Commodity Special Feature: Market Developments and the Inflationary Effects of Metal Supply Shocks

Primary commodity prices increased between February and August 2024, driven by natural gas, precious metal, and beverage prices. In oil markets, supply cuts by OPEC+ (Organization of the Petroleum Exporting Countries plus selected nonmember countries, including Russia) and geopolitical tensions in the Middle East offset strong non-OPEC+ supply growth. Beverage prices continued their ascent, which was driven by the impact of El Niño on tropical crops. Gold prices soared owing to geopolitical uncertainty and rising anticipation of rate cuts. This Special Feature analyzes the role of metals in the economy and their impact on inflation.[1]

Commodity Market Developments

Oil prices steadied between February and August 2024 amid OPEC+ production cuts and Middle East tensions. Before weakening in September, oil prices held steady, with oil trading in a range of $75 to $90 a barrel between February and August, averaging $83 a barrel. Oil demand growth for this year was expected to match its 21st century average, but this forecast was surrounded by great uncertainty (Figure 1.SF.1, panel 3).[2] Deep production cuts by OPEC+, totaling 5.86 million barrels per day (mb/d), have put a floor on prices, partially offsetting strong output growth in non-OPEC+ countries, led by Canada, Guyana, and the United States (Figure 1SF.1, panel 4).

Fears of a broader regional escalation of tensions in the Middle East have added a volatile risk premium to oil prices, though no major supply disruptions have occurred so far. A rise in Red Sea maritime attacks has dislocated seaborne oil flows, decreasing traffic through the Suez Canal by almost two-thirds and largely rerouting it around the Cape of Good Hope, though tanker rates for both products and crude oil

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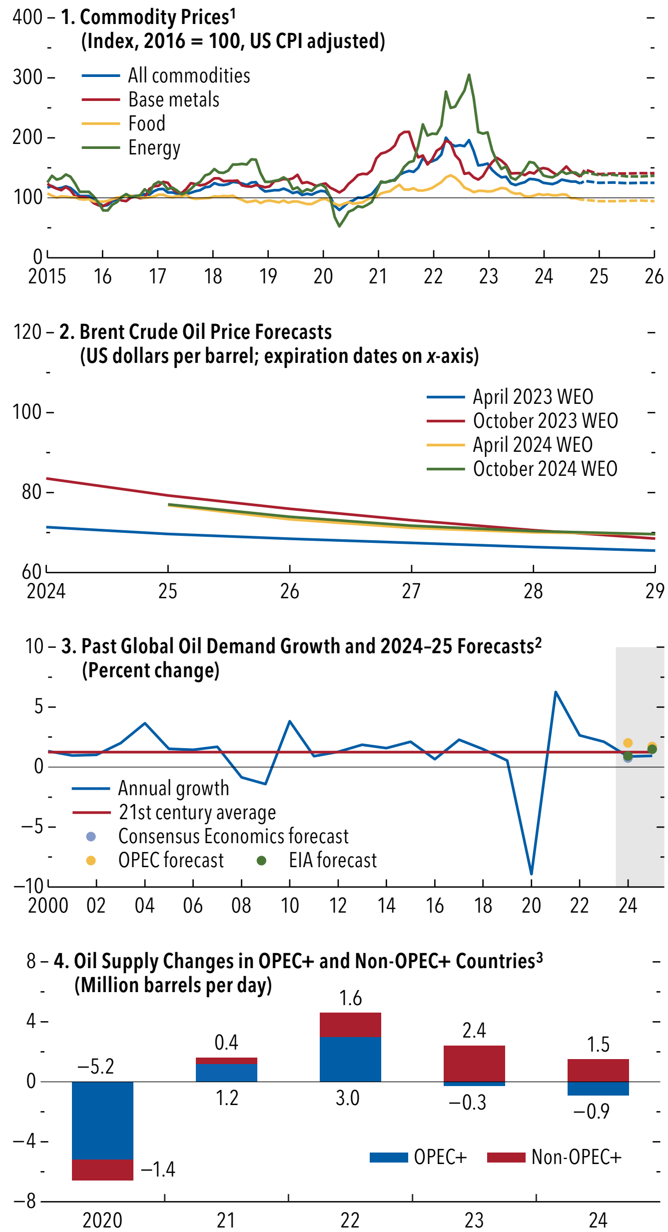
[2]As of its September reports, the International Energy Agency forecasts 0.90 million barrels a day (mb/d) in average demand growth for 2024, compared with OPEC's 2.00 mb/d, the US Energy Information Administration's 0.94 mb/d, and Consensus Economics' polling of 0.75 mb/d. Most of the discrepancy relates to the pace of demand growth in economies outside of the Organisation for Economic Co-operation and Development.

Figure 1.SF.1. Commodity Market Developments



Sources: Bloomberg Finance L.P.; Consensus Economics (CE); Haver Analytics; IMF, Primary Commodity Price System; International Energy Agency (IEA); Refinitiv Datastream; US Energy Information Administration (EIA); and IMF staff calculations.

Note: CPI = consumer price index; OPEC = Organization of the Petroleum Exporting Countries; WEO = *World Economic Outlook*.

[1]Latest actual CPI value is applied to the dashed forecast.
[2]Data on past growth are from the IEA. 2024–25 forecast area is shaded. Baseline blue line in shaded area represents IEA forecast. Forecasts from CE, OPEC, and EIA are also included. CE does not have a 2025 forecast. All forecasts are from the latest September 2024 reports of the respective entities.
[3]OPEC+ denotes OPEC members plus some other oil-producing countries. Numbers are adjusted to account for Angola's departure from OPEC. Data are from the IEA, which assumes an extension of OPEC+ cuts for 2024.

have dropped back to pre-conflict prices. Russian oil, exported primarily to China and India, has been trading above the Group of Seven price cap for most of the past year—but at a $15–$20 discount to Brent.

Futures markets suggest that prices will rise by 0.9 percent year over year to average $81.3 a barrel in 2024 and then fall to $67.0 in 2029 (Figure 1.SF.1, panel 2). Risks to this outlook are tilted to the downside. Upside price risks from an escalation of the Middle East conflict or from a prolonged extension of OPEC+ cuts are outweighed by risks of weaker oil demand in China and the United States—which collectively account for almost 40 percent of global demand—as well as in Japan and other advanced economies, and a rise in OPEC+ production to regain market share.

Natural gas prices rose because of weather and supply concerns. Title Transfer Facility (TTF) trading hub prices in Europe rose 26.4 percent between February and August to $10.2 a million British thermal units (MMBtu), though they remain well below their peak in 2022. Price increases were driven by warmer-than-expected summer weather in the Northern Hemisphere and a potential cutoff from Russia's remaining Europe-destined pipeline gas. Subdued economic activity in the European Union and high storage levels capped further price increases. For liquefied natural gas, Asian prices increased by 49.8 percent following strong import demand from Japan and especially China and India, and US Henry Hub prices rose by 16.8 percent. Futures markets suggest that TTF prices will average $10.4/MMBtu in 2024, decreasing to $8.2/MMBtu in 2029. Henry Hub prices may rise from $2.3/MMBtu in 2024 to $3.6/MMBtu in 2029, as US export capacity is expected to almost double through 2027, according to the US Energy Information Administration. Risks to this outlook are balanced.

Metals prices increased. The IMF's metals price index increased by 7.7 percent between February and August 2024 (Figure 1.SF.1, panel 1). Gold prices surged by 21.9 percent to record highs against the US dollar, driven by geopolitical uncertainty, expectations of US rate cuts, and past US consumer price index (CPI) inflation. Conversely, iron ore prices fell by 19.9 percent, affected by reduced demand from the steel and construction sectors in China. Copper (aluminum) prices soared by 8.1 (7.8) percent, reaching a record nominal high in early July, fueled by growing demand from renewable energy sources, electricity grids, electric vehicles, and data centers. However, starting in July, both copper and aluminum prices retrenched on account of weaker demand projections from China.

Agricultural commodity prices declined. Between February and August 2024, the IMF's food and beverages price index decreased slightly, by 2.4 percent, as large price increases for beverages were more than offset by decreases in prices for other food categories. Cereal prices declined by 14.3 percent, with global grain production forecast to reach a record high over marketing year (MY) 2024–25. Cocoa prices increased by 20.4 percent, peaking at a record high in April, in line with expectations by the International Cocoa Organization of an 11 percent decline in global cocoa supply for MY 2023–24 on account of El Niño and crop diseases in West Africa. Coffee prices rallied, rising by 33.8 percent, following weather-related supply concerns in key producers Brazil and Vietnam. Rice prices declined by 7.5 percent, retreating from a multiyear peak reached in January of this year, as crop conditions improved in India and other parts of Asia. Upside risks stem from further trade disruptions in the Black Sea and new food export restrictions. Larger-than-expected harvests constitute the most important downside risk.

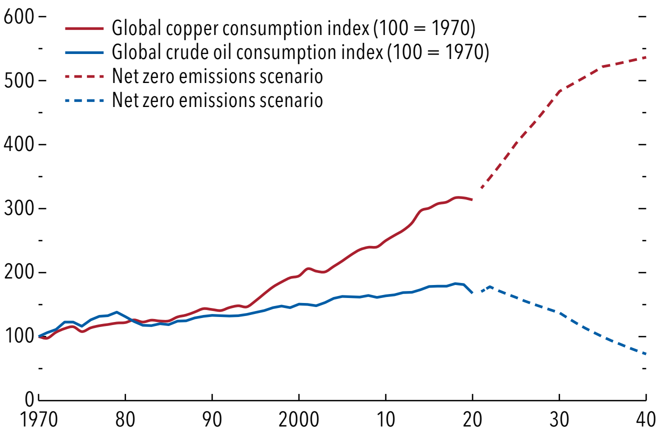
Metals Matter: The Economic Relevance of Critical Inputs

Since the end of World War II, oil has played a major role, among commodities, as a source of shocks for the global economy and inflation (see, for example, Hamilton 1983; and Kilian 2008, 2009). However, the shift from fossil fuels to metals as inputs to energy systems may render the global economy less oil intensive and relatively more metals intensive (Boer, Pescatori, and Stuermer 2024). The International Energy Agency predicts that demand for copper may grow by a factor of more than 1.5, and the consumption of oil could decline by 25 percent by 2030 in a net zero emissions scenario (Figure 1.SF.2; IEA 2022).

At the same time, metals production could become less reliable because of geopolitical tensions. Since most metals production is geographically concentrated (more so than that of oil) and most metals are not easily substitutable, trade disruptions could lead to sharp swings in prices, with a growing economic impact as the global economy and energy systems become more reliant on metals (Alvarez and others 2023).[3]

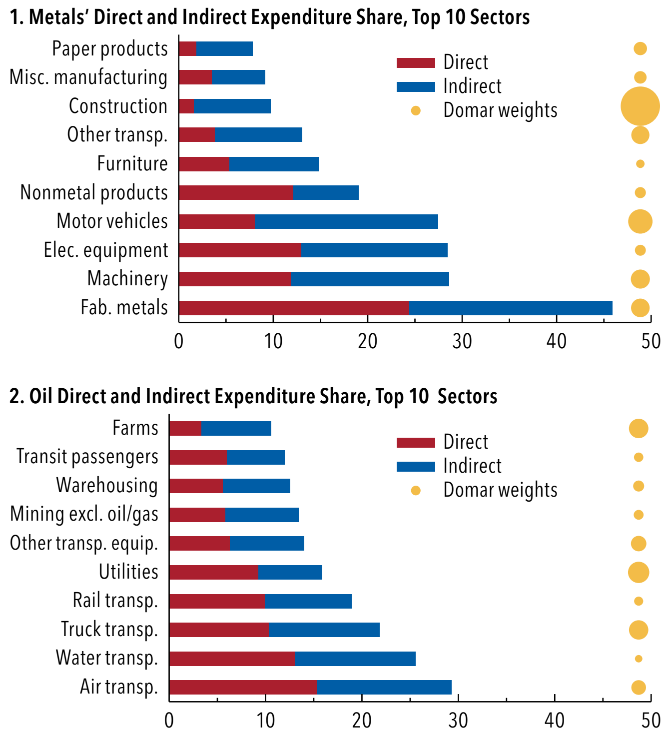
[3]New trade restrictions, including those on metals trade, have almost doubled since the start of the war in Ukraine (Gopinath and others 2024).

Figure 1.SF.2. Consumption of Copper and Oil
(Index)



Sources: Boer, Pescatori, and Stuermer 2024; Schwerhoff and Stuermer 2019; International Energy Agency 2022; and IMF staff calculations.
Note: We assume that consumption equals production in 1970–2020.

Figure 1.SF.3. Intermediate Input Expenditure Share of Metals and Oil in Gross Output in the United States
(Percent)



Source: Miranda-Pinto and others 2024.
Note: "Direct" is sectoral intermediate input expenditure of metals (oil) as a share of sectoral gross output. "Indirect" is Leontief inverse share element minus "Direct." The Domar weight is the ratio of the nominal value of each industry's gross output to GDP and is expressed by the bubble size. The highest Domar weight is for construction (9.59 percent), and the lowest is for water transportation (0.03 percent). We define the metals sector as the sum of the non-oil and non-gas mining sector and the primary metals sector. The oil sector is the sum of the oil and gas mining sector and the petroleum manufacturing sector. equip. = equipment; excl. = excluding; Misc. = miscellaneous; transp. = transportation; Elec. = electrical; Fab. = fabricated.

Employing time series econometrics and a quantitative production network model, this Special Feature investigates how metals are used in an economy and how they affect fluctuations in inflation, using oil as a comparator.

Metals Embodied in Investment Goods

Primary metals are embodied in the production of investment goods in a different way than oil is. In fact, even as metals like copper and aluminum represent only a small fraction of final consumption expenditure (for example, 0.01 percent against 2.6 percent for oil and coal products in the United States), they are critical *direct* intermediate inputs into the production of investment goods. For example, metals represent more than 10 percent of direct input expenditure in US sectors for electrical equipment and machinery (Figure 1.SF.3, panel 1).

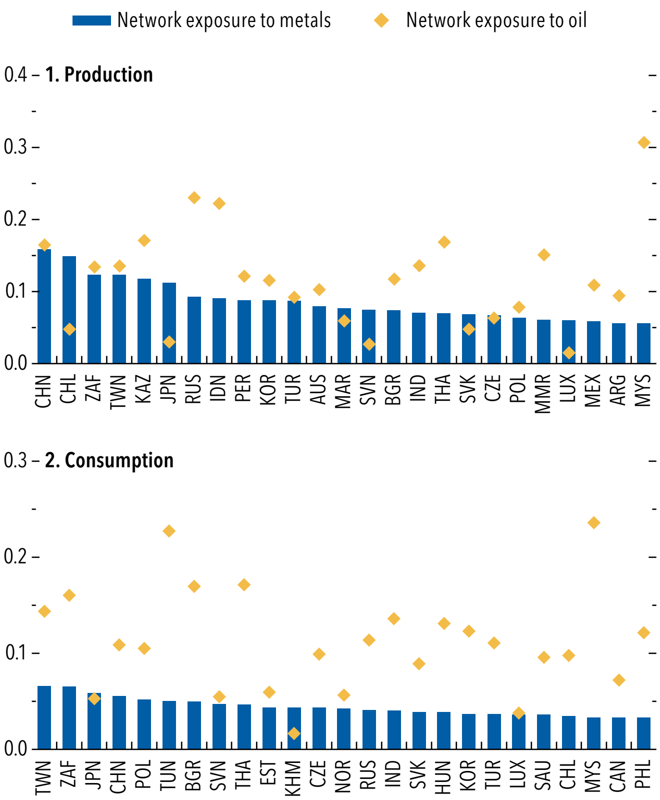
Because metals are embodied in investment goods, they are also *indirect* inputs. For example, to produce vehicles, metals are used not only for the body of the car, but also for the machines used to assemble the car. To capture these indirect effects, a production network model with flexible prices (for example, Balke and Wynne 2000) is used.

As shown later empirically, the fact that key upstream sectors providing capital are highly exposed to metals implies a slower and more persistent response of inflation to metals price shocks. In contrast, gas and petroleum products are much less embodied in machines and investment goods. Instead, they are used chiefly as fuel to produce energy, mostly in transportation (air, water, truck, rail) and utilities (Figure 1.SF.3, panel 2). This makes the effect of an oil price shock on headline inflation more immediate. Once the indirect component is considered, fabricated metals and machinery stand out, with 28 percent and 46 percent shares, respectively, for the United States (Figure 1.SF.3, panel 1). Shares are also sizable for motor vehicles and electrical equipment and appliances.

Metals Are Important in Many Countries' Production Networks

The relevance of metals in the production network is even more pronounced in some countries than in the United States. Figure 1.SF.4 plots the (total input-output network) exposure to metals and oil,

Figure 1.SF.4. Countries' Input-Output Network Exposure to Metals and Oil
(Percent)



Sources: Organisation for Economic Co-operation and Development; and IMF staff calculations.

Note: The figure depicts countries' network exposure for the year 2018. Data labels in the figure use International Organization for Standardization (ISO) country codes. Sectoral exposures are weighted by (1) sectors' value-added share in total value added (panel 1) and (2) sectors' final consumption share.

at the aggregate level, for the top 25 countries, using input-output data from the Organisation for Economic Co-operation and Development.[4] Panel 1 aggregates sectoral exposures to metals and oil using *value-added* shares, which are suited for use in gauging the exposure of an economy to metals and oil on the *production* side. Panel 2 shows the exposure to metals and oil on the consumption side. It uses *final consumption expenditure* shares, the relevant measure for CPI, to construct the consumption exposure, which indicates the percent increase in the CPI of a country following a 10 percent negative supply shock that results in about a 15 (16) percent increase in metals (oil) prices, on average, across countries.

Several results stand out from Figure 1.SF.4. First, the heterogeneity in the exposure of production is starker than the one in the exposure of consumption across countries. This is because consumption preferences are likely similar across countries, leading to less heterogeneity in consumption exposure. At the same time, the location of production of tradable goods is independent of the location of consumption, creating more heterogeneity in production exposure. Moreover, differences in technological adoption also induce significant heterogeneity in sectoral exposures to metals and oil across countries. For instance, whereas the total metal exposure of the motor vehicle sector in the average country is 16 percent, the 10th percentile is 5 percent, and the 90th percentile is 34 percent.

Second, metals are more relevant than oil in production in 7 of the top 25 countries. Nevertheless, once consumption shares are used to aggregate, only three countries display larger exposure to metals than to oil. Indeed, the median CPI exposure is three times larger for oil than for metals.

Third, there are significant cross-country differences. Although the median country has a metals exposure of 0.03, a country in the 90th percentile has an exposure that is five times larger than that of a country in the 10th percentile of the distribution. For instance, a 10 percent supply-driven increase in metals prices would generate a 0.36 percentage point increase in China's CPI, compared with a 0.1 percentage point increase for the United States, according to the network model.

The Impact of Metal Supply Shocks on Inflation

To study the inflationary consequences of metal and oil supply shocks empirically, this Special Feature follows Silva (2023) and uses a small open economy production network model (see Online Annex 1.1).[5] To test the implications of the model, local projections instrumental variables (LP-IV) methods are employed. These estimate the effects of copper and oil price shocks for a balanced panel of 39 countries from 1996 to 2019.[6]

Panel 1 of Figure 1.SF.5 shows the cumulative 12-month effects of copper and oil supply shocks on headline and core inflation. A 10 percent increase in copper prices raises both headline and core inflation by

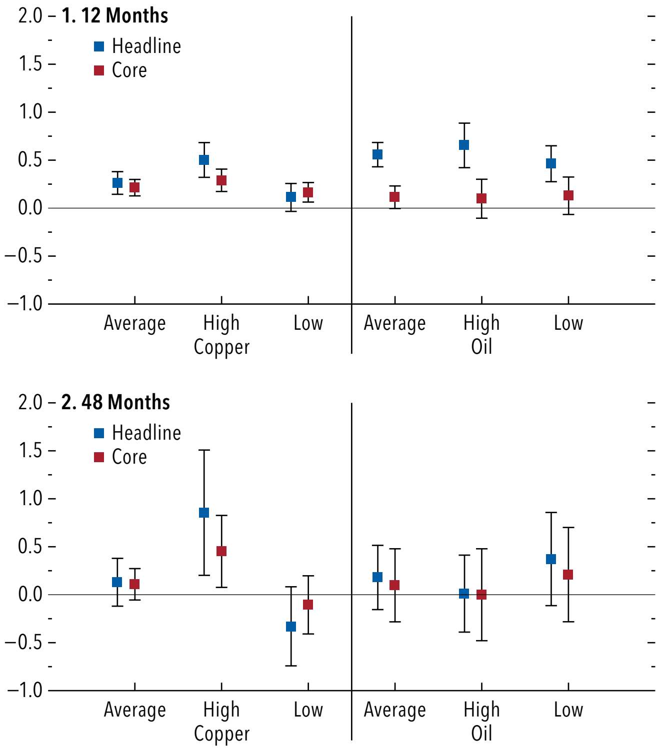
[4]The data cover 45 sectors for 2018 and include imports of intermediates, which are sizable in the case of metals and oil.

[5]All online annexes are available at www.imf.org/en/Publications/WEO.

[6]The instruments for copper and oil prices are the copper supply shocks from Baumeister, Ohnsorge, and Verduzco-Bustos (2024) and the oil supply shocks from Baumeister and Hamilton (2019).

Figure 1.SF.5. Impulse Responses
(Percent)

The figure shows impulse responses to a 10 percent increase in the prices of copper (left side) and oil (right side) for countries with a high (90th percentile) and low (10th percentile) network exposure to metals and oil.



Sources: Baumeister and Hamilton 2019; Baumeister, Ohnsorge, and Verduzco-Bustos 2024; and IMF staff calculations.

Note: Panel 1 shows the 12-month responses, while panel 2 shows the 48-month responses. Copper = impulse responses to copper supply shock. Oil = impulse responses to oil supply shock. "High" and "Low" indicate the 90th and 10th percentiles of network exposure to metals (for copper shock) and oil (for oil shock). Blue and red squares are the response for headline consumer price index (CPI) and core CPI. Whiskers indicate the 90 percent confidence intervals.

about 0.2 percentage point within 12 months, whereas oil price shocks show a substantial effect on headline inflation, but not on core.

There are, however, significant differences in the response of inflation as a function of countries' network exposure to metals and oil. The 12-month cumulative effect of a 10 percent increase in prices on headline (core) inflation is 0.5 (0.3) percentage point for copper and 0.7 (0.1) percentage point for oil in countries with high network exposure to metals and oil. For countries with low network exposure to metals and oil, the effect of a 10 percent increase in prices on headline (core) inflation is 0.1 (0.2) percentage point for copper and 0.5 percentage point (0.1) percentage point for oil.

To highlight the delayed and persistent effects on headline and core inflation, panel 2 of Figure 1.SF.5 shows the cumulative 48-month effects of metal and oil supply shocks. A 10 percent increase in copper prices leads to a cumulative 0.5 percentage point increase over 48 months in core inflation for the group of countries with high network exposure to metals. In contrast, a 10 percent increase in oil prices does not cause any significant increase in core inflation over the long term.[7]

Overall, empirical results underscore the delayed and persistent effects of metals prices on inflation through production networks' long-lasting effects on marginal costs through the cost of capital.[8]

Conclusions and Policy Implications

Primary metals play a major role as intermediate inputs for investment goods in production networks. Given how they enter the production network, metal supply shocks can have significant, persistent effects on core and headline inflation. In contrast, oil supply shocks affect mostly headline inflation.

Does this make the work of central banks easier or more difficult? Central banks have typically "looked through" oil price shocks, provided these shocks were not excessively large. As the energy system moves away from fossil fuels, however, such an approach may not work well when economies face major fluctuations in metals prices.[9] Monetary authorities may eventually need to react to metal supply shocks, because these shocks have a more persistent effect on core inflation. In conclusion, central banks must be prepared for a potentially more metals-intensive global economy in which metals price shocks could become increasingly more relevant. Their impact on inflation may initially appear subtle but could prove to be quite persistent.

[7]The persistence of the copper and oil price shocks is roughly similar. However, copper price shocks have a stronger 48-month effect on copper prices than oil supply shocks have on oil prices. See Online Annex 1.1 for more details. Country heterogeneity is not significant for oil.

[8]The more persistent effect of metals price shocks is consistent with the version of the model with a capital stock (see Online Annex 1.1). Also, since copper represents 30 percent of the IMF's trade-weighted base metals index, these estimates are a lower bound in the case of a supply shock that increases base metals prices by 10 percent, as this effect is expected to be three times greater.

[9]Supply shocks to metals markets are more dispersed than those for oil markets, as they typically do not hit each of the metals markets at the same time. This has so far made the magnitude of supply shocks for the aggregate primary metals sector smaller than that for those in the petroleum sector.