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# The impacts of price insulation on world wheat markets during the 2022 food price crisis

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## Abstract

This paper begins with a survey of recent commodity price developments that highlights the magnitude of this price surge and identifies the rapid rise in wheat prices as a key element. The analysis in this paper focuses on the extent to which domestic markets are insulated from these changes and on the resulting impacts on world prices. An econometric analysis using error-correction models finds stable long-term relationships between world wheat prices and most domestic prices of wheat and wheat products, but with considerable variation across countries in the rate of price transmission. A case study of the price shocks during the COVID-19 pandemic and the Ukraine food price crisis finds that price insulation roughly doubled the overall increase in world wheat prices and raised their volatility both during periods of price increase and price decline.

## KEYWORDS

cointegration, COVID, ECM, error correction, food price crisis, model, price insulation, Ukraine war

## JEL CLASSIFICATION

F13, F14, O13, Q17, Q18, Q21

## 1 | INTRODUCTION

When world food prices rise, a critically important question is what happens to the domestic prices that confront producers and consumers. These are the prices that bring about the needed adjustments in demand and supply and determine the impacts on households. The extent to which changes in world prices are transmitted also determines the impacts of any shocks on world market prices. If domestic prices in key countries are insulated from changes

in world market prices by, for instance, export market restrictions or variable levies, then more of the adjustment to the shock must be made by the markets that are more strongly linked to world markets, and the volatility of world market prices may be greatly increased (Martin & Anderson, 2011).

In this paper, we first examine the extent of the recent shocks to world wheat prices and then analyse the extent to which these changes have passed through to domestic prices. The first approach to analysing price insulation uses econometric techniques to assess the extent to which changes in international prices are generally passed through into domestic prices. The second approach, an event study, estimates the degree to which price insulation has exacerbated the volatility of world prices during the COVID-19 pandemic and Ukraine war episodes (2020 to mid-2022).

This research builds on two broad strands of literature. The first is the literature on price transmission that uses econometric techniques to assess the extent to which changes in external prices are transmitted into domestic prices (see von Cramon-Taubadel & Goodwin, 2021). The second is the literature on event studies such as Martin and Anderson (2011), Jensen and Anderson (2017) and Giordani et al. (2016) that examine the extent to which increases in world prices were magnified by price insulation that reduced the extent to which markets in some countries adjusted to deal with shocks. Combining these approaches is useful because the econometric approach allows testing of hypotheses about price transmission as a guide to what might be expected in general. The event study approach incorporates the special features of periods during which there are large changes in world prices and explicit use of policy measures such as export restrictions.

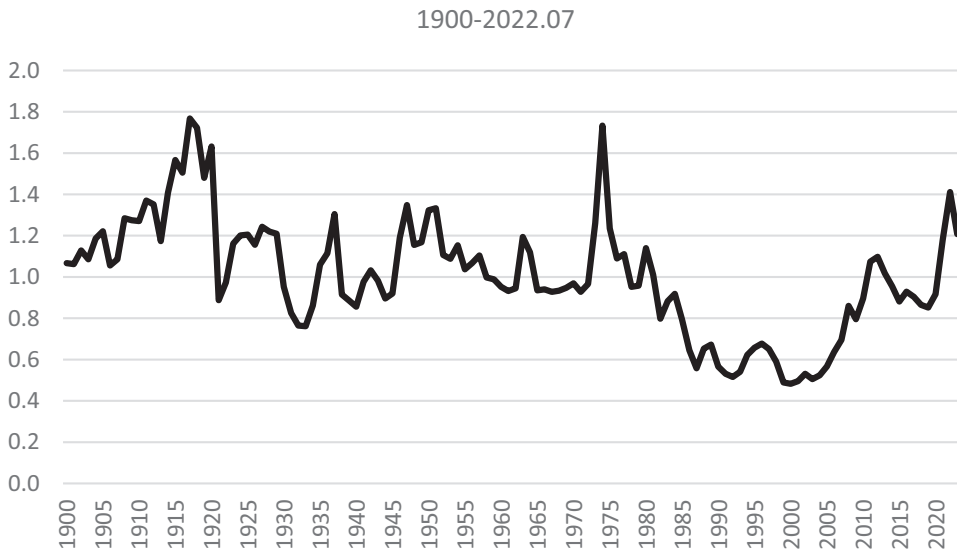
This study adds to the earlier literature in several ways. The first is by giving the error-correction model a policy interpretation. A second is by examining an important event—the large increase in world wheat prices during the later stages of the COVID-19 pandemic and following the Russian invasion of Ukraine, and the subsequent sharp decline in mid-2022. It adds to the available analyses of impacts of the Ukraine war on world food prices<sup>1</sup> a systematic consideration of the extent to which domestic wheat prices have been insulated from world market prices and the implications of this insulation for world prices. In doing this, it provides a basis for assessing the extent to which individual countries insulating themselves from rising world prices, and the collective effect of all countries' insulation has affected people in different countries (see, for example, Martin & Anderson, 2011).

The next section of the paper considers recent developments in world food markets, seeking to identify the magnitude of the change in world food prices and the most important contributors to those changes—an examination that highlights the importance of wheat. The third section uses econometric approaches to identify the extent to which domestic markets are insulated from changes in world market prices. Section 4 examines the extent to which price insulation contributed to the increase in world wheat prices during the COVID era and following the outbreak of the Ukraine war, and to the rapid decline from the peak in April–May of 2022. The ultimate section offers conclusions.

## 2 | RECENT DEVELOPMENTS IN FOOD MARKETS

An indication of the severity of the current food price surge is provided by comparing the world price of food with historic food prices. Figure 1 does this by comparing the level of real food prices in mid-2022 with annual price data back to 1900. A striking feature of this graph is how extraordinarily high real food prices were in mid-2022. At an index level of 1.4, the food

<sup>1</sup> See, for example, <https://www.ifpri.org/landing/war-ukraine-blog-landing-page>.



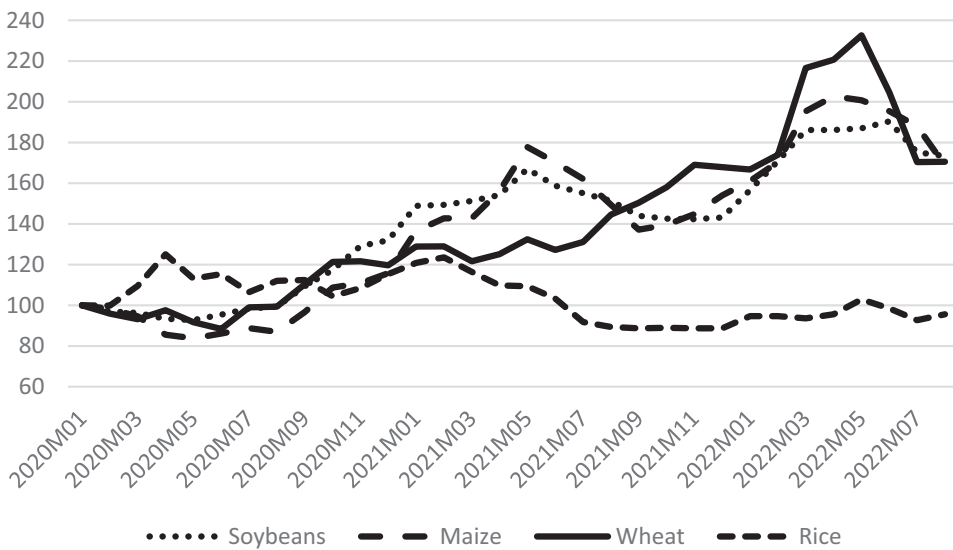
**FIGURE 1** Real Food Price Index, 1900 to July 2022 (1.0 = average). *Source:* To 2011, the Pfaffenzeller et al. (2007) extension of the Grilli and Cheng Yang (1988) data. This was spliced to the World Bank's annual real food price series from 2012 to 2021. Downloaded from [www.worldbank.org/en/research/commodity-markets](http://www.worldbank.org/en/research/commodity-markets) on 14 June 2022. The final two data points are for the May 2022 price peak and for July 2022. These use World Bank Food Price Index data deflated by the average of manufactures unit values for the United States and the EU.

price index was almost one and a half standard deviations above the average of 1.0 for the entire period of 123 years. It was well above the peak of 1.07 in the 2011 food price crisis and fell short only of the massive food price spikes around 1917 and 1974. If food prices remain anywhere near this level, the steady decline in real food prices apparent throughout the 20th century—reflecting a century of technological progress—will be wiped out. Even after the decline in world prices to July 2022, the real price of food remained above all but a few price spikes, mostly in the first half of the 20th century.

The period between January 2020 and mid-2022 is of particular interest. It involved substantial price increases following a period of relative stability between 2016 and 2019. [Figure 2](#) shows changes in the prices of wheat, maize, rice and soybeans, four crops accounting for the overwhelming majority of global calorie consumption. As is clear from [Figure 2](#), the prices of wheat, rice and soybeans declined by around 10% in the first half of 2020. From mid-2020, maize and soybean prices rose relatively steadily, almost doubling by February 2022. By contrast, wheat prices rose little until the second half of 2021, climbed to around 170 in February 2022 and then rose by another third between February and May—a sharp increase that appears to have been set off by Russia's invasion of Ukraine on 24 February 2022. Rice prices, by contrast, were relatively stable throughout and remained close to their initial level through the first half of 2022. Clearly, the determinants of wheat prices are of particular interest, both because of its importance as a staple food and because of the dramatic increase in its world price—to a peak well over twice its initial level—and its subsequent relatively sharp decline.

To understand the effects of commodity price surges on world prices and on vulnerable people, it is very useful to distinguish the following: (i) primary shocks, such as those resulting from war or weather; (ii) the relationship between these shocks and price outcomes; and (iii) the extent to which domestic prices change in response to changes in world prices.

Primary supply shocks matter because their size, other things equal, affects the size of any price change. If these shocks directly affect outcomes in countries with vulnerable people—as



**FIGURE 2** Price indexes for key staple crops (2020 M01 = 100). *Source:* World Bank Commodity Price Indexes updated to 19 September 2022.

in the case of a weather shock in a poor country—it may also be very important to consider their direct impacts on the incomes of those people.

The key influence on the link between primary shocks and prices of storable commodities is the level of stocks. Stocks matter because they can buffer almost all positive shocks and many negative shocks. Only when stocks are too low and/or negative supply shocks are too large does market clearing require large price increases—which is why the time series of prices for storable commodities consist of long periods in the doldrums punctuated by infrequent but short-lived price surges (Deaton & Laroque, 1992).

The extent to which changes in world prices are transmitted into domestic prices—or its obverse the extent of price insulation—matters because it determines how readily world markets can adjust to shocks, such as those from grain yields or wars. The adjustments in global supply and demand needed to restore equilibrium after a shock can be made much more easily if they are shared across a wide range of markets than if all the adjustment is forced onto a few markets. Price insulation also involves economic costs, such as the economic waste associated with export bans. It also increases the volatility of world prices and potentially puts at risk the ability of poor people to access food.

The most striking feature of the developments reviewed is the dramatic rise in the price of wheat, particularly since the invasion of Ukraine. The relative stability of wheat prices through most of 2020 seems consistent with the supply–demand position.<sup>2</sup> World demand and production were roughly in balance during the 2020–21 marketing season, although demand rose much more than production, and closing stocks (excluding China) were at a generally comfortable level of 23.6% of consumption. In the 2021–22 marketing year product remained stagnant, while demand grew by almost 2%, putting downward pressure on ending stocks—reducing stocks outside China to 21.6% of consumption—and placing upward pressure on prices. The invasion of Ukraine and subsequent imposition of sanctions put further upward pressure on prices by making some of Ukraine's wheat production unavailable, reducing estimates of Ukrainian production in the 2022–23 marketing year and raising uncertainties about exports from Russia.

<sup>2</sup> All data from the USDA PSD database downloaded on 16 June 2022.

Before the invasion, Ukraine accounted for around 4.2% of global wheat production and 9.5% of exports. In the 2022–2023 marketing year, Ukraine's production share is projected to fall to 2.8% and its export share to 4.9%. The USDA estimate of the reduction in Ukraine's exports is equivalent to 1.2% of world production. For this reduction in supplies alone to explain the 30% increase in world prices between February and July 2022 would require an elasticity of demand of  $-0.035$ , which seems extraordinarily small.<sup>3</sup> This suggests that additional factors, such as extensive price insulation from measures such as export bans and/or variable levies (Martin & Anderson, 2011), might be needed to explain the extent of the price impact. Ivanic and Martin (2014) show that protection rates for eight agricultural commodities respond sharply to changes in world prices, while Martin and Anderson (2011) show that price insulation for wheat and rice contributed substantially to the world price surges of 1973–4 and 2007–8.

This brief discussion of the complex events associated with the current surge in world food prices leads to a highly tentative conclusion that the surge in the price of wheat is perhaps the most pressing question. To assess this, we need to be able to identify the extent to which higher world prices are actually transmitted into domestic markets, rather than being insulated by market features such as transportation costs and/or policies such as export bans or variable import levies. That is the focus of the remainder of this paper.

### 3 | ECONOMETRIC ANALYSIS OF PRICE TRANSMISSION IN WHEAT MARKETS

This analysis examines the long-term relationship between the international price of wheat and the domestic price of wheat and wheat products in various countries. While newspaper headlines generally focus on shocks in international prices, the impacts on consumers and producers are better measured by domestic prices. This analysis uses a vector error-correction model to study the short- and long-term effect of shocks in international wheat prices on 46 wholesale and retail prices of wheat and wheat products in 19 countries.

Price transmission refers to the degree of influence of prices in one market on prices in another market. The transmission of prices between spatially distinct markets is widely seen as based on the economics of spatial arbitrage (Takayama & Judge, 1971). One motivation for studying price transmission is that high transmission is considered an indicator of efficient, well-functioning markets. Early studies of price transmission were based on static correlation coefficients and standard regression models, with the assumption that high transmission was an indicator of competitive, well-functioning markets. Harriss (1979) reviews these studies and identifies flaws in their assumptions. For example, if transportation costs are high enough, there may be little or no price transmission even if markets are competitive. Ravallion (1986) introduced dynamic regression models of price transmission incorporating lagged effects.

By the 1980s, researchers became aware of the econometric problems resulting from non-stationary data (Granger & Newbold, 1974). Engle and Granger (1987) demonstrated that two or more nonstationary variables could be cointegrated, meaning that there can be a stable relationship between nonstationary variables. The vector error-correction model (VECM) was developed to test and interpret models incorporating two or more cointegrated variables. Error-correction models have been widely used to examine price transmission in developing countries (see Abdulai, 2002; Moser et al., 2009; Myers & Jayne, 2012; Negassa & Myers, 2007;

<sup>3</sup> Fally and Sayre (2018) survey the recent literature, finding elasticities of demand ranging from  $-0.095$  to  $-1.6$ . Even the low range of  $-0.095$  to  $-0.109$  suggested by Roberts and Schlenker (2013), who do not take price insulation into account, is too elastic to explain the observed price rise.

van Campenhout, 2007). Earlier studies of price transmission from international to domestic commodity markets include Quiroz and Soto (1995), Conforti (2004), Minot (2011), Baquedano and Liefert (2014) and Greb et al. (2016). A comprehensive review of the price transmission literature is provided by von Cramon-Taubadel and Goodwin (2021).

While the VECM methodology has typically been used to analyse lags in price transmission due to market imperfections or differences in product attributes, it is general enough to capture the effects of policy responses that seek to insulate domestic prices from changes in external market prices. As shown by Nickell (1985), this estimation form can be derived from a policy choice model in which policymakers face quadratic costs of making abrupt policy changes and of being away from equilibrium.

### 3.1 | Data

The econometric analysis is based on price data compiled by the Food and Agriculture Organization (FAO) as part of its Global Information and Early Warning System (GIEWS; FAO, 2022). One component of GIEWS is the food price monitoring and analysis tool that makes available 83 international prices and 1823 domestic prices of agricultural commodities and food products. Most of these price series are monthly and are available in nominal US dollars. The international prices are FOB reference prices, generally in exporting countries. There are 12 international wheat prices, including prices from the United States, Argentina, Australia, Russia and the Black Sea. The VECM analysis uses the price of US No. 2 soft red winter (SRW) wheat delivered to the Gulf of Mexico, one of two standard reference prices for wheat from the United States and globally.

The domestic prices in the FAO GIEWS database include a range of commodities, including cereals, pulses, fruits and vegetables and animal products. Where possible, this analysis uses monthly wholesale prices of wheat grain but, where this is not available, uses prices of wheat flour and bread, which are frequently at retail level. The database includes 294 price series for wheat and wheat products, but many of these price series do not have enough observations for econometric analysis. For the econometric analysis, two more conditions are imposed on the data that the series must: (i) cover the period from January 2004 to March 2022 and (ii) have no more than 5% missing values. This yields 46 price series including: 17 wheat grain prices, 18 wheat flour prices and 11 bread prices. They represent data from 19 countries. Most of the prices (65%) are at the retail level, with the remainder being wholesale prices.

### 3.2 | Methods

The vector error-correction model is appropriate if two conditions are met:

- Each variable is nonstationary, but the first differences of the variables are stationary.
- The variables are cointegrated, meaning that there is a linear combination of the two variables that is stationary. This cointegrating equation is considered the long-run relationship between the variables.

The generalised VECM can be expressed as follows:

$$\Delta p_t = \alpha + \Pi p_{t-1} + \sum_{k=1}^q \Gamma_k \Delta p_{t-k} + \varepsilon_t \quad (1)$$

where  $\Delta p_t$  is a vector of the first difference of the log of prices;  $\alpha$  is a vector of estimated parameters that describe the trend component;  $\Pi$  is a matrix of estimated parameters that describe the long-term relationship and the speed of adjustment towards the long-term relationship;  $\Gamma_k$  is a set of matrices of estimated parameters that describe the short-run relationship between prices, one for each of  $q$  lags included in the model; and  $\varepsilon_t$  is a vector of error terms.

In this study, we use a two-variable version of the VECM, which generates estimates of the effect of world prices on domestic prices and vice versa. Since most markets can be considered 'small countries' in the staple grain markets, we focus on the parameters describing the effects of world prices on domestic prices. For our purposes, then, we are interested in only one portion of the VECM. Applying the Johansen normalisation to the parameters in  $\Pi$  in Equation (1), the determinants of domestic prices can be simplified as follows:

$$\Delta p_t^d = \alpha + \theta(p_{t-1}^d + \beta_0 + \beta_1 p_{t-1}^w) + \sum_{k=1}^q \delta_k \Delta p_{t-k}^w + \sum_{k=1}^q \sigma_k \Delta p_{t-k}^d + \varepsilon_t \quad (2)$$

where  $\Delta p_t^d$  is the first difference of the log of the domestic price in US dollars;  $\Delta p_t^w$  is the first difference of the log of the world price in US dollars;  $\alpha$ ,  $\theta$ ,  $\beta_0$ ,  $\beta_1$ ,  $\delta_k$ , and  $\sigma_k$  are estimated parameters; and  $\varepsilon_t$  is the error term.

The coefficients in the error-correction model can be interpreted as follows:

- $\beta_0$  is the constant in the long-run equilibrium;
- $\beta_1$  is the coefficient in the long-run equilibrium, reflecting the long-run elasticity of the domestic price with respect to the international price;
- $\theta$  reflects the speed of adjustment towards the long-run equilibrium;
- $\delta_k$  is the short-run impact of changes in the international price on domestic prices with a lag of  $k$  months; and
- $\sigma_k$  is the autoregressive term, reflecting serial correlation in the domestic price between changes in one month and changes  $k$  months later.

The econometric analysis proceeds through four steps: the first is to test for nonstationarity of prices, first in levels and then in first differences. Cointegration analysis is based on the assumption that the levels are nonstationary but the first differences are stationary; the second step is to test for the optimal lag length, that is  $q$  in Equation (2); the third step is to test for cointegration, or more accurately the number of cointegrating equations in the system; and finally, the error-correction model is run to estimate the parameters of Equation (2). The analysis was carried out using version 17 of Stata software.

The method and data are similar to those used by Minot (2011) in an analysis of price transmission from world markets to 67 staple grain markets in sub-Saharan Africa. However, this analysis uses a larger and more recent set of prices and focuses on price transmission in wheat markets. It also emphasises the role of policy in addition to market frictions.

The term in parentheses,  $(p_{t-1}^d + \beta_0 + \beta_1 p_{t-1}^w)$ , in Equation (2), represents the steady-state relationship between domestic and international prices.<sup>4</sup> In the absence of policy intervention or market power in the transport sector, this is an arbitrage condition reflecting the costs of transporting goods between countries. However, in the current context, it also captures the steady-state effects of any trade policy measures, whether based on political-economy competition between producers and consumers (Grossman & Helpman, 1994), or countries' attempts to exploit their terms of trade (Bagwell & Staiger, 1999).

<sup>4</sup>This expression is sometimes written as  $p_{t-1}^d - \beta_0 - \beta_1 p_{t-1}^w$  to highlight the fact that it is the residual from a linear regression model of the domestic price as a function of the world price. This also explains the negative sign on estimated values of  $\beta_0$  and  $\beta_1$ .

The  $\delta$  and  $\sigma$  coefficients in Equation (2) measure the generally partial short-term changes in domestic prices following changes in world prices, while the  $\theta$  term measures the extent of price adjustment to reduce deviations from the political-economy equilibrium. Frequently, such partial responses are interpreted as resulting from influences such as imperfect information or delays in updating prices. We follow Nickell (1985) in interpreting this ECM as representing policymakers minimising the political costs associated both with changing domestic prices and with deviations from the desired relationship between domestic and world prices. After a shock to world prices, the relationship between domestic and world prices initially changes but eventually returns to the political-economy equilibrium in the absence of any further shocks.

## 4 | RESULTS

The first step in the analysis is to examine the statistical properties of the monthly price series. Specifically, we test the stationarity of the prices and their first differences using the generalised least squares variant of the Dickey–Fuller test (DF-GLS). Studies show that this test has greater power than the augmented Dickey–Fuller test (Elliott et al., 1996). Table 1 shows the results, where the null hypothesis is that the series is nonstationary. The first row shows the test statistic for the level of the international wheat price, expressed as the logarithm of the real price of No. 2 soft red winter wheat delivered to the Gulf of Mexico. The last two columns indicate that we cannot reject the null hypothesis of nonstationarity. The second row shows the results for the first difference of this price. Based on the last two columns, the DF-GLS test rejects the null hypothesis of nonstationarity, implying that the first difference of the international wheat price is stationary.

The third row summarises the results for the 46 domestic prices used in the study, expressed as the logarithm of the real price in US dollars. The results suggest that we cannot reject the null hypothesis of nonstationarity in 45 of the 46 prices tested, implying that the price levels are nonstationary. The only exception is the wholesale price of wheat in Khartoum, Sudan. The fourth row tests the first difference of each domestic price. Nonstationarity is rejected for a large majority of the 46 domestic prices tested, implying that the first differences are stationary. At the 5% level of confidence, 38 prices (83%) are stationary, while at the 1% level, 41 are (89%).

Broadly speaking, almost all prices, domestic and international, are nonstationary in levels, and a large majority become stationary when expressed in first differences. This is a common result in working with time-series price data and suggests that the error-correction model of cointegration is appropriate.

TABLE 1 Tests of nonstationarity

Variable	Descriptive statistics for test statistic					Whether $H_0$ rejected	
	$N$	Mean	Min	Max	SD	5%	1%
International price, level	1	−2.25				No	No
International price, 1st diff	1	−9.50				Yes	Yes
	$N$	Mean	Min	Max	SD	Number of cases where $H_0$ rejected	
Domestic prices, level	46	−1.89	0.68	−4.44	−0.77	1	1
Domestic prices, 1st diff.	46	−6.99	2.71	−11.62	−1.65	38	41

Source: GLS Dickey–Fuller test of prices in the FAO GIEWS database over January 2005–March 2022.

The next step is to identify the optimal lag length,  $q$ , in Equation (2). If too many lags are incorporated into the model, degrees of freedom are wasted, reducing the precision of the parameter estimates. On the contrary, using too few lags will cause the model to be misspecified and may lead to autocorrelation in the residuals. Various methods have been proposed to select the lag length ( $q$ ) in vector autoregression and error-correction models, including likelihood ratio tests of each new lag term, minimization of the final prediction error and minimization of various information criteria. It has been shown that the Schwarz–Bayesian information criterion (SBIC) and the Hannan–Quinn information criterion (HQIC) perform better than the final prediction error and the Akaike information criterion (AIC) in that the latter two tests tend to overestimate the lag length (Lutkepohl, 2005).

Table 2 shows the distribution of the optimal lag length, as determined by minimization of the SBIC and minimization of the HQIC. Both the SBIC and the HQIC tests indicate that one or two lags are optimal for all 46 models comparing a domestic wheat price and the international wheat price. However, the SBIC finds that two lags are optimal in 24 models, while the HQIC finds two are optimal in 40 of the 46 models. In other words, there are 16 models where the SBIC test indicates one lag, while the HQIC lag suggests two lags. Given that  $N$  is over 200 and each lag represents just two additional parameters ( $\delta_2$  and  $\sigma_2$  in Equation 2), it seems likely to be safer to lose two degrees of freedom rather than risk misspecification. For this reason, the HQIC test was used to determine the lag length in the error-correction model.

The third step in the analysis is to determine the number of cointegrating equations in each of the 46 error-correction models. In this analysis, each model has two variables (the international wheat price and one of the domestic wheat prices), so there can be zero or one cointegrating equation. Zero cointegrating equations imply that there is no long-run relationship between the international wheat price and the domestic price being considered. One cointegrating equation means there is a long-term relationship between the international wheat price and the domestic price of wheat or a wheat product.

Table 3 presents the results for three test statistics. The first is the Johansen trace statistic, which increases the number of cointegrating equations until the trace statistic falls below the

TABLE 2 Optimal lag length based on SBIC and HQIC

Lag length	Number of models	
	SBIC	HQIC
1	22	6
2	24	40
3	0	0
Total	46	46

Source: SBIC and HQIC tests of lag length of the log of real international and domestic wheat prices from the FAO GIEWS database.

TABLE 3 Tests of the number of cointegrating equations

No. of cointegrating equations	Number of models		
	Johansen trace statistic	SBIC	HQIC
0	10	26	9
1	3	20	37
Total	13	46	46

Source: Trace statistic, SBIC and HQIC tests of the number of cointegrating equations in the relationship between log of real international and domestic wheat prices from the FAO GIEWS database.

critical value, indicating that the null hypothesis that the number of integrating equation is  $n$  or less is rejected. The table also shows the results of two information criteria: the SBIC and the HQIC. In these tests, the number of cointegrating equations is the one that minimises the information criterion.

The three test statistics generate different results. According to the trace statistic, only three of the prices show cointegration (a long-run relationship) between the international and domestic price. Ten show no relationship, and the remainder include stationary variables. This result is not consistent with the GLS Dickey–Fuller tests in [Table 1](#), which indicated that the international wheat price and 45 of the 46 domestic prices are nonstationary in levels. The SBIC test indicates that 20 domestic prices are cointegrated with the international price and 26 are not. And, the HQIC test suggests that a large majority of the domestic prices (37) are cointegrated with the international wheat price.

Focussing on the results of the SBIC and HQIC tests, the 46 domestic prices can be categorised in three groups: 20 prices with strong evidence of cointegration (confirmed by both tests); 17 with modest evidence of cointegration (confirmed by the HQIC only); and nine that show no evidence of cointegration (rejected by both tests).

[Table 4](#) describes the estimates of the long-run relationship between the international price of wheat and each domestic price of wheat or a wheat product,  $\beta_1$  in [Equation \(2\)](#). We expect  $\beta_1$  to be negative because this expression should be zero when there is a steady-state relationship between these two integrated variables. Furthermore,  $\beta_1$  can be interpreted as an elasticity because both prices are expressed in logarithms.

The first row of [Table 4](#) shows the descriptive statistics for  $\beta_1$  in the models where there is evidence of cointegration. The average value is  $-0.765$ , implying a long-run elasticity of the domestic price with respect to the international price of  $0.765$ . Of the 37 parameters, 28 (76%) are statistically significant at the 5% level. If we limit the analysis to the 20 cases with strong evidence of cointegration, the elasticity is  $0.96$ , close to unity, and 19 of 20 are statistically significant. In the 17 cases where the evidence of cointegration is moderate, the average elasticity is  $0.535$ , and less than half are statistically significant.

[Table 5](#) gives the speed of adjustment towards the long-run relationship,  $\theta$  in [Equation \(2\)](#). The coefficients are negative because the cointegration equation describes deviations of the domestic price from its long-run equilibrium, so a positive deviation leads to a negative adjustment in the domestic price. The absolute value of the coefficient can be interpreted as the share of the gap between the current domestic price and the long-run equilibrium that is closed each month. The results indicate that, on average, 8% of the gap is closed each month for all models where there is evidence of cointegration. The half-life of adjustment (the time it takes to reduce the gap by 50%) is 7.6 months when the evidence of cointegration is strong and 10 months when it is only moderate. The coefficient is statistically significant at the 5% level in 33 of the 37 models (89%).

**TABLE 4** Long-term relationship between domestic and international wheat prices

	Descriptive statistics for test statistic					No of cases for which $H_0$ is rejected at
	<i>N</i>	Mean	SD	Min	Max	5% level
$\beta_1$ when there is cointegration	37	-0.765	0.502	-1.418	0.300	28
$\beta_1$ when cointegration strong	20	-0.960	0.267	-1.418	-0.136	19
$\beta_1$ when cointegration is moderate	17	-0.535	0.616	-1.317	0.300	9

Source: Vector error-correction model on monthly wheat price data from FAO GIEWS.

Table 6 presents the results for the short-term impact of changes in world prices on changes in domestic prices ( $\delta$ ) and the autoregressive term reflecting the effect of changes in domestic prices in one period on changes in the next period ( $\sigma$ ). In the case of the short-term impact of international prices on domestic prices ( $\delta$ ), the mean value among models with evidence of cointegration is about 0.10. Somewhat less than half the coefficients were statistically significant at the 5% level.

In the case of the autoregressive coefficient ( $\sigma$ ), the mean value among models with cointegration was 0.17. Slightly more than half (17 of 33) of these coefficients were statistically significant.

Table 7 reports average impulse response functions for each of the three groups of countries, incorporating all types of adjustment into the ECM equation. Under the political-economy interpretation of this equation discussed in Section 3.2, the desired equilibrium relationship between domestic and world prices has been perturbed, and policymakers begin to move to restore this relationship at a rate given by  $\theta$ . The autoregressive component of the adjustment also plays a role in adjusting domestic prices.

The impulse response functions differ considerably by country. Figure 3, to be read in conjunction with Table 7 shows the price transmission by month for domestic prices that

TABLE 5 Speed of adjustment towards the long-term relationship between domestic and international wheat prices

	Descriptive statistics for test statistic					Half-life of adjustment (months)	No of cases with $H_0$ rejected at 5% level
	<i>N</i>	Mean	SD	Min	Max		
$\theta$ when there is cointegration	37	-0.077	0.038	-0.164	-0.009	8.7	33
$\theta$ when cointegration strong	20	-0.086	0.044	-0.164	-0.018	7.6	19
$\theta$ when cointegration is moderate	17	-0.067	0.028	-0.110	-0.009	10.0	14

Source: Vector error-correction model on monthly wheat price data from FAO GIEWS.

TABLE 6 Short-term relationship impact on domestic prices of wheat products

	Descriptive statistics for test statistic					No of cases for which $H_0$ is rejected at 5% level
	<i>N</i>	Mean	SD	Min	Max	
Impact of changes in international price on changes in domestic price						
$\delta$ when there is cointegration	33	0.099	0.072	-0.103	0.278	15
$\delta$ when cointegration strong	17	0.084	0.079	-0.103	0.212	5
$\delta$ when cointegration is moderate	16	0.116	0.062	0.011	0.278	10
Autoregressive impact of changes in domestic price on next period						
$\sigma$ when there is cointegration	33	0.173	0.113	-0.189	0.441	17
$\sigma$ when cointegration strong	17	0.206	0.136	-0.189	0.441	12
$\sigma$ when cointegration is moderate	16	0.137	0.072	0.018	0.251	5

Source: Vector error-correction model on monthly wheat price data from FAO GIEWS.

TABLE 7 Average price transmission by month

Months after initial shock	Domestic price change as a percentage of world price change		
	Highly cointegrated prices	Moderately cointegrated prices	Prices that are not cointegrated
1	15	14	5
2	26	20	7
3	35	23	9
4	41	25	11
5	47	27	12
6	51	28	13
7	55	29	14
8	58	30	16
9	61	31	17
10	64	32	17
11	66	33	18
12	67	33	19

Source: Impulse response functions from error-correction model of domestic prices of wheat and wheat products and world price of wheat.

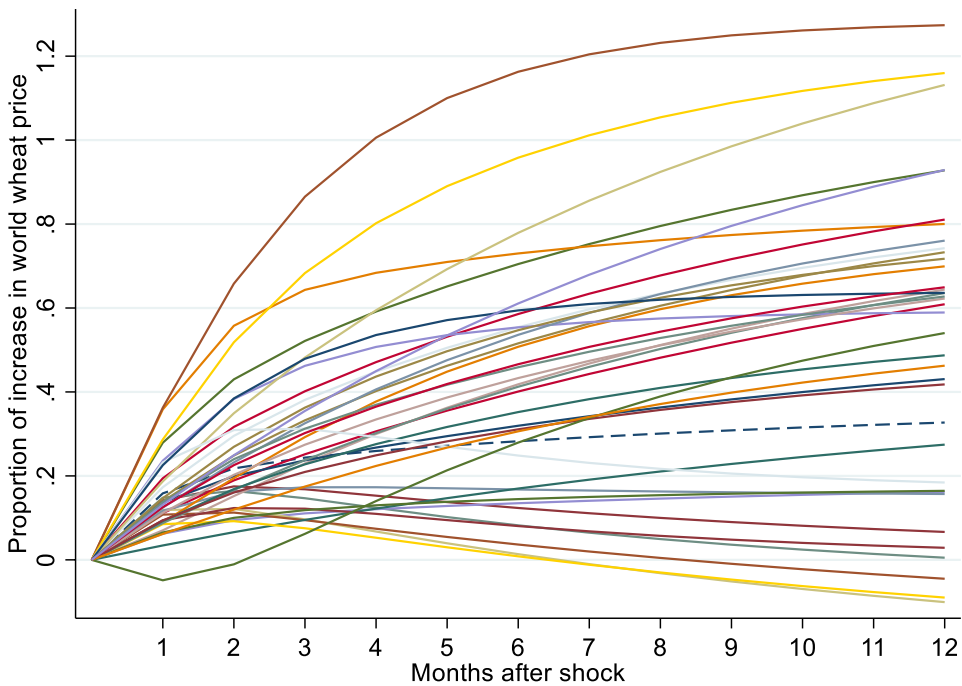
show evidence of either high or moderate cointegration. In some cases, the response is rapid and, in a few of these, the increase in the domestic price is greater than the increase in the world price—perhaps reflecting additive transport costs on exports that mean prices in the exporting country move more than proportionately with changes in world prices.<sup>5</sup> In some other countries, adjustment is partial and does not come near to full adjustment within a year.

The econometric analysis has established several important features of countries' responses to changes in world wheat prices. The first is that there seem to be quite strong and stable relationships between domestic and world prices, with prices initially adjusting slowly to changes in world prices. But in most cases, the underlying relationship between these variables is restored after some time. Importantly, however, the adjustment paths in response to shocks seem quite heterogeneous even among the group of countries with strongly related prices. To capture the impact of shocks on domestic and world prices during the current period of turbulence in both domestic and world markets will, therefore, require an examination of responses in a range of countries—an examination to which we now turn.

## 5 | A CASE STUDY OF PRICE TRANSMISSION IN THE COVID AND UKRAINE CONFLICT PRICE SURGES

Whether the dramatic changes in food prices observed since 2020 have been transmitted into domestic markets is central to analysis of their impacts for two key reasons. The first is that the change in world prices resulting from any given primary shock is itself a function of the extent to which countries insulate their markets from changes in world prices. As shown by Martin and Anderson (2011), the impact of a primary shock on world market prices may be magnified—or multiplied in the terminology of Giordani et al. (2016)—by trade policy responses.

<sup>5</sup> Of the three prices showing more than 100% proportional price transmission, one (Russia) is a consistent wheat exporter and the other two (Italy and Kyrgyzstan) are occasional exporters.



**FIGURE 3** Impulse response functions for wheat price transmission for different countries and products [Colour figure can be viewed at [wileyonlinelibrary.com](http://wileyonlinelibrary.com)]

A second is that the prices faced by consumers and producers depend not only on the international prices but also on domestic prices which, in turn, depend on both the changes in world prices and the changes in the gaps between domestic and world prices.

When world prices surge, domestic prices may rise less rapidly than world prices if policy makers seek to insulate their markets. The approach we use follows OECD (2022) in using changes in the price gap between domestic and world prices as a tentative indicator of the effects of policy interventions such as tariffs or quotas. Our approach is, on the one hand, less ambitious than OECDs in that, we do not attempt to measure levels of protection, but only changes in price gaps. On the other hand, it is more ambitious in seeking to identify changes in monthly, rather than annual, data which is why we generally use flexible wholesale prices, rather than farm prices, which may adjust less rapidly.

Other potential causes of slow responses to world prices include market inefficiencies such as those resulting from imperfect information, nonproportional margins and differences between traded and domestic products. Since information about wheat prices is widely available, it seems unlikely that asymmetric information is sufficient to cause the frequently observed large differences in price changes between domestic and world prices.

Nonproportional margins could certainly explain some differences in responses, with domestic prices changing proportionately less than world prices in importing countries, and more than world prices in exporting countries, if margins are additive. On balance, this form of potential price insulation might be expected to become less problematic when both importing and exporting countries are considered, as in the present analysis.

Differences between domestic and imported products may explain partial price transmission into importing markets when shocks arise outside these markets. In this type of analysis, this problem is minimised by selecting products that are as similar as possible both in characteristics and in location. These problems will also be less serious when the domestic price series considered include prices in exporting and importing countries. Wherever possible, this event

study uses domestic wholesale wheat prices near major ports and, by design, includes prices in both importing and exporting countries.

Given the rapid evolution of shocks to world prices—both during the COVID-19 pandemic and since the invasion of Ukraine—it would clearly be inadequate to follow the approach of Martin and Anderson (2011) and use annual changes in prices and protection rates. Instead, we use monthly data, primarily from the FAO GIEWS database.<sup>6</sup> These data provide information on domestic prices of staple commodities for 97 countries. A second source of domestic price data was World Food Program (WFP) country data files,<sup>7</sup> while a few series were obtained from individual country sources. In a few countries, domestic prices were obtained from national sources or price series published in USDA's GAIN reports. The world wheat price was calculated as the simple average of export prices from Canada, France and the United States (for which both hard and soft wheat were included in the average).

The approach taken to disaggregating primary shocks and the impacts of price insulation followed Martin and Anderson (2011) and Anderson et al. (2014). This approach begins with the global market equilibrium condition:

$$\sum_i (S_i(p_i) + v_i) - \sum_i D_i(p_i) = 0 \quad (3)$$

where  $S_i$  is supply in region  $i$ ;  $p_i$  is the region's producer price;  $v_i$  is a random supply shock variable for that region;  $D_i$  is demand in region  $i$ ; and  $p_i$  is the consumer price in region  $i$ . We assume that  $p_i = (1 + t)p^*$  where  $t$  is the proportional gap between the domestic price and the international price,  $p^*$ . For simplicity and clarity, the approach used here ignores the revenues that arise from export taxes or revenue spent on import subsidies and the income effects of the distortions used. These could be added but are likely to make little difference to the results.

Totally differentiating Equation (3), rearranging it and expressing the results in percentage change form yields the following expression for the impact of a set of primary shocks and changes in price gaps on the international price:

$$\hat{p}^* = \frac{\sum_i H_i \hat{v}_i + \sum_i (H_i \gamma_i - G_i \eta_i) \hat{T}_i}{\sum_j (G_j \eta_j - H_j \gamma_j)} = \frac{\sum_i H_i \hat{v}_i}{\sum_j (G_j \eta_j - H_j \gamma_j)} - \sum_i W_i \cdot \hat{T}_i \quad (4)$$

where  $\hat{p}^*$  is the proportional change in the international price;  $\hat{v}_i$  is an exogenous proportional shock to output such as might result from better or worse weather than average;  $\eta_i$  is the uncompensated elasticity of demand;  $\gamma_i$  is the elasticity of supply;  $G_i$  is the share at international prices of country  $i$  in global demand;  $H_i$  is the share of country  $i$  in global production;  $\hat{T}_i$  is the proportional change in  $(1 + t_i)$  and  $W_i = (H_i \gamma_i - G_i \eta_i) / \sum_j (G_j \eta_j - H_j \gamma_j)$ .

When world price changes are fully transmitted into domestic prices in market  $i$ , the change in the proportional price gap is zero ( $\hat{T}_i = 0$ ). When domestic prices are fully insulated—when policymakers support a fixed domestic price using a variable levy or export tax—the change in domestic prices is zero ( $\hat{p}_i = 0$ , implying  $\hat{T}_i = -\hat{p}^*$ ). Domestic prices are partially insulated when both domestic and world prices move in the same direction, and the proportional change in domestic prices is less than the proportional change in world prices ( $|\hat{p}_i| < |\hat{p}^*|$ ). As seen in the econometric analysis, it is also possible for price transmission to be more than

<sup>6</sup><https://fpma.apps.fao.org/giews/food-prices/tool/public/#/home>.

<sup>7</sup><https://mvam.org/2018/11/20/getting-up-to-speed-wfp-food-data-on-hdx>.

complete. If, for instance, a country uses a quantitative trade barrier and has an adverse harvest shock, the domestic price may rise more than the international price, although the expected change in domestic prices would be zero.

Thus, the impact on the international price of a change in country  $i$ 's price gap depends on the importance of that country in global supply and demand, as well as the responsiveness of its production and consumption to price changes in the country, as represented by  $\gamma_i$  and  $\eta_i$ .  $W_i$  is a set of weights, summing to one, which translate proportional changes in price gaps into proportional changes in the world price.

If ad valorem equivalents of changes in the gaps between domestic and world prices are available, then Equation (4) can be used, as in Anderson et al. (2014), to infer the hypothetical change in world prices that would occur in the absence of changes in price gaps. It turns out that this is given by the weighted average of the domestic price changes. To see this, begin with the identity:

$$\hat{p}^* = \hat{p}_i - \hat{T}_i \quad (5)$$

Multiplying all elements of Equation (5) by their corresponding weights and summing yields:

$$\hat{p}^* = \sum_i W_i \cdot \hat{p}_i - \sum_i W_i \cdot \hat{T}_i \quad (6)$$

Comparing the first expression on the right-hand side of Equation (6) with the final term in Equation (4) shows that the weighted sum of domestic price changes,  $\sum_i W_i \cdot \hat{p}_i$ , equals the effects of the primary shocks on the world price at unchanging price gaps,  $\sum_i H_i \hat{v}_i / \sum_j (G_j \eta_j - H_j \gamma_j)$ . This seems reasonable because it is the changes in domestic prices facing producers and consumers that bring about the adjustments to quantities supplied and demanded needed to maintain equality between global supply and demand.

One difficulty for this approach is that it is hard to know the relevant elasticities,  $\gamma$  and  $\eta$ . The relevant elasticities of demand depend importantly on initial stocks in each market because the elasticity of demand for stocks is likely very high relative to the elasticity of consumption demand. The relevant elasticities of supply also vary—being very low within the growing season—rising with the first harvest in response to changes in variable inputs such as fertiliser, water and harvesting effort and rising further when there is time for planted area to adjust in following seasons. Given our inability to distinguish the changes in these elasticities over time, we assume they are the same across countries. Jensen and Anderson (2017) used a global general equilibrium model to examine the 2006–2008 world food price surge, allowing them to capture differences in demand and supply elasticities between markets. Reassuringly, they found broadly the same results for magnification of shocks to world market prices as in Martin and Anderson (2011).

Since our focus—particularly when considering the impacts of the Ukraine conflict—is on a short-term period in which there is little opportunity for supply to respond to price changes, Equation (4) can be specialised to:

$$\hat{p}^* = \frac{\sum_i H_i \hat{v}_i + \sum_i (-G_i \eta_i) \hat{T}_i}{\sum_i (G_i \eta_i)} \quad (7)$$

Assuming constant elasticities across countries allows us to use weights based only on each country's share in global food demand,  $G_i$ , in the period when only demand can adjust. If

the consumption and production shares are the same across countries—which we know to be approximately true—then these same shares will also apply in the longer term when supply is able to respond if elasticities are constant across countries. The consumption shares used were for wheat and products in the FAO Food Balance Sheet data for 2018. The largest 38 countries/regions—including the EC-27 as one—accounting for 92% of global consumption were included in the analysis, with the consumption shares for these countries normalised to sum to one.

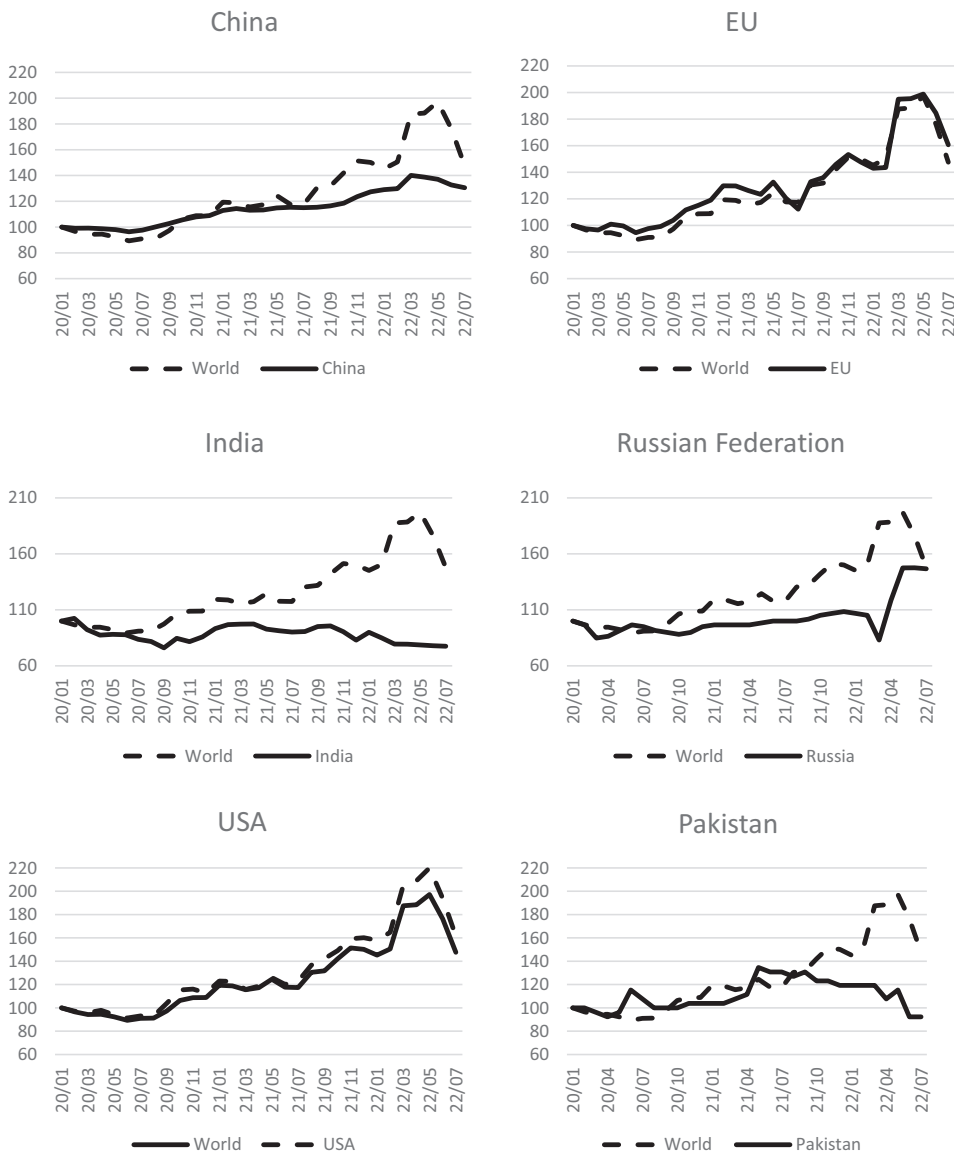
A visual comparison of changes in prices for key countries is very helpful in understanding developments. These are presented in [Figure 4](#) for the six countries with the largest consumption shares, countries that account for around 60% of the total considered. The world price lines in each panel of [Figure 4](#) show that world prices declined in the early months of the COVID-19 pandemic from 100 to 89 in June of 2020, before beginning a sustained rise to 151 on the eve of the Russian invasion of Ukraine in late February 2022. Following the invasion, world wheat prices rose dramatically, to almost 200 in May 2022, before declining to 148 in July 2022. Examination of net trade for each of these economies revealed that there were no direction-of-trade reversals during the period that could complicate the interpretation of price transmission.

Within [Figure 4](#), there appear to be some striking differences in the behaviour of the domestic and international prices. In the United States and the EU, domestic wheat prices track world prices closely, despite the differences in product composition and the modest share of each country's product in the average international price. In China, India and Pakistan, domestic prices have not increased nearly as much as world prices and have been considerably less volatile. Prices within Russia remained low and stable until February of 2022, before declining in March and then returning to more or less their original relationship with world prices. The gap between Russian and world prices around March 2022 probably reflects not just domestic policies, but the anticipated impacts of sanctions on wheat exports.

The set of countries where prices did not rise in line with world prices up to February 2022 includes both importers—China and Pakistan—and exporters—India and Russia—suggesting the differences in responses to the world price changes are not due to mechanical influences such as additive margins. The quite sharp differences in quality characteristics between US and EU wheat and high correlations between the international price series suggest that product attribute differences are unlikely to be sufficient to explain such large changes in price gaps. Using alternative international prices, such as the US hard red winter wheat price, or alternative domestic prices, such as New Delhi wholesale prices in India or the Linyi prices in China, gave similar results, suggesting the conclusions are not sensitive to the specific price series chosen.

Whether price-insulating policies can explain the different responses of domestic to world prices is an important question. Despite China's market-oriented reforms as part of the WTO accession process (Bhattasali et al., 2004), China's policymakers still have some discretion on imports and pricing, especially following the increases in tariffs on imports from the United States arising from the Trump tariff war (Zheng et al., 2022), which make it more difficult for private firms to import from the United States. India's policymakers certainly retain the ability to influence domestic prices and used this policy discretion to impose a wheat export ban from May 2022. Pakistan's policymakers have strong incentives to maintain price stability, given the importance of wheat as a staple food, and have exercised their policy discretion in the past using measures such as Statutory Regulatory Orders to reduce tariffs (Ejaz & Ahmad, 2017) and sometimes import subsidies (Dorosh & Salam, 2009).

A striking feature of [Figure 4](#) is the diversity of responses. China's response is well within the range of results from the VECM modelling, with the steady rises in world prices before March 2022 being progressively passed through to domestic prices. In India, by contrast, insulation was more than complete, with domestic prices trending down during most of the period



**FIGURE 4** International and domestic US\$ price indexes for wheat, January 2020 to July 2022. *Note:* World prices are the average of US hard red winter, US soft red winter, Canadian Western Red Spring & French Grade 1 (Rouen) wheat. China: National average wheat wholesale. EU: French Grade 1. India: Wholesale wheat price, Mumbai. Russia: National average retail flour. USA: Hard Red Winter wheat. Pakistan: wheat flour, Lahore. *Source:* FAO GIEWS.

of sharply rising world prices. Prices in Pakistan followed world prices over most of the period before declining in USD terms from late 2021, even while world prices soared.

The approach used in this section, as outlined in [Equations \(3\)–\(7\)](#), allows us to estimate three key features of price adjustment in any time period: the first is the change in world prices; the second is the change in the average domestic price; and the third is the change in the average gap between domestic and world prices. As noted above, the average change in domestic prices is both the change in prices needed to balance supply and demand given the shocks to wheat markets over that period and the change in the world price that would have been needed absent any changes in price gaps. The negative of the change in the proportional price gap is

the extent to which changes in world prices are magnified by price insulation. If, for instance, one country, accounting for 10% of world market share lowers its protection rate by 20%, the world market price must rise by 2% more than would otherwise be needed.

Results for each of these changes are presented in [Table 8](#) for five distinct periods: the first column refers to the period from January–February 2020 to January–February of 2022—a period corresponding quite closely to the worst of the COVID-19 pandemic; the second period compares January–February 2022 with April–May of 2022—the surge in prices to their post-Ukraine war peak; the third column considers the whole period from January–February 2020 to the peak of April–May 2022; the fourth column refers to the sharp decline in world prices between April–May 2022 and July of 2022; and the final column covers the entire period from early 2020 to July of 2022. Because all proportional price changes are measured using log changes, the sum of the world price change and the change in the price gap equals the change in domestic prices.

The first column of the table shows that the world price increase of 40.6% during the COVID-19 era was associated with a much smaller, 22.4%, increase in average domestic prices. The difference between the two is the decline in the average rate of protection of  $-18.4\%$ , reflecting imperfect price transmission into domestic markets. Some of this imperfect transmission may have been due to market imperfections, or to differentiated products, but it seems likely given our examination of developments in the largest six markets that most of it was due to increases in export tax equivalents or reductions in import tax equivalents designed to insulate domestic prices from the large rises in world prices. In conventional percentage change terms, the increase in world prices was 50% and the needed increase in prices was 25%, suggesting that price insulation doubled the increase in world prices during this period.

During the period immediately following the Ukraine invasion (March to April–May 2022), the impact of price insulation was even more dramatic. While the weighted average of domestic prices rose by only 11.3% in del log terms, world prices rose by 30.4%. In conventional percentage terms, this is a magnification of the increase of world prices from 12% to 34%.

Over the whole period from 2020 to the peak in April–May 2022, price insulation increased the shock to world prices from 33.7% to 67.4%. Using conventional percentage changes, this is an increase from 40% to 96%. Using either measure, the increase in world prices was more than doubled.

During the price decline from April–May to July 2022, the effect of price insulation worked in reverse, as would be expected. Average protection rates rose as world prices fell relative to unchanging or slowly changing domestic prices. This reduced the need for high world prices, allowing them to fall much more rapidly than would otherwise have been the case. A decline of 7.8% in domestic prices translated, with a sharp rise in price gaps, into a decline of 27% in world prices. It is, of course, important not to allow declines in prices to create a false sense of security. Prices remain elevated and could surge again. A key feature of price insulation is that it magnifies the volatility of world prices in both directions.

**TABLE 8** Changes in world prices, weighted domestic prices and Price gaps (% Del log)

	COVID-19 era	Ukraine to peak	2020 to peak	Peak to July	2020 to July 22
World price change	40.8	26.5	67.4	-26.7	40.7
Price gap change	-18.4	-15.2	-33.7	18.9	-14.8
Domestic price change	22.4	11.3	33.7	-7.8	25.9

*Note:* Price gaps and domestic price changes are weighted by national shares of global consumption. Per cent changes are calculated using differences in logarithms to ensure that they are additive.

## 5.1 | Contributions by country to world price changes

An important question is which were the countries where changes in price gaps contributed the most to magnifying the recent surges in world wheat prices. This can be estimated using by weighting the change in protection for each country by the country's share in global consumption. Countries with large consumption shares and increasing gaps between world and domestic prices—likely associated with strong price insulation—likely made the strongest contributions to magnifying increases in world market prices. The 10 countries whose price insulation made the largest contributions to the increases in world prices are shown in [Table 9](#).

In each of the three subperiod of price increases considered, price insulation in India's market appears to have contributed the most to magnifying the increase in world prices. The strength of India's insulation—inherent in the price developments in [Figure 1](#)—outweighed its smaller market share (13 vs 17% for China), making it the largest contributor to magnifying the increase in world prices. China's contribution was the second largest in each period. In each period, these two giants contributed around 60% of the price magnification effect.

Russia made the third largest contribution during the COVID-19 era, as domestic prices fell behind rising world prices in this period. Pakistan's choice to lower domestic prices during the rise to the post-Ukraine peak made it the third largest contributor in that period. Increasing gaps between world and domestic wheat prices during the COVID-19 and Ukraine to peak periods caused Turkey to become the fourth largest contributor to higher world prices in those two periods.

Algeria entered the top five contributors in the COVID-19 era, as the gap between world and domestic prices increased. Ukraine involuntarily entered this group after being invaded, as its exports were sharply restricted by the loss of key ports and inability to export from Odessa during the period to July 2022.

All the remaining contributions in the table were below 5% individually, although they added up to a substantial contribution to the problem of magnification. While all the individual contributions to the world price rise are measured with a degree of error, their collective impact is subject to much smaller errors.

Politically, price-insulating policies are often highly attractive for policymakers in individual countries. They frequently provide a much less expensive path to food price stability than reliance only on domestic production and grain storage. But, they are much less effective than they might appear to participants, just as individuals standing in a stadium to get a better

**TABLE 9** Top ten insulating contributions to surges in world wheat prices (%)

	COVID-19 era		Post-Ukraine peak		2020 to peak
India	43.6	India	34.8	India	39.6
China	15.0	China	25.2	China	19.6
Russia	10.5	Pakistan	8.2	Russia	6.4
Turkey	6.4	Turkey	4.1	Pakistan	6.3
Algeria	5.4	Ukraine	3.8	Turkey	5.4
Pakistan	4.8	Algeria	3.5	Algeria	4.5
Nigeria	3.3	Morocco	3.2	Morocco	3.0
EU	3.2	Iran	3.2	Egypt	2.5
Morocco	2.8	Egypt	3.2	Nigeria	2.2
Indonesia	2.4	Uzbekistan	2.2	Indonesia	2.1
Top-10	97.4		91.4		91.6

view is much less effective than it might initially be expected (Martin & Anderson, 2011). And, the problems resulting from the higher world price volatility generated by price insulation are extremely serious. Many poor, vulnerable countries must face much more volatile world prices than they would otherwise need to confront and the short-run impacts of higher prices of staple foods can throw millions into poverty (Ivanic & Martin, 2008). Many of these countries are unable to afford costly policies, such as import subsidies, which are needed to insulate their markets from higher food prices.

Clearly, the asymmetry of gains and losses makes it difficult to design policies to deal with the collective action problems resulting from price insulation. There appear to be two broad approaches to reducing the adverse impacts of price-insulating policies. One would be through redesign of countries' own domestic trade and storage policies to reduce both their direct cost and their impacts on world markets (see, for example, Gouel et al., 2016). Another would be through international agreements to limit particularly adverse forms of price insulation such as export bans and variable import levies.

An encouraging feature of the results in Table 3 is the relatively small contribution made by today's high-income countries. This is in strong contrast to the 1970s and 1980s, when high-income countries made a substantial contribution to inflaming the price shock of 1973–74, and particularly to the depressed prices of the late 1980s (Martin & Anderson, 2011). This success is not an accident, but in large part a consequence of the Uruguay Round agreement to outlaw the type of variable levy that was previously a mainstay of the European Community's Common Agricultural Policy.

## 6 | CONCLUSIONS

The initial review of recent developments in world commodity markets led to the conclusion that the sharp increase in world wheat prices was potentially an important contributor to rising poverty and food insecurity, particularly following the invasion of Ukraine. But, based on past analyses, it seemed unlikely that the increases in world prices were being fully transmitted into the domestic prices that matter for farm incomes, food security and poverty. Domestic markets are often partially insulated from world markets, partly by transportation costs and partly due to insulating policies, such as export bans, tariff reductions and import subsidies. Empirical research is needed to assess the extent to which world price changes are being transmitted into domestic prices.

An econometric analysis of price transmission between world and domestic prices was used to try to understand how domestic prices respond to changes in world prices. This suggests that most domestic wheat prices are, in the long run, linked to changes in international wheat prices. However, even the long-run price transmission is less than 100% in many cases, and the movement towards the equilibrium appears to be slow on average, closing only 8% of the gap each month. It is likely that the long-term relationships between domestic and world prices partly reflect a political-economy equilibrium between producer and consumer interests, which tends to reassert itself as domestic prices are attracted back towards their longer run relationship with world prices. Impulse response functions point to considerable heterogeneity in the adjustment paths across countries, highlighting the need to examine the responses of individual countries.

We also conducted a case study to examine policy response to the current, dramatic surge in world wheat prices. It shows that only a little over 60% of the increase in world prices was transmitted into domestic prices in the COVID-19 era of sustained price increases. The collective impact of this price insulation was to magnify increases in world prices—more than doubling the needed increases in world prices during the COVID-19 era and almost tripling the world price increase needed during the spike following the Russian invasion of Ukraine. Price

insulation also contributed to the sharp fall in prices between May and July 2022—roughly tripling the decline in world prices during that period.

This finding of low transmission from international into domestic wheat markets has important implications for policy—building a case for reforming policies in individual countries to help reduce the pressure on world market prices, and hence the pressure on countries unable to afford the costs of insulating their markets from world price changes. Knowledge of the extent of each country's degree of price insulation in key food products is also an essential input into the task of assessing the impacts of domestic wheat price changes on poverty and food insecurity.

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## DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author on reasonable request.

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