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A study on asymmetric price transmission in Gujarat's major cereal markets

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Abstract
For analysing asymmetric price transmission of major cereals of Gujarat state from 2001-2022 Paddy, Wheat, Maize, and Pearl Millet was selected purposively for the study as they were contributing maximum to the markets of Gujarat in terms of arrivals. On the basis of highest wholesale and retail price during January 2001 to December-2022, twelve markets; three markets for each selected cereal were selected. Negative values of ECT (+) (Error Correction Term) markets of selected cereals indicated slow adjustments when the prices were above equilibrium. Positive values of ECT (-) in markets of selected cereals indicated quicker adjustments when the prices were above equilibrium. All the markets of selected cereals rejected null hypothesis of test of symmetry and resulted in asymmetry of price behaviour, which showed potential market inefficiencies or retailer power in market.

Keywords: Asymmetric price transmission, error correction term, equilibrium, market inefficiencies, stationarity, Unit root test

Introduction

Asymmetric price transmission refers to the unequal or unbalanced response of prices to various economic or market conditions. "Asymmetric" means that the way prices react to different factors or events is not uniform; instead, it may vary depending on the specific circumstances, Ben-Kaabia, M., Gil, J. M., and Serra, T. (2005) [12]. Price Transmission Asymmetries in the Spanish Lamb Sector. It can help in making more accurate predictions about market responses to various events, designing effective pricing strategies, and formulating economic policies that account for the potential uneven impact of price changes on different market participants. Capps, O., and Sherwell, P. (2007) [2], Reziti, I., and Panagopoulos, Y. (2008) [11].

Methodology

Under Wolfram – Houck Model framework, any change in the retail price Δy_t was regressed upon $\Delta\ x_t^+$ and $\Delta\ x_t^-$ which are the positive and negative changes in the wholesale price respectively.

$$\Delta yt = \beta 0 + \sum_{t=1}^{\tau} \beta 1^{+} \Delta xt^{+} + \sum_{t=1}^{\tau} \beta 1^{-} \Delta xt^{-} + vt$$

If the coefficients β_1^+ and β_1^- are found to be statistically different, then price transmission is said to be asymmetric. If this model do not give satisfactory result as it do not include the presence of unit root in the price series then will use Von Cramon – taubadel model. (Meyer, J., and von Cramon-Taubadel, S. (2004)) [1], Frey, G., and Manera, M. (2007) [3].

$$ECT_{t-1} = \varepsilon t - 1 = yt - \alpha - \beta_t x_t$$

Using the F- test on the null hypothesis $\beta 2^{+} = \beta 2^{-}$, we can check for asymmetric price transmission. If the null hypothesis $\beta 2^{+} = \beta 2^{-}$, then it implies that the price transmission is asymmetric. Von Cramon-Taubadel, S. (1998) [6]. Cramon-Taubadel, S. V., and Loy, J. P. (1996) [10].

Test of stationarity and test of asymmetry of pearl millet

For pearl millet, the ADF test results in table 1 showed that the residuals are stationary at the 5% significance level in Gandhinagar (t-statistic = -3.785, Prob. = 0.019), Rajkot (t-statistic = -3.484, Prob. = 0.041), and Vadodara (t-statistic = -3.271, Prob. = 0.032). However, the PP test results do not confirm stationarity, with probabilities well above the 5% significance level for Gandhinagar (t-statistic = -0.836, Prob. = 0.807), Rajkot (t-statistic = -1.822, Prob. = 0.369), and Vadodara (t-statistic = -1.018, Prob. = 0.747).

Table 1: Unit root test for residuals in pearl millet

Markets	ADF at Level		PP at Level	
	t-statistic	Prob.	t-statistic	Prob.
Gandhinagar	-3.785	0.019	-0.836	0.807
Rajkot	-3.484	0.041	-1.822	0.369
Vadodara	-3.271	0.032	-1.018	0.747

The asymmetry test results in table 2 for pearl millet prices in Gandhinagar, Rajkot, and Vadodara demonstrate significant differences in the responses to positive and negative price shocks. Across all three regions, pearl millet prices exhibit a much stronger response to negative shocks than to positive ones. Specifically, Gandhinagar's WP(-) is 3.73 compared to WP(+) of 0.80, Rajkot's WP(-) is 3.45 versus WP(+) of 0.60, and Vadodara's WP(-) is 3.55 against WP(+) of 0.67. These figures indicate that adverse market conditions lead to considerably larger price changes than favorable ones, highlighting the greater sensitivity of pearl millet prices to negative shocks.

Additionally, the Error Correction Terms (ECT) show how quickly prices return to equilibrium after experiencing shocks. The negative values for ECT(+) suggest a slow adjustment following positive shocks, while the positive ECT(-) values indicate a quick return to equilibrium after negative shocks. In Gandhinagar, ECT (+) is -3.08 and ECT(-) is 4.02; in Rajkot, ECT(+) is -2.76 and ECT(-) is 3.73; and in Vadodara, ECT(+) is -2.81 and ECT(-) is 3.85. These differential adjustment rates underscore the asymmetry in the price correction process. Ghosh, M., and Kanjilal, K. (2014) [13].

The hypothesis test results (Ho = B1+ = B2-) further confirm the presence of this asymmetry, with high test statistic values of 58.99 for Gandhinagar, 50.24 for Rajkot, and 52.64 for Vadodara. These values indicate statistically significant differences between the responses to positive and negative shocks in each region.

Table 2: Parameter estimates of asymmetry test in pearl millet

Markets	WP(+)	WP(-)	ECT(+)	ECT(-)	$Ho=B_1^+=B_2^-$
Gandhinagar	0.80	3.73	-3.08	4.02	58.99
Rajkot	0.60	3.45	-2.76	3.73	50.24
Vadodara	0.67	3.55	-2.81	3.85	52.64

Test of stationarity and test of asymmetry of maize

For maize, in table 3 the ADF test indicates stationarity of residuals in Gandhinagar (t-statistic = -3.437, Prob. = 0.046), Rajkot (t-statistic = -3.438, Prob. = 0.046), and Vadodara (t-statistic = -4.407, Prob. = 0.002). Conversely, the PP test results show non-stationarity in Gandhinagar (t-statistic = 0.168, Prob. = 0.970), Rajkot (t-statistic = -1.070, Prob. = 0.728), and Vadodara (t-statistic = -0.067, Prob. = 0.950).

Table 3: Unit root test for residuals in maize

Markets	ADF at Level		PP at Level	
	t-statistic	Prob.	t-statistic	Prob.
Gandhinagar	-3.437	0.046	0.168	0.970
Rajkot	-3.438	0.046	-1.070	0.728
Vadodara	-4.407	0.002	-0.067	0.950

The asymmetry test results in table 4 for maize prices in Gandhinagar, Rajkot, and Vadodara reveal a pronounced disparity in the response of prices to positive and negative shocks. In all three regions, maize prices exhibit a considerably stronger reaction to negative shocks compared to positive ones. Specifically, Gandhinagar' s WP(-) is 3.86 compared to WP(+) of 0.75, Rajkot's WP(-) is 3.55 versus WP(+) of 0.64, and Vadodara's WP(-) is 3.75 against WP(+) of 0.88. These results indicate a heightened sensitivity of maize prices to adverse conditions, with negative shocks causing significantly larger price changes than positive shocks. Vavra, P., and Goodwin, B. K. (2005) [9].

The Error Correction Terms (ECT) illustrate the speed at which prices return to equilibrium after experiencing shocks. The negative ECT(+) values indicate a slower adjustment following positive shocks, while the positive ECT(-) values reflect a rapid return to equilibrium after negative shocks. For Gandhinagar, ECT(+) is -2.96 and ECT(-) is 3.92, in Rajkot ECT(+) is -2.85 and ECT(-) is 3.88, and in Vadodara ECT(+) is -3.18 and ECT(-) is 4.10. These differential rates of adjustment further emphasize the asymmetry in the price correction process. Ghosh, M., and Kanjilal, K. (2014) [13].

The hypothesis test results (Ho = B1+ = B2-) confirm the presence of this asymmetry with high test statistic values: 58.58 for Gandhinagar, 53.75 for Rajkot, and 61.22 for Vadodara. These values indicate statistically significant differences in how positive and negative shocks affect maize prices. Peltzman, S. (2000) [5].

Table 4: Parameter estimates of asymmetry test in maize

Markets	WP(+)	WP(-)	ECT(+)	ECT(-)	$Ho=B_1^+=B_2^-$
Gandhinagar	0.75	3.86	-2.96	3.92	58.58
Rajkot	0.64	3.55	-2.85	3.88	53.75
Vadodara	0.88	3.75	-3.18	4.10	61.22

Test of stationarity and test of asymmetry of paddy.

Table 5 for paddy, the ADF test results reveal stationarity of residuals in Gandhinagar (t-statistic = -4.728, Prob. = 0.001), Rajkot (t-statistic = -3.208, Prob. = 0.043), and Vadodara (t-statistic = -3.589, Prob. = 0.031). However, the PP test results indicate non-stationarity in Gandhinagar (t-statistic = -1.351, Prob. = 0.606), Rajkot (t-statistic = -0.992, Prob. = 0.757), and Vadodara (t-statistic = -1.676, Prob. = 0.442).

Table 5: Unit root test for residuals in paddy

Markets	ADF at Level		PP at Level	
	t-statistic	Prob.	t-statistic	Prob.
Gandhinagar	-4.728	0.001	-1.351	0.606
Rajkot	-3.208	0.043	-0.992	0.757
Vadodara	-3.589	0.031	-1.676	0.442

The asymmetry test results from table 6 for paddy prices in Gandhinagar, Rajkot, and Vadodara indicate distinct differences in how prices respond to positive and negative shocks. Across all three regions, paddy prices exhibit a significantly stronger response to negative shocks compared to positive ones, as evidenced by the higher WP(-) values in contrast to WP(+). Specifically, Gandhinagar shows a WP(-) of 3.78 versus a WP(+) of 0.89, Rajkot has a WP(-) of 3.60 compared to a WP(+) of 0.69, and Vadodara exhibits a WP(-) of 3.88 against a WP(+) of 0.98. These results highlight a pronounced sensitivity of paddy prices to adverse market conditions.

Furthermore, the Error Correction Terms (ECT) provide insights into the speed at which prices return to equilibrium following shocks. The negative values for ECT (+) reflect a slower adjustment back to equilibrium after positive shocks, while the positive ECT(-) values indicate a rapid reversion following negative shocks. In Gandhinagar, the ECT (+) is -3.16 and ECT(-) is 4.08, in Rajkot ECT(+) is -2.88 and ECT(-) is 3.90, and in Vadodara ECT(+) is -3.36 and ECT(-) is 4.15. These differing rates of adjustment further underscore the asymmetry in price correction mechanisms. Ghosh, M., and Kanjilal, K. (2014) [13].

The hypothesis test results (Ho = B1+ = B2-) substantiate the presence of this asymmetry, with high test statistic values of 60.89 for Gandhinagar, 54.42 for Rajkot, and 64.81 for Vadodara. These values confirm statistically significant differences between the responses to positive and negative shocks across all regions. Serra, T., and Goodwin, B. K. (2003) [7].

Table 6: Parameter estimates of asymmetry test in paddy

Markets	WP(+)	WP(-)	ECT(+)	ECT(-)	$Ho=B_1^+=B_2^-$
Gandhinagar	0.89	3.78	-3.16	4.08	60.89
Rajkot	0.69	3.60	-2.88	3.90	54.42
Vadodara	0.98	3.88	-3.36	4.15	64.81

Test of stationarity and test of asymmetry of Wheat

For wheat, the ADF test in table 7 showed that residuals are stationary in Gandhinagar (t-statistic = -3.976, Prob. = 0.010), Rajkot (t-statistic = -3.610, Prob. = 0.029), and Vadodara (t-statistic = -2.405, Prob. = 0.047). In contrast, the PP test results indicate non-stationarity for Gandhinagar (t-statistic = -0.169, Prob. = 0.939), Rajkot (t-statistic = -0.146, Prob. = 0.942), and Vadodara (t-statistic = -1.714, Prob. = 0.423).

Table 7: Unit root test for residuals in wheat

Markets	ADF at Level		PP at Level	
	t-statistic	Prob.	t-statistic	Prob.
Gandhinagar	-3.976	0.010	-0.169	0.939
Rajkot	-3.610	0.029	-0.146	0.942
Vadodara	-2.405	0.047	-1.714	0.423

The results of the asymmetry test in wheat prices from table 8 across Gandhinagar, Rajkot, and Vadodara reveal significant differences in the way prices respond to positive and negative shocks. In all three regions, wheat prices exhibit a stronger reaction to negative shocks compared to positive ones, as indicated by the higher WP(-) values compared to WP(+). Specifically, negative shocks result in more substantial changes in prices, with Gandhinagar showing a WP(-) of 3.56, Rajkot 3.65, and Vadodara 3.76, compared to the positive shock responses of 0.61, 0.76, and 0.82 respectively. This suggests that adverse events affecting wheat prices have a more pronounced impact than favourable events. Ghoshray, A. (2002) [8].

Moreover, the Error Correction Terms (ECT) indicate how quickly prices revert to equilibrium aftershocks. Negative ECT values for positive shocks (ECT (+)) show a slow adjustment back to equilibrium, whereas positive ECT values for negative shocks (ECT(-)) demonstrate a quick reversion but at a different rate. This differential speed of adjustment highlights the presence of asymmetry in price correction mechanisms. The hypothesis test results (Ho = B1+ = B2-) further underscore this asymmetry, with high test statistic values of 53.45 for Gandhinagar, 57.19 for Rajkot, and 60.19 for Vadodara, indicating statistically significant differences between the responses to positive and negative shocks. Goodwin, B. K., and Holt, M. T. (1999) [4].

Overall, these findings suggest that wheat prices are more sensitive to negative market conditions and adjust back to equilibrium at varying rates depending on the nature of the shock. This asymmetry has important implications for market participants and policymakers, indicating a need for more robust measures to mitigate the impact of negative price shocks and ensure stability in the wheat market.

Table 8: Parameter estimates of asymmetry test in Wheat

Markets	WP(+)	WP(-)	ECT(+)	ECT(-)	$Ho=B_1^+=B_2^-$
Gandhinagar	0.61	3.56	-2.83	3.86	53.45
Rajkot	0.76	3.65	-2.98	3.98	57.19
Vadodara	0.82	3.76	-3.12	4.06	60.19

Conclusion

Negative values of ECT (+) in all the markets of selected cereals shows downward correction to bring prices in line with wholesale prices. It indicates slow adjustments when the prices were above equilibrium. positive values of ECT (-) in all the markets of selected cereals shows upward correction to bring prices in line with wholesale prices. It indicates quicker adjustments when the prices were above equilibrium. All the markets of selected cereals rejected null hypothesis of test of symmetry and resulted in asymmetry of price behaviour, which showed potential market inefficiencies or retailer power in market.

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