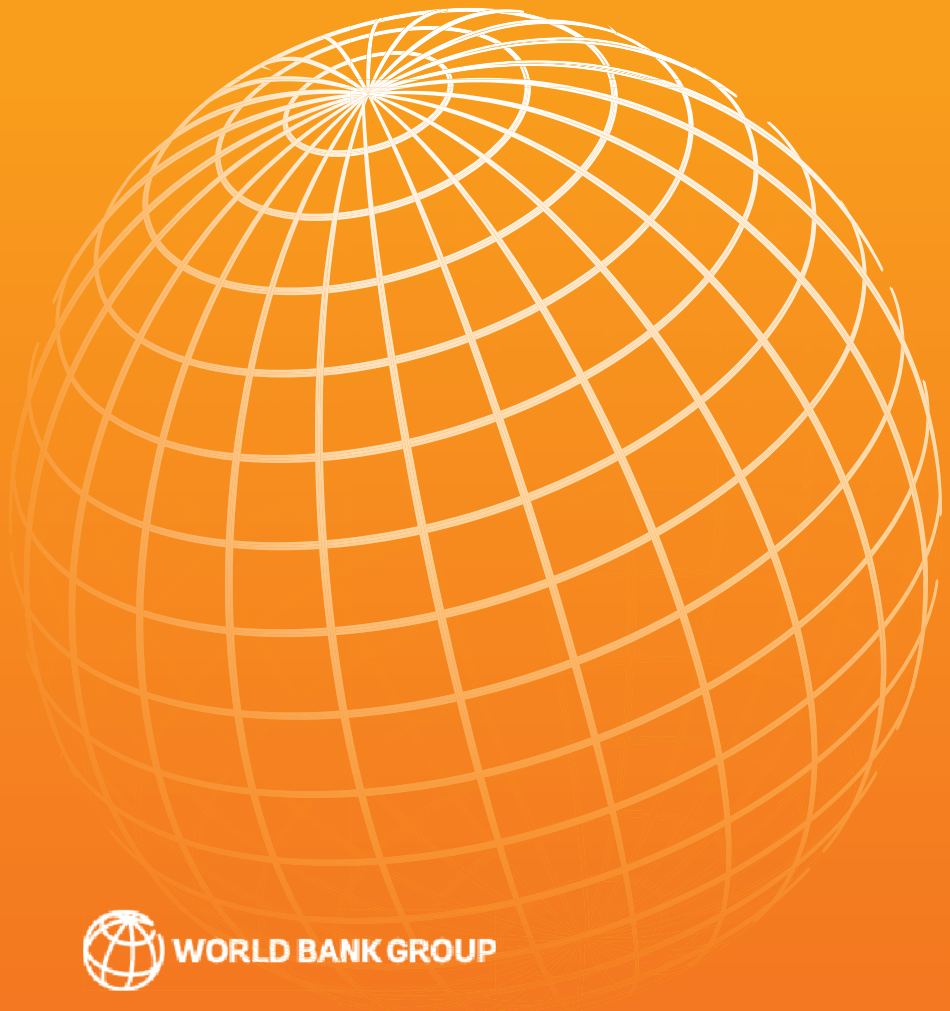
A World Bank Report

APRIL 2023

Commodity Markets Outlook

Lower Prices, Little Relief



Apr

Oct

WORLD BANK GROUP

A World Bank Report

APRIL 2023

Commodity Markets Outlook

1818 H Street NW, Washington, DC 20433

Telephone: 202-473-1000; Internet: www.worldbank.org

The cutoff date for the data used in this report was April 21, 2023.

Table of Contents

Acknowledgments

This World Bank Group Report is a product of the Prospects Group in the Development Economics Vice Presidency. The report was managed by Valerie Mercer Blackman under the general guidance of Ayhan Kose and Franziska Ohnsorge.

The Special Focus on "Forecasting Industrial Commodity Prices" was authored by Jeetendra Khadan and Franziska Ohnsorge. Authors of sections on market developments include Peter Nagle (oil), Paolo Agnolucci (natural gas, coal, fertilizers, and precious metals), John Baffes and Dawit Kelemework Mekonnen (agriculture), Jeetendra Khadan (metals), and Hamza Zahid (critical minerals). Shane Streifel provided inputs and reviewed the report. Kaltrina Temaj coordinated data analysis and supported empirical analysis. Additional research assistance was provided by Lule Bahtiri and Muneeb Ahmad Naseem. Maria Hazel Macadangdang managed the database and forecast tables. Design and production of the report were handled by Adriana Maximiliano. Graeme Littler produced the accompanying website.

Amat Adarov, Marie Albert, Francisco Arroyo Marioli, Carlos Arteta, John Paxton Dearborn, Betty Dow, Sergiy Kasyanenko, and Garima Vasishtha reviewed the report. Kevin Clinton, Graeme Littler, James Rowe, and Christopher Towe edited the report. External affairs for the report were managed by Joseph Rebello and Nandita Roy, supported by Sandya Deviah, Jose Carlos Ferreyra, Kristen Milhollin, and Mariana Lozzi Teixeira. Staff of the Translation and Interpretation Services unit provided translations of dissemination materials.

The World Bank's *Commodity Markets Outlook* is published twice a year, in April and October. The report provides detailed market analysis for major commodity groups, including energy, agriculture, fertilizers, metals, and precious metals. Price forecasts for 46 commodities are presented. Commodity price data updates are published separately at the beginning of each month.

The report and data can be accessed at:
www.worldbank.org/commodities

For inquiries and correspondence, email at:
commodities@worldbank.org

Executive Summary

Global commodity prices fell 14 percent in the first quarter of 2023, and by the end of March, they were roughly 30 percent below their historic peak in June 2022. The surge in prices after Russia's invasion of Ukraine has largely been unwound on a combination of slowing economic activity, favorable winter weather, and a global reallocation of commodity trade flows. For the remainder of this year, commodity prices are forecast to remain broadly unchanged. However, prices are still expected to remain above pre-pandemic levels, which will continue to weigh on affordability and food security. Upside risks to prices include possible disruptions in the supply of energy and metals (in part due to trade restrictions), intensifying geopolitical tensions, a stronger-than-anticipated recovery in China's industrial sector, and adverse weather events. Disappointing global growth is the major downside risk.

Recent developments

Commodity prices have declined sharply over the past six months, after many posted record-high levels last year. The World Bank commodity price index declined by 32 percent from its historic peak in June 2022, the sharpest drop since the COVID-19 pandemic started. As a result, the price surges that followed the Russian Federation's invasion of Ukraine have largely been unwound due to a combination of slowing global economic activity, favorable winter weather, and the redirection of trade of key commodity exports from Russia and Ukraine. By March of this year, prices of wheat and natural gas have registered especially large drops from their peaks in May and August last year, respectively. Nonetheless, prices of all major commodity groups and about four-fifths of individual commodities remain above their 2015-19 average levels (figures 1.A and 1.B). Fertilizer prices reached an all-time high in real terms in 2022, while the food price index reached its second-highest level in real terms—behind the 1973-75 period of grain shortages.

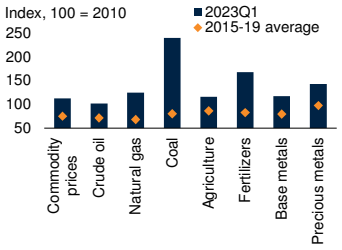
Energy prices were 20 percent lower in the first quarter of 2023 than in the final quarter of 2022. The Brent oil price is 35 percent below its recent record high in June 2022, despite experiencing volatility in March 2023. The discount on the benchmark price paid for Russian oil against the Brent price widened in December 2022 after the introduction of a price cap by the Group of Seven (G7) industrial countries. In Europe, milder-than-expected winter weather, a surge in imports of liquefied natural gas (LNG), and a concerted effort to increase energy efficiency and conservation helped bring down natural gas prices by about 80 percent from their August peak. Larger export volumes and a redirection of trade routes have enabled both natural gas and coal markets to adjust to disruptions triggered by Russia's invasion of Ukraine. Russia continues to redirect its mineral fuel exports from Europe to China, India, and other emerging markets and developing economies (EMDEs), as it has been doing since the start of the invasion (figure 1.C). The price of fertilizers, which use natural gas and coal as inputs, also declined sharply.

Agricultural prices were broadly unchanged between the final quarter of 2022 and the first quarter of 2023—at 14 percent below their April 2022 peaks. Renewal of the Black Sea Grain Initiative continued to help grain exports from Ukraine reach global markets. The initiative, better harvests in other major grain-producing countries, and lower energy prices, have helped reduce agricultural commodity prices from their early-2022 peaks. Grain prices fell 5 percent in the first quarter of 2023, while prices of most other food commodities rose slightly. In real terms, food prices continue to remain above levels observed during the 2007-08 food crisis (figure 1.D). Elevated food prices contribute to higher food insecurity, with severe implications for poorer populations in many developing economies. Annual domestic food price inflation across 146 countries averaged 20 percent in February 2023, the highest level over the past two decades. Of those, nine out of ten low- and middle-income countries face food price inflation above 5 percent.

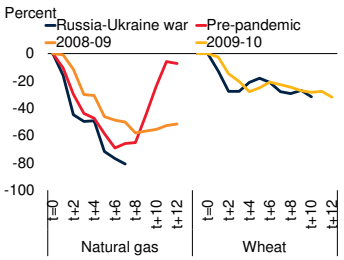
FIGURE 1 Commodity prices and outlook

Commodity prices have declined from their record levels in 2022 but remain well above their pre-pandemic (2015-2019) average. Natural gas prices had historically large declines from their August 2022 peak and wheat prices had a similar decline from their May 2022 peak, both reflecting improved supply prospects and redirection of trade. Russia has been able to redirect its mineral fuel exports from Europe to China, India, and other EMDEs since February 2022. Food and fertilizer prices are still near their record levels, and are expected to remain high in real terms, reducing affordability for lower-income households. Commodity prices are expected to remain broadly unchanged over the remainder of 2023 and into 2024 amid improved supply prospects and weakening global demand.

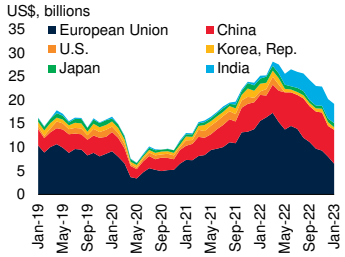
A. Commodity price indexes



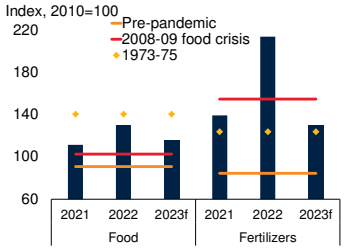
B. Commodity price drops from crises peaks



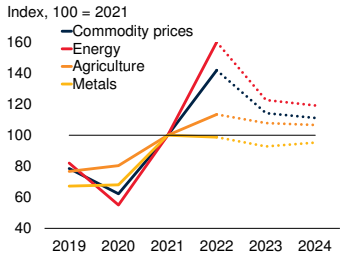
C. Destination of Russia's mineral fuels exports



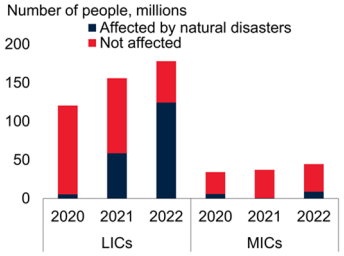
D. Real food and fertilizer prices against record-high price episodes



E. Commodity price forecasts



F. Number of people with food insecurity, by income grouping



Sources: Bruegel Research Service; EM-DAT (database); Food and Agriculture Organization of the United Nations; World Bank.
A.E. Commodity prices refers to the World Bank commodity price index, excluding precious metals.
A. Natural gas index is the weighted average of U.S. natural gas, European natural gas, and Japan LNG prices. Crude oil refers to Brent benchmark and Coal refers to Australian benchmark.
B. Natural gas and wheat showed the steepest declines from the recent 2022 peaks compared to 69 other key commodities examined. Crisis peaks are denoted t = 0. For natural gas, t = 0 for Russia-Ukraine war = August 2022; Pre-pandemic = Nov 2019; 2008-09 = November 2008. For wheat: Russia-Ukraine conflict = May 2022; 2009-10 = May 2009. April 1996 wheat drop not shown.
C. Monthly series. Area represents share in Russia's total export of mineral fuels. Mineral fuels include coal, natural gas and petroleum for 34 countries. Last observation is January 2023.
D. Pre-pandemic = 2015-19 average; 2008-09 food crisis = 2008-09 average. 1973-75 = 1973-75 averages. 2023 real price indexes assume annual change for U.S. CPI deflator of 4 percent.
E. Dashed lines indicate forecasts.
F. Natural disasters, defined as floods, droughts, or wildfires, as recorded in the EM-DAT database. LICs = low-income countries; MICs = middle-income countries. See figure 11.B for definitions.

The metals and minerals price index rose 10 percent in the first quarter of 2023 from the final quarter of 2022. A short-lived price spike in January was fueled by expectations that the end of China's zero COVID-19 policy would push demand higher, as China accounts for roughly half of the global consumption of base metals. However, prices declined in March, largely because of weakening global demand. The precious metals index increased by 9 percent in 2023Q1, driven by a weakening dollar, safe haven buying following banking stress in the United States and Europe, and strong industrial demand for platinum and silver.

Outlook

After rising by 45 percent in 2022, commodity prices are expected to fall by 21 percent this year and remain mostly stable in 2024. The expected decline in prices for 2023 as a whole represents the steepest decline since the pandemic. The decline in energy prices in the first quarter of 2023 is expected to fade and be followed by stable prices over the remainder of 2023 and a slight uptick in 2024, as markets are expected to tighten amid supply pressures. Non-energy commodity prices, in contrast, will decline by about 10 percent in 2023 and almost 3 percent in 2024 as global demand is proving to be weaker than initially expected in the October 2022 forecast (figure 1.E).

Energy price forecasts have been downgraded sharply. The energy price index is expected to fall by 26 percent in 2023 (much of that decline has already taken place) and remain broadly unchanged (up 0.1 percent) in 2024. Brent crude oil prices are forecast to average $84 per barrel in 2023. Weaker global demand has already caused them to drop 15 percent below the 2022 average, and they are projected to remain at that level through the end of 2024. Natural gas prices in Europe have fallen precipitously, with a 53 percent decline expected in 2023, but will remain almost three times as high as the average levels seen in 2015-19. Europe still faces challenges to ensure adequate supply next winter, among them increased competition for LNG exports from Asia.

Coal prices are forecast to fall 42 percent in 2023 and 23 percent in 2024. The anticipated increase in demand from China is likely to be offset by weaker demand elsewhere, as utilities switch back to natural gas. Exports from major producers (particularly Australia, and Indonesia) are anticipated to rise. Fertilizer prices are projected to fall by 37 percent in 2023 in tandem with expected declines in the prices of natural gas and coal, but in real terms remain near the high levels during the 2008-09 food crisis.

Agricultural prices are projected to decline 7 percent in 2023 and ease further in 2024. Food prices are expected to fall by 8 percent in 2023 and 3 percent in 2024, assuming that grain and oilseed exports from the Black Sea region will remain stable. Nevertheless, real food prices in 2023 will remain at their second highest levels since 1975—exceeded only by 2022 (figure 1.D). More than 349 million people globally are projected to face food insecurity this year—double the number in 2020—because of high food and fertilizer prices, conflicts, and economic and climate shocks (WFP 2023). The prevalence of natural disasters is associated with a significant increase in the number of food insecure households, particularly in low-income countries (figure 1.F). Prices for agricultural raw materials, which include cotton, timber, and rubber, will decline by about 6 percent in 2023, reflecting sluggish global industrial demand growth, and rebound by 2 percent in 2024 as China's demand picks up.

Metals and minerals prices, which briefly increased in January 2023, are expected to fall by 8 percent in 2023 relative to last year and a further 3 percent in 2024. Global demand in manufacturing is expected to remain weak, and China's recovery is expected to be heavily services-oriented (World Bank 2023a). Strong supply growth is projected over the forecast horizon, supported by a recovery from production outages and new mines coming on stream for key metals (copper, nickel, and zinc). Precious metals prices are expected to increase by 6 percent in 2023 as safe-haven demand rises amid elevated uncertainty with respect to future growth prospects, ongoing concerns about inflation, and financial stress in the first quarter.

Risks

Risks to the forecast are tilted to the upside, primarily because many of the factors underlying the shocks to commodity markets in recent times still prevail:

- *Weaker-than-expected oil supply.* Supply could disappoint both in Russia, especially if sanctions disrupt oil exports more than anticipated, and in other Organization of Petroleum Exporting Countries and 10 affiliated member countries (OPEC+), where supply remains below target—with many countries at or near full capacity. Tighter credit conditions may impede the ability of oil or coal companies to increase supply elsewhere. Policies to hasten the energy transition may discourage fossil fuel production, while also increasing demand for metals, particularly copper, nickel, and lithium. Fossil fuel energy producers may prefer to use profits to strengthen balance sheets and reward shareholders, rather than investing in expanding production. This would lead to higher prices of carbon-intensive energy commodities, but also metals and minerals.

- *Direction of demand from China.* The recovery in China may be tilted toward commodity-intensive sectors, and not services (as forecast). This would lead to higher prices for energy and metals because of larger demand from industry. The real estate sector in China may begin to strengthen sooner than assumed, raising import demand and prices for base metals. This could result in upward pressure on prices of aluminum, copper, lithium, and nickel, which are anticipated to experience a surge in global demand over the medium term because of their usage in the manufacturing of electric vehicle batteries.

- *Intensification of geopolitical tensions.* Global supplies of grain and energy (particularly coal and natural gas) could change course unexpectedly if geopolitical tensions intensify. In the case of energy, European natural gas stocks are high but may not be sufficient to cover consumption in the 2023-24 winter months

(European Commission 2023). Disruptions in trade routes—particularly for grains around the Black Sea and Ukraine—amid sanctions and counter-measures could raise grain prices. Against the backdrop of already elevated food prices, this could deepen food insecurity in many EMDEs.

- *Unfavorable weather conditions.* The occurrence of adverse weather events that affect crops in major global food-producing regions could result in an increase in food prices. Colder-than-usual winter weather or warmer-than-usual summer weather could raise heating or cooling demand for energy in the northern hemisphere. Adverse weather events could be driven by natural disasters that are happening more frequently as a result of climate change (IPCC 2023; World Bank 2020a). In addition, if an El Niño event happens, it could lead to higher temperatures and heavy rainfall later in 2023 (NOOA 2023).

The main downside risk is if prices of industrial commodities—energy and metals commodities—retreat if global activity ends up weaker than expected (World Bank 2023b). Continued elevated inflationary pressures could require an even more aggressive policy response from major central banks. Following the recent financial stress episode, credit conditions could tighten. If these types of risks occur, they would dampen demand for industrial commodities and lead to lower prices.

Special Focus: Forecasting Industrial Commodity Prices

The Special Focus (SF) of this edition assesses the performance of a wide range of approaches used to forecast prices of seven industrial commodities—oil and six industrial metals—by reviewing 60 studies published in academic journals. The studies evaluate the performance of models based on three criteria: (i) directional bias (whether forecast and actual prices move in the same direction); (ii) precision (measured as the root mean squared forecast error); and (iii) unbiasedness (whether the forecasts systematically over- or under-predict prices). The SF reports four key results. First, futures prices, which are widely used for price forecasts, often lead to large forecast errors. Second, multivariate time series models tend to outperform other model-based approaches. Third, early studies suggest that machine learning techniques yield better forecasts than some traditional approaches. Finally, augmenting model-based forecasting approaches, by incorporating the dynamics of commodity prices over time and controlling for other economic factors, enhances forecast accuracy.

TABLE 1 World Bank Commodity Price Forecasts

							Percent change from previous year		Differences in levels from October 2022 projections	
Commodity	**Unit**	**2020**	**2021**	**2022**	**2023f**	**2024f**	**2023f**	**2024f**	**2023f**	**2024f**
Price indexes in nominal U.S. dollars (2010 = 100)										
World Bank Commodity Price Index [1]		63.1	101.0	143.3	112.9	112.1	-21.2	-0.8	-16.2	-4.8
Energy [2]		52.7	95.4	152.6	113.2	113.3	-25.8	0.1	-21.5	-5.0
Non-Energy		84.1	112.5	124.4	112.5	109.5	-9.6	-2.7	-1.2	-3.5
Agriculture		87.1	108.3	122.7	113.9	111.6	-7.2	-2.0	-3.8	-5.9
Beverages		80.4	93.5	106.3	101.0	97.6	-5.0	-3.4	-0.5	-3.9
Food		93.1	121.8	143.7	132.4	128.7	-7.9	-2.8	-2.3	-5.4
Oils and Meals		89.8	127.1	145.2	124.7	122.4	-14.1	-1.9	-9.6	-11.3
Grains		95.3	123.8	150.4	135.8	125.3	-9.7	-7.8	-5.2	-14.5
Other food		95.5	113.1	135.6	139.3	140.1	2.7	0.6	9.8	10.7
Raw Materials		75.8	82.9	80.3	75.7	77.3	-5.7	2.2	-9.0	-8.1
Timber		86.4	90.4	80.1	80.7	82.0	0.8	1.6	-5.7	-5.6
Other raw materials		64.2	74.8	80.5	70.2	72.3	-12.8	2.9	-12.5	-10.6
Fertilizers [3]		74.6	152.3	235.7	148.7	138.2	-36.9	-7.1	n/a	n/a
Metals and Minerals [4]		79.1	116.4	115.0	105.3	101.8	-8.4	-3.4	8.8	4.9
Base Metals [5]		80.2	117.7	122.4	111.5	107.9	-8.9	-3.2	8.5	4.1
Precious Metals [6]		133.5	140.2	136.8	144.3	134.0	5.5	-7.2	14.6	7.3
Price in nominal U.S. dollars										
Energy										
Coal, Australia	$/mt	60.8	138.1	344.9	200.0	155.0	-42.0	-22.5	-40.0	-57.3
Crude oil, Brent	$/bbl	42.3	70.4	99.8	84.0	86.0	-15.9	2.4	-8.0	6.0
Natural gas, Europe	$/mmbtu	3.2	16.1	40.3	19.0	17.0	-52.9	-10.5	-13.0	-11.0
Natural gas, U.S.	$/mmbtu	2.0	3.9	6.4	2.7	3.7	-57.6	37.0	-3.5	-2.3
Liquefied natural gas, Japan	$/mmbtu	8.3	10.8	18.4	18.0	16.0	-2.3	-11.1	1.0	0.1
Non-Energy Commodities										
Agriculture										
Beverages										
Cocoa	$/kg	2.37	2.43	2.39	2.70	2.55	12.8	-5.6	0.40	0.21
Coffee, Arabica	$/kg	3.32	4.51	5.63	4.80	4.60	-14.7	-4.2	-0.70	-0.81
Coffee, Robusta	$/kg	1.52	1.98	2.29	2.30	2.25	0.7	-2.2	0.20	0.14
Tea, average	$/kg	2.70	2.69	3.05	2.70	2.75	-11.5	1.9	-0.10	-0.07
Food										
Oils and Meals										
Coconut oil	$/mt	1,010	1,636	1,635	1,100	1,300	-32.7	18.2	-570	-372
Groundnut oil	$/mt	1,698	2,075	2,203	2,000	2,050	-9.2	2.5	-100	-41
Palm oil	$/mt	752	1,131	1,276	980	1,020	-23.2	4.1	-70	-34
Soybean meal	$/mt	394	481	548	590	570	7.7	-3.4	50	31
Soybean oil	$/mt	838	1,385	1,667	1,120	1,105	-32.8	-1.3	-430	-432
Soybeans	$/mt	407	583	675	590	540	-12.6	-8.5	-60	-101
Grains										
Barley	$/mt	98	…	…	210	190	...	-9.5	35	18
Maize	$/mt	165	260	319	270	240	-15.3	-11.1	-20	-47
Rice, Thailand, 5%	$/mt	497	458	437	510	490	16.8	-3.9	75	54
Wheat, U.S., HRW	$/mt	232	315	430	355	335	-17.4	-5.6	-55	-70

TABLE 1 World Bank Commodity Price Forecasts (*continued*)

							Percent change from previous year		Differences in levels from October 2022 projections	
Commodity	**Unit**	**2020**	**2021**	**2022**	**2023f**	**2024f**	**2023f**	**2024f**	**2023f**	**2024f**
Price in nominal U.S. dollars										
Non-Energy Commodities										
Other Food										
Bananas, U.S.	$/kg	1.22	1.21	1.49	1.60	1.65	7.5	3.1	0.20	0.26
Beef	$/kg	4.67	5.39	5.78	5.25	5.40	-9.2	2.9	-0.55	-0.42
Chicken	$/kg	1.63	2.26	3.35	3.30	3.20	-1.5	-3.0	0.20	0.13
Oranges	$/kg	0.60	0.65	0.92	1.20	1.14	30.5	-5.0	0.35	0.29
Shrimp	$/kg	12.67	13.70	13.51	12.00	12.50	-11.2	4.2	-2.00	-1.80
Sugar, World	$/kg	0.28	0.39	0.41	0.45	0.46	10.3	2.2	0.07	0.08
Raw Materials										
Timber										
Logs, Africa	$/cum	399	414	369	380	390	3.0	2.6	-10	-5
Logs, S.E. Asia	$/cum	279	271	228	230	235	0.9	2.2	-20	-19
Sawnwood, S.E. Asia	$/cum	700	750	675	680	689	0.8	1.4	-45	-46
Other Raw Materials										
Cotton	$/kg	1.59	2.23	2.86	2.20	2.25	-23.2	2.3	-0.70	-0.61
Rubber, TSR20	$/kg	1.33	1.68	1.54	1.40	1.50	-9.3	7.1	-0.50	-0.44
Tobacco	$/mt	4,336	4,155	4,270	4,100	4,120	-4.0	0.5	0	4
Fertilizers										
DAP	$/mt	312	601	772	580	570	-24.9	-1.7	-170	-80
Phosphate rock	$/mt	76	123	266	260	240	-2.3	-7.7	60	65
Potassium chloride [3]	$/mt	241	543	863	475	425	-45.0	-10.5	n/a	n/a
TSP	$/mt	265	538	716	560	510	-21.8	-8.9	-90	-40
Urea, E. Europe	$/mt	229	483	700	325	315	-53.6	-3.1	-325	-285
Metals and Minerals										
Aluminum	$/mt	1,704	2,473	2,705	2,400	2,450	-11.3	2.1	0	16
Copper	$/mt	6,174	9,317	8,822	8,500	8,000	-3.7	-5.9	1200	639
Iron ore	$/dmt	108.9	161.7	121.3	115.0	110.0	-5.2	-4.3	15	12
Lead	$/mt	1,825	2,200	2,151	2,100	2,000	-2.4	-4.8	200	83
Nickel	$/mt	13,787	18,465	25,834	22,000	20,000	-14.8	-9.1	1000	-708
Tin	$/mt	17,125	32,384	31,335	24,000	24,500	-23.4	2.1	2000	2243
Zinc	$/mt	2,266	3,003	3,481	2,800	2,700	-19.6	-3.6	0	-71
Precious Metals										
Gold	$/toz	1,770	1,800	1,801	1,900	1,750	5.5	-7.9	200	100
Silver	$/toz	20.5	25.2	21.8	23.0	22.0	5.5	-4.3	2.0	1.0
Platinum	$/toz	883	1,091	962	1,000	1,050	4.0	5.0	0	0

Source: World Bank.

1. The World Bank *commodity price index* comprises all energy and non-energy commodities weighted by their share in 2002-04 export values. The index excludes precious metals. The energy index's share in the overall index is 67 percent.
2. Energy price index includes coal (Australia), crude oil (Brent), and natural gas (Europe, Japan, U.S.).
3. Forecast changes for potassium chloride and the fertilizer index are not reported because the benchmark for potassium chloride changed from f.o.b. Vancouver to CFR Brazil.
4. Base metals plus iron ore.
5. Includes aluminum, copper, lead, nickel, tin, and zinc.
6. Precious metals are not part of the non-Energy index.

f = forecast.

Commodity Market Developments and Outlook

Energy

During the first quarter of 2023, energy prices continued their sharp decline from last year's record highs, as global growth weakened and the global reshuffling of export markets for natural gas and coal settled. For 2023 as a whole, the energy price index is forecast to fall by 26 percent from 2022, mostly driven by a decline in natural gas prices, and remain broadly stable in 2024. Brent crude oil prices are forecast to average $84 per barrel (bbl) in 2023, down from $100/bbl in 2022, before a slight increase in 2024 as supplies tighten. A barrel represents 42 gallons of oil. European and U.S. natural gas prices are forecast to decline by more than half between 2022 and 2023, while coal prices are forecast to decrease 42 percent in 2023; both European natural gas and coal prices will likely fall further in 2024. The main upside risk to the oil price forecast is lower-than-expected production. In the natural gas market, supply disruptions related to the war in Ukraine, as well as rising demand for liquified natural gas (LNG) imports as China's economy rebounds, might drive up prices. On the downside, prices may be lower if disappointing global growth weakens demand for energy commodities.

Crude Oil

Recent developments

The price of Brent crude oil averaged $81/bbl in 2023Q1, a decrease of 8 percent from the previous quarter (quarter on quarter; q/q); in March 2023, the price was down 35 percent from its peak in June 2022 (figure 2.A). Daily prices fluctuated in the range of $72-87 per barrel during the quarter—with moves largely driven by news relating to China's reopening, the monetary policy stance in major advanced economies, and recent financial market stress. Prices rose at the beginning of April following a surprise announcement of a production cut by OPEC+. The spot price of Urals, the Russian benchmark, is estimated to have averaged $47/bbl in early February (excluding freight and insurance costs), below the G7 price cap of $60/bbl (IEA 2023a). There is significant variation in Russian export prices, however, depending on the port of exit and method and cost of transport. For example, crude oil exported via the East Siberia Pacific Ocean pipeline to China and other countries in Asia averaged $72/bbl in January 2023 (IEA 2023a). In addition, some countries were reported to have obtained sizable discounts on their imports of Russian oil, although spot price data for Urals has become less reliable (Technical Note 1).

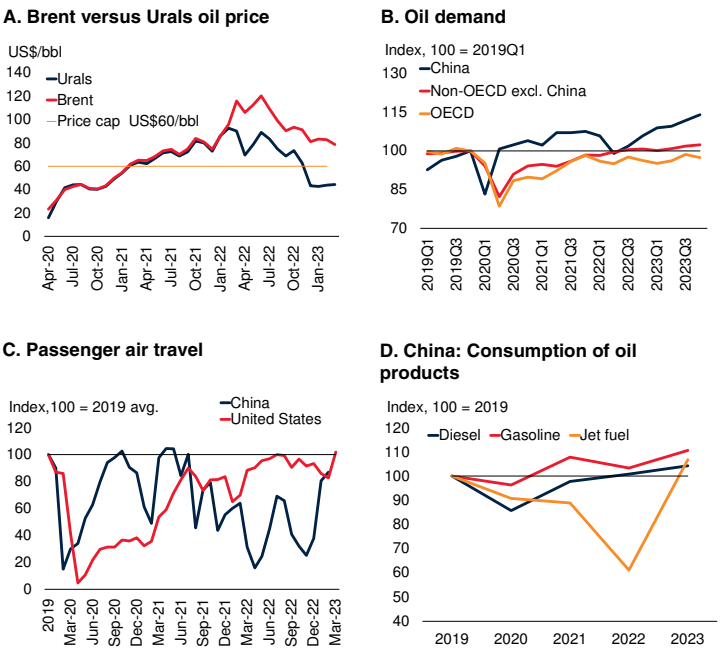
A key development in oil demand since the start of 2023 has been China's reopening from stringent COVID-19-related restrictions. Markets initially anticipated that China's reopening would lead to rapid growth in demand for oil because the country is the world's second-largest consumer (BP 2022). China's oil demand declined by 3 percent in 2022—the first annual decline in more than three decades (figure 2.B). The fourth quarter was particularly steep for jet fuel (31 percent) and gasoline consumption (4 percent; figure 2.D). Since the start of this year, travel has been recovering, particularly air travel, with international passenger flights up 34 percent between February 2022 and February 2023 (figure 2.C). The recovery in travel is expected to lead to a sharp rise in oil demand through 2023.

Optimism associated with China's reopening has been tempered, however, by rising global interest rates. The Brent oil price dropped precipitously from $85/bbl to $74/bbl in the first half of March, during a bout of financial instability in the United States and Europe, before fully recovering after OPEC+ announced production cuts. In the United States, the world's largest consumer of oil, monetary policy rate hikes by the Federal Reserve have weighed on activity and oil demand. In Europe, tightening monetary policy and Russia's invasion of Ukraine have led to a slowdown in activity and a decline in oil demand. In 2022Q4, European oil demand was 0.7 million barrels per day (mb/d) below the previous year—with notable drops for gasoil (essentially diesel) and naphtha, which are predominantly used in industrial activity.

On February 5, 2023, the EU and G7 imposed a price cap on Russia's oil product exports, to complement a similar cap on crude oil that became effective on December 5, 2022. The crude oil cap is currently $60 per barrel, while the oil

FIGURE 2 Recent developments in oil markets

Oil prices fell in the first quarter of 2023 as financial market stress raised concerns about a deeper global slowdown and Russia's exports held up better than expected. Air travel in China is starting to recover as tourism picks up, and it is expected to increase through the rest of this year, which will boost jet fuel consumption. Urals oil trades at a significant discount to Brent prices.



Sources: Bloomberg; International Energy Agency; Transportation Security Administration; World Bank.
A. Monthly data. Last observation is March 2023. Price for Urals is from IEA's *Oil Market Report*.
B.D. Annual and quarterly data for 2023 are IEA forecasts.
C. Index showing rate of change in number of air travel passengers for China and United States. Last observation is March 2023 for the United States and February 2023 for China.

products cap is $100 per barrel (oil products such as diesel and gasoline normally price above crude oil).[1] The EU embargo and Maritime Services Ban on Russian oil products also went into effect on February 5, 2023. The objective of the price caps on crude oil and oil products is to maintain flows of Russian oil, while also reducing the revenue Russia earns (U.S. Department of the Treasury 2022). Russian oil production and exports have so far remained broadly unchanged from their levels prior to the war (figure 3.A). While Russia's oil exports to the EU and other G7 members (such as Japan, the United Kingdom, and the United States) have fallen sharply, increased sales elsewhere, particularly to EMDEs in Asia, have offset the lower exports to industrial countries (figure 3.B). To overcome the price cap restrictions, Russia is thought to have been assisted by a "shadow fleet" of oil tankers that operates outside usual maritime channels. This fleet is not insured or financed by countries in the price cap coalition, so in principle Russia could sell the oil and products at higher prices to third parties not participating in the agreement. The trade diversion has led to less efficient transport of oil, however, because journey times are longer, leading to a higher cost of transport, while the use of older vessels increases the risk of oil spills.

The price Russia has been receiving for its oil exports is substantially lower than the price of Brent crude oil. As a result, Russia's oil revenues have declined—down 48 percent in January 2023 from January 2022—and export revenues are down 36 percent (IEA 2023b). Since the EU's embargo on Russian oil products went into effect in February, Russia needs to redirect a larger amount of oil to other countries. The narrower transport channels that Russia is using means it may increasingly struggle to maintain its oil export volume.[2] Russia announced it would reduce crude oil production by 0.5 mb/d from March to June 2023, possibly reflecting a need to reduce the level of refining amid difficulties in exporting oil products.

Among the remainder of the OPEC+ group of countries, production rose by 3 mb/d in 2022 but remains below the announced production target (figure 3.C). Since the start of 2023, the shortfall between quota and actual production has averaged about 2 mb/d, with the largest shortfalls outside of Russia in Angola and Nigeria (0.4 mb/d and 0.5 mb/d, respectively). In April 2023, OPEC+ announced a surprise production cut of 1.16 mb/d,—to start in May and last until the end of 2023. Russia announced it would extend its 0.5 mb/d cut beyond June to the end of the year, bringing the total OPEC+ cuts to nearly

[1] Shipping, and other companies are prohibited from financing, insuring, trading, brokering, or carrying cargoes of Russian crude and oil products unless they were bought at or below the set price caps.

[2] Since the price cap was introduced, information on exports and prices of supplies originating from Russia have become more limited (see Technical Note 1).

1.7 mb/d. Production in the Islamic Republic of Iran, which is in OPEC+ but exempt from production targets, averaged 2.6 mb/d in 2023Q1, their highest level since 2019Q1, as exports rose, particularly to China (IEA 2023b).

Among non-OPEC+ countries, production was broadly flat in the first quarter of 2023. In the United States, production edged higher, although the rig count has declined slightly since the start of the year as prices have eased (figure 3.D). The number of drilled but uncompleted wells has also continued to fall steadily, which will constrain the ability of companies to ramp up future production. In addition, the shale industry faces significant constraints, with many operators citing sharp increases in the cost of labor and other key inputs (Federal Reserve Bank of Dallas 2022). In addition, limited capacity of oil field services, especially fracking fleets, is constraining completion of wells already drilled (IEA 2023c). Outside of the United States, production has started to ramp up in Guyana after its first oilfields began drilling, with production reaching 0.4 mb/d in 2023Q1, up 0.3 mb/d from the previous year.

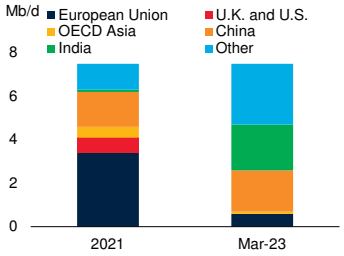
Global oil inventories in January rose to their highest level since September 2021. Among OECD countries, commercial inventories surged in the first two months of 2023, however governments' strategic stockpiles have yet to be replenished to 2021 levels after the substantial drawdowns in the initial phases of Russia's invasion of Ukraine (World Bank 2022).

FIGURE 3 Oil production

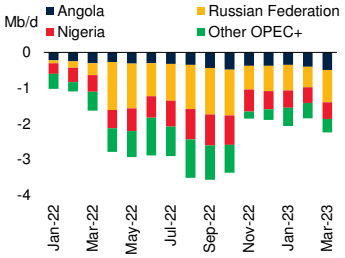
Russia's oil production and exports have been resilient since April 2022, although they are expected to decline in the remainder of this year as a result of the EU's import ban. In the past year, Russia has increasingly diverted its oil exports to India and China, while reducing its supply to the EU, the United Kingdom, and the United States, which have shunned Russian oil. OPEC+ member countries continue to produce below their target, although production has risen slightly in recent months. In the United States, production has continued to increase modestly, while the rig count has plateaued.

A. Russia crude oil production and exports

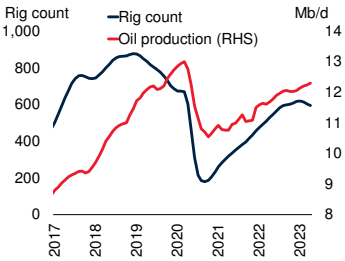
B. Oil exports from Russia, by destination country/region



C. Shortfall in OPEC+ production from quota



D. U.S. rig count and oil production



Sources: Baker Hughes; International Energy Agency; JODI (database); U.S. Energy Information Administration; World Bank.

A. Data on exports from 2016-2021 are from JODI database. Data for 2022 on crude oil exports are from IEA's *Oil Market Report*, April 2023 edition. Monthly production data for 2023 are IEA forecasts.

B. Exports for European Union include crude oil and oil products. Data from IEA *Oil Market Report*, April 2023 edition. Data for 2021 show year average.

C. OPEC = Organization of the Petroleum Exporting Countries. Data based on the IEA *Oil Market Report* March 2023. Target refers to the maximum production level allowed under the OPEC cartel's agreement.

D. Three-month rolling averages. Latest data as of April 6, 2023.

Outlook

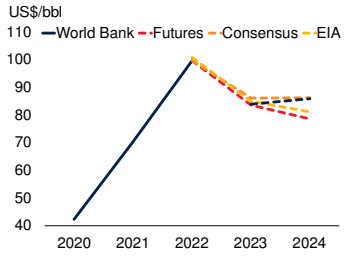
The price of Brent crude oil is forecast to average $84/bbl in 2023, down from almost $100/bbl in 2022, and a downward revision from October 2022, mostly reflecting weaker growth prospects in advanced economies (figure 4.A). The economic recovery in China will support demand growth in 2023-24. Supply will be slower to pick up due to OPEC+ production quotas and limits on capacity in most other regions. Prices are expected to increase slightly 2024 and will remain higher than their 2015-19 monthly average of $57/bbl.

Oil consumption is expected to rise by 2 percent in 2023 to a new all-time high of 101.9 mb/d, according to the International Energy Agency's April assessment, and in line with forecasts from the U.S. Energy Information Administration (EIA) and from OPEC (IEA 2023a; EIA 2023a; OPEC 2003, figure 4.B). Parts of the global economy have already seen a marked deceleration, and tighter financial conditions could dampen activity further. The recovery in China will account for more than half of the expected increase in global oil demand. The resurgence of travel-

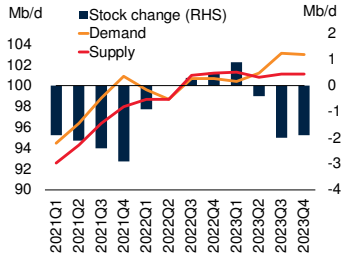
FIGURE 4 Outlook for oil markets

Oil prices are forecast to decline in 2023 before a slight increase in 2024 due to the recovery of demand, particularly from China. One of the many risks to the forecast is the possibility of weaker-than-expected U.S. shale production. Well productivity has been declining.

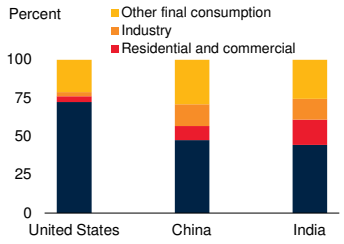
A. Oil price forecasts



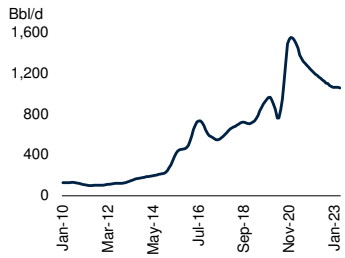
B. Changes in oil demand, supply, and inventory



C. End use of oil (final consumption), by sector, 2020



D. U.S. oil well productivity



Sources: Bloomberg; Energy Information Administration; International Energy Agency; World Bank.
A. Data for 2023-24 are projections.
B. IEA data and forecast (2023Q2-Q4).
C. "Other final consumption" includes power generation.
D. Oil production per new rig drilled. Latest observation is April 2023.

related sectors will result in a notable expansion of demand for gasoline and jet fuel (IEA 2023c). Other Asian countries account for most of the rest of anticipated global oil demand growth. Outside of Asia, oil demand growth is expected to moderate in 2023. This reflects sluggish industrial activity and the continuing transition to a low-carbon-emissions economy.

The outlook for oil production assumes a smaller increase of 1.2 percent in 2023, which will take production to an all-time high of 101 mb/d. The increase is largely accounted for by a further expansion of U.S. production of 1 mb/d, with smaller additions by Brazil (0.3 mb/d), Guyana (0.2 mb/d), Canada (0.1 mb/d), and Norway (0.1 mb/d). Supply of the OPEC+ group of countries (excluding Russia) is assumed to remain near current levels, in line with the group's guidance, which would allow a modest decrease compared to 2022. Russia's production is expected to decline by between 0.4 mb/d and 0.8 mb/d in 2023 (IEA 2023c; EIA 2023a; OPEC 2023).

Risks

The two prominent upside risks to the oil price forecast concern the speed and oil intensity of China's reopening, and weaker-than-expected oil production growth, particularly in the United States and among OPEC countries. The possibility of stronger-than-expected oil exports from Russia and disappointing global growth could lead to lower-than-expected oil prices.

The effect of China's reopening on oil demand will depend on the strength and nature of the recovery. China is assumed to grow just over 5 percent in 2023, with a recovery in domestic consumption, particularly for gasoline and jet fuel. The magnitude of the economic slowdown last year and subsequent rebound this year means the increase in oil demand will be substantial (figure 4.C). A recovery driven in China by more oil-intensive sectors could lead to much higher prices by the end of 2023.

Production may be lower than assumed in the forecast. Investment by oil producers outside of OPEC+ may disappoint, given perceived shifts in demand from the transition away from fossil fuels. Production rates in existing mature fields are declining about 9 percent per year, and substantial new investment is needed just to maintain current levels of production (IEA 2022a; figure 4.D). In addition, U.S. shale production could be weaker than expected if companies continue to prioritize profitability over expansion of capacity. Costs have increased and further constraints in oil services and fracking fleets could restrict output. Such constraints could, over time, shift the balance of power in the oil market toward a more assertive OPEC+, led by the major Gulf producers. The OPEC+ decision to restrict oil supply in early April may signal that the group is prepared to support higher prices going forward.

The outlook for production in Russia is particularly uncertain and will depend on the

severity of the EU embargo, the impact of the G7 price cap, and on physical limitations Russia encounters in redirecting exports. Previous estimates of the impact of trade restrictions by the IEA (and other forecasters) have generally been larger than actual outcomes; Russia has been able to export more oil than expected. It is possible that Russia could again offset the EU's import ban on Russian oil products by overcoming transport bottlenecks and ship its oil product exports to other countries.

Finally, the possibility of policy interest rates remaining higher for longer amid persistently elevated inflation could lead to weaker-than-expected global growth, which would weigh on oil demand. One potentially offsetting factor could be the refilling of strategic oil inventories. However, the United States, which made the largest inventory drawdowns, has indicated that replenishing the Strategic Petroleum Reserve would take several years (IEA 2023c).

Natural gas

Recent developments

European and the U.S. natural gas spot prices plunged more than 50 percent between 2022Q4 and 2023Q1, extending their large losses in the final three months of 2022. Despite the sharp decline, the European benchmark price in March 2023 was 133 percent above its 2015-19 average due to severed pipeline supplies from Russia. The fall in U.S. prices reflected in part an expansion of shale gas production: the U.S. gas price was in March 2023 16 percent below its 2015-19 average. The Japan LNG import price (mainly set under long-term contracts linked to the price of oil) fell by just 9 percent in 2023Q1, and in March 2023 it remains at about twice its 2015-19 average. Spot LNG prices mirrored the spike and subsequent collapse in Europe LNG prices, and spot shipments represent an increasing share of Japanese LNG imports.

The unusually wide price gaps that have emerged since 2021 among the three benchmarks—Europe, the United States and Japan—have narrowed, partly due to a surge in LNG exports to European markets (figure 5.A). The European price benchmark, which rose to record-highs in August 2022 due to efforts to replace Russian imports, declined by 80 percent by March 2023. This reflect the effects of mild winter weather, reduced demand, ample inventories, and additional sources of supply. The diversion of LNG shipments from Asia to Europe helped facilitate the convergence between the European benchmark and the Japanese LNG prices by January 2023.

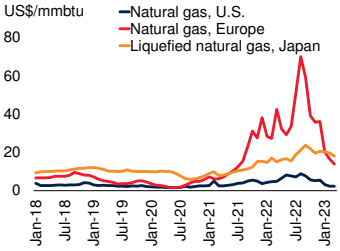
Global natural gas demand fell by about 2 percent in 2022—only the fifth time an annual decline has occurred since 1965. Reductions were concentrated in Europe, driven by high prices (especially in industry and power generation), mild winter weather (mainly affecting residential and commercial customers), and government policy inducements to conserve energy (such as the European Gas Demand Reduction Plan). European demand in 2022 was 8 percent lower than the 2015-19 average (figure 5.B). Demand from electrical power generation held up, as natural gas filled shortfalls from hydropower and nuclear generation in southern Europe, despite coal being a much more price-competitive input in the power generation sector for most of 2022. However, this has recently changed, due to the plunge in the price of European natural gas and high price of European carbon allowances (which discourage coal use). Gas demand in Asia was stable in 2022, with dampening effects from high prices, mild weather, and the lingering impact of COVID-19. Natural gas consumption in North America last year is estimated to have increased by 5 percent, led by the residential and commercial sectors in the United States, industrial consumers in Canada, and power generation in both countries.

Global supplies of natural gas were disrupted by the loss of Russian exports, but other suppliers helped fill the gap. Global production was stable last year (IEA 2023d). The Russian share of EU pipeline gas imports dropped to about 11 percent in 2022Q4 from 43 percent in 2021 (figure 5.C). Pipeline capacity limited the extent to which Russia could divert exports to China and Türkiye.

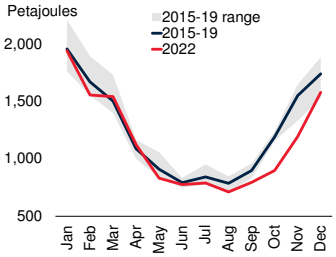
FIGURE 5 Natural gas markets

Natural gas prices fell in the first quarter of 2023. Lower pipeline flows from Russia to the EU were offset by higher LNG deliveries, especially from the United States. Storage operators were able to maintain inventories at a record level for this time of year due to a high level of supplies to Europe, combined with lower-than-expected consumption.

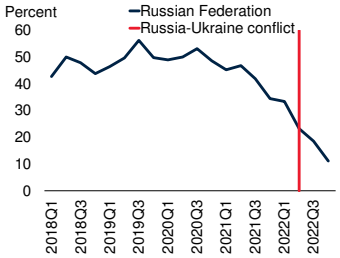
A. Natural gas prices



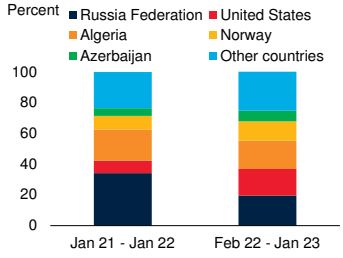
B. European natural gas consumption



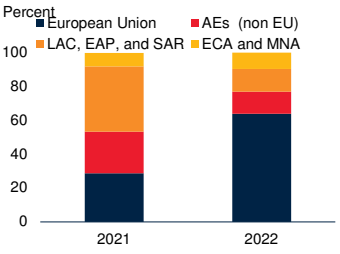
C. Russia's share of EU gas pipeline imports



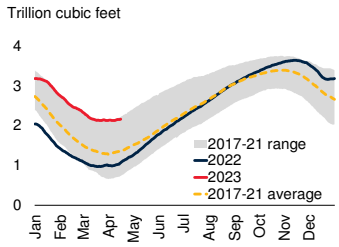
D. Shares of EU natural gas imports, by country



E. Destination of U.S. LNG exports



F. European natural gas inventories since 2017



Sources: Energy Information Administration; Eurostat; World Bank.
Note: AEs = advanced economies; EAP = East Asia and Pacific; ECA = Europe and Central Asia; LAC = Latin America and the Caribbean; MNA = Middle East and North Africa; SAR = South Asia. LNG = liquified natural gas.
A.C. Monthly data. Last observation is March 2023.
B.E. Monthly data. Last observation is December 2022.
D. Shares of EU natural gas imports. "Other countries" include gas exporters to Europe not identified in the chart, for example Qatar.
F. Includes 20 European Union countries and the United Kingdom. Last observation is April 15, 2023.

Stimulated by high prices and LNG export demand, natural gas production in the United States reached a record high in 2022.

Europe turned to alternative sources of gas. Increased pipeline imports from Norway and Azerbaijan, and by ship from the United States largely filled the gap caused by lower imports from Russia (figure 5.D). As price differentials between Europe and the United States increased, Europe bought two thirds of U.S. LNG exports, about twice the share in 2021 (figure 5.E). A key enabling factor for this shift in trade was reduced demand from China, the world largest LNG importer in 2021. U.S. LNG exports to China decreased by 75 percent in 2022, mostly due to reduced economic activity and ample domestic energy supplies in China, notably coal.

European natural gas inventories entered the 2022-23 winter heating season virtually full and have so far been ample, a strong turnaround from the first quarter of 2022 when the level of gas in storage was very low (figure 5.F). U.S. inventories at the end of March were also well above the five-year average because of higher production, lower-than-expected demand amid mild winter weather, and an outage at the Freeport, Texas, export terminal.

The extraordinary redirection of LNG trade over the past several months had unintended adverse consequences for EMDEs. Higher LNG prices reduced import demand for natural gas in the power sector in Asia, Africa, and South America. When countries such as Bangladesh and Pakistan could not secure alternative power sources in mid-2022, widespread electricity blackouts ensued. Intermittent power supplies resulted in higher production costs—because of the need to use back-up generators and from missed delivery deadlines—reducing the competitiveness of export industries.

Outlook

Natural gas prices are forecast to be significantly lower in 2023. Following a record-high annual increase of 150 percent in 2022, the European benchmark price is expected to fall by 53 percent from its 2022 average on lower demand, above average inventories, and improved access to supply. The U.S. benchmark price will decline by 58 percent in 2023, mainly because of increased domestic production. In 2024, prices in Europe are expected to fall 11 percent from 2023, assuming Europe embarks on investments in LNG

importing facilities. Nevertheless, price levels are expected to remain elevated over the forecast period because Europe still faces challenges in ensuring adequate supply next winter, including from Asian competition for LNG supplies. U.S. prices are expected to bounce back in 2024 as production growth slows and demand increases, including that for LNG exports. The Japan LNG benchmark price is expected to decrease by 2 percent in 2023 and fall by 11 percent in 2024, although spot-price imports will play an increasing role as long- term contracts expire.

The forecast assumes that global demand for natural gas in 2023 will increase marginally, with most of the additional consumption occurring in China. Consumption in Europe and North America is expected to decrease, largely driven by lower use in the power sector as renewable sources capture a larger share of the energy market. Europe will continue to rely heavily on LNG imports despite current high storage levels to meet winter demand, because even inventories at full capacity provide no more than one-third of gas consumed in a typical winter (European Commission 2023). Global production is expected to be stable in 2023, with a contraction in Russian output effectively offset by increases in the United States and China. Significant new LNG export capacity is expected to come onstream by 2026.

Risks

Risks to the outlook are broadly balanced. Higher natural gas prices could materialize if China's industrial recovery proves stronger than expected, or if Russian exports decline further. Gas prices could be lower if production and LNG exporting capacity in the United States continues to expand, and if the use of coal in the European power sector persists.

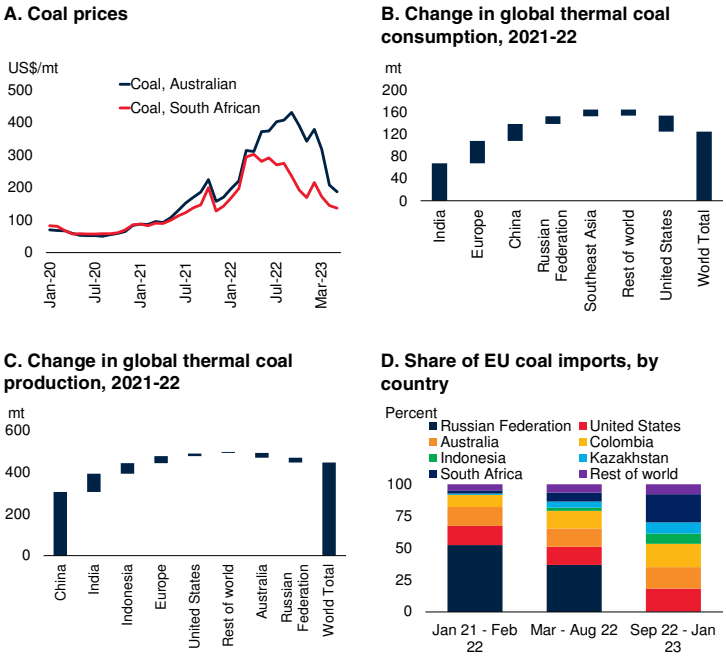
The economic recovery in China's industrial sector following reopening might be much stronger than the baseline assumes. The resulting higher demand for natural gas would trigger an increase in Chinese LNG imports, potentially leading to higher prices amid heightened global competition. This would be reinforced if Russia further reduced exports to Europe, which would require additional supply from other sources (LNG and piped gas). Meeting European demand—including gas required to fill storage facilities in the summer months—would be increasingly difficult under scenarios in which LNG or pipeline imports from Russia to the EU are blocked or significantly curtailed. A marked increase in gas prices would weigh on global industrial production and on household energy consumption, particularly in Europe.

On the other hand, gas prices could be lower than expected if supply surprises on the upside or in the event of greater-than-anticipated substitution with other energy sources, especially coal. A key downside risk to the price forecast relates to the level of U.S. production, which continues to rise despite falling prices. That is because the growth is mainly from gas produced during oil extraction (so-called associated gas), which is partly driven by high oil prices. With respect to drilling targeted for gas, current active rigs are almost equal to the maximum number of rigs since 2020. The ability of many countries to switch to coal as an input in electricity generation could act as a ceiling for gas price increases. The price forecasts for European natural gas and coal in 2024 imply similar generating costs in the power sector when using either fuel, assuming average efficiency of power plants and the current price of EU Emission Trading Scheme (ETS) allowances. There is a risk of generators switching back to coal if coal prices fall more than expected and the natural gas market tightens, or if the price of carbon allowances in Europe markedly declines.

The decrease in Russian gas production and changes in LNG trade patterns are likely to persist in the long term due to an increased focus on energy security, particularly in Europe (Tollefson 2022, World Economic Forum 2022). Europe is set to expand LNG import capacity by 40 billion cubic meters by the end of 2023. Meanwhile investment in renewable sources has accelerated, which could result in a considerable, permanent reduction in gas demand. As an example, power generation from wind and solar in China increased 21 percent in 2022, to reach 14 percent of total electricity consumption, reducing global demand for natural gas.

FIGURE 6 Coal markets

Coal prices fell in the first quarter of 2023 as additional production was about three times the level of additional consumption. The supply gap triggered by the European ban on coal imports from Russia was filled by Colombia, Indonesia, South Africa, and Kazakhstan.



Sources: Eurostat; International Energy Association; World Bank.
Note: mt = metric tons.
A. Monthly data. Last observation is March 2023.
B.C. Change in 2022 from the previous year.
D. Shares of EU coal imports by country. January 2021-February 2022 is the period before the Russian invasion of Ukraine; March-August 2022 is the period between the start of the invasion and the effective date of embargoes on Russian export; September 2022 onwards represents the period when sanctions were in place.

Coal

Recent developments

Coal prices fell in 2023Q1 (q/q), extending declines that began in the previous quarter. Australian coal prices fell by 36 percent (q/q) in the first quarter of 2023, following a 10 percent drop in 2022Q4 (figure 6.A). In March 2023, Australian coal prices are about half what they were at their peak after Russia's invasion of Ukraine—although they remain well above their 2015-19 average. Several constraints that led to sharply higher prices in 2022 have continued to unwind. The fall in natural gas prices and high prices for the EU ETS allowances has meant that coal has lost its cost advantage in European power plants. Demand is down because mild winter weather left inventories higher than expected. On the supply side, Australian production and exports have recovered from disruptions during the severe tropical cyclone season in late 2022. Russia's coal exports increased to China, India, South Korea, and Türkiye—offsetting reductions to the rest of Europe and Japan. Japanese utilities, seeking low-cost coal, are also switching to other sources as contracts with Russia expire. China has resumed imports from Australia, ending an informal ban imposed in late 2020. So far, imports have been modest.

Global coal consumption reached an all-time high in 2022. Coal demand rose 2 percent in 2022, with increases in all main consuming regions except the Unites States (figure 6.B). In Europe, coal consumption grew by an estimated 7 percent, as power generators sought alternatives to Russian natural gas. Coal also helped fill supply gaps arising from nuclear generation outages in France and hydropower reductions in southern Europe. Consumption in India in 2022 also rose by an estimated 7 percent to meet its increasing power needs, while in China, the moderate increase in consumption was mainly driven by the need to fill shortfalls from hydropower caused by record-breaking droughts. Finally, consumption in the United States shrank by 6 percent, as part of a long-term shift toward renewables in the power sector.

Production is estimated to have risen globally in 2022 in response to higher prices (IEA 2022b). China, which produces about half of the global coal supply, increased output in 2022 by an estimated 9 percent from 2021 (figure 6.C). Production in India increased by an estimated 10 percent in 2022, in line with domestic consumption. Indonesia increased production by an estimated 8 percent and the United States by 3 percent. In contrast, production in Australia fell due to mining disruptions by heavy rains induced by La Niña, the sea surface temperature phenomenon that affects global weather. Output declined in South Africa due to labor unrest and railway disruptions. Estimates for Russia also point to lower production due to infrastructural bottlenecks amid higher consumption.

Increasing export volumes and trade redirection have enabled the coal market to adjust to the disruptions caused by the Russian invasion of Ukraine. The EU has increased imports from Australia, Colombia, Indonesia, Kazakhstan and South Africa to make up for about 40 percent of its imports from Russia, which are now banned (figure 6.D). At the same time, Russian coal was redirected to China and India, at a discounted price.

Outlook

Coal prices are forecast to fall 42 percent in 2023 and 23 percent in 2024, but remain well above the 2015-19 average. The forecast assumes that high carbon prices in Europe, combined with lower LNG prices and European natural gas prices, will reduce demand for coal. Strong demand from China's industrial sector is expected to increase exports from Indonesia, Mongolia, and Russia. Australia is also likely to benefit, following the lifting of the unofficial import ban in January 2023 by the Chinese government. With La Niña ended, Australian exports are set to increase measurably this year. Production is expected to rise in all major exporting regions. The forecast assumes that Indonesia, the largest coal exporter, will increase exports by 5 percent, in response to prices that are still much higher than historical averages (IEA 2022b). It also assumes that coal exports from the United States will increase by about 4 percent, driven by elevated prices. Indian coal production should also increase as extraction at existing facilities intensifies.

Risks

In the short term, upside risks include the possibility that the recovery in China will be stronger than expected, which would raise demand for coal in the industrial and power sectors, increasing import demand and prices. Production shortfalls, or reduced Russian exports, would raise prices. In Europe, higher natural gas prices next winter could encourage switching from gas to coal. Downside risks include a deeper-than-expected slowdown in global activity, which would reduce energy demand more broadly. Favorable weather conditions, or reduced demand from China, would also dampen prices.

Russia's invasion of Ukraine has strengthened the incentives to transition away from fossil fuels, both through increased renewable energy production and reduced energy consumption—particularly in the United States and Europe. This contributes to the expectation that coal consumption by the United States and Europe will continue to fall. The IEA expects a sharp decline in coal consumption by 2025, particularly in China: global consumption is expected to peak in 2023, and plateau thereafter (IEA 2022b). Most of the additional energy demand in China is being filled by renewable sources, while generation from renewables in the United States has already surpassed generation from coal (EIA 2023b).

Fertilizers

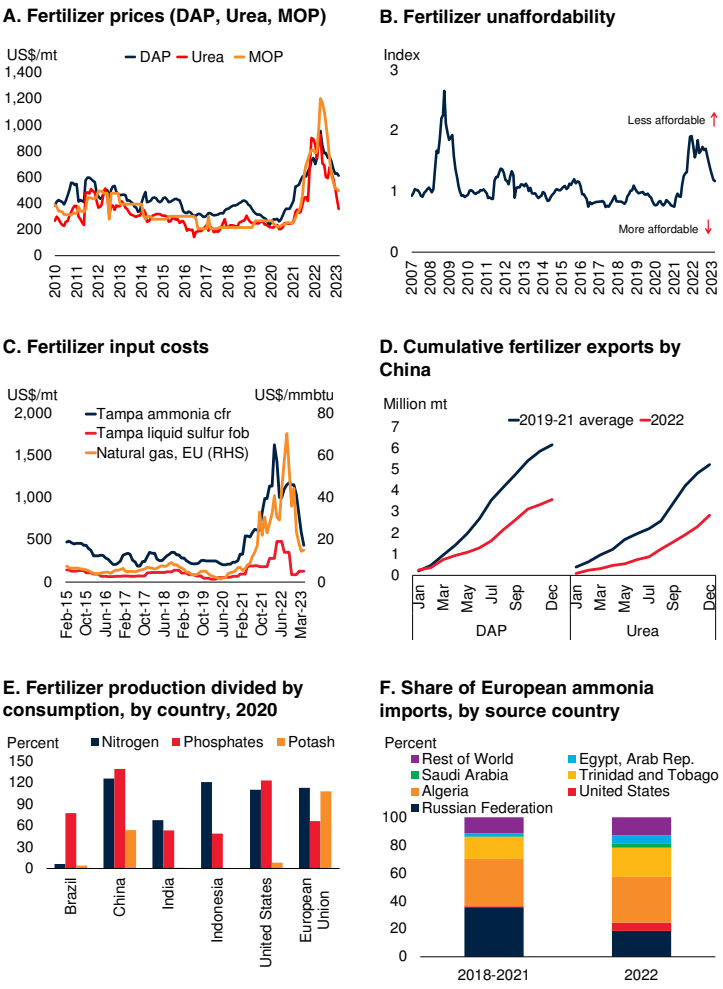
The World Bank's fertilizer price index fell by 18 percent in 2022 but remains well above the 2015-19 average, in part due to reduced supplies following Russia's invasion of Ukraine and ensuing trade restrictions. The recent decrease in prices has been much more pronounced for synthetic fertilizers produced from natural gas, such as urea, than for fertilizers obtained from mined minerals, such as DAP and MOP. Declining prices have made fertilizers more affordable, but farmers continue to reduce application rates. Following an expected 37 percent decrease in 2023, the fertilizer price index is projected to fall by 7 percent in 2024 as supply disruptions gradually ease and energy input prices fall, but the index will remain at high levels. Upside risks to the price forecast include higher input costs, especially for natural gas.

Nitrogen

Nitrogen (urea) prices fell 36 percent in 2023Q1 (q/q), after falling 7 percent in 2022Q4 (figures 7.A and 7.B). The fall was driven by reductions in input costs, notably for coal and natural gas which have seen even sharper price drops over the same period (figure 7.C). Global demand for nitrogen-based fertilizers is estimated to have contracted by 4 percent in 2022, in part due to lower exports by

FIGURE 7 Fertilizer market developments

Fertilizer prices fell in 2023Q1, reflecting declining input costs. Nevertheless, fertilizer prices and affordability levels are still well above pre-pandemic levels. China's fertilizer exports have declined because of trade restrictions while Russia's ammonia exports to Europe have been replaced by Algeria, Egypt, and Trinidad and Tobago.



Sources: Bloomberg; General Administration of Customs (China); UN Comtrade; World Bank.
Note: DAP = diammonium phosphate; MOP = muriate of potassium; mt = metric tons; mmbtu = million British thermal units.
A.C. Monthly series. Last observation is March 2023.
B. Ratio of Fertilizer prices over Food price index. Last observation is March 2023.
D. Monthly series. Last observation is December 2022.
E. European Union share includes United Kingdom.
F. Bars represent each individual country's percentage share in Europe's ammonia imports. Last observation is December 2022.

Russia and China (figure 7.D). China's urea exports were down 47 percent in 2022; similarly, urea imports by India and Brazil, which produce only a limited share of their domestic urea consumption, declined in 2022 before beginning to recover in early 2023 (figure 7.E). Declines in fertilizer production in Europe were in part due to the high cost of natural gas (a main input), implying that the impact of restrictions in Russia and China on the EU and United Kingdom did not bind. Global urea production increased by an estimated 2 percent as a result of new capacity, and increased production in low-cost export-oriented producers such as Nigeria and Brunei.

Urea prices are expected to halve in 2023 and remain stable in 2024, as new capacity in the rest of the world offsets lower exports from China and Russia. The decline in urea prices is expected to encourage farmers to switch to urea from other nitrate fertilizers (Technical Note 2). One key risk is that prices could be higher than projected if additional expected production does not materialize, or if trade disruptions continue to prevail. Longer-term headwinds for urea are related to its high carbon content. As the energy transition intensifies, one long-term growth opportunity is to use clean nitrogen in energy-efficient projects (for example, as fuel for ships, as a hydrogen carrier, and in power generation).

DAP

DAP (diammonium phosphate) prices fell 8 percent in 2023Q1 (q/q), although they remain about 76 percent higher than the 2015-19 average (figure 7.A). The DAP price trajectory has followed the price of phosphate and natural gas, as the latter is used in the production of ammonia required to produce DAP (figure 7.C). Following the 260 percent price increase between January 2020 and April 2022, application rates on crops fell in the 2022/23 crop year in several large agricultural commodity-producing countries. As with urea, export restrictions impacted global trade flows, especially ammonia from Russia (starting in April 2022) and phosphate from China in 2022 (figure 7.D). However, exports in the first two months of 2023 seem to have increased from earlier months. Europe has partially offset the lower imports from Russia with higher imports of ammonia from Trinidad and Tobago and Egypt, and phosphate from Saudi Arabia, the United States and Morocco (figure 7.F). DAP prices are projected to fall in 2023 as supply constraints loosen and remain stable in 2024. China's trade ban is expected to be lifted in

April 2023 as scheduled, but exports may remain constrained by high domestic demand. The forecast assumes that Russia will continue to redirect most exports towards Brazil and India. Still, ammonia prices will continue to be affected by gas market dynamics and trade restrictions. Long-term demand for phosphate by producers of EVs should increase as carmakers follow China in the adoption of lithium-iron phosphate batteries to cut costs.

MOP

MOP (muriate of potash, or potassium chloride) prices continued to fall, by 14 percent in 2023 Q1, although they remain about 95 percent above their 2015-19 average (figure 7.A). Demand has been weak because of high prices following the sanctions imposed in 2022 on exports from Russia and Belarus, which together produce about 40 percent of global MOP output. Brazil's imports were also down more than 50 percent in 2022Q4 partly because of high prices (figure 7.E). As with other fertilizers, the MOP market continues to be affected by a redirection of Russian and Belarussian exports to Brazil, China, and India, while Canadian exports are being diverted to Europe. Prices are projected to fall by 45 percent in 2023, and a further 10 percent in 2024. Global demand is expected to recover in 2023 from reduced fertilizer application in 2022. Global supply is projected to edge higher, although significant new capacity is not expected until 2026 with Canada's large Jansen project. A downside risk to prices (assuming continuation of sanctions) stems from the possibility that Belarus finds an alternate seaborne export route, including through Russian territory) .

Agriculture

The broader food price index did not change between 2022Q4 and 2023Q1 as increased prices of other foods were offset by declines in prices of grains. Beverage prices have remained broadly stable during the past few quarters, with price declines in tea and coffee and price increases in cocoa. The agricultural raw materials index rose in 2023Q1, led by gains in timber prices. Agricultural prices are projected to decline by 7 percent in 2023, and ease further in 2024 as supplies increase, and pressures from input costs ease. The food price index is expected to decline by 8 percent in 2023 and 3 percent in 2024, although prices for most food commodities are expected to remain above pre-pandemic levels. Risks to the outlook are tilted to the upside and include higher input prices, severe weather events, and an unraveling of the Black Sea Grains Initiative. Food insecurity remains a critical challenge in many developing economies, reflecting elevated food prices, adverse weather events, and fragility and conflicts.

Grains, oils, and meals

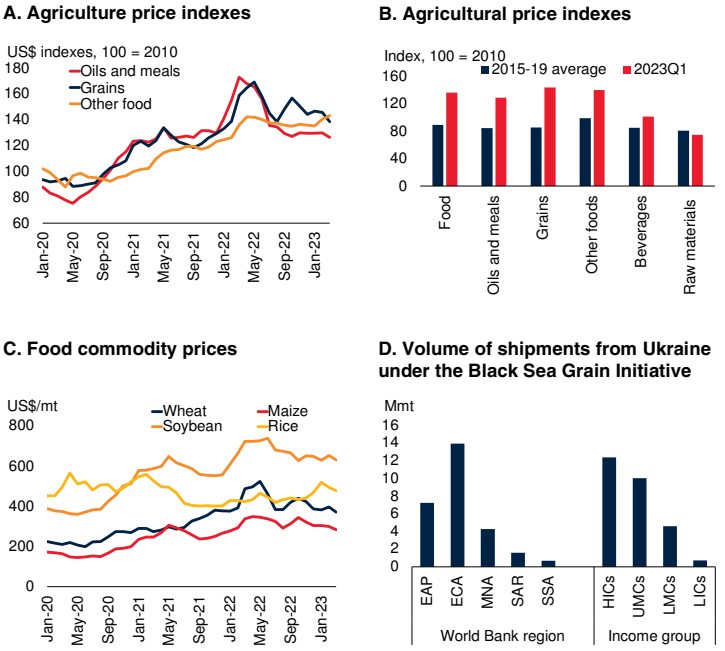
Recent developments

The World Bank's *grains price index* eased almost 5 percent in the first quarter of this year, but remains two-thirds above its pre-pandemic (2015-19) average (figures 8.A and 8.B). Wheat and maize prices declined 8 percent in the first quarter (figure 8.C). However, in 2023Q1, wheat prices were 100 percent above their 2015-19 average and maize prices were 80 percent higher. The Black Sea Grain Initiative, which helped most of Ukraine's grains and oilseeds reach the world market, and good harvests in other major producing countries helped ease price pressures (figure 8.D). Several factors contributed to the 11 percent rice price gain in the first quarter: strong demand related to major festivals and restocking in Asia; currency appreciations against the U.S. dollar in India, Thailand, and Vietnam; and tight supply conditions in the 2022-23 season in most of Asia's rice producers—including China, India, Myanmar, Thailand, and Vietnam. Also, Pakistan suffered catastrophic floods in September 2022 which have since devastated harvests and exports of rice.

The *oils and meals price index* was stable between 2022Q4 and 2023Q1, as the surge in the first half of 2022 had largely been unwound by 2022Q3, but the index remains 52 percent above its 2015-19 average. Prices were down for the three oils most affected by Russia's invasion of Ukraine. Between 2022Q4 and 2023Q1, the price of soybean oil was off 20 precent, rapeseed oil was down 14 percent, and sunflower oil declined 12 percent. In contrast, prices of groundnuts, fishmeal, soybean meal, and palm oil increased.

FIGURE 8 Agricultural commodity market developments

Agricultural prices in 2023Q1 have dropped to levels comparable to those before April 2022, but they still remain historically high. Despite the recent decline, grain prices are more than two-thirds higher than their pre-pandemic average. Prices of oils and meals remain high in real terms, around the same level reached during the 2012 food price crisis.



Source: World Bank.

A.C. Monthly data. Last observation is March 2023.

C. Wheat refers to the U.S. hard red winter (HRW) benchmark. Rice refers to Thai 5 percent benchmark. mt = metric tons.

D. EAP = East Asia and Pacific; ECA = Europe and Central Asia; MNA = Middle East and North Africa; SAR = South Asia; SSA = Sub-Saharan Africa. HICs = high-income countries; UMCs = upper-middle income countries; LMCs = low-middle income countries; LICs = low-income countries. Mmt = million metric tons. Black See Grain Initiative Outbound Shipments from inception in July 22, 2022 to April 12, 2023.

The increase in edible oil supplies in 2022, the Black Sea Grain Initiative, the expiration of several export bans, and improving global supply chain conditions contributed to the price decline (figure 9.A; USDA 2023a).

Outlook

The *grains price index* is expected to fall by 10 percent in 2023 and a further 8 percent in 2024, following a 21 percent increase in 2022. The *oils and meals price index* is expected to decline by 14 percent in 2023 and 2 percent in 2024. The forecast assumes that there are no further disruptions from the war in Ukraine, while good harvests in major grain producing countries—such as Australia, Canada, Russia, and the United States—contribute to lower prices. In 2023, wheat prices are expected to be 17 percent lower and maize prices 15 percent lower than in 2022, amid weak global demand (aside from China, which may see a pickup in demand for maize in animal feed). At the same time, falling crude oil prices should reduce demand for maize in ethanol production. Rice prices on average are expected to be 17 percent higher in 2023, with much of the increase already having taken place. Rice prices are expected to decline in 2024, as Pakistan's exports recover and high rice prices in 2023 encourage rice production elsewhere.

Global grain supplies over the forecast period are expected to rebound from the supply contraction in 2022 (figure 9.B). Brazil is set for a record-breaking grain harvest in 2023 as a result of favorable weather. Similarly, better-than-expected grain harvests in Australia, Canada, Kazakhstan, and Russia in the 2022 production season are likely to lead to higher stock-to-use ratios for 2023 (figure 9.C). In addition, planting intentions surveys from the United States indicate sizable increases in maize and wheat acreage, which may put additional downward pressure on 2023 prices (figure 9.D; USDA 2023b). Global production of oil seeds, oil meals, and vegetable oils is expected to be higher in 2022-23 than in the previous season because of favorable planting conditions in countries that are major producers or crushers of oil seeds.

Other foods

The World Bank's *other food price index*—which includes sugar, meat, and fruits—increased in the first quarter of 2023, driven by price gains in sugar and oranges. Sugar prices gained 4 percent in the United States, 5 percent in the EU, and 8 percent in the world (international sugar agreement) between 2022Q4 and 2023Q1 as the global economy recovered from the pandemic. Orange prices rose by 13 percent because of production declines in Spain and Italy—countries that account for three-quarters of EU orange production—due to hot and dry summer conditions. Prices of beef and poultry remained stable in 2023Q1.

Prices of other foods are expected to increase by 3 percent in 2023 and 1 percent in 2024. The reopening of China's economy is expected to raise demand for meat and sugar from the country's catering sector amid a strong revival of tourism. World sugar prices are expected to increase by 10 percent in 2023 and 2 percent in 2024 for similar reasons. Both meat and sugar prices are expected to level off in 2024 as China's post-pandemic rebound fades. Despite production increases in Brazil and Thailand, growing consumption—combined with adverse weather and poor harvests in the EU, India, China, and Pakistan so far this year—will likely tighten the supply of sugar further. Expected record production of grains in Brazil, which use transport routes similar to those for sugar, will also complicate the logistics of transporting sugar destined for exports. Beef prices are forecast to be lower in 2023 in the United States (the reference market for beef) based on increased slaughter projections.

Risks to the food price forecasts

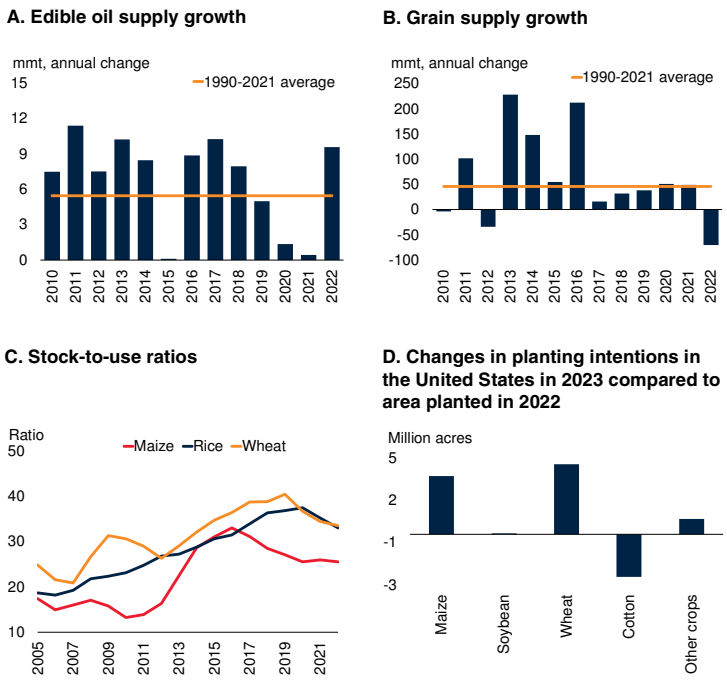
Risks to the food price forecast are tilted to the upside but have receded somewhat since the October 2022 assessment. In the short term, the removal of trade restrictions and slower global growth could push food prices lower, while geopolitical risks and possible severe weather events in 2023 could push up food prices. In the longer term, intensification of climate change, biofuels mandates, and greater market concentration are likely to play an important role.

Trade restrictions and related policies. The list of active trade restrictions—such as export bans, export requirements, and export licensing requirements—continued to expand in 2022, as policy makers used these to respond to inflationary pressures. Most of the active restrictions on cross-border trade, however, are expiring soon. If they are not renewed, this will exert downward pressure on prices as better price signals allow global markets to adjust.

Lower global growth. Continued weakness in global growth could lead to lackluster demand and lower prices of agricultural commodities.

FIGURE 9 Global supply conditions for grains and edible oils

During the 2022-23 crop season, supply conditions for grains were tight. But they were improving for edible oils. Stock-to-use ratios for grains have fallen but remain adequate (a rough indicator of supply relative to projected demand). Planting intentions surveys in the United States for 2023 indicate that planted acreage for maize and wheat will increase by 4 percent and 9 percent, respectively, compared to 2022, while soybean acreage will increase slightly, and cotton acreage will decline by 18 percent.



Sources: U.S. Department of Agriculture; World Bank.
A.-C. Years represent crop season (for example, 2019 refers to 2019-20). Data as of April 2023.

Geopolitics. The war in Ukraine remains a major risk that could unsettle wheat, maize, oilseeds, and fertilizer markets—possibly raising prices. The Black Sea Grain Initiative was renewed in mid-March on the day it was due to expire. The terms of a renewal are still uncertain as Ukraine stated that the initiative should be renewed for 120 days, while Russia indicated that it has agreed to a 60-day arrangement. These developments suggest that, before the end of the year, the global grains market could see new bouts of price volatility amid heightened uncertainty about the longer-term outlook. The stakes for the success of the Black Sea Grain Initiative are now higher since agricultural products leaving Ukraine via road, rails, and river, face new challenges. In mid-April,

Ukraine's EU-member neighbors—through which Ukraine's products were transiting to third countries under an EU agreement—blocked import and transit of the country's agricultural products. Ukraine's neighbors took this action because much of the produce destined for overseas markets stayed in their countries due to shortages of trains and trucks, which dampened local prices.

Weather. As of April 2023, there is a 62 percent chance that the weather-affecting El Niño-Southern Oscillation (ENSO) phenomenon will develop during May-July, and a more than 80 percent chance during September-November (NOAA 2023). This raises the odds that record-warm temperatures and altered precipitation patterns could affect crop yields across the globe, particularly in the Southern Hemisphere. Commodities sensitive to El Niño effects include coffee, rice, palm oil, and natural rubber (World Bank 2015).

Some long-term risk factors will continue to affect food production and food prices:

Climate change. Climate change is raising the probability of food shortages and hunger through desertification, land degradation, crop failures, and damage to food supply infrastructure. Under the medium socio-economic pathways (SSP2) assumption of the Intergovernmental Panel on Climate Change (IPCC), model-based forecasts show a median increase of 7.6 percent (in the range of 1-to-23 percent) of cereal prices by 2050 due to climate change (IPCC 2019).[3] With rising global temperatures, the frequency of droughts will increase. The effects on output will be particularly severe in regions that are highly fertile yet already arid—which include the Mediterranean countries, southern Africa, the western United States, and grasslands (prairies, savannas, and pampas) in many parts of the world. The frequency and intensity of extreme rainfall events will increase in many regions (IPCC 2019). The corresponding shocks to agricultural production will pose upside price risks, and at the worst, cause widespread famine.

Biofuels. Growing biofuels production in the United States, and favorable biofuel policies in Brazil, Indonesia, and Malaysia support sustained demand for ethanol and biodiesel, which will put upward pressure on prices of maize, soybeans, and oilseeds (figure 10.A). The push for a transition to electric vehicles, particularly in the United States, will gradually depress demand for fossil fuels and ethanol, although it is unlikely to have a similar impact on biodiesel because electric vehicle technology is less prevalent in heavy trucks and machinery that use diesel and substitutes. This may induce acreage shifts to soybeans and away from maize, as biodiesel production will provide sustained demand for soybeans.

Changing market structure. Market concentration is a potential source of price uncertainty. The rice market is a case in point. Rice is an internationally thinly traded commodity, where the share of export in production is only around 10 percent (figure 10.B). In the last three years, rice markets shifted from being competitive to moderately concentrated as measured by the Herfindahl-Hirschman Index, a commonly accepted gauge of market concentration. Thailand, once the leading exporter, has been replaced by India. India's market share of rice exports increased from 25 percent in 2017 to 40 percent in 2022—as India's export volumes rose, and Thailand's export volumes fell. With frequent trade restrictions imposed in India—the latest a 20 percent export duty on certain rice varieties and a complete ban on broken rice—such a change in market concentration can exert upward pressure on prices, especially when accompanied by distortionary practices such as trade restrictions (figures 10.C and 10.D; Laborde and Mamun 2022).

Implications for food insecurity and food price inflation

More than 349 million people worldwide are projected to be food insecure in 2023 (more than double the number in 2020), due to conflicts, economic shocks, climate extremes, and soaring fertilizer prices (WFP 2023). More than 100

[3] IPCC's medium socio-economic pathways (SSP2) assumes medium population growth with medium income and technological progress, where production and consumption patterns are a continuation of past trends with only a gradual reduction in inequality. The analysis assumes a greenhouse gas concentration trajectory (representative concentration pathway) that sees emissions peak around 2080, and then decline.

million people in sub-Saharan Africa face acute food insecurity, with 72 percent of them residing in east and southern Africa. The unprecedented three years of drought in the Horn of Africa, with five consecutive seasons of below-average rains, have created a humanitarian emergency. Twenty million people in Somalia and South Sudan face famine, while 22 million people in Ethiopia and 10 million people in the Democratic Republic of Congo face acute food insecurity. The risk of acute food insecurity is high in countries facing fragility, conflict, and violence and is increasingly likely to affect low-income countries experiencing natural disasters (figures 11.A and 11.B).

The global year-on-year domestic food price inflation rate in the first quarter of 2023 averaged about 19.5 percent, with large variation across countries (figure 12.A).[4] Nine out of 10 low- and middle-income countries are experiencing food price inflation above 5 percent (figure 12.B). Food price inflation has been highest on average in the Middle East and North Africa region, but individual countries elsewhere have experienced extreme inflation. For example, in early 2023, food price inflation exceeded 100 percent in Argentina, Lebanon, and Zimbabwe, and was higher than 30 percent in many countries. Trade-limiting government restrictions have exacerbated the global problem. There is a risk that persistent headline inflation might spill over into the costs of labor and other inputs to farming, thereby generating unexpected cost-push pressures on food prices.

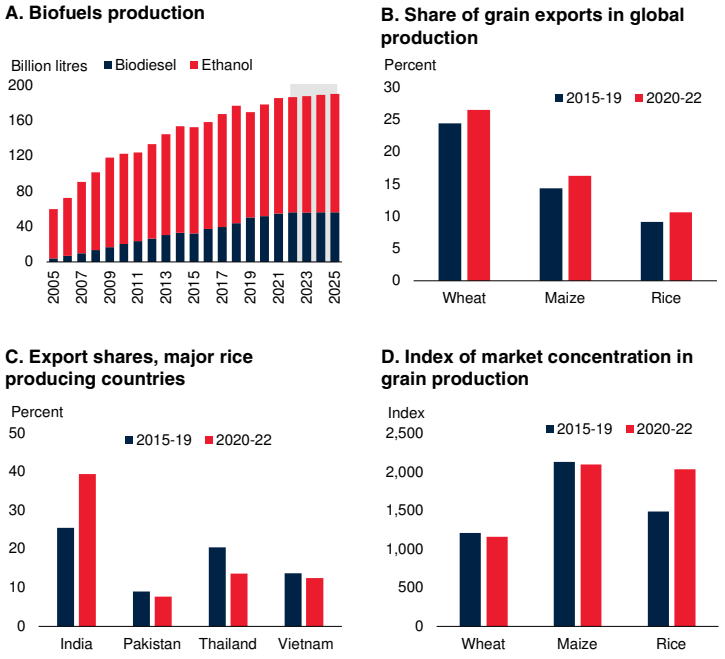
Beverages

The World Bank's *beverage price index* was broadly stable between 2022Q4 and 2023Q1, despite an 11 percent increase in cocoa prices—which was offset by a similarly large decline in tea prices (figure 13.A). With the beverage index in the first quarter of 2023 down more than 7 percent from a year ago, the index is expected to be 5 percent lower in 2023 than in 2022. In 2024, it is expected to drop a further 3 percent as new supplies, particularly in the coffee market, come online.

[4] Global inflation is calculated as the annual (year-over-year), unweighted average of 152 countries (including 51 high-income countries, 44 upper-middle-income countries, 40 lower-middle-income countries, and 17 low-income countries) as of 2023Q1. The figure for February 2023 alone is 20 percent.

FIGURE 10 Long-term risks to food outlook

Growing biofuels production in the United States, and biofuel policies in Brazil, Indonesia, and Malaysia, support sustained demand for ethanol and biodiesel. Over the last five years, India's share of global rice exports has surged from 25 to 40 percent. India has now surpassed Thailand to become the world's largest exporter of rice. The growing concentration of rice markets could result in a greater impact on prices from India's recent restrictions on exports.



Sources: Organisation of Economic Co-operation and Development; U.S. Department of Agriculture; World Bank; OECD-FAO Agricultural Outlook 2022-2031, OECD Agriculture statistics (database), http://dx.doi.org/10.1787/agr-outl-data-en.

D. Herfindahl-Hirschman index (HHI) of market concentration. An HHI reading below 1,500 is considered competitive; an HHI of 1,500 to 2,500 is moderately concentrated; and an HHI of 2,500 or greater is highly concentrated.

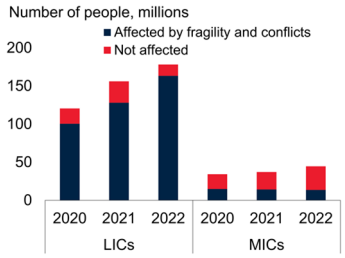
Coffee

Arabica coffee prices have not experienced significant changes between 2022Q4 and 2023Q1, but they are 49 percent above their pre-pandemic average (2015-19). Meanwhile, Robusta coffee prices have increased by 6 percent in the first quarter of 2023 (q/q) but remain more than 5 percent lower than they were a year ago. Global coffee production is expected to rise by more than 5 percent in the current season (July-to-June), with most of the growth coming from Brazil, which is projected to account for over one-third of

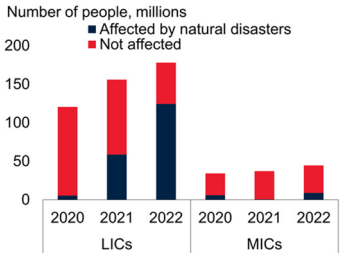
FIGURE 11 Food insecurity

Food insecurity has worsened in 2022, and acute food insecurity reached its highest level of the last seven years. This reflects the effects of elevated food price inflation, adverse weather events, and fragility and conflict situations.

A. Number of people with food insecurity by fragility and conflict situations



B. Number of people with food insecurity by occurrence of natural disasters

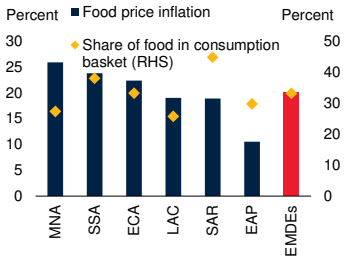


Sources: EM-DAT (database); Food and Agriculture Organization of the United Nations; World Bank; World Food Program.
Note: LICs = low-income countries; MICs = middle-income countries.
A.B. International Food Security Phase Classifications (IPC) include (1) minimal/none, (2) stressed, (3) crisis, (4) emergency, and (5) catastrophe/famine. Bars represent the number of people worldwide that face crisis or more severe (IPC3+) food insecurity.
B. Natural disasters are floods, droughts, or wildfires that affected at least 4 million people, as recorded in the EM-DAT database.

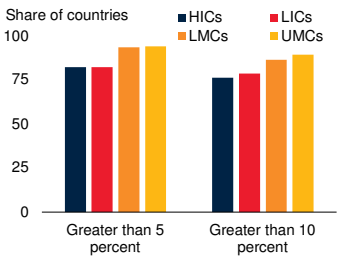
FIGURE 12 Domestic food price inflation

High food and energy prices continue to pass through to domestic food inflation, a major concern because households in developing countries on average spend about a third of their consumption basket on food. Ninety percent of low- and middle-income countries face food price inflation above 5 percent.

A. Domestic food price inflation in 2023Q1



B. Share of countries with high domestic food price inflation in 2023Q1



Sources: Food and Agriculture Organization of the United Nations; World Bank; World Food Program.
A. Year-on-year change of food price inflation, average of January-March 2023.
EAP = East Asia and Pacific; ECA = Europe and Central Asia; LAC = Latin America and the Caribbean; MNA = Middle East and North Africa; SAR = South Asia; SSA = Sub-Saharan Africa.
B. HICs = high-income countries; UMCs = upper-middle-income countries; LMCs = lower-middle-income countries; LICs = low-income countries. Share of countries where food price inflation in 2023Q1 is higher than 5 percent and 10 percent, year-on-year.

global output (figure 13.B). The increase in Brazil's production is in part a rebound from a sharp decline last year that was caused by adverse weather conditions. In 2023, Arabica coffee prices are expected to fall by 15 percent due to the increased output, while Robusta coffee prices are expected to remain broadly stable due to a tighter market. Prices for both Arabica and Robusta are forecast to decline marginally in 2024.

Cocoa

Cocoa prices increased 11 percent between 2022Q4 and 2023Q1, and they are more than 5 percent higher than the 2015-19 average (figure 13.C). The global production of cocoa is projected to grow by 3 percent during the current 2022-23 season (figure 13.D). There has been an even faster increase in consumption, supporting cocoa prices as well as leading to a depletion of inventory levels from 1.97 million metric tons (mmt) in 2020-21 to 1.78 mmt in 2022-23. Cocoa prices are expected to average 13 percent higher in 2023 before easing in 2024 when more cocoa supplies are projected to come online.

Tea

Tea prices declined by almost 11 percent between 2022Q4 and 2023Q1. The Kolkata auction was particularly affected, with a 30 percent drop, while the decrease was a more moderate 4 percent in Mombasa (figure 13.E). The primary reason for the recent price weakness has been slowing demand in key tea consumption regions, especially in Central Asia related to the war in Ukraine. As demand weakness is expected to continue throughout the rest of the year, the three-auction average will be around 11 percent lower in 2023 compared to 2022. However, an anticipated reduction in production is expected to stabilize prices in 2024 (figure 13.F).

Agricultural raw materials

The World Bank's *raw material price index* gained a little more than 2 percent between 2022Q4 and 2023Q1, but it is 13 percent lower than a year ago. Cotton and natural rubber prices, key

components of the index, are 28 and 22 percent lower than in 2022Q1, respectively (figure 14.A). Robust supplies from key producers have kept prices in check during the last two quarters. The index is expected to be almost 6 percent lower in 2023 and gain marginally in 2024.

Cotton

Cotton prices declined slightly in 2023Q1 from the previous quarter, but they are down by 28 percent compared to the same period last year. This drop is mainly due to a decrease in global consumption, which is expected to be more than 5 percent lower this season (ending in July 2023), in response to global growth concerns. Although cotton production in Australia, Côte d'Ivoire, Mali , and Pakistan is expected to decline, this will be offset by increases in China and India, resulting in little overall change in global cotton production (figure 14.B). Cotton prices are projected to decline by more than 23 percent in 2023 but are expected to increase slightly in 2024 due to reduced plantings in key producing countries like the United States.

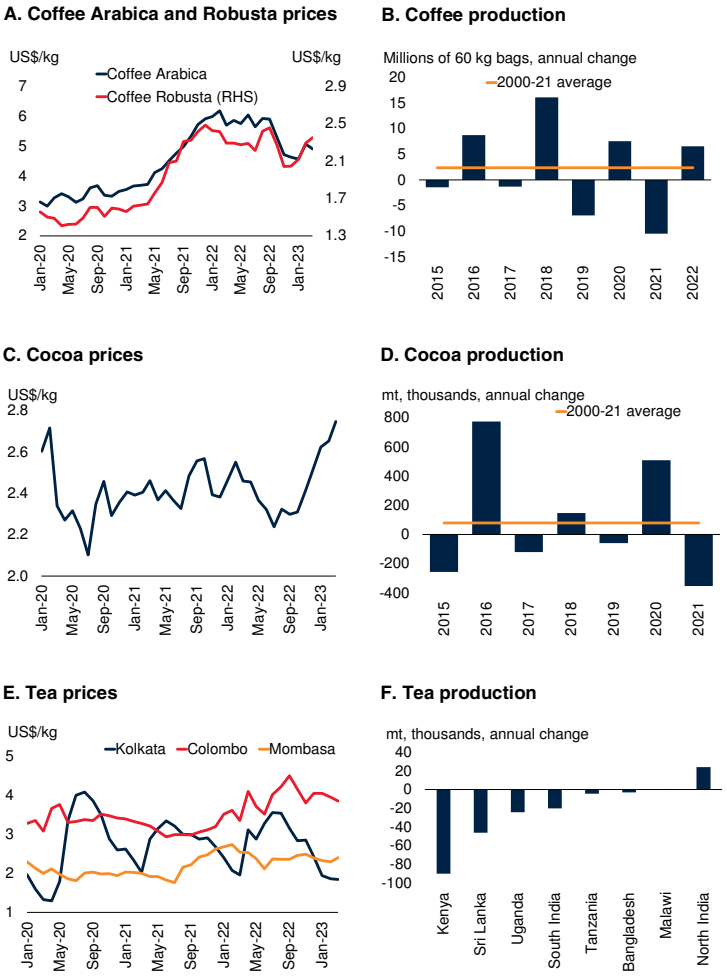
Natural rubber

Natural rubber prices gained 7 percent between 2022Q4 and 2023Q1, but they are 22 percent lower than a year ago. The price weakness reflects weak growth in auto production, as nearly two-thirds of natural rubber is used for tire manufacturing. Global natural rubber demand totaled 13.7 mmt in 2022 (slightly down from a year earlier, figure 14.C). Meanwhile, global production reached a record high of 14.3 mmt due to good crops in Thailand and Vietnam, the world's largest suppliers (figure 14.D). Natural rubber prices are projected to average 9 percent lower in 2023 compared to last year. Prices are expected to gain more than 7 percent in 2024 as demand for natural rubber strengthens, especially from China.

A key long-term risk to agricultural markets is a new environmental law by the EU to moderate global deforestation, which will have beneficial long-run implications for climate change, and for sustainable farming (European Commission 2022). However, the law also raises uncertainty for many food commodities grown in forested areas—for example, cattle, cocoa, coffee, palm oil, and soybeans. Similar uncertainty applies to agricultural raw materials such as wood and leather.

FIGURE 13 Beverage commodity market developments

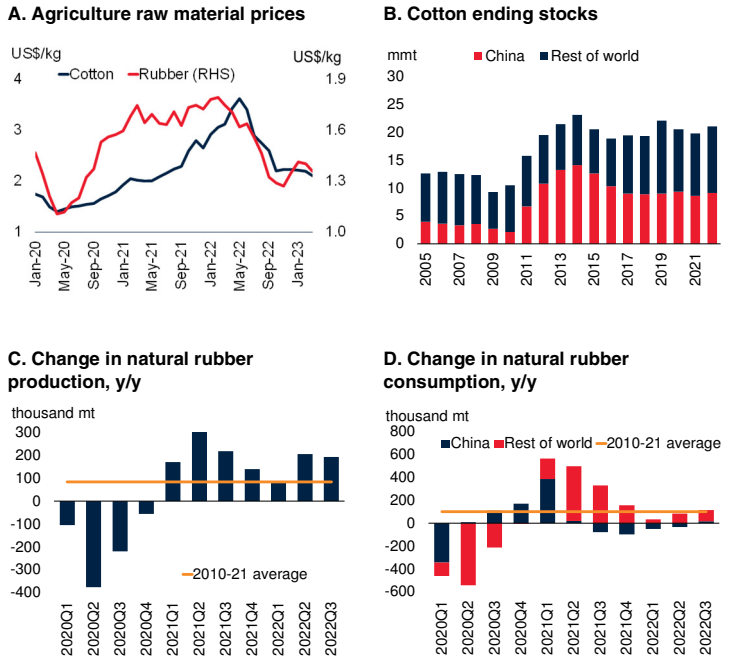
Arabica coffee prices declined less than 1 percent, while Robusta coffee gained 6 percent in 2023Q1, reflecting slower exports from South America, weather concerns, and low inventory levels. Cocoa prices increased nearly 11 percent in 2023Q1 because of reduced inventories linked to unfavorable weather in west Africa. Tea prices declined more than 10 percent in 2023Q1, led by large declines in the Kolkata auction, with moderate declines in Mombasa and Colombo auctions.



Sources: Africa Tea Brokers Limited; Bloomberg; International Cocoa Organization (ICCO); International Tea Committee; Tea Board India; Tea Exporters Association Sri Lanka; U.S. Department of Agriculture; World Bank.
Note: mt = metric tons.
A.C.E. Monthly data. Last observation is March 2023.
B.D. Years represent crop season (for example, 2021 refers to 2021-22). Data updated as of February 12, 2023.
D. Data for 2021-22 is ICCO forecast.
F. 12-month change in tea production between March 2022 and February 2023.

FIGURE 14 Agricultural raw materials market developments

Cotton prices declined marginally in 2023Q1, reflecting improved stocks and weaker demand that is considerably below its five-year average. Natural rubber prices gained 8 percent in 2023Q1. The reopening of China (a major natural rubber consumer that accounts for one-third of global tire manufacturing) has affected increases in demand and prices.



Sources: Bloomberg; International Cotton Advisory Committee; International Rubber Study Group; World Bank.
Note: mmt = million metric tons; mt = metric tons.
A. Monthly data. Last observation is March 2023.
B. Ending stocks, based on International Cotton Advisory Committee projection for 2022-23. Years represent crop season (for example, 2020 refers to 2020-21 crop season).
C.D. Changes from the same quarter of the previous year. Last observation is 2023Q2.

Metals and Minerals

The World Bank's metals and minerals price index rose 10 percent in the first quarter of 2023, reflecting optimism for a strong recovery in China and improved global growth prospects at the start of the year. All metal prices were higher for the quarter, particularly iron ore and tin. However, this optimism waned, and most prices receded from their January highs by the end of the quarter. Only iron ore prices remained firm, due to strong demand from China's steel sector. Metal prices are projected to fall by 8 percent in 2023, and a further 3 percent in 2024. Key upside risks to the price forecast include a stronger-than-expected recovery in China's real estate sector and supply disruptions, including those resulting from trade restrictions. In the longer term, the energy transition could significantly lift the demand for and prices of some metals—notably aluminum, copper, and nickel.

Base metals and iron ore

The World Bank's *metals and minerals price index* increased 10 percent in the first quarter of 2023 from the previous quarter (figure 15.A). The price index in 2023Q1 was 51 percent above its 2015-19 average, with all base metals posting higher prices. The reopening of China's economy and supply concerns have been the main factors supporting price increases, especially for copper and tin (figure 15.B). China's reopening following its "Zero COVID-19" policy initially raised optimism regarding the demand for industrial commodities. However, China's property sector, which accounts for an outsized share of global demand for metals, continues to face financial challenges despite policy support. The property sector remained weak in early 2023, although activity in the sector is anticipated to gradually recover throughout the year and into 2024. Spending on infrastructure projects has so far partly offset weak property investment. For the remainder of 2023 and in 2024, metal prices are forecast to decline as supply improves, and as China's growth recovery is expected to be supported predominantly by strong consumption, particularly of services.

Iron ore

Iron ore prices rebounded 27 percent from 2022Q4 to 2023Q1. They were 80 percent higher than their 2015-19 average. The recent gains were mainly due to a seasonal rise in China's steel output, which raised steel prices and the demand for iron ore. This effect is expected to subside over the remainder of 2023. On the supply side, although seaborne shipments of iron ore have been reduced by weather-related disruptions, they are still poised to grow moderately in the second half of the year. As a result, for 2023 as a whole, iron ore prices are forecast to be 5 percent lower than in 2022 and fall by a further 4 percent in 2024 (figure 15.C). Demand is expected to remain strong in the second quarter of this year when steel production is expected to peak, but to fade in the

second half. This slowing reflects a decline in China's steel output as the government contemplates again restricting steel production to curb pollution. Over the longer term, the outlook is for steady growth in supply from new mines in Africa, Australia, and Brazil, but more sluggish growth in demand as China transitions to activities that are less steel-intensive. These supply-demand trends are expected to push iron ore prices closer toward average production cost.

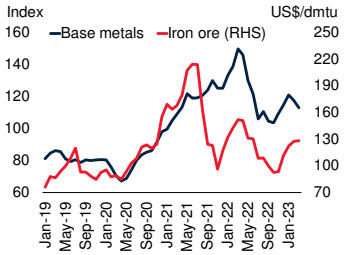
Aluminum

Aluminum prices increased 3 percent in 2023Q1 from the previous quarter. They were 32 percent above their 2015-19 average, but down more than one quarter from a year ago. The price gains in early January were driven by optimistic expectations for China's reopening amid falling inventories. Since then, however, a seasonal dip in China's demand and rising inventories have reversed the earlier price pressure. Demand in China is expected to grow moderately through the rest of this year, while consumption elsewhere is expected to be flat or declining as economies slow in Europe and North America. Some of China's largest aluminum smelters have faced hydroelectric power shortages due to drought, which has resulted in production cuts, notably in the large producing province of Yunnan. Nevertheless, aluminum supply is expected to increase in 2023 as China adds new capacity elsewhere and lower energy prices facilitate the restarting of existing smelters (aluminum production is very energy-intensive). However, China is approaching its self-imposed production cap of 45 million tons of aluminum production per year to curb carbon emissions. Any future capacity would have to originate in countries with low-cost, and preferably clean, energy sources. A recovery in production, as temporary bottlenecks are resolved, is expected to lower aluminum prices by 11 percent in 2023. A tepid recovery in global activity, combined with capacity constraints, is expected to raise prices by just 2 percent in 2024. In view of aluminum's multiple uses, and growing demand for use in transmission lines, electric vehicles and solar panels, higher prices could generate the incentives needed to raise supply over the long term.

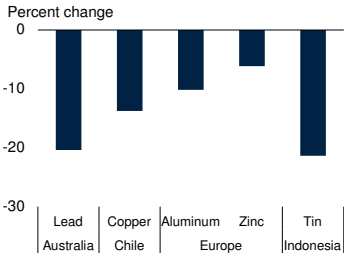
FIGURE 15 Metals and minerals market developments

Metal prices briefly rose in early 2023, driven by expectations of demand growth from China's reopening and production disruptions in 2022. But they have since moderated because of weaker-than-expected global growth prospects. Metal prices are expected to decline this year, largely based on weak global demand and strong supply. Metal prices could be higher than anticipated if China's rebound proves to be more construction-intensive than expected or disruptions to production emerge.

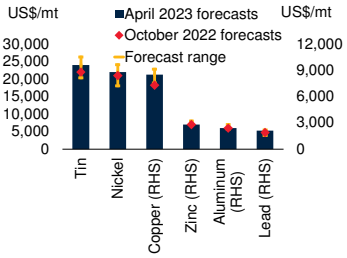
A. Base metals index and iron ore prices



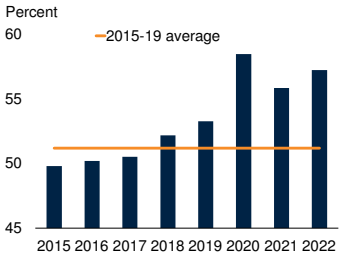
B. Production disruptions for various metals in 2022



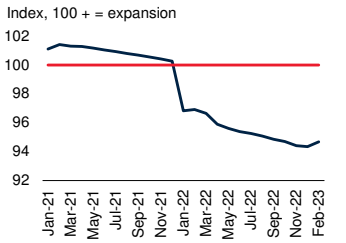
C. Metal price forecasts for 2023



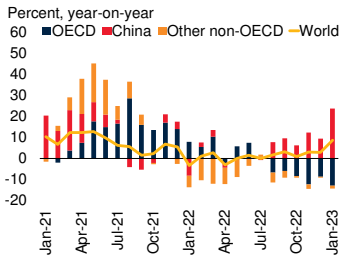
D. China's share in global copper consumption



E. China's real estate climate indicator



F. Metals demand growth



Sources: Haver Analytics; national authorities; World Bank; World Bureau of Metal Statistics.
A. Monthly data. Last observation is March 2023.
B. Production disruptions in major metal producers in 2022 compared with their 2015-19 average.
C. The range displays the most optimistic to pessimistic forecasts based on models presented in Arroyo Marioli et al. (forthcoming). Red diamonds show 2023 forecasts from October 2022 *Commodity Markets Outlook*.
E. A reading above 100 indicates expansion and a reading below 100 indicates a slowdown in China's real estate market. Last observation is February 2023.
F. OECD = Organisation for Economic Co-operation and Development. Last observation is January 2023.

Copper

Copper prices jumped 11 percent in 2023Q1 from the previous quarter and were 54 percent above their 2015-19 average. Prices surged at the

start of the year on expectations for a robust recovery in China's property sector—China accounts for 57 percent of global copper consumption (figure 15.D). However, prices edged lower during the rest of the quarter as expectations adjusted toward a less metal-intensive recovery in China. A slowdown in real estate sectors in some advanced economies also weighed on copper demand growth—the metal is a key input material for electrical power, plumbing, communications, and appliances. While these demand-side developments caused prices to edge lower, production disruptions in the world's three largest copper producers—Chile, Peru, and the Democratic Republic of Congo—as well as in Indonesia and Panama, supported prices in the first quarter. For example, mines in Chile continue to face water restrictions and deteriorating ore quality, and mines in Peru have struggled because of social unrest. Copper prices are forecast to fall 4 percent in 2023 compared with 2022, and by a further 6 percent in 2024 as supply conditions improve. Supply growth will be concentrated in the Americas, but also in the Democratic Republic of Congo and Russia. Longer-term, key demand drivers will be from electric vehicles, renewable power, and associated electric grid infrastructure, requiring additional investment to boost supply.

Lead

Lead prices increased by 1 percent in 2023Q1 from the previous quarter, marginally above their 2015-19 average, amid a substantial drawdown of stocks due to reduced primary and secondary (recycled) supply last year. About 85 percent of lead demand is for batteries, with two-thirds for automobiles (of which more than three-quarters is for replacement batteries). Primary lead supply is expected to grow strongly this year, with refineries returning to full capacity following production disruptions last year and the startup of new facilities. Increased production of lead (usually produced jointly with zinc) is expected in Alaska, Australia, Kazakhstan, and Russia. Lead demand is expected to grow this year, benefiting from China's reopening and the easing of semiconductor shortages that restricted auto production in advanced economies. Lead prices are expected to decline by 2 percent in 2023 and by a further 5 percent in 2024 amid a steady increase in supply. Longer-term, lead faces headwinds from increased production of electric vehicles. These vehicles tend to rely on lithium batteries, rather than lead batteries, because lithium batteries have high energy density, are lightweight, and energy efficient. While lead acid batteries are used for auxiliary functions in electric vehicles, there are indications that some manufacturers are considering phasing these out as well.

Nickel

Nickel prices rose by 2 percent in 2023Q1 from the prior quarter and were more than double their 2015-19 average. Growing production of lithium-ion batteries underlies the strong demand—and higher prices—for high-grade refined Class 1 nickel, which represents about one-quarter of the global nickel market. In contrast, prices for Class 2 nickel, which is used in stainless steel and accounts for two-thirds of nickel use, declined because of a 2.3 percent contraction in global stainless steel output last year and rapidly expanding production of nickel pig iron—one of the two sources of Class 2 nickel—especially in Indonesia, where production increased 54 percent (U.S. Geological Survey 2023; World Bureau of Metal Statistics 2023). Nickel prices are forecast to drop by about 15 percent in 2023 and by another 9 percent in 2024 amid increased production from China and Indonesia. These additions to supply could relieve price pressures on Class 1 nickel later this year. However, demand for stainless steel products, and hence Class 2 nickel, remains subdued. The development of non-nickel batteries for electric vehicles, already underway in China, poses a downside risk for the longer-term outlook for nickel demand and prices.

Tin

Tin prices increased the most of all base metal prices. They rose 22 percent in 2023Q1 from the previous quarter, to 42 percent above their 2015-19 average, because of disruptions to supply in Bolivia, Indonesia, and Peru, and prospects of higher demand in China. Prices fell from their

January highs on dampened prospects for consumption, especially in China. This follows a price plunge in 2022 because of slowing consumer electronics demand and sharply higher stocks of the metal. Tin prices are forecast to decline by 23 percent in 2023 and to remain subdued in 2024. Weak global demand and stubbornly high inflation are likely to continue to mute industrial and consumer tin consumption this year. Supply is expected to increase, as Indonesia's largest producer, PT Timah, recovers from operational and weather-related disruptions last year. Malaysian output is also expected to recover from labor and operational interruptions. Partly offsetting these gains, output is declining at major mines in South America. Tighter environmental regulations globally could also curb mining activities, particularly in China, which accounts for 33 percent of global supply (World Bureau of Metal Statistics 2023). Tin prices are expected to benefit from the energy transition because of increased usage in solar photoelectric cells, electric vehicles, and electronics.

Zinc

Zinc prices rose 4 percent between 2022Q4 and 2023Q1 and were 27 percent higher than their 2015-19 average. Price increases mainly reflect optimism early in the year about a strong recovery in China. Stocks have risen recently, but are still very low because of a large drawdown last year when several zinc smelters in Europe closed because of high energy costs. Smelter losses have also been observed in Australia, Canada, and Mexico due to plant maintenance and logistical problems. Now that energy prices have fallen, most European smelters have restarted. Zinc prices are forecast to drop by 20 percent in 2023 and 4 percent in 2024. Although some non-residential construction in China could increase demand for zinc in 2023, demand growth is expected to be modest outside of China due to slowing economic activity. Supply growth is also expected to be moderate this year. In contrast, both demand and supply will increase strongly in 2024 and beyond. Large projects in the Democratic Republic of Congo, Russia, and South Africa will likely dominate potential supply.

Risks

Key upside risks to the price forecast include the nature of China's recovery, metal production constraints, uncertainty with respect to trade policy in some major producers, and the evolution of the energy transition. A stronger-than-expected recovery of China's real estate sector could boost prices for metals used in construction—such as aluminum, copper, iron ore, and zinc (figure 15.E). Disruptions at mines due to weather, technical operating issues, labor disputes, and power/water constraints, could adversely affect raw material supplies for metals in several regions—especially in Africa, the Americas, Australia, and Asia, especially Indonesia.

Trade restrictions could also pose upside risks. The Philippines, the second-largest nickel ore producer in the world, is considering an export tax on nickel ore, following Indonesia's export ban on nickel in 2022. The proposed tax could further tighten supply and put upward pressure on nickel prices, although its impact is expected to be modest because the country accounts for only about 15 percent of the global mined nickel supply (U.S. Geological Survey 2023). Similarly, Indonesia is reportedly considering a ban on tin exports to attract investment in value-added processing. Indonesia's tin exports are already in the form of refined metal, rather than ore, but attempts to encourage further downstream processing could tighten an already supply-constrained market. Other policy interventions, such as further sanctions on Russia, and China's rapidly approaching aluminum production cap, could also limit supply.

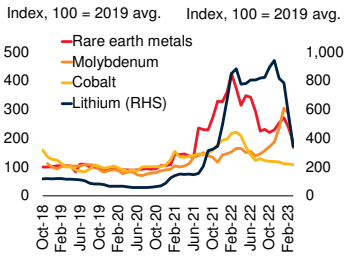
A key downside risk to the price forecast emanates from slower growth in advanced economies, which could further dampen consumer confidence, investment, and thus demand for base metals (figure 15.F).

Over the medium-to-long term, the energy transition could significantly lift the prices of some metals—notably aluminum, copper, nickel, and tin. Their usage spans a wide range of renewable technologies and critical infrastructure, such as wind turbines, electric vehicles, solar panels, and

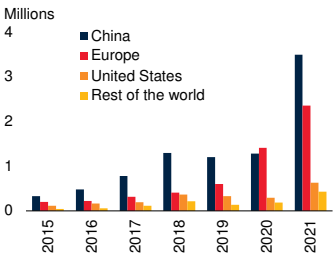
FIGURE 16 Critical minerals market developments

Critical mineral prices have been volatile over the past two years, reflecting thin and segmented markets. Lithium prices declined by nearly 35 percent in 2023Q1 from 2022Q4 partly due to the global economic slowdown and the termination of a decade-long electric vehicles subsidy initiative in China. Because of the wide-ranging applications of metals and minerals in this category and the geographic concentration in production, significant disparities exist in price movements across individual commodities.

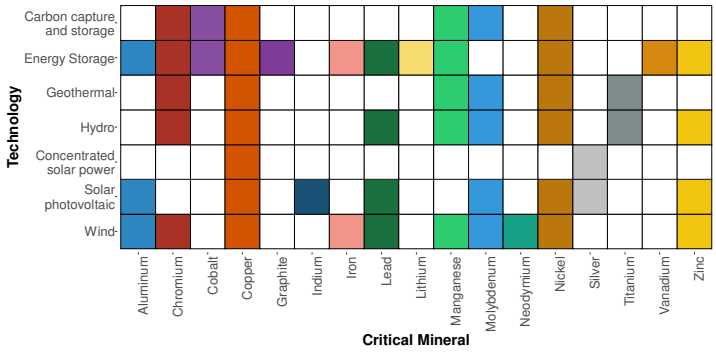
A. Price indexes for selected critical minerals



B. Electric vehicle sales



C. Use of critical minerals in renewable energy technology



Sources: Bloomberg (accessed April 13th, 2023); International Energy Agency (IEA); World Bank (2020b).

A. Prices refer to the following: Cobalt = China Shanghai Changjiang Cobalt; Lithium = China Lithium Carbonate 99% Battery Grade; Molybdenum = China Molybdenum Trioxide 51% Industrial Grade; and Rare Earth Metals = China Shanghai Rare Earth Carbonate REO >= 45%. Monthly data. Last observation is March 2023. Seven of the 17 critical minerals are not currently monitored by the World Bank Commodity Markets Group.

B. Electric vehicles (EVs) encompass cars, vans, buses, and trucks with powertrains including battery electric vehicles (BEV) and plug-in hybrid electric vehicles (PHEV). Europe comprises EU27, Iceland, Norway, Switzerland, and the United Kingdom. Annual data. Last observation is 2021.

C. Critical minerals shown correspond to the critical minerals' designation for use in renewable technologies identified in World Bank (2020b).

power grid systems. New technologies, such as hydrogen-based energy, could create additional demand for nickel.

Other critical minerals

Production of renewable energy and electric vehicles is expected to rise markedly in the next several years as economies intensify their efforts on energy transition. Consequently, demand for the commodities used as inputs into their production—so-called "critical minerals" is expected to rise.

New critical mineral prices have exhibited unusual volatility in recent months, as their demand has been affected by dampening global economic growth, though China's reopening has offset some of the effects. Given the diverse array of metals and minerals within this category, notable variations exist among individual commodities. Moreover, markets are nascent and segmented for some of the less common minerals.[5] For instance, prices for cobalt, primarily utilized for battery production, have plunged 51 percent from their April 2022 peak. Current prices are almost 60 percent below the past decade's highest price, in March 2018, reflecting cobalt-reducing innovations in battery chemistry. Prices for lithium are down 67 percent and those of rare earth elements are down 58 percent from their 2022 peaks, but they remain above the 2015-19 average (figure 16.A). China—the largest global market for electric vehicles—exerts substantial influence on lithium markets (figure 16.B). The termination of a decade-long subsidy program for new electric-vehicle purchases, starting in January 2023, has softened demand for electric vehicles in China. In contrast, the price of molybdenum—a lesser-known commodity employed to reinforce steel, and to improve battery performance—rose 28 percent in 2023Q1 from the previous quarter due to supply disruptions and increased demand from renewable energy sectors.[6]

There is growing recognition worldwide of the strategic importance of ensuring a consistent and reliable supply of these essential commodities. Critical mineral production has a higher geographic concentration than energy and base metals, with a limited number of producers responsible for a large fraction of global supply (World Bank forthcoming). A notable development involves stepped-up mining of rare earth elements outside China—particularly in Australia, Myanmar, and the United States. Brazil, India,

[5] World Bank (2020b) lists 17 "critical minerals" for the energy transition. Six of those (aluminum, copper, iron ore, lead, nickel, zinc) are part of the World Bank's *metals and minerals price index*.

[6] The World Bank does not forecast prices of cobalt, lithium, molybdenum, and rare earth elements.

Russia, and Vietnam have large, yet unexploited, reserves. Established lithium operations in Australia and Chile have increased their production capacities, while supply is expanding elsewhere (U.S. Geological Survey 2023).

Several countries have also proposed key initiatives aimed at reducing their dependence on foreign sources and promoting domestic production of critical minerals, such as the U.S. Inflation Reduction Act and the European Commission's Critical Raw Materials Act.[7] However, significant heterogeneity persists across these commodities, with idiosyncratic demand and supply drivers resulting in price volatility. The recent push by policy makers to accelerate the energy transition fosters a positive outlook, given the mineral-intensive nature of low-carbon technologies (figure 16.C). Increased adoption of low-carbon technologies is expected to raise demand for these essential commodities as the energy transition accelerates (World Bank 2017; IEA 2021).

Precious Metals

The World Bank's precious metals index increased by 9 percent in 2023Q1, driven by a weakening U.S. dollar, increased geopolitical tensions and inflationary pressures, as well as strong industrial demand for silver and platinum. Potential decisions by central banks to hold more gold is a key upside risk for gold prices, while supply constraints may lead to higher silver and platinum prices.

Gold

The price of gold increased 9 percent in 2023Q1 because of a weakening dollar, continued geopolitical uncertainty related to the war in Ukraine, and persistently high inflation, which drives some investors to buy gold (considered by many to be a safe-haven, low-risk asset). Prices in March 2023 were 51 percent higher than their 2015-19 average (figure 17.A). Increases in central bank policy rates since 2022 have restrained gold prices by raising the opportunity cost of holding the metal. However, the recent divergence of movements in gold prices and the yield on 10-year Treasury Inflation-Protected Securities (TIPS) suggests that the impact of geopolitical and economic uncertainty on prices has been stronger than the opportunity cost effect (figure 17.B). While gold holdings by exchange-traded funds have fallen for nine consecutive months, uncertainty has fueled an increase in physical demand, especially in the second half of 2022 (figure 17.C). On the demand side, purchases by central banks soared to a 55-year high (figure 17.D). Jewelry demand from China continues to be subdued despite the easing of pandemic-related restrictions, while demand from India has returned to pre-COVID-19 levels, despite a fall in imports due to additional duties and taxes since July 2022. On the supply side, elevated gold prices continue to incentivize additional production.

Gold prices are expected to average $1,900 per troy ounce in 2023—6 percent higher than in 2022. In 2024, gold prices are projected to decrease by 8 percent as the global economy begins to recover gradually and inflationary pressures recede. Physical demand is expected to support gold prices, although that demand remains price sensitive. Decisions from central banks on how much gold to hold will also be a key factor, with a possible return to 2021 levels of weaker gold demand exerting downward pressure on prices. Over the longer run, the path of inflation and interest rates will be the key factors driving gold prices. Short-run price volatility is likely to continue, in view of elevated geopolitical and economic uncertainty.

Silver

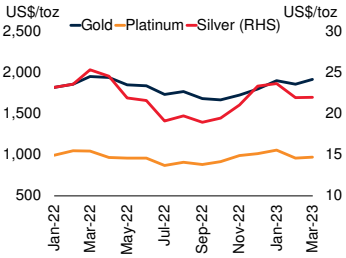
Silver prices increased 6 percent in 2023Q1 over the previous quarter, following a 10 percent increase in 2022Q4 (q/q). In March 2013, prices were 34 percent higher than their 2015-19 average (figure 17.A). Prices in the last two quarters were

[7] Enacted in August 2022, the Inflation Reduction Act advances the U.S. critical mineral supply chain through tax credits for domestic mineral production and electric vehicle purchases with U.S.-sourced batteries, allocating $500 million for supply chain improvement. Concurrently, the European Commission's Critical Raw Materials Act, proposed in March 2023, establishes self-sufficiency targets in 2030, aiming for 10 percent extraction, 40 percent domestic processing, and 15 percent recycling capacity for strategic raw materials, while promoting international partnerships to diversify supply chains, expedite permitting processes, and support strategic projects to decrease dependency on single-source countries.

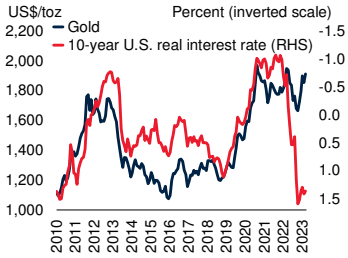
FIGURE 17 Precious metals

Precious metals prices increased moderately in 2023Q1. The price of gold responded to inflationary pressures and geopolitical concerns. Although investment in exchange-traded funds continued to decrease, purchases of gold by central banks were at a record high.

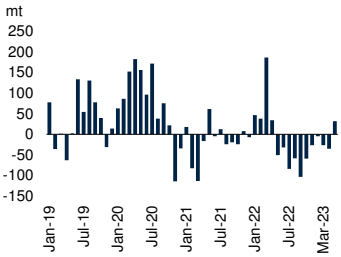
A. Monthly precious metals prices



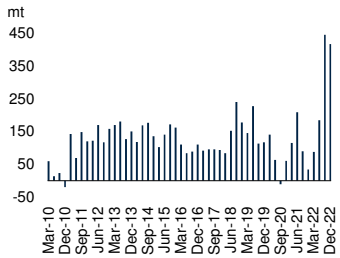
B. Gold price and interest rates



C. Changes in gold exchanged-trade funds, m/m



D. Central bank gold purchases



Sources: Bloomberg; Federal Reserve Bank of St. Louis; World Bank.
A.C. Monthly series. Last observation is March 2023.
B. Interest rate is the 10-year U.S. Treasury inflation-indexed security with constant maturity (not seasonally adjusted), inverted scale. Last observation is March 2023.
D. Monthly series. Last observation is December 2022.

driven by the same factors that were instrumental in pushing up gold prices. Moreover, industrial demand for silver in 2022 reached its highest level in the past decade despite somewhat sluggish global industrial activity. Industrial demand for silver rose by 6 percent last year, reflecting sharp increases in the use for photovoltaics (12 percent) and consumer electronics (7 percent). Demand for silverware was up a remarkable 25 percent, although it is only a small fraction (5 percent) of total demand. On the supply side, high prices have led to larger mine investment and production, despite labor disruptions in South America. Production is expected to increase steadily in the near-to-medium term, notably in the Americas.

Silver prices are projected to increase by 6 percent in 2023, amid continued high precautionary demand, while they are expected to fall 4 percent next year as the global economy recovers, and safe-haven demand subsides. In the longer term, the increase in production of solar photovoltaic products, automotive, and certain electronics components (such as for 5G internet) could lead to greater demand and higher prices.

Platinum

The price of platinum was broadly unchanged in 2023Q1, increasing 2 percent, because of fairly stable supply and demand conditions. In the previous quarter platinum prices rose 10 percent (figure 17.A). Industrial demand remained strong but was still about 14 percent lower than its record level in 2021. Demand for platinum used in auto catalysts has benefited from substitution away from higher priced palladium. Ongoing disruptions to energy output in South Africa, the largest global producer of platinum, reduced supply by 14 percent. The industry has faced several obstacles in recent years—among them power shortages, operational challenges, and labor market disruptions. Recycling of platinum catalysts from old vehicles has also been affected by supply chain interruptions in the auto sector in 2021, which reduced inventory.

Prices are expected to remain around $1,000 per troy ounce in 2023, a 4 percent increase over 2022, and rise a further 5 percent in 2024. Demand for 2023 is expected to grow strongly, driven by industrial, automotive, and investment sectors, while supply in 2023 is expected to be largely stable. Upside price risks are related to South African supply, which could be disrupted by ongoing blackouts in the next few years. Downside price risks are related to market penetration of electric vehicles, which do not use catalytic converters. The long-term outlook for platinum demand is positive as the energy transition intensifies, given its use in electrolyzers, carbon-free hydrogen production, and fuel cells.

Technical Notes

1. Pricing Russian oil during the war

Since late-2022, there has been increasing uncertainty regarding the discount at which Russian oil actually trades. The quoted "benchmark" Urals price is related to exports going through ports in the Baltic and Black Seas, which together used to handle more than half of the Russian seaborne oil exports covered by the dataset produced by Argus. The average price for Urals at Primorsk was $43/bbl in January (before shipping costs, or FOB), substantially below the G7 price cap of $60/bbl. Other price benchmarks are higher; the ESPO FOB at Kozmino (for delivery to Asia) was reported as $72/bbl in January. Considering the flows going through Russian ports in the Arctic and the Pacific Ocean, the FOB weighted average for Russian seaborne crude exports would be estimated at $53/bbl in January, almost $10/bbl higher than the quoted Urals price (based on Argus' price and Kpler's export data; Argus 2023; IEA 2023a; Kpler 2023).

The extent to which these benchmarks provide a true reflection of the price at which Russia's oil is being sold may be clouded by two additional factors. First, price quotes for the Urals price are increasingly opaque, partially because this benchmark is not derived from actual deals but from the Brent-Urals spread (mainly based on information from the European market) and shipping costs estimates (Vakulenko 2023).

Second, because Russian crude shipped to Europe has fallen dramatically and European shipping brokers transact a much smaller share of activities related to Russian oil exports, there is less confidence in the shipping costs estimates from European brokers. It is also not clear to what extent Kpler's volumes consider the increasing trade delivered through the Russian "shadow fleet" (Brooks, Fortun, and Pingle 2023). Based on Russian customs data, the average export price for Russian crude oil was estimated to be about $74/bbl in December 2022 for the four weeks after the cap, a $22/bbl premium compared with the Urals price and implying a $9/bbl discount to Brent (Babina et al. 2023). However, this discount estimate could change in the coming months, as the timing of payments and deliverables in the dataset used in the analysis was very close to the price cap introduction (a wind-down period of 45 days). However, if this premium persists and becomes more widespread, it could signal violations of the price cap.

2. Differences across fertilizer markets

The World Bank monitors the prices of three key fertilizer markets, which differ primarily due to their composition and primary use: nitrogen-based fertilizers (such as urea) are primarily used to enhance leaf growth; use of phosphorus-based (DAP) fertilizers facilitates the growth of seeds and fruits; and potassium-based fertilizers (MOP) are used to promote stem growth. Among these, nitrogen-based fertilizers are the most widely used, accounting for almost 60 percent of nutrient supply. China, India, the United States, Russia, and Indonesia are the top five producers of nitrogen-based fertilizers. In contrast, phosphate fertilizers are extracted from underground deposits of phosphate rock and are primarily produced by Morocco, China, and the United States.

Nitrogen-based fertilizer prices tend to co-move with natural gas prices given that the production of nitrogen-based fertilizers is an energy-intensive process. Urea, methane, and DAP fertilizer production involves using natural gas or (less so) coal to supply hydrogen and capture nitrogen from the air. In addition to the top five producers, countries with high natural gas reserves such as Saudi Arabia, Islamic Republic of Iran, and Qatar are also increasingly producing nitrogen-based fertilizers. Over the past 70 years, global fertilizer consumption has quadrupled, with nitrogen-based fertilizers being the most widely used. Nitrogen-based fertilizers are used in the production of agricultural commodities responsible for feeding almost half of the world's population (Smil 2004; Erisman et al. 2008). Fertilizer and grain prices also tend to move together as wheat is the crop that requires the most fertilizer, with an average of 116 kg per hectare, followed by rice, maize, and other cereals (FAO 2016).

References

Argus. 2023. "ARGUS Russian Domestic Crude Market." Accessed on April 19, 2023. https://argusmedia.com/en/crude-oil/argus-russian-domestic-crude-market.

Arroyo-Marioli, F., J. Khadan, F. Ohnsorge, and T. Yamazaki. Forthcoming. "Forecasting Industrial Commodity Prices: Literature Review and a Model Suite." Unpublished paper.

Babina, T., B. Hilgenstock, O. Itskhoki, M. Mironov, and E. Ribakova. 2023. "Assessing the Impact of International Sanctions on Russian Oil Exports." Social Science Research Network. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4366337.

BP (British Petroleum). 2022. "Statistical Review of World Energy." https://bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy.html.

Brooks, R., J. Fortun, and J. Pingle. 2023. "Global Macro Views—The End of Russia's Energy Windfall." Institute of International Finance, Washington, D.C.

Bruegel Research Service (website). 2023. Accessed April 17, 2023. https://bruegel.org/bruegel-european-think-tank-specialises-economics.

EIA (Energy Information Administration). 2023a. "Short-Term Energy Outlook." April. Energy Information Administration, Washington, DC.

EIA (Energy Information Administration). 2023b. "Electric Power Monthly." March. Energy Information Administration, Washington, DC.

European Commission. 2022. "Green Deal: EU Agrees Law to Fight Global Deforestation and Forest Degradation Driven by EU Production and Consumption." https://ec.europa.eu/commission/presscorner/detail/en/IP_22_7444.

European Commission. 2023. "Gas Storage." Accessed on April 17, 2023. https://energy.ec.europa.eu/topics/energy-security/gas-storage_en.

FAO (Food and Agriculture Organization of the United Nations). 2016. "Fertilizer Use by Crop." Food and Agriculture Organization, Rome.

Federal Reserve Bank of Dallas. 2022. "Oil and Gas Expansion Still Solid; Cost Increases Moderate, Supply-Chain Delays Persist." Dallas Fed Energy Survey, fourth quarter 2022.

IEA (International Energy Agency). 2021. "The Role of Critical Minerals in Clean Energy Transitions." IEA, Paris. https://iea.org/reports/the-role-of-critical-minerals-in-clean-energy-transitions.

IEA (International Energy Agency). 2022a. "World Energy Investment 2020." International Energy Agency, Paris.

IEA (International Energy Agency). 2022b. "Coal 2022." International Energy Agency, Paris.

IEA (International Energy Agency). 2023a. "Oil Market Report." February. International Energy Agency, Paris.

IEA (International Energy Agency). 2023b. "Oil Market Report." March. International Energy Agency, Paris.

IEA (International Energy Agency). 2023c. "Oil Market Report." April. International Energy Agency, Paris.

IEA (International Energy Agency). 2023d. "Gas Market Report, Q1-2023." International Energy Agency, Paris.

IPCC (Intergovernmental Panel on Climate Change). 2019. "Summary for Policymakers." In *Climate Change and Land: An IPCC Special Report on Climate Change, Desertification, Land Degradation, Sustainable Land Management, Food Security, and Greenhouse Gas Fluxes in Terrestrial Ecosystems*, edited by P. R. Shukla, J. Skea, E. Calvo Buendia, V. Masson-Delmotte, H.-O. Pörtner, D. C. Roberts, P. Zhai, et al. https://doi.org/10.1017/9781009157988.001.

IPCC (Intergovernmental Panel on Climate Change). 2023. "Synthesis Report of the IPCC Sixth Assessment Report (AR6). https://report.ipcc.ch/ar6syr/pdf/IPCC_AR6_SYR_SPM.pdf.

Kpler. 2023. "Flows. Tools to Gain the Deepest Understanding of Global Trades." https:// kpler.com/products/flows.

Laborde, D., and A. Mamun. 2022. "Documentation for Food and Fertilizers Export Restriction Tracker: Tracking Export Policy Responses Affecting Global Food Markets during Crisis." Food and Fertilizer Trade Policy Tracker Working Paper 2, International Food Policy Research Institute, Washington, DC.

NOAA (National Oceanic and Atmospheric Administration). 2023. "April 2023 ENSO Update: El

Niño Watch." *ENSO BLOG.* April 13, 2023. https://climate.gov/news-features/blogs/april-2023-enso-update-el-niño-watch.

OPEC (Organization of the Petroleum Exporting Countries). 2023. "Monthly Oil Market Report." March. https://opec.org/opec_web/en/publications/338.htm.

Tollefson, J. 2022. "What the War in Ukraine Means for Energy, Climate and Food." *Nature* 04: 232-233.

U.S. Department of the Treasury. 2022. "FACT SHEET: Limiting Kremlin Revenues and Stabilizing Global Energy Supply with a Price Cap on Russian Oil." Press Release, December 2, 2022. https://home.treasury.gov/news/press-releases/jy1141.

U.S. Geological Survey. 2023. *Mineral Commodity Summaries 2023*. Retrieved from https://pubs.usgs.gov/periodicals/mcs2023/mcs2023.pdf. Reston, VA: U.S. Geological Survey.

USDA (United Stated Department of Agriculture). 2023a. "WASDE Report." April. World Agricultural Supply and Demand Estimates (WASDE), United Stated Department of Agriculture, Washington, DC.

USDA (United Stated Department of Agriculture). 2023b. "Prospective Plantings." March. National Agricultural Statistics Service, United Stated Department of Agriculture, Washington, DC.

Vakulenko, S. 2023. "A Price Cap or Smoke and Mirrors? How Much Does Russian Oil Actually Cost?" *Re: Russia* (online forum). https://re-russia.net/en/expertise/049/.

WFP (World Food Program). 2023. "A Global Food Crisis." United Nations World Food Program. Accessed on March 29, 2023. https:// wfp.org/global-hunger-crisis.

World Bank. Forthcoming. "Energy Transition Policy Research Note." World Bank, Washington, DC.

World Bank. 2015. *Commodity Markets Outlook: Understanding El Niño—What Does It Mean for Commodity Markets*? October. Washington, DC: World Bank.

World Bank. 2017. *The Growing Role of Minerals and Metals for a Low Carbon Future*. Washington, DC: World Bank.

World Bank. 2020a. "Atlas of Sustainable Development Goals." From *World Development Indicators*. World Bank, Washington, DC.

World Bank. 2020b. *Minerals for Climate Action: The Mineral Intensity of the Clean Energy Transition*. Washington, DC: World Bank.

World Bank. 2022. *Commodity Markets Outlook*. April. Washington, DC: World Bank.

World Bank. 2023a. Reviving Growth. World Bank East Asia and Pacific Economic Update (April). Washington, DC: World Bank.

World Bank. 2023b. *Global Economic Prospects*. January. Washington, DC: World Bank.

World Bureau of Metal Statistics. 2023. "Metal Bulletin Monthly." March. Refinitiv, London, U.K.

World Economic Forum. 2022. "6 Ways Russia's Invasion of Ukraine Has Reshaped the Energy World." Accessed on March 29, 2023. https://weforum.org/agenda/2022/11/russia-ukraine-invasion-global-energy-crisis/.

SPECIAL FOCUS

Forecasting Industrial Commodity Prices

Commodity price forecasts provide important forward guidance to economic agents and policymakers in emerging market and developing economies (EMDEs). A large literature has developed a wide range of forecasting models, which are reviewed in this Special Focus for seven industrial commodity prices (oil and six industrial metals). A widely used forecast approach, futures prices, has been shown to yield unbiased forecasts (without systematic over- or under-prediction) but inefficient forecasts (with large forecast errors in either direction). Multivariate time series models have generally outperformed other model-based approaches. Increasingly, machine learning techniques are being shown to yield better forecasts than traditional benchmark models, such as no-change forecasts or forecasts based on univariate time series models. However, their performance against other model-based forecast approaches has only begun to be explored. Augmenting model-based forecast approaches by the time series properties of commodity prices and other economic factors has been shown to enhance forecast accuracy.

Introduction

Almost two-thirds of emerging market and developing economies (EMDEs) depend heavily on commodities for export or fiscal revenue and economic activity. Among commodity-exporting EMDEs, resource sectors accounted for an average of 39 percent of exports of goods and non-factor services, 31 percent of goods exports, and 10 percent of value added in 2019. In some commodity-importing EMDEs, in turn, commodities account for a large share of imports and, in the presence of subsidies, fiscal spending.

For both public and private sectors, the ability to engage in sound economic and financial planning, therefore, depends heavily on the quality of commodity price forecasts. Yet, many institutions rely on futures prices for commodity price forecasts, despite their well-known shortcomings in providing accurate predictions (Alquist and Kilian 2010).

This Special Focus reviews the large literature of price forecasting approaches for a subset of seven industrial commodities: oil as well as six industrial metals commodities (aluminum, copper, lead, nickel, tin, and zinc). Together, these commodities account for 10 percent of global goods exports and 32 percent of global commodity trade.

The analysis focuses on these commodities because their demand is primarily driven by economic growth, in contrast to demand for agricultural commodities, which is mainly driven by population growth (Baffes and Nagle 2022). Oil prices are treated as representative of energy prices more broadly because, until recently, they have generally correlated closely with non-oil energy prices.

This Special Focus is a comprehensive review of the broadest range of studies and for the widest range of commodities thus far. Earlier studies have compiled reviews of forecasting models, but only for individual commodity prices.

This Special Focus reviews 60 studies in peer-reviewed journals. For crude oil price forecasts, it draws on 40 studies, most of which examine West Texas Intermediate (WTI) prices and five of which examine Brent prices (figure 18).[1] For industrial metal prices, it draws on 20 price forecast studies covering aluminum (11 studies), copper (14), lead (8), nickel (8), tin (5), and zinc (8).

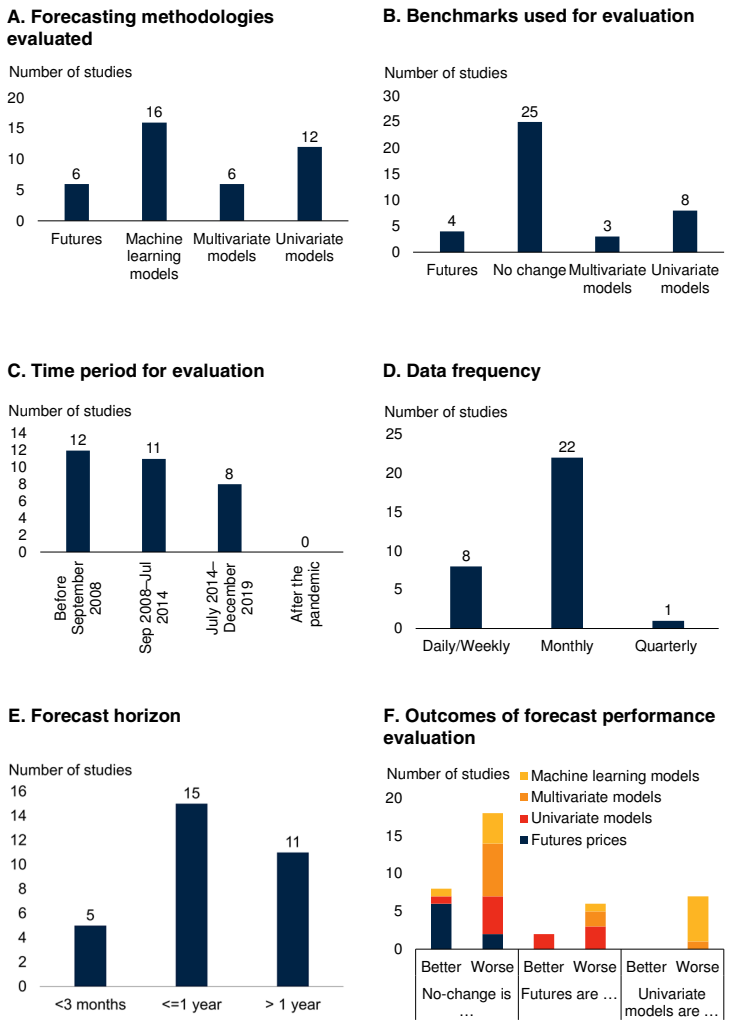
Most of these studies analyze monthly forecasts, focusing on forecast horizons of less than one year for oil prices and on forecast horizons longer than one year for metal prices. The most common forecasting approaches used in this literature have included futures prices, time series models (univariate and multivariate), and machine learning techniques (Behmiri and Manso 2013).

Note: This Special Focus was prepared by Jeetendra Khadan and Franziska Ohnsorge. The discussion is drawn from Arroyo-Marioli et al. (forthcoming). Helpful comments were provided by Paolo Agnolucci, John Baffes, Christiane Baumeister, Valerie Mercer Blackman, Pablo Pincheira Brown, Marek Kwas, Dawit Mekonnen, and Peter Nagle.

[1] The WTI price has increasingly reflected U.S.-specific rather than global oil market dynamics since 2010 (Berk 2016; Manescu and Van Robays 2017).

FIGURE 18 Summary of studies of crude oil price forecast performance

The review of the literature on crude oil price forecasting draws on 40 studies. The vast majority of studies examine the performance of time series models and machine learning techniques—mostly benchmarked against no-change forecasts or futures prices. Most studies examined time periods that ended before the collapse in oil prices in mid-2014 and relied on monthly data frequencies. Forecast horizons between 3 and 12 months and of more than one year were almost equally common.



Source: World Bank.

A. Number of studies that examine the forecast performance of futures prices, machine learning techniques, multivariate models (including structural VARs and Bayesian VARs), and univariate time series models against a benchmark. The two studies that examine both multivariate and univariate models are shown in the category for multivariate models.

B. Number of studies that benchmark forecast performance against latest spot prices ("no-change"), futures prices, multivariate models (including structural VARs and Bayesian VARs), and univariate time series models. Studies that benchmark against both no-change forecasts and futures prices (9) and against both no-change forecasts and univariate models (2) are shown in the category for no-change benchmarks.

C.-E. Number of studies by end date of sample period (C), data frequency (D), and forecast horizon (E).

F. Number of studies in which benchmark approaches on the x-axis (no-change forecasts, futures, univariate models) had better or worse forecast performance than the approaches listed in the legend (futures prices, univariate models, multivariate models, and machine learning techniques).

Most studies evaluate forecast performance based on directional accuracy, precision, and unbiasedness. Directional accuracy assesses whether the forecast and actual prices move in the same direction. Precision, usually measured by the root mean square forecast error, measures the degree of forecast accuracy. Unbiasedness evaluates whether forecasts systematically over- or under-predict their actual values. The remainder of this Special Focus examines the most common forecasting approaches.

Futures prices

Futures prices are based on the collective judgment of market participants' expectations of future spot prices. They provide insights into perceptions of factors that influence future prices, such as demand and supply dynamics. Futures prices are widely used for forecasting purposes.

For *oil* prices, several studies have found that futures prices tend to be unbiased predictors of future spot oil prices, meaning they do not systematically over- or under-predict actual prices. However, they are not always efficient predictors and can generate large forecast errors in either direction (Abosedra and Baghestani 2004; Chinn, LeBlanc, and Coibion 2005; Jiang, Xie, and Zhou 2014). Futures prices have underperformed forecasts from a no-change benchmark (Alquist and Kilian 2010; Alquist, Kilian, and Vigfusson 2013), vector autoregression (VAR) models (Baumeister and Kilian 2012, 2014), machine learning techniques (Moshiri and Foroutan 2006), and univariate time series models (Jin 2017). However, the predictive content of futures prices appears to have improved since the mid-2000s, possibly due to increased financialization of commodity markets (Ellwanger and Snudden 2023). Using weekly data, Rubaszek et al. (2020) found that futures prices outperformed the random walk benchmark.

Futures prices of *metals* have also underperformed the no-change benchmark. Chinn and Coibion (2014) showed this for aluminum, copper, lead, nickel, and tin at horizons of 3, 6, and 12 months. On the other hand, Bowman and Husain (2004) showed that incorporating futures prices in an

error correction model improved the directional accuracy and precision of forecasts for several metal prices, particularly at longer forecast horizons, compared to models that relied solely on historical data or judgment.

Univariate time series models

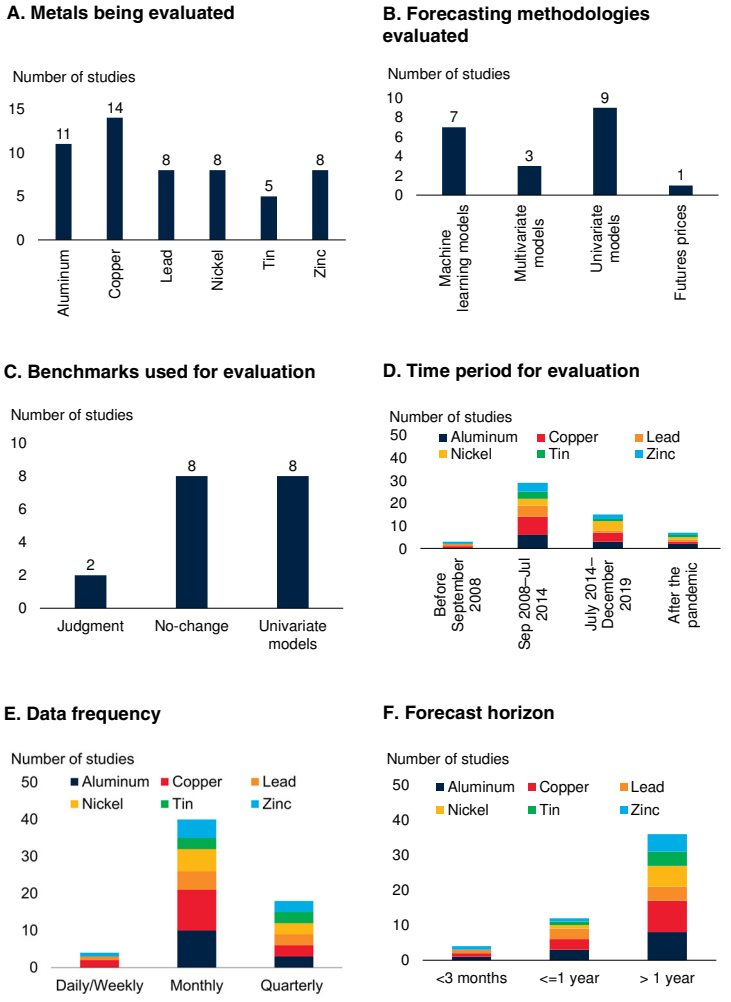
Univariate time series forecasting involves modeling and predicting future values of prices by correlating the price with its own lagged values. The most common univariate time series approach used in commodity price forecasting is the family of autoregressive integrated moving average (ARIMA) models.

Several studies have shown that *oil* price forecasts based on univariate time series models perform poorly against other approaches, although they outperform the no-change benchmark (Alquist, Kilian, and Vigfusson 2013; Jin 2017). Univariate models produce less accurate forecasts than futures oil prices (Abosedra 2006), Bayesian vector autoregression (BVAR) models (Baumeister and Kilian 2012), and machine learning techniques (Mostafa and El-Masry 2016). ARIMA models have also had poorer out-of-sample forecasting power than non-standard methods, such as nonlinear artificial neural network models and support vector machines (Mostafa and El-Masry 2016; Xie et al. 2006). Autoregressive moving average (ARMA) models have been found to lack directional accuracy and precision compared with VAR models (Baumeister and Kilian 2012).

Similarly, for *metals* prices, univariate time series models have performed better than no-change forecasts but underperformed other quantitative methods (figure 19; Alipour, Khodaiari, and Jafari 2019; Buncic and Moretto 2015; Rubaszek, Karolak, and Kwas 2020). For aluminum, copper, nickel, and zinc, univariate autoregressive models delivered significantly better forecasts than the no-change benchmark (Rubaszek, Karolak, and Kwas 2020). For lead, ARIMA models have generated slightly better forecasts than models based on lagged forward prices (Dooley and Lenihan 2005). For copper, the forecast performance of ARIMA and no-change forecasts was inferior to that of neural networks, dynamic averaging and selection

FIGURE 19 Summary of studies of metal price forecast performance

The review of the literature on forecasting metals prices draws on 20 studies. The most commonly evaluated methods are time series models, mostly benchmarked against no-change forecasts. Most studies use sample periods that end before the commodity price collapse of mid-2014 and most examine monthly data. The most commonly examined forecast horizon for metals prices is above one year.



Source: World Bank.

Note: Figures show the number of studies that included each commodity or applied different forecasting methods. Since several studies examine more than one metal price, the total can be larger than the number of studies.

A. Number of studies that evaluate forecast performance for each metal price.

B. Number of studies that examine the forecast performance of futures prices, machine learning techniques, multivariate models (including structural VARs and Bayesian VARs), and univariate time series models against a benchmark. The one study that examined both machine learning techniques and univariate models is shown in the category for machine learning techniques. The one study that examines both futures prices and univariate models is shown in the category for futures prices.

C. Number of studies that benchmark forecast performance against judgement-based models, latest spot prices ("no-change"), and univariate time series models.

D.-F. Number of studies by end date of sample period (D), data frequency (E), and forecast horizon (F).

models, and stochastic differential equations (Alipour, Khodaiari, and Jafari 2019; Buncic and Moretto 2015; Lasheras et al. 2015). For aluminum and nickel prices, a modified grey wave forecasting technique—a univariate technique that explicitly accounts for irregular fluctuations in time series—performed better than no-change (and ARMA) methods (Chen, He, and Zhang 2016).

Multivariate time series models

Unlike univariate time series models, multivariate forecasting techniques account for multiple variables and their relationships when modeling and predicting the future values of a time series. VAR models are the most common multivariate time series models used in forecasting commodity prices.

For *oil* prices, VAR models have produced smaller out-of-sample forecast errors and more accurate directional accuracy at horizons up to 12 months than no-change forecasts and ARMA models (Alquist, Kilian, and Vigfusson 2013; Baumeister and Kilian 2012). They also have produced more accurate real-time short-run forecasts than futures prices, no-change forecasts, and regression models, while BVAR models have offered the best combination of low forecast error and high directional accuracy (Baumeister and Kilian 2012, 2014).

For *metals* prices, multivariate time series models have generally outperformed the no-change benchmark and, in many cases, univariate models. Issler, Rodrigues, and Burjack (2014) found that model performance differed by data frequency and commodity. For annual data, univariate autoregressive models performed best for aluminum and copper prices, while VARs produced the best forecasts for lead and zinc, and vector error correction models (VECMs) the best forecasts for nickel and tin. But for monthly data, VECMs of all metal prices and U.S. industrial production showed superior forecasting performance. Castro, Araujo, and Montini (2013) also showed that VECMs have had better out-of-sample forecast accuracy than VAR and ARIMA models for aluminum prices.

Machine learning techniques

Machine learning forecasting techniques use algorithms and methods to learn patterns and relationships in data, and then make predictions based on these patterns in an atheoretical manner. The most common machine learning forecasting techniques used in commodity price forecasting are artificial neural network and support vector regressions.

Machine learning techniques have generally shown better forecast performance for *oil* prices than other approaches, such as univariate time series models (Moshiri and Foroutan 2006; Xie et al. 2006).[2] A neural network ensemble learning model based on an empirical mode decomposition (EMD) has had better forecast prediction and directional accuracy than an ARIMA model and other nonlinear methods, for both WTI and Brent prices (Yu, Wang, and Lai 2008). But the comparison has been sensitive to the forecast horizon (figure 20). For example, ARIMA models have outperformed artificial neural network models at the very shortest forecast horizons. However, at longer horizons, artificial neural network models and support vector regressions have outperformed ARIMA models (Fernandez 2007).

For *metals* prices, machine learning techniques have shown superior forecasting performance over several other approaches (Lasheras et al. 2015). For copper prices, artificial neural network models and support vector regressions have produced better forecasts than a range of other models, and the gene expression programming method has generated more accurate predictions than time series and multivariate regression methods (Astudillo et al. 2020; Dehghani 2018; Khoshalan et al. 2021).

[2] Notwithstanding their reported success, Yu, Wang, and Lai (2008) and Yu, Zhao, and Tang (2014) pointed to local minima and overfitting in artificial neural network models, the requirement of long time series in support vector machine models, and sensitivity to parameter selection in artificial neural network models, support vector machine models, and genetic programming models. Zheng, Cheng, and Yang (2014) and Lei et al. (2013) point to the sensitivity of EMD models to statistical problems in irregular (that is, noisy) data. Peng et al. (2014) note challenges with convergence and efficiency in gene expression programming.

Approaches to enhancing forecast performance

Two approaches have been used to improve forecast performance: combining multiple models and adding more information.

Forecast combination approaches consist of weighted averages of forecasts from different models, such as futures, no-change forecasts, VARs, and general equilibrium models. These have generated more accurate out-of-sample forecasts with better directional accuracy than no-change forecasts (Baumeister and Kilian 2015; Issler, Rodrigues, and Burjack 2014). Manescu and Van Robays (2017) also found that forecast combination approaches have improved directional accuracy and unbiasedness over futures prices and no-change forecasts.

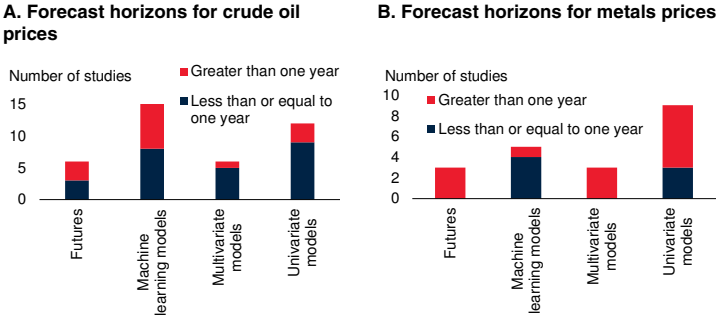
Additional information on the behavior of economic agents and relevant economic variables has been included in modelling approaches. Accounting for global economic conditions, petroleum inventories, world output gap, the U.S. dollar real effective exchange rate, and the possibility of speculation has been shown to improve oil price forecasts (Baumeister, Korobilis, and Lee 2022; Kaufmann et al. 2008; Lalonde, Zhu, and Demers 2003). Similarly, accounting for relevant external regressors—such as industrial production, exchange rate dynamics, commodity currencies, international metal stock indexes, structural breaks, and short-run common-cycle restrictions—has improved forecast performance of some metal prices (Gong and Lin 2018; Issler, Rodrigues, and Burjack 2014; Pincheira-Brown and Hardy 2019).

Conclusion

The following general conclusions can be drawn from the literature review for both oil and metal price forecasts. First, many studies have empirically established that forecasts of WTI and Brent oil prices and metal prices based on futures contracts are inferior to several model-based approaches. Yet, futures prices are still used extensively.

FIGURE 20 Forecast horizon by methodologies for oil and metal prices

Most studies employing multivariate and univariate models to forecast crude oil prices did so for forecast horizons less than or equal to one year, while forecast horizons less than and greater than one year were equally common for studies using futures and machine learning methods. For metal prices, futures and multivariate models examined forecasts horizons greater than one year, while the majority of machine learning methods examined forecast horizons below one year.



Source: World Bank.
Note: Figures show the number of studies that used different forecast horizons by forecasting methods.
A. Number of studies that examine the forecast horizons less than or equal to one year and greater than one year for crude oil prices, by forecasting methods.
B. Number of studies that examine the forecast horizons less than or equal to one year and greater than one year for metal prices (aluminum, copper, lead, nickel, tin, and zinc), by forecasting methods. The one study that examined both machine learning techniques and univariate models is shown in the category for machine learning techniques. The one study that examined both futures prices and univariate models is shown in the category for futures prices.

Second, multivariate time series models have generally outperformed other methods covered in this literature review. Several studies have found that incorporating relevant external regressors and controlling for time series properties embedded in oil or metal prices can improve forecast accuracy.

Third, machine learning techniques have tended to yield better forecasts than traditional benchmarks (such as no-change forecasts) and univariate methods, but they have been sensitive to different specifications. Comparisons of machine learning techniques with multivariate time series models-based approaches have been limited. The few available studies show that, in at least two cases, machine learning techniques have outperformed unrestricted reduced-form VAR models of oil price forecasts, but only at very short forecast horizons (Cheng et al. 2019) or up to one year (Mirmirani and Li 2004). To our knowledge, no such comparison is available for industrial metal prices.

Future editions of the *Commodity Markets Outlook* will present detailed empirical results about the performance of forecasting models discussed here for seven industrial commodity prices (aluminum, copper, lead, nickel, oil, tin, and zinc).

References

Abosedra, S. 2006. "Futures versus Univariate Forecast of Crude Oil Prices." *OPEC Review* 29 (4): 231-41.

Abosedra, S., and H. Baghestani. 2004. "On the Predictive Accuracy of Crude Oil Futures Prices." *Energy Policy* 32 (12): 1389-93.

Alipour, A., A. Khodaiari, and A. Jafari. 2019. "Modeling and Prediction of Time-Series of Monthly Copper Prices." *International Journal of Mining and Geo-Engineering* 53 (1): 91-97.

Alquist, R., and L. Kilian. 2010. "What Do We Learn from the Price of Crude Oil Futures?" *Journal of Applied Econometrics* 25 (4): 539-73.

Alquist, R., L. Kilian, and R. J. Vigfusson. 2013. "Forecasting the Price of Oil." In *Handbook of Economic Forecasting*, edited by G. Elliott, C. W. J. Granger, and A. Timmermann, 2 (A): 427-507. Amsterdam: Elsevier.

Arroyo-Marioli, F., J. Khadan, F. Ohnsorge, and T. Yamazaki. Forthcoming. "Forecasting Industrial Commodity Prices: Literature Review and a Model Suite." Unpublished paper.

Astudillo, G., R. Carrasco, C. Fernández-Campusano, and M. Chacón. 2020. "Copper Price Prediction Using Support Vector Regression Technique." *Applied Sciences* 10 (19): 1-12.

Baffes, J., and P. Nagle, eds. 2022. *Commodity Markets: Evolution, Challenges and Policies.* Washington, DC: World Bank, 2022.

Baumeister, C., and L. Kilian. 2012. "Real-Time Forecasts of the Real Price of Oil." *Journal of Business and Economic Statistics* 30 (2): 326-36.

Baumeister, C., and L. Kilian. 2014. "What Central Bankers Need to Know about Forecasting Oil Prices." *International Economic Review* 55 (3): 869-89.

Baumeister, C., and L. Kilian. 2015. "Forecasting the Real Price of Oil in A Changing World: A Forecast Combination Approach." *Journal of Business and Economic Statistics* 33 (3): 338-51.

Baumeister, C., D. Korobilis and T. Lee. 2022. "Energy Markets and Global Economic Conditions." *Review of Economics and Statistics* 104 (4): 828-44.

Behmiri, N. B., and J. R. P. Manso. 2013. "Crude Oil Price Forecasting Techniques: A Comprehensive Review of Literature." *Alternative Investment Analyst Review* 2013 (2): 29-48.

Berk, C. 2016. "Indexing Oil from a Financial Point of View: A Comparison between Brent and West Texas Intermediate." *International Journal of Energy Economics and Policy* 6 (2): 152-58.

Bowman, C., and A. Husain. 2004. "Forecasting Commodity Prices: Futures Versus Judgment." Working Paper 04/41, International Monetary Fund, Washington, DC.

Buncic, D., and C. Moretto. 2015. "Forecasting Copper Prices with Dynamic Averaging and Selection Models." *The North American Journal of Economics and Finance* 33 (2015): 1-38.

Castro, J., A. Araujo, and A. A. Montini. 2013. "Comparative Modeling Assessment of Aluminum Price Forecast." Conference proceedings, XVI Seminários em Administração, São Paulo, 2013.

Chen, Y., K. He, and C. Zhang. 2016. "A Novel Grey Wave Forecasting Method for Predicting Metal Prices." *Resources Policy* 49 (C): 323-31.

Cheng, F., T. Li, Y.-M. Wei, and T. Fan. 2019. "The VEC-NAR Model for Short-Term Forecasting of Oil Prices." *Energy Economics* 78 (C): 656-67.

Chinn, M. D., and O. Coibion. 2014. "The Predictive Content of Commodity Futures." *Journal of Futures Markets* 34 (7): 607-36.

Chinn, M.D., M. LeBlanc, and O. Coibion. 2005. "The Predictive Content of Energy Futures: An Update on Petroleum, Natural Gas, Heating Oil and Gasoline." Working Paper 11033, National Bureau of Economic Research, Cambridge, MA.

Dehghani, H. 2018. "Forecasting Copper Price Using Gene Expression Programming." Journal of Mining and Environment 9 (2): 349-60.

Dooley, G., and H. Lenihan. 2005. "An Assessment of Time Series Methods in Metal Price Forecasting." *Resources Policy* 30 (3): 208-17.

Ellwanger, R., and S. Snudden. 2023. "Futures Prices are Useful Predictors of the Spot Price of Crude Oil." *The Energy Journal* 44 (4): 45-62.

Fernandez, V. 2007. "Forecasting Commodity Prices by Classification Methods: The cases of Crude Oil and Natural Gas Spot Prices." Working Paper, Department of Industrial Engineering, University of Chile, Santiago.

Gong, X., and B. Lin. 2018. "Structural Breaks and Volatility Forecasting in the Copper Futures Market." *Journal of Futures Markets* 38 (3): 290-339.

Issler, J. V., C. Rodrigues, and R. Burjack. 2014. "Using Common Features to Understand the Behavior of Metal-Commodity Prices and Forecast them at Different Horizons." *Journal of International Money and Finance* 42 (C): 310-35.

Jiang, Z.-Q., W.-J. Xie, and W.-X. Zhou. 2014. "Testing the Weak-Form Efficiency of the WTI Crude Oil Futures Market." *Physica A: Statistical Mechanics and its Applications* 405 (C): 235-44.

Jin, X. 2017. " Do Futures Prices Help Forecast the Spot Price?" *Journal of Futures Markets* 37 (12): 1205-25.

Kaufmann, K., S. Dées, A. Gasteuil, and M. Mann. 2008. " Oil Prices: The Role of Refinery Utilization, Futures Markets and Non-linearities." *Energy Economics* 30 (5): 2609-22.

Khoshalan, H. A., J. Shakeri, I. Najmoddini, and M. Asadizadeh. 2021. "Forecasting Copper Price by Application of Robust Artificial Intelligence Techniques." *Resources Policy* 73 (C): 1-11.

Lalonde, R., Z. Zhu, and F. Demers. 2003. "Forecasting and Analyzing World Commodity Prices." Bank of Canada Working Paper 03-24, Bank of Canada, Ottawa.

Lasheras, S., F. Juez, A. S. Sánchez, and A. Krzemień. 2015. "Forecasting the COMEX Copper Spot Price by Means of Neural Networks and ARIMA Models" *Resources Policy* 45 (C): 37-43.

Lei, Y., J. Lin, Z. He, and M. J. Zuo. 2013. "A Review on Empirical Mode Decomposition in Fault Diagnosis of Rotating Machinery." *Mechanical Systems and Signal Processing* 35 (2): 108-26.

Manescu, C., and I. Van Robays. 2017. "Forecasting the Brent Oil Price: Addressing Time-Variation in Forecast Performance." CESifo Working Paper 6242, Center for Economic Studies, Munich.

Mirmirani, S., and H. C. Li. 2004. "A Comparison of VAR and Neural Networks with Genetic Algorithm in Forecasting Price of Oil." *Advances in Econometrics* 19 (2004): 203-23.

Moshiri, S., and F. Foroutan. 2006. "Forecasting Nonlinear Crude Oil Futures Prices." *The Energy Journal* 27 (4): 81-95.

Mostafa, M. M., and A. A. El-Masry. 2016. "Oil Price Forecasting Using Gene Expression Programming and Artificial Neural Networks." *Economic Modelling* 54 (C): 40-53.

Peng, Y., C. Yuan, X. Qin, J. Huang, and Y. Shi. 2014. "An Improved Gene Expression Programming Approach for Symbolic Regression Problems." *Neurocomputing* 137 (2014): 293-301.

Pincheira-Brown, P., and N. Hardy. 2019. "Forecasting Base Metal Prices with the Chilean Exchange Rate." *Resources Policy* 62 (C): 256-81.

Rubaszek, M., Z. Karolak, and M. Kwas. 2020. "Mean-Reversion, Non-Linearities and the Dynamics of Industrial Metal Prices: A Forecasting Perspective." *Resources Policy* 65 (C): 1-8.

Rubaszek, M., Z. Karolak, M. Kwas, and G. Uddin. 2020. "The Role of the Threshold Effect for the Dynamics of Futures and Spot Prices of Energy Commodities." *Studies in Nonlinear Dynamics and Econometrics* 24 (5): 1-20.

Xie, W., L. Yu, S. Xu, and S. Wang. 2006. "A New Method for Crude Oil Price Forecasting Based on Support Vector Machines." Conference proceedings, Computational Science–ICCS 2006: 6th International Conference, Reading, United Kingdom, May 28-31, 2006.

Yu, L., S. Wang, and K. K. Lai. 2008. "Forecasting Crude Oil Price with an EMD-Based Neural Network Ensemble Learning Paradigm." *Energy Economics* 30(5): 2623-35.

Yu, L., Y. Zhao, and L. Tang. 2014. "A Compressed Sensing-Based AI Learning Paradigm for Crude Oil Price Forecasting." *Energy Economics* 46 (C): 236-45.

Zheng, J., J. Cheng, and Y. Yang. 2014. "Partly Ensemble Empirical Mode Decomposition: An Improved Noise-Assisted Method for Eliminating Mode Mixing." *Signal Processing* 96 (B): 362-74.

Commodity Markets Outlook: Selected Topics, 2011-23

Topics	Date
Pandemic, war, recession: Drivers of aluminum and copper prices	October 2022
The impact of the war in Ukraine on commodity markets	April 2022
Urbanization and commodity demand	October 2021
Causes and consequences of metal price shocks	April 2021
Persistence of commodity shocks	October 2020
Set up to fail? The collapse of commodity agreements	April 2020
A Shock Like no Other: The Impact of COVID-19 on Commodity Markets	April 2020
The role of substitution in commodity demand	October 2019
Innovation, disruptive technologies, and substitution among commodities	October 2019
Oil market implications of the strike on Saudi Arambo facilities	October 2019
Food price shocks: Channels and implications	October 2019
The implications of tariffs for commodity markets	October 2018
The changing of the guard: Shifts in commodity demand	October 2018
Oil exporters: Policies and challenges	October 2018
Investment weakness in commodity exporters	January 2017
OPEC in historical context: Commodity agreements and market fundamentals	October 2016
From energy prices to food prices: Moving in tandem?	July 2016
Resource development in era of cheap commodities	October 2016
Weak growth in emerging market economies: What does it imply for commodity markets?	January 2016
Understanding El Niño: What does it mean for commodity markets?	October 2015
Iran nuclear agreement: A game changer for energy markets?	October 2015
How important are China and India in global commodity consumption?	July 2015
Anatomy of the last four oil price crashes	October 2015
Putting the recent plunge in oil prices in perspective	January 2015
The role of income growth in commodities	October 2014
Price volatility for most commodities has returned to historical norms	July 2014
The nature and causes of oil price volatility	January 2014
A global energy market?	July 2013
Global reserves, demand growth, and the “super cycle” hypothesis	July 2013
The “energy revolution,” innovation, and the nature of substitution	January 2013
Commodity prices: levels, volatility, and comovement	January 2013
Which drivers matter most in food price movements?	January 2013
Induced innovation, price divergence, and substitution	June 2012
The role of emerging markets in commodity consumption	June 2012
WTI-Brent price dislocation	January 2012
Metals consumption in China and India	January 2012
China, global metal demand, and the super-cycle hypothesis	June 2011

ECO-AUDIT

Environmental Benefits Statement

The World Bank Group is committed to reducing its environmental footprint. In support of this commitment, we leverage electronic publishing options and print-on-demand technology, which is located in regional hubs worldwide. Together, these initiatives enable print runs to be lowered and shipping distances decreased, resulting in reduced paper consumption, chemical use, greenhouse gas emissions, and waste.

We follow the recommended standards for paper use set by the Green Press Initiative. The majority of our books are printed on Forest Stewardship Council (FSC)-certified paper, with nearly all containing 50-100 percent recycled content. The recycled fiber in our book paper is either unbleached or bleached using totally chlorine-free (TCF), processed chlorine-free (PCF), or enhanced elemental chlorine-free (EECF) processes.

More information about the Bank's environmental philosophy can be found at http://www.worldbank.org/corporateresponsibility.

Global commodity prices fell 14 percent in the first quarter of 2023, and by the end of March, they were roughly 30 percent below their June 2022 peak. The unwinding of prices reflects a combination of slowing economic activity, favorable winter weather, and a global reallocation of commodity trade flows. Commodity prices are expected to fall by 21 percent this year and remain mostly stable in 2024, although the outlook is subject to multiple risks in a highly uncertain environment. These risks include intensification of geopolitical tensions, the strength of demand from China following its post-COVID reopening, likely energy supply disruptions, and weather conditions, including the emerging El Niño.

A Special Focus section evaluates the performance of several approaches used to forecast prices of seven industrial commodities. It finds that futures prices, which are widely used for price forecasts, often lead to large forecast errors. Time-series models based on multiple independent variables tend to outperform other model-based approaches as well as futures prices. Machine-learning techniques yield better forecasts than some of the traditional approaches. The analysis suggests that augmenting model-based forecasting approaches—by incorporating the dynamics of commodity prices over time and controlling for other economic factors—enhances forecast accuracy.

The World Bank's *Commodity Markets Outlook* is published twice a year, in April and October. The report provides detailed market analysis for major commodity groups, including energy, metals, agriculture, precious metals, and fertilizers. Price forecasts for 46 commodities are also presented together with historical price data. Commodity price data updates are published separately at the beginning of each month.

The report and data can be accessed at:

www.worldbank.org/commodities

WORLD BANK GROUP