Understanding Commodity Price Fluctuations: Trends, Cycles, and Volatility

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Motivation

The post-COVID surge in price volatility has renewed interest in commodity supply management

It has led to a range of proposals:

- Support for the production of key commodities (Singh and Datta, 2024)
- Food commodity stockpiling (Weber and Schulken, 2024)
- Measures to enhance supply chain resilience (Alabi and Ngwenyama, 2023)
- Formation of a critical minerals cartel (Harris, 2023)
- Strategic stockpiling frameworks (Moerenhout, Vazir, and Patrahau, 2025)
- Stockpiling mechanisms and quotas for critical minerals (Ali et al., 2025).

Objectives

- How does the volatility of commodity prices and its persistence evolve over time and across phases of commodity cycles?

- Do the macro-financial drivers of price volatility differ in the pre- and post-pandemic commodity cycles?

Methodology

GARCH (1,1) model specification

Mean equation:

$$R_t^C = \delta + \varepsilon_t$$

$R_t^C = \log\left(\frac{P_t^C}{P_{t-1}^C}\right)$ is the log return of commodity C at time t

P_t^C is the price of commodity C at time t, δ is a constant term. ε_t is the error term: $\varepsilon_t \sim N(0, \sigma_t^2)$

Variance equation:

$$\sigma_t^2 = \omega + \alpha_1 \varepsilon_{t-1}^2 + \beta_1 \sigma_{t-1}^2 + \varphi X_t$$

σ_t^2: conditional variance of returns

ω: constant term

α_1: coefficient of the lagged squared white noise errors (ARCH)

β_1: coefficient of the lagged conditional variance

X_t: exogenous variables, including S&P 500 returns; crude oil returns, US dollar index returns

Interpretation: σ_t^2 captures the volatility of R_t^C,

$\alpha_1 + \beta_1$ volatility persistence—values close to 1 imply high volatility persistence.

Methodology: Types of cycles

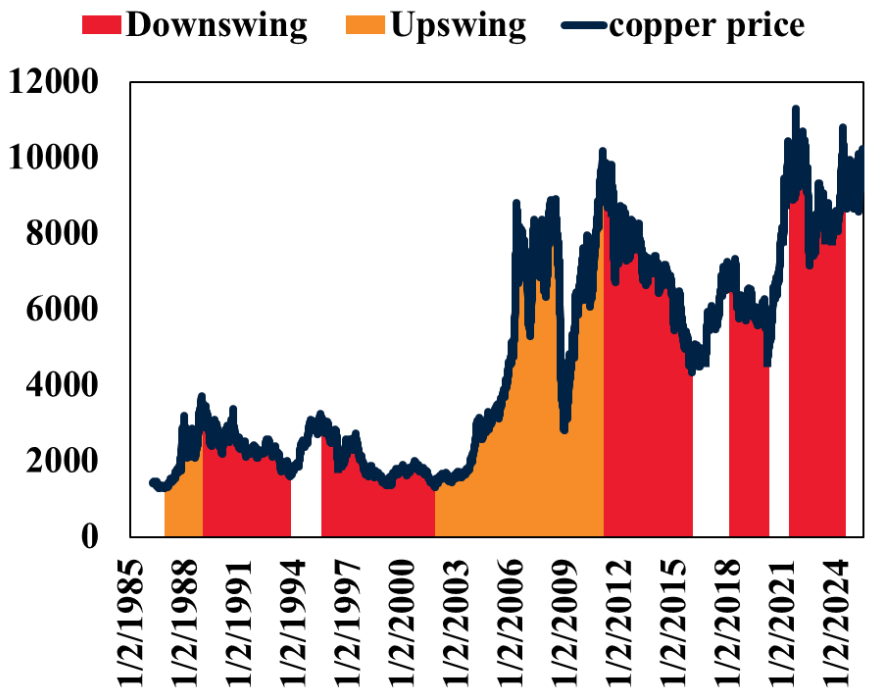
- **Commodity specific cycle dating approach**
  - **Balatti (forthcoming) algorithm:** detects turning points without smoothing/detrending (World Bank 2025).
  - **Rules:** minimum phase 12 months; minimum cycle 36 months.
  - **Key difference vs. previous literature:** adds 15% amplitude filter → removes minor fluctuations, improves boom/slump classification.

- **Global economic cycles – HP Filter**
  - **Data:** Global GDP (constant prices).
  - **Method:** Hodrick–Prescott (HP) filter to separate the cyclical component from trend.
  - **Purpose:** Identify periods when global growth is above or below trend.

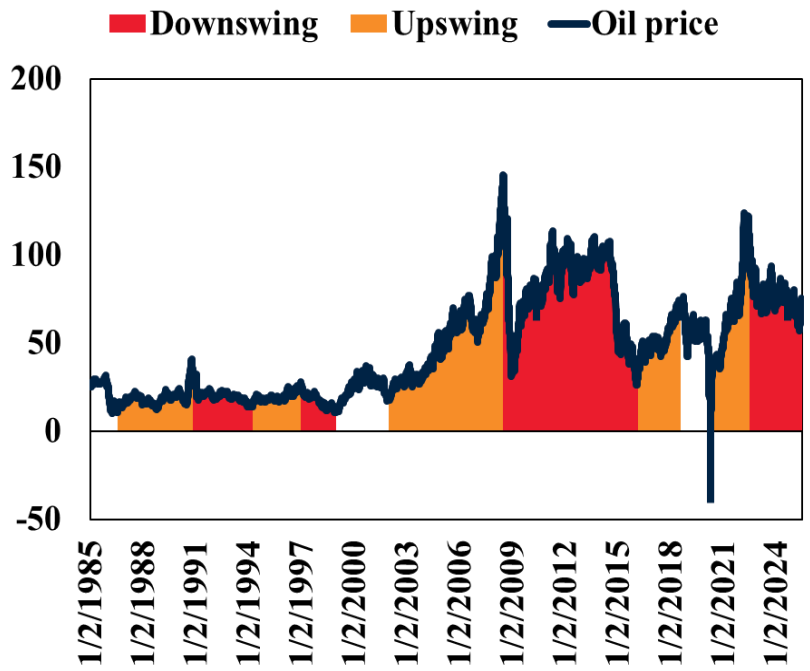
Commodity cycles

Selected commodities

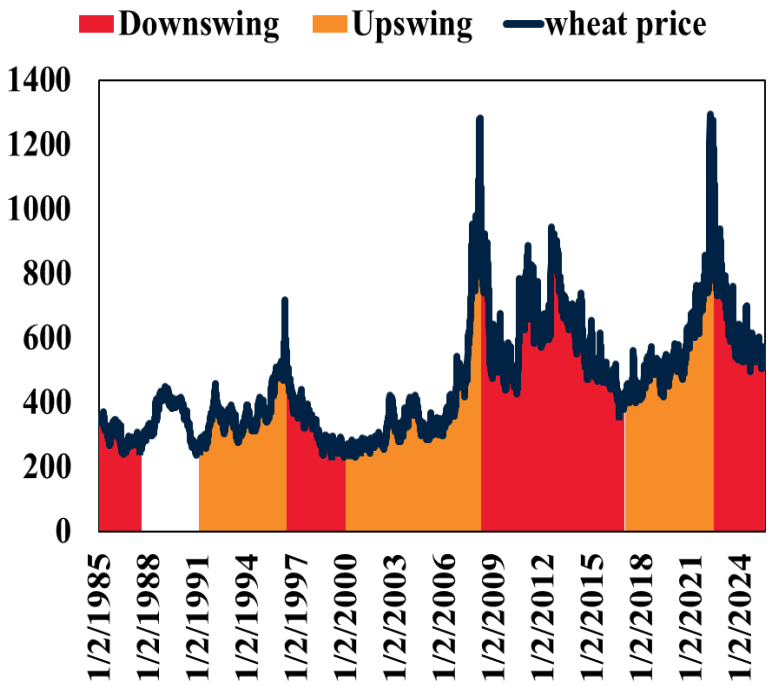
Copper



Crude oil



Wheat



Sources: Balatti (forthcoming) and World Bank 2025.

Data and variables

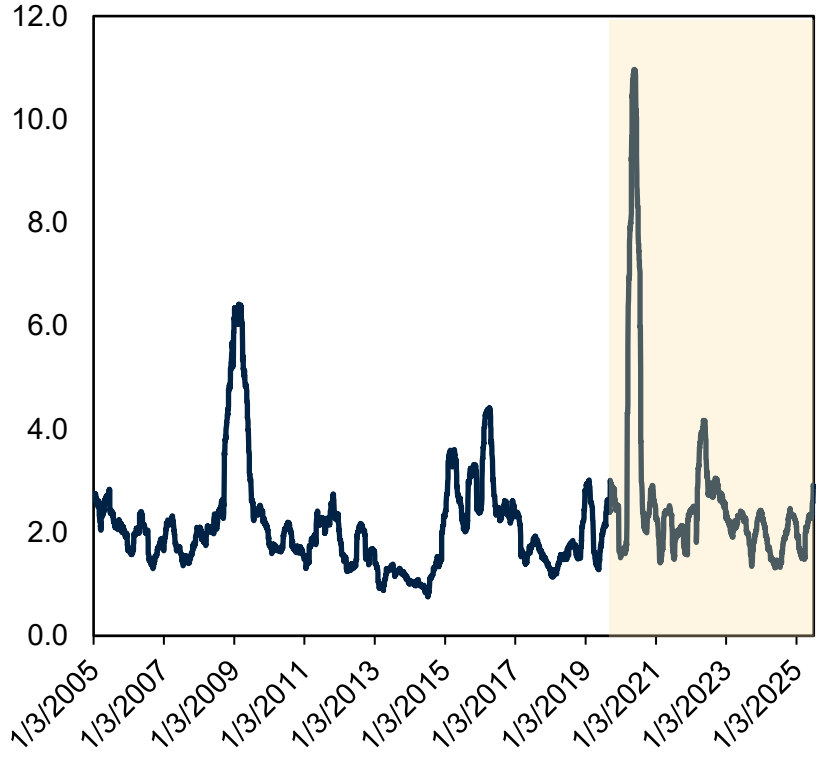
- **Daily data from 1985 to July 2025 (where available) for 22 commodities:**
  - Agriculture and food [10 commodities]
  - Energy [3 commodities]
  - Industrial metals [6 commodities]
  - Precious metals [3 commodities]
- **Financial indicators and oil price**
  - S&P 500 equity index
  - US dollar index
  - West Texas Intermediate prices
- **Commodity prices and financial indicators are sourced from Bloomberg**

Commodity price volatility

90-day rolling volatility for crude oil, agriculture, and metals (2005–2025)

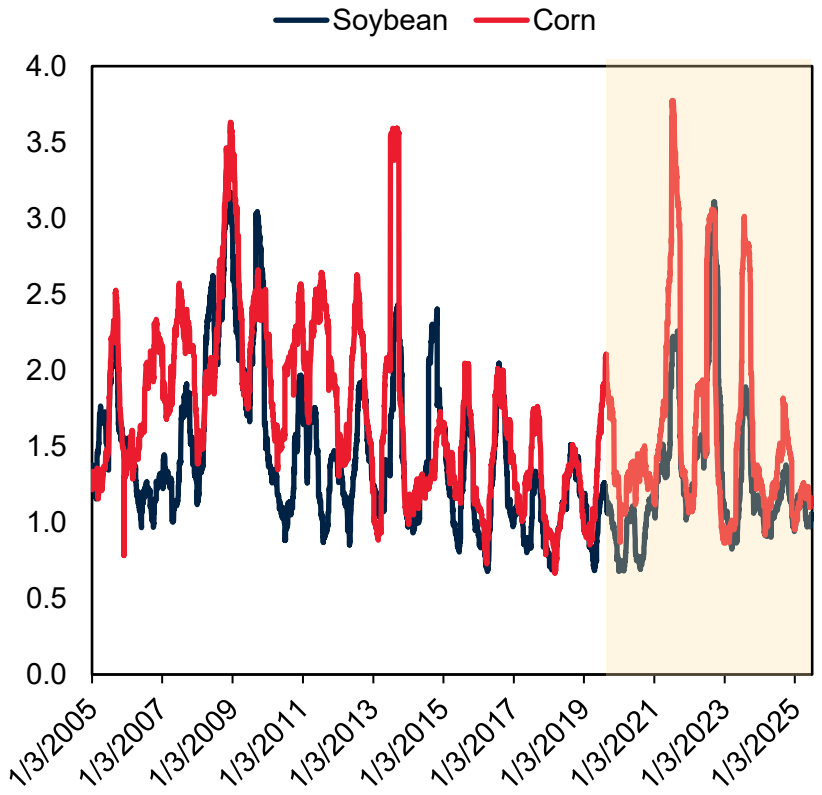
Crude oil prices

(90 day rolling volatility)



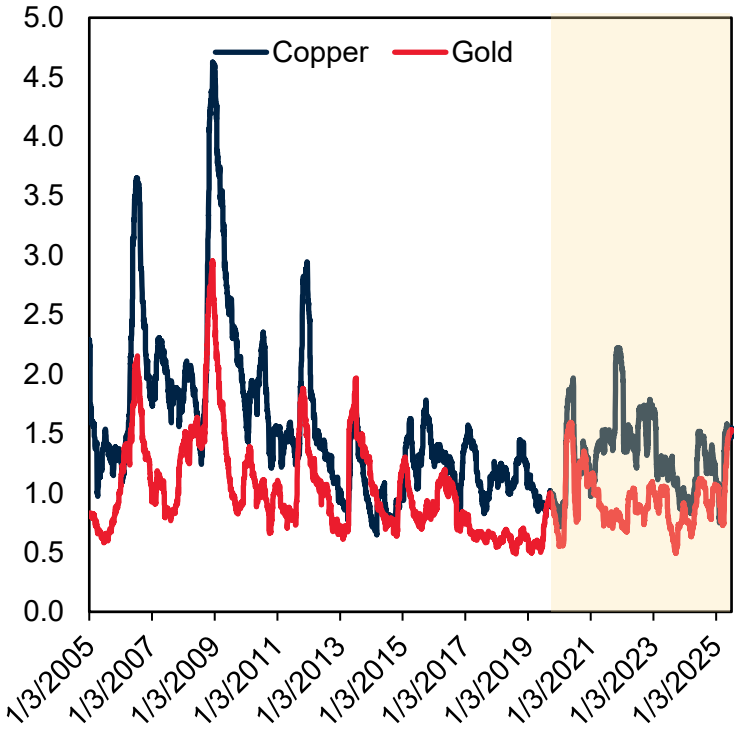
Corn and soybean prices

(90 day rolling volatility)



Copper and gold prices

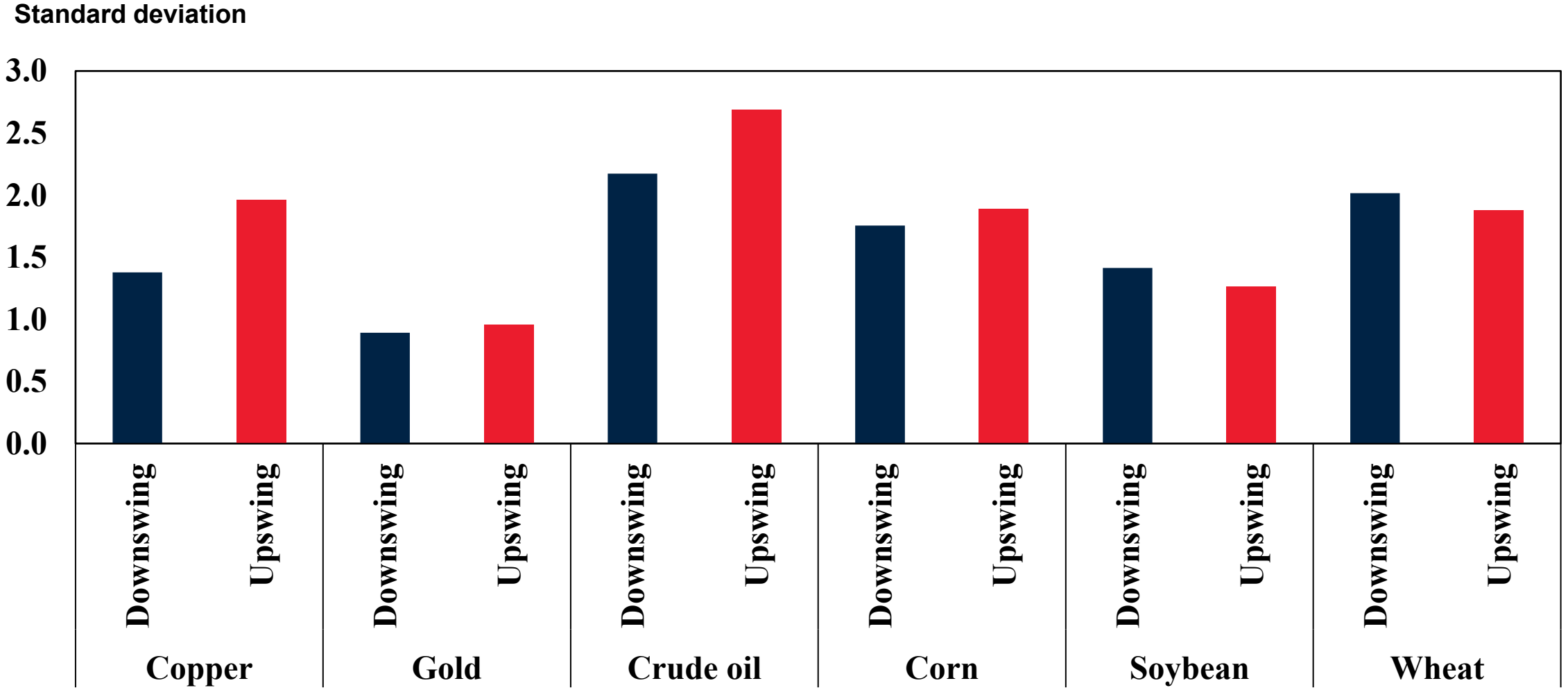
(90 day rolling volatility)



Source: World Bank.
Note: Volatility is the standard deviation of commodity price changes, presented as a 90-day window.

Volatility varies across upswing and downswing phases

Generally higher in upswing phases

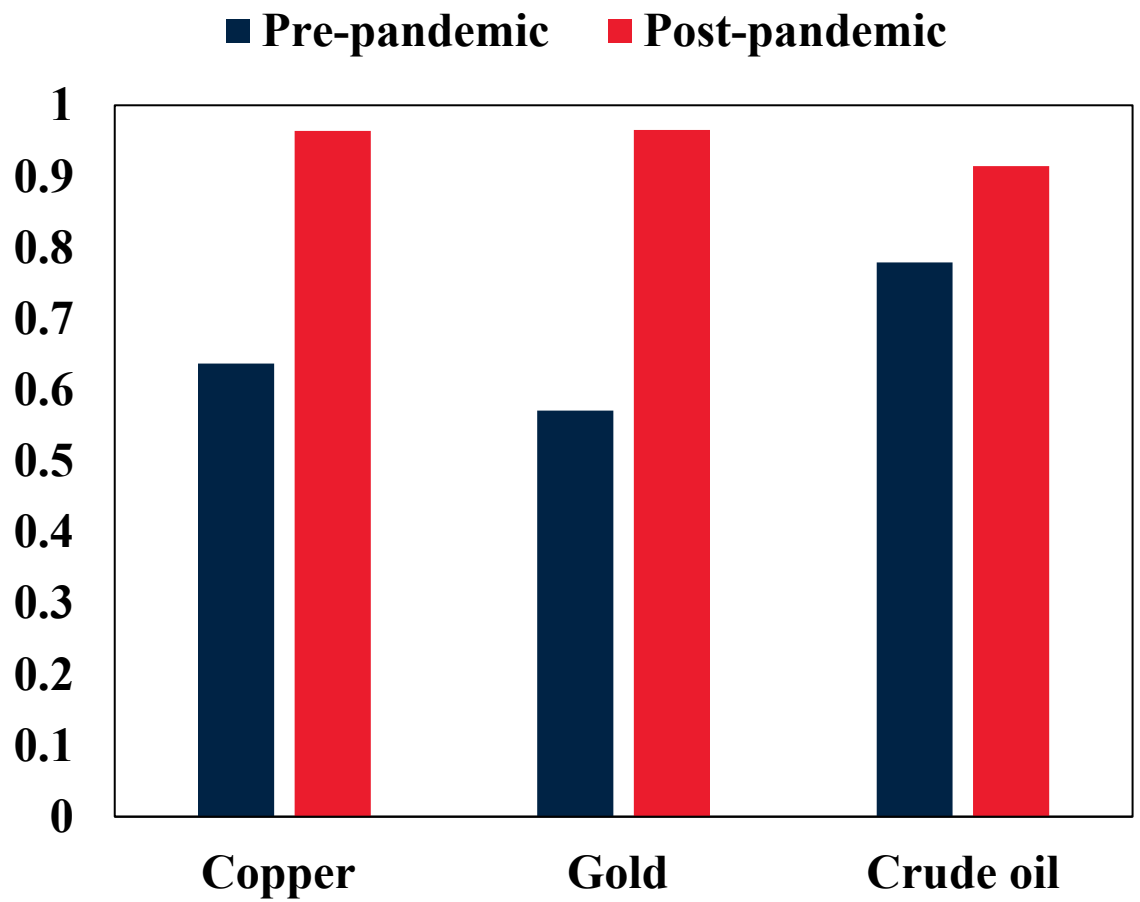


Source: World Bank.
Note: Bars show the standard deviation of prices for selected commodities during the most recent upswing and downswing phases of their respective price cycles.

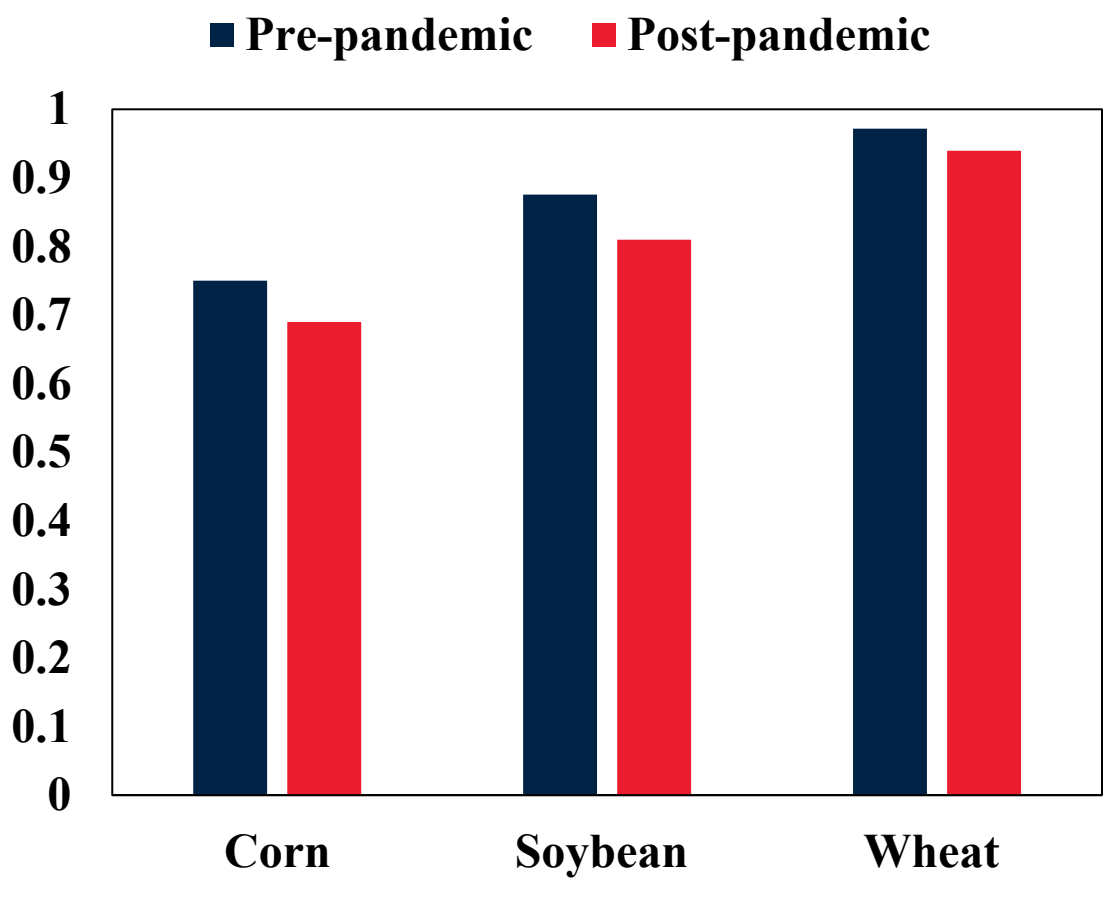
Persistence of volatility in pre- and post-pandemic cycles

GARCH estimates of $\alpha_1 + \beta_1$

Crude oil and metals



Agricultural commodities



Note: Bars show volatility persistence ($\alpha_1+\beta_1$) from the GARCH(1,1) model; values closer to 1 indicate that volatility shocks fade more slowly, implying higher persistence. The (latest) post-pandemic phase (upswing or downswing) is compared with the latest similar phase in the pre-pandemic period. Crude oil, copper, and the three grains are for downswing phases, and gold is for upswing phases.

Macro-financial drivers for volatility (GARCH estimates)

Full sample (selected commodities)

Commodity	SP500	Crude oil	US dollar	L.arch	L.garch
Copper	-0.404***	-0.114**	2.022***	0.188***	0.766***
Corn	-0.386***	-0.126**	1.234**	0.214***	0.752***
Cotton	0.138	-0.567**	-0.332	0.165***	0.758***
Gold	-0.350***	-0.191***	1.204***	0.142***	0.739***
Natural rubber	-0.538***	-0.0831	0.382	0.200***	0.692***
Nickel	-0.540**	0.128	1.320***	0.257***	0.620***
Crude oil	-0.695***		0.486	0.235***	0.646***
Silver	-0.393***	-0.122**	1.546***	0.179***	0.714***
Soybeans	-0.278***	-0.105***	1.098***	0.149***	0.787***
Tin	-0.527***	-0.0688	1.403***	0.258***	0.675***
Wheat	-0.263***	-0.100**	1.112***	0.131***	0.814***

Macro-financial drivers for volatility (GARCH estimates)

*Selected pre- and post-pandemic **downswing** phases*

Commodity	Periods	SP500	Crude oil	US dollar	Obs. (days)	Sample period
Copper	Pre-pandemic	0.01	-0.11	0.58	584	2018-20
	Post-pandemic	-0.47*	0.20	-3.91***	1026	2021-25
Nickel	Pre-pandemic	-0.55**	-0.20	0.14	1305	2011-16
	Post-pandemic	-0.79***	-0.49***	0.78	808	2022-25
Tin	Pre-pandemic	-0.05	-0.17***	0.18	564	2018-20
	Post-pandemic	-0.29*	-0.26***	0.63*	831	2022-25
Crude oil	Pre-pandemic	-0.75***		-0.25	2000	2008-16
	Post-pandemic	-0.33**		2.95***	743	2022-25
Corn	Pre-pandemic	-0.04	0.05	0.12	2041	2012-20
	Post-pandemic	0.19	-0.08	0.43	585	2022-24
Wheat	Pre-pandemic	-0.22**	-0.33**	1.16**	2284	2008-16
	Post-pandemic	0.13	-0.48**	0.74	765	2022-25
Soybean	Pre-pandemic	-0.17	-0.23***	0.39	1760	2012-19
	Post-pandemic	-0.26	-0.57***	-1.02	808	2022-25
Cotton	Pre-pandemic	0.23	-0.04	-0.85*	523	2014-16
	Post-pandemic	-0.12	-0.10	0.09	765	2022-25

Macro-financial drivers for volatility (GARCH estimates)

*Selected pre- and post-pandemic **upswing** phases*

Commodity	Periods	SP500	Crude oil	US dollar	Obs. (days)	Sample period
Gold	Pre-pandemic	-0.34	-0.06	-0.14	1215	2016-20
	Post-pandemic	0.36***	0.65***	-1.60***	656	2022-25
Silver	Pre-pandemic	-0.32***	-0.07	1.69***	2455	2001-11
	Post-pandemic	-0.35	0.13	-3.03***	677	2022-25
Natural rubber	Pre-pandemic	-0.71***	-0.13	0.18	2390	2002-11
	Post-pandemic	-0.76*	-0.41	0.67	634	2022-25

Conclusions

- **Volatility declines with higher SP500 and crude oil returns but rises with USD appreciation.**

- **Significant heterogeneity exists in volatility levels, its persistence and drivers, across pre- and post-pandemic periods and phases of commodity cycles.**

  - **Volatility is generally higher in upswing phases of commodity cycles**

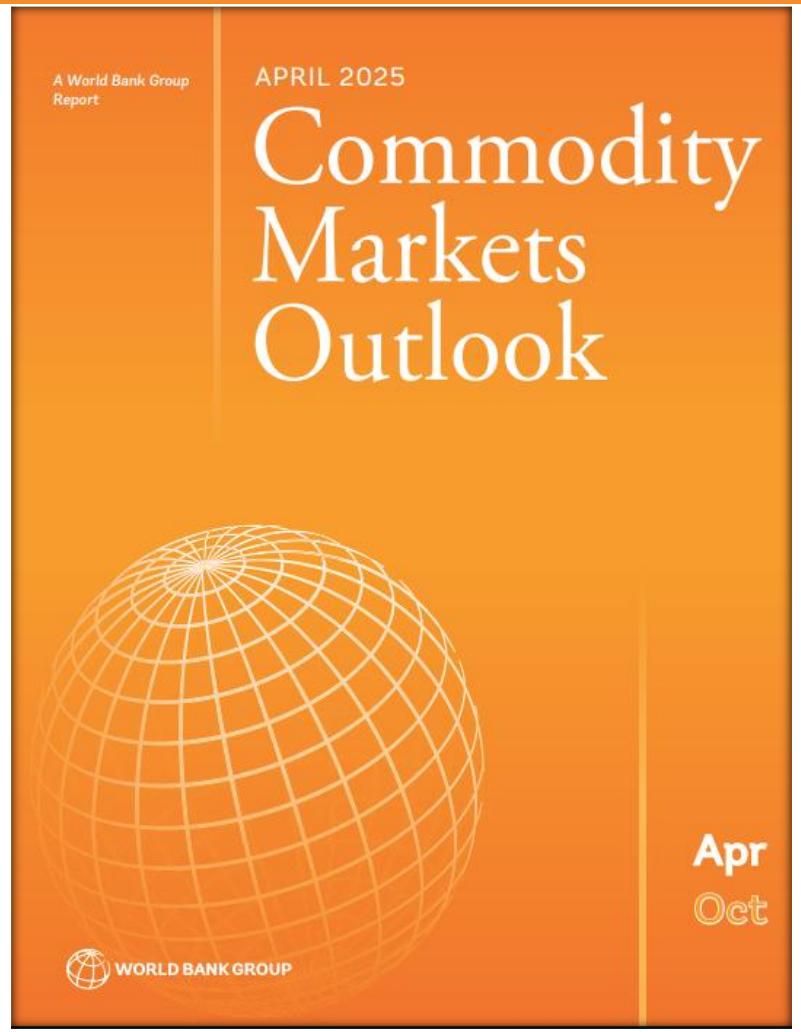
  - **Volatility shocks last much longer after the pandemic and vary across commodity groups**
    - Persistence has increased markedly for industrial commodities but declined for most agricultural commodities.

  - **Global macro factors have become more influential in driving volatility in industrial metal prices**
    - Volatility in copper, nickel, and tin is dampened by strong equity and oil price returns.

  - **The negative relationship between crude oil returns and grain price volatility stronger post-COVID**
    - Likely due to intensified biofuel linkages.
    - No significant relationship between SP500 or USD exchange rate with grain price volatility post-COVID.

www.worldbank.org/commodities

Commodity report



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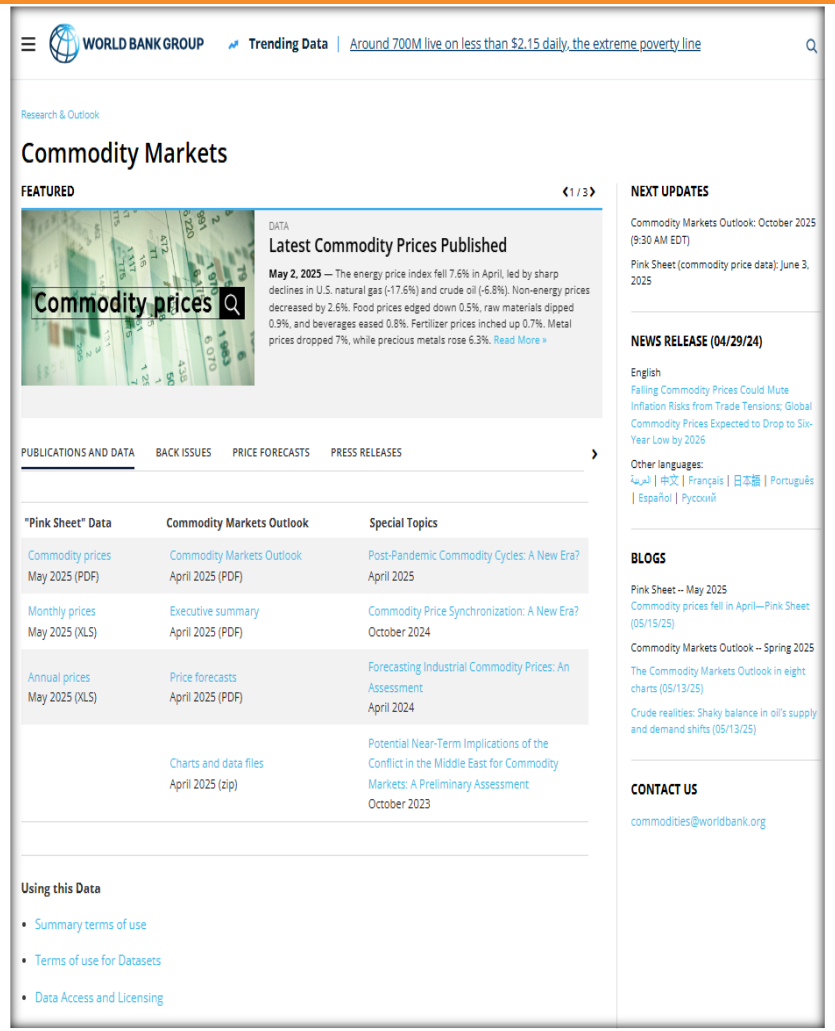

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