubber prices have a long-term relationship with international price movements that restrict them from drifting away without bound. We expect the contemporaneous change in the values of rubber in Indian market with the fluctuations in global markets Moreover, the existing price variations in domestic rubber market are independent of previous price changes in Indian as well as world rubber markets. While testing the evidence for cointegration, the static equation (3) is first estimated with OLS and then the stationarity of the residuals of the relationship between international and Indian rubber prices is tested with the ADF test. The results of Engle Granger cointegration test reported in Table 7 which exhibits the coefficients of the exogenous variables and respective values in the cointegration vector. The null hypothesis of non cointegration in the rubber markets are rejected for both sample periods. We examined only the direction of price transmission from global markets to Indian markets, but not vice versa. One notable point here is that the price transmission effect from global markets is immediate and dynamic since both price series are integrated at l(1) and parameters in the model are consistent and independent of the period observed. Constants in the models are statistically insignificant and have no implication in the regression estimated.

As noted earlier in the model specification, to verify whether the two rubber price series are truly cointegrated or not, we should estimate the residual sequence from equation (3). If $\hat{\mathbf{e}}_t$, the series of the estimated residuals of the long run relationship, are found to be stationary, then the prices are considered to be cointegrated. The test statistics presented in Table 8 are ADF tests regarding the hypothesis of a unit root in the cointegrating regression residuals of each of the equation that we made. The test results show that $\hat{\mathbf{e}}_t$ series are integrated of the order zero {I(1)} in both equations. Consequently, we reject the null hypothesis that the two price series are not cointegrated. In other words, our empirical results claim the price transmission effect from global rubber markets to national rubber markets in Indian context has been prevailing for the past many years prior to recession.

Table 7. Cointegrating Regression Test Results

Period	Independent Variable	Co efficient	Std. Error	t ratio	P value
Pre Recession	Constant	2.7948	4.7251	0.5914	0.5544
	Rubber: Global	0.7364	0.0213	34.5126	0.000*
Post Recession	Constant	0.4274	4.3863	0.0974	0.9224
	Rubber: Global	0.3578	0.0159	22.5012	0.000*

*indicates rejection of the hypothesis at one percent level.

The results of causality and cointegration indicate that there is positive significant relations between international rubber prices and Indian rubber prices. Based on the calculated price transmission coefficients, there is evidence of immediate effect that a one unit change in global prices lead to 0.74 per cent change in Indian rubber prices before recession and 0.34 percent variation after recession. The difference in the two price elasticity coefficients impel the presence of structural break on the influence of global rubber prices on the domestic rubber prices.

On looking into price transmission elasticity coefficient according to our cointegration models, the long run dynamic effects of global rubber price changes on domestic rubber prices are stable and almost at same rate. In fact, the decline in production and increase in consumption of natural rubber made India over dependent on global markets for her supplies. As a result, base effects came into play and the domestic rubber prices become more cointegrated with global prices. Moreover, the disruptions in arrivals of new stock due to demonetisation and GST in India and the increased supplies of synthetic substitute to natural rubber might be the factors extraneous to our regression model affecting the domestic rubber prices.This could be the plausible reason for the reduction in price transmission elasticity during the period subsequent to recession.

Table 8. *Error Correction Terms: Residuals from the Cointegrating regression*

Period	tau statistic	P value
Pre recession	-13.6465	0.0000*
Post recession	-15.8325	0.0000*

*significant at one per cent level.

Conclusion

The study investigated the short run as well as long run integration of Indian rubber prices with global rubber prices. The ultimate aim of the research to assess the price transmission effect from global market forces to domestic rubber market of the country. The research used daily price data on global and Indian rubber prices during the period from 1st January 2004 to 31st December 2017. For verifying the presence of structural break, if any, we divided the study period into pre-recession period (2004-2008) and post-recession period (2009-17). The base level data were transformed into the first-differenced data, which were integrated of order one.

We adopted Classical Engle Granger cointegration methodology to examine the long run horizontal price transmission effect from international markets to Indian rubber markets. Granger causality test produced evidence in favour of the effect of international rubber price variations on the domestic price changes implying the unidirectional causality from global markets to national markets for rubber in India. The price transmission elasticity coefficient computed in the study found higher degree of price integration between markets until recession, the same was almost halved during the years subsequent to recession. Despite these dilutions, the price transmission elasticity coefficient derived from our cointegration framework suggests long memory or long range persistence of international effect in domestic price variations in Indian rubber.

The rubber farming becomes unprofitable for most rubber growers in India and they force to curtail their production. The leaning rubber production and the widening deficit has incited users in natural rubber markets to contract for imports and to substitute their material needs with synthetic products. However, the domestic rubber prices in India have been ruling 8 to 10 per cent higher than the global prices which might be due to the disruptions in arrivals of new stock on account of the recently initiated reforms like demonetisation and GST.

The findings are much significant to the Government of India with regard to the import substitution of rubber from Malaysia China and other countries. The substitution of domestic rubber with imported rubber or synthetic substitute to natural rubber has serious socio economic implications as it leads poverty and unemployment, impacting the growers of natural rubber. The outcome of this research definitely be a good guide for the policy makers to assess the economic value of rubber trade while planning measures to boost domestic production and usage to strengthen and stabilise its prices. The research suggests optimal trading choices to commodity traders who look for arbitrage opportunities to capitalise price differentials across markets. India should encourage domestic production to limit dependence on global markets. India must consider a broad portfolio of production including agriculture to ensure reliable resources to fuel her economic growth for its growing population instead of focusing only on services which can lead to serious consequences in future.

This research examined the price transmission effect of international rubber prices in Indian rubber prices. Further research could include the domestic price data from other producing countries in the sample to make out better the price integration along the horizontal supply chain of natural rubber. The study used relatively simple co-integration technique, Engle Granger model, with a single structural break of global recession of 2008. We need more research to investigate price transmission effect in rubber prices using advanced econometric tools under multiple breaks and seasonal pattern.

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