Commodity Special Feature: Market Developments and the Macroeconomic Impact of Declines in Fossil Fuel Extraction

Primary commodity prices declined 28.2 percent between August 2022 and February 2023. The decrease was led by energy commodities, down 46.4 percent. European natural gas prices declined by 76.1 percent amid lower consumption and high storage levels. Base and precious metal prices rebounded by 19.7 and 3.3 percent, respectively, whereas food prices increased slightly, by 1.9 percent. This Special Feature analyzes the impact of declines in the extraction of fossil fuel and other minerals on the macroeconomic activity of commodity exporters.

Commodity Market Developments

Energy prices waver. Crude oil prices retreated by 15.7 percent between August 2022 and February 2023 as the slowing global economy weakened demand (Figure 1.SF.1, panels 1 and 3). China experienced its first annual decline in oil consumption this century amid repeated shutdowns in response to COVID-19 outbreaks and a faltering real estate market. Recession fears due to higher-than-expected inflation and tighter monetary policy in many major economies and banking woes sparked concerns about flagging demand.

On the supply side, uncertainty over the effects of Western sanctions on Russian crude oil exports whipsawed expectations about global market balances. As of March, Russian crude oil exports had held steady since implementation of the Group of Seven (G7) price cap and ban on crude oil imports on December 5. Russia rerouted its oil, reportedly sold at a major discount to Brent oil prices, to nonsanctioning countries, primarily India and China. Downside supply risks did not materialize until Russia's recent announcement of a modest production reduction. A sizable release of strategic petroleum reserves by Organisation for Economic Co-operation and Development member countries also helped keep oil markets well supplied, in part offsetting underproduction and reduced targets by OPEC+ (Organization of the Petroleum Exporting Countries plus selected nonmember countries).

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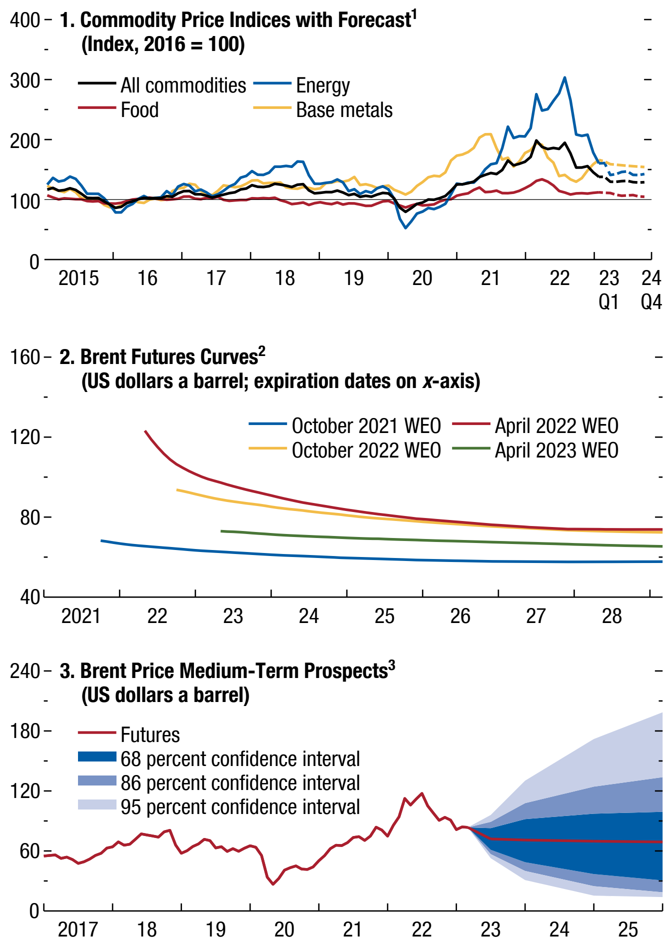
Figure 1.SF.1. Commodity Market Developments



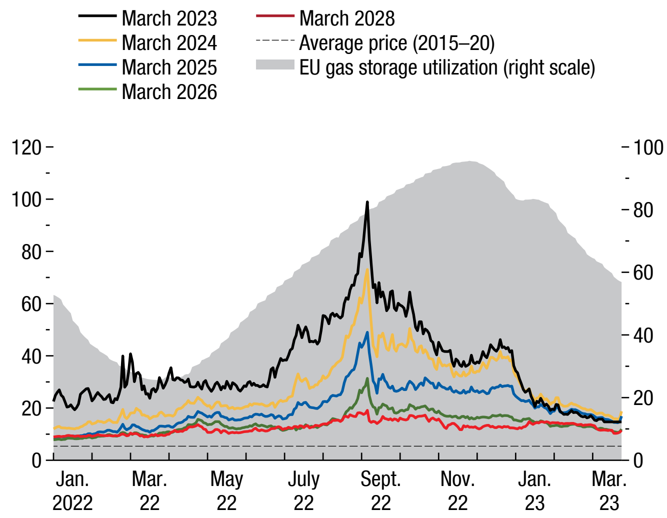
Sources: Bloomberg Finance L.P.; IMF, Primary Commodity Price System; Kpler; Refinitiv Datastream; and IMF staff calculations.
Note: WEO = *World Economic Outlook.*
[1]Adjusted for inflation using the US consumer price index (CPI). Last actual value is applied to the forecast period. Dashed lines are the forecasts from 2023:Q1 to 2024:Q4.
[2]WEO futures prices are baseline assumptions for each WEO and derived from futures prices. Prices in the April 2023 WEO are based on the March 17, 2023 closing.
[3]Derived from prices of futures options on March 17, 2023.

Futures markets suggest that crude oil prices will slide by 24.1 percent, to average $73.1 a barrel, in 2023 (from $96.4 in 2022) and continue to fall in the coming years, to $65.4 in 2026 (Figure 1.SF.1, panel 2). Uncertainty around this price outlook is elevated in part due to the uncertain rebound in China's growth, as well as the energy transition (Figure 1.SF.1, panel 3). Upside price risks stem from potential supply disruptions, including those from Russian retaliation to a binding price cap, and insufficient investment in fossil fuel extraction. Following the financial market turmoil that emerged in mid-March, downside price risks of a widespread global economic relapse have increased significantly.

Natural gas prices at the European Title Transfer Facility trading hub receded 76.1 percent from record highs in August 2022 to $16.7 a million British thermal units (MMBtus) in February 2023 as concerns about supply shortages faded. Prices reached nearly $100 a MMBtu in late August when EU countries raced to refill their gas storage facilities amid fears of supply shortages during the winter. This followed Russia's progressive shutdown of roughly 80 percent of pipeline gas supplies to European countries. Prices in the global liquefied natural gas market followed in lockstep. For the winter of 2022–23, a crisis was averted, with ample storage at European facilities owing to higher liquefied natural gas imports and lower gas demand amid high prices as well as an atypically mild winter. Lower demand due to an economic slowdown in China and substitution of other fuel sources, such as coal, also helped ease pressures on the global liquefied natural gas market. A price decline to historical averages is expected by 2028 (Figure 1.SF.2). Risks of price spikes remain somewhat elevated, however, for next winter. Spillovers from gas markets caused a 50.9 percent slide in coal prices over the reference period.

Metal prices recover after steep drop. The base metal price index dropped below levels preceding Russia's invasion of Ukraine. It surged after the invasion but experienced a broad-based retreat amid slowing Chinese metal demand (accounting for roughly half of global consumption of major metals) and monetary policy tightening. With China's reopening and increased infrastructure spending, as well as an expected slower pace of interest rate hikes from the Federal Reserve, base metal prices partially rebounded, increasing by 19.7 percent from August 2022 to February 2023. Recent banking distress presents significant downside risks to prices. The IMF's energy transition metal index increased 14.3 percent. Gold prices rose by 5.1 percent, and central banks' net purchases broke a 55-year record. The base metal price index is projected to increase 3.5 percent in 2023 and

Figure 1.SF.2. EU Gas Storage and Futures Contract Prices
(US dollars per million British thermal units; percent)

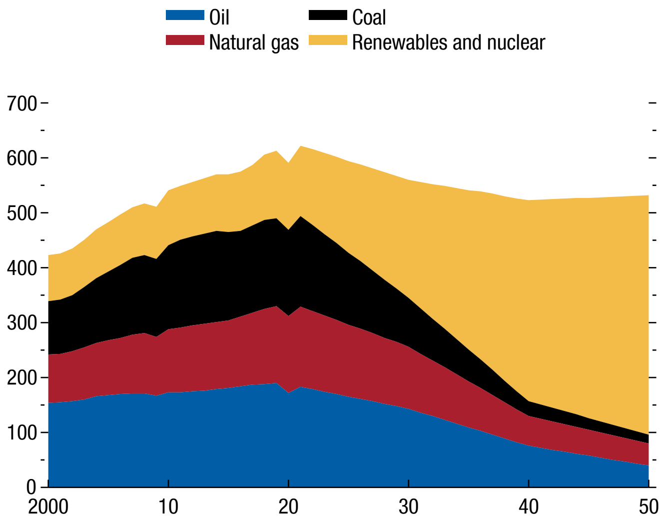


Sources: Argus Direct; Bloomberg L.P.; Gas Infrastructure Europe (GIE); and IMF staff calculations.
Note: European Union country coverage by the GIE definition. Dates in legend are Dutch Title Transfer Facility (TTF) futures contracts expiration date.

then decrease 2.6 percent in 2024. Traders seem to price in a potential rebound in demand from China.

Agricultural prices continue on a downward trend. Drawdowns of stocks of staple foods in major exporting countries, due to major shocks in the past two years from the pandemic and the war in Ukraine, have stopped as supply and demand have reacted to higher prices. Food and beverage prices peaked in May 2022 and are up 1.3 percent from last August. They remain 22.3 percent above the past-five-year average and 39.1 percent above pre-pandemic levels. The supply outlook improved as Ukrainian wheat and other products entered the global market after the Black Sea corridor initiative was renewed last November. High prices also provided incentives to other regions, such as the European Union and India, to step up wheat production. However, some of the correction has likely come from demand destruction of price-elastic components such as meat and biofuels. Risks remain balanced as spillovers from gas to fertilizer prices and a possible abrupt ending of the Black Sea corridor deal offset possibly reduced consumption and a potentially stronger supply reaction. Prices of raw agricultural materials declined by 9.1 percent from last August amid slowing global demand but, like base metal prices, have partly rebounded in recent months.

Figure 1.SF.3. Global Fossil Fuel Production Declines 60 Percent in a Net Zero Emissions Scenario
(Exajoule)



Sources: International Energy Agency; and IMF staff calculations.
Note: Renewables include solar, wind, hydro, bioenergy, and traditional use of biomass. Fossil fuel production includes fossil fuels for non-energy use (for example, petrochemicals) as well as carbon capture and storage abatement.

The Macroeconomic Impact of Declines in Fossil Fuel Extraction

Reaching net zero emissions by 2050 will require an 80 percent reduction in global fossil fuel extraction compared with 2021 levels, according to the International Energy Agency (2022) (Figure 1.SF.3). Though the situation is highly uncertain, it is worth asking what economic repercussions a contraction in fossil fuel extraction could have for fossil fuel exporters. A large amount of literature emphasizes the negative impact a sizable extraction industry has on a country's economic growth (the *resource curse*) because it weighs on the performance of the manufacturing sector (Krugman 1987; Frankel 2012) and on the quality of institutions (Mauro 1995; Lane and Tornell 1996).[1] There is, however, a dearth of analysis on the macroeconomic effects of a reversal, to the extent that there is still debate over whether a *decline* in fossil fuel production is detrimental or beneficial to countries' economic growth.[2]

This Special Feature contributes to filling this gap by estimating the macroeconomic impact of persistent declines in extraction activity.[3] It focuses on production declines, given that the effects of climate policies on fossil fuel prices are uncertain, depending on whether policies curbing demand for fossil fuels will prevail over those curbing their supply (see the April 2022 *World Economic Outlook*). Even though production declines will likely vary substantially and are hard to anticipate, these estimates can help inform fossil-fuel-exporting countries' medium- to long-term planning and policies.

Countries depending on fossil fuel output: Between 2010 and 2019, average oil and gas production-to-GDP ratios were large in countries such as Angola, Azerbaijan, the Republic of Congo, Kuwait, and Saudi Arabia (Figure 1.SF.4 panel 1). Gas production is particularly relevant in Qatar and Trinidad and Tobago. Coal production, on the other hand, is less relevant to GDP at the country level, except in the case of Mongolia. Most extracted fossil fuels are exported and so are a fundamental source of cash inflows in economies' external balance. Indeed, ratios of net exports of oil and gas to GDP surpassed 25 percent on average over 2010–2019 in more than ten countries (Figure 1.SF.4 panel 2). The oil and gas sector is also a substantial contributor to tax revenues and, to a lesser extent, to employment (see Online Annex Figures 1.SF.1 to 1.SF.4).[4]

A new data set on declines in extraction: The empirical exercise conducted for this Special Feature relies on a new data set on the extraction of oil, coal, gas, and metals for countries worldwide from 1950 to 2020. To deal with endogeneity, the analysis identifies 35 episodes involving persistent declines in extractive activity out of a total of 154 observed episodes. It verifies that these episodes are driven by factors exogenous to economic conditions such as depletion or sector-specific policy changes. For example, included are episodes such as the sudden tax increase on bauxite mining in Suriname in 1974, which led to a persistent

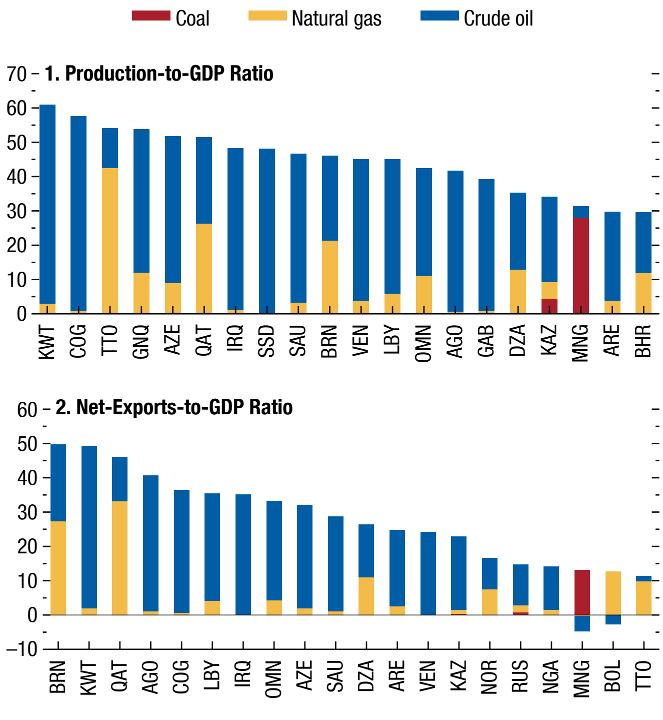
[1]"Dutch disease" is a version of the resource curse in which an increase in commodity prices leads to a real exchange rate appreciation that crowds out a commodity exporter's domestic manufacturing sector. Total output can still expand, and the country can become richer. See Brunnschweiler and Bulte (2008) and van der Ploeg and Venables (2012).

[2]A small body of literature examines the local effects of mining booms and busts. See Black, McKinnish, and Sanders (2005); Jacobsen and Parker (2016); Cavalcanti, Da Mata, and Toscani (2019); Watson, Lange, and Linn (2023); and Hanson (2023).

[3]This Special Feature is based on Bems and others (forthcoming).

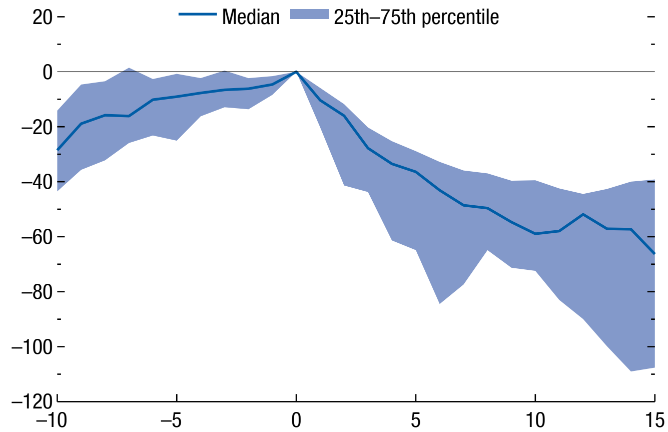
[4]All online annexes are available at www.imf.org/en/Publications/WEO.

Figure 1.SF.4. Top Twenty Countries by Share of Fossil Fuel Production and Net Exports in GDP
(Percent)



Sources: International Energy Agency; United Nations Comtrade database; World Bank; and IMF staff calculations.
Note: Ratios are computed annually and averaged over 2010–2019. Prices are taken at the regional level in US dollars. Iran is excluded due to data limitation. Country list uses International Organization for Standardization (ISO) country codes.

Figure 1.SF.5. Episodes of Extraction Declines
(Percent)



Sources: Bems and others (forthcoming); and IMF staff calculations.
Note: *X*-axis unit is years before and after peak extraction year.

contraction in bauxite output (other examples feature in Bems and others, forthcoming). Extraction declines driven by global recessions, policy decisions directly affecting other sectors of an economy, and structural transitions such as the breakup of the Soviet Union and civil wars are excluded. Across those identified, the *typical* episode is a 10 percent contraction in extraction activity in the episode's first year that cumulates to a 40 percent reduction over 10 years (Figure 1.SF.5).

Estimating the macroeconomic effects of declines in extractive activity: Following Jordà (2005), local projections are used to estimate the effects of episodes of persistent exogenous extraction declines on real GDP and the external and domestic sectors using the following:

$$y_{t+h,i} - y_{t-1,i} = \alpha + \beta^h \Delta q_{t,i} + \sum_{j=1}^{p} \Gamma_j^h y_{t-j,i} + \sum_{j=1}^{p} \Pi_j^h \Delta q_{t-j,i} + \psi_n + \phi_t + u_{t+h,i} y_{t+h,i} - y_{t-1,i}.$$

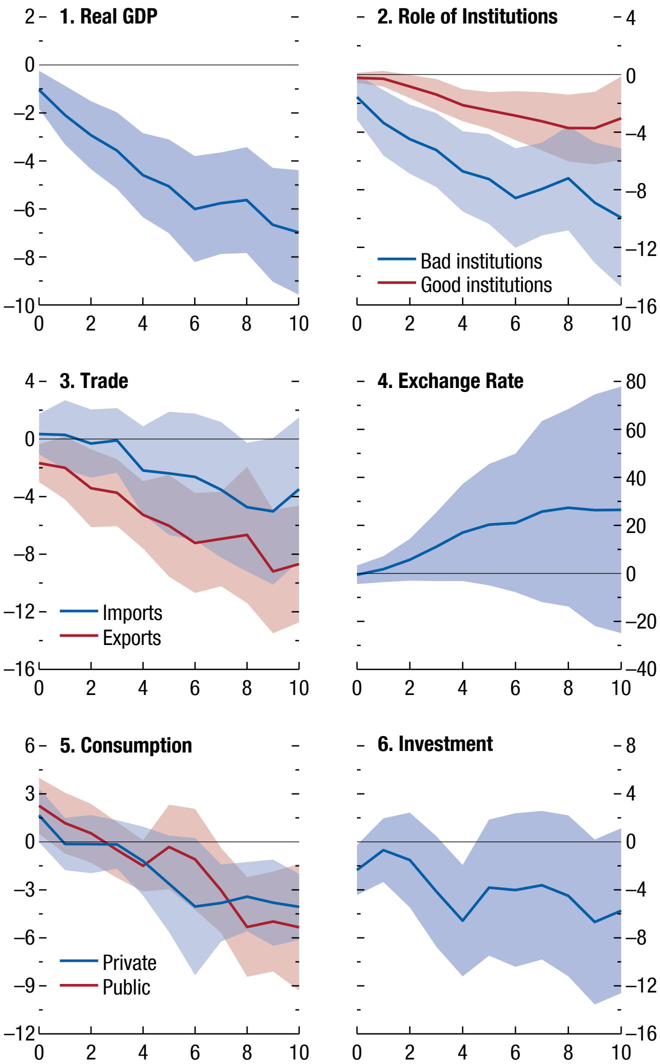
The equation's left side represents the log deviation of the variable of interest from its initial value over the horizon h, up to 10 years. Results may thus be interpreted as cumulative percentage changes from the baseline to a shock in year t. The term $\Delta q_{t,i}$ captures the percentage change in extraction output for episode i at year t. The baseline includes country fixed effects ψ_n to account for structural differences across countries, time fixed effects ϕ_t to control for global price movements and other common global factors, as well as three lags of the dependent variable, and a shock series to deal with autocorrelation, following Montiel Olea and Plagborg-Møller (2021).

Negative macroeconomic effects: A typical episode leads to a 1 percent initial decline from the baseline in real GDP, cumulating to 5 percent after five years. The decline is persistent, with no rebound until the end of the horizon (Figure 1.SF.6, panel 1).

The real exchange rate depreciates slowly by 20 percent. This does not stimulate enough reallocation of production factors such as labor and capital toward tradables sectors, which could offset the decline in exports that depend on extractive industries. Instead, the trade balance worsens, driven by a decline in exports of about 6 percent (Figure 1.SF.6, panel 3). Imports and investment also decline, though the estimates for these effects are less precise. Aggregate consumption responds only with a lag of more than five years.

The role of manufacturing: Spillover effects on the manufacturing and services sectors are significant and negative. Their value added falls significantly by about 5 percent (Bems and others, forthcoming).

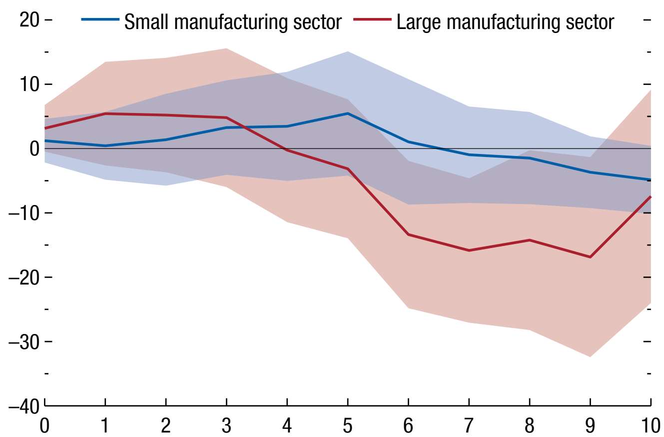
Figure 1.SF.6. Responses of Macroeconomic Variables to an Extraction Decline Shock
(Percent)



Sources: Bems and others (forthcoming); and IMF staff calculations.
Note: The unit of the *x*-axis is years after the shock. Shaded areas represent 90 percent confidence intervals.

These sectors provide mining sector inputs and process outputs. The negative impact more than offsets the potential benefits of the depreciation in the real exchange rate. The initial share of the manufacturing sector in value added matters. Economies with bigger initial manufacturing shares fare better, suggesting the presence of sunk costs in the tradables sector that favor existing exporting manufacturing firms over new ones. The negative impact on employment is, on the other hand, small, likely owing to the high capital intensity of the extraction sector.

Figure 1.SF.7. Response of Institutional Quality Interacted with Manufacturing Sector Size to an Extraction Decline Shock
(Percent)



Sources: Bems and others (forthcoming); and IMF staff calculations.
Note: The unit of the *x*-axis is years after the shock. Shaded areas represent 90 percent confidence intervals.

The role of institutions: The estimated GDP impact is significantly larger for middle- and low-income countries than for those with high incomes. One plausible explanation for this is that high-income countries tend to have stronger institutions. Five years after the shock, the GDP difference between countries with high and low institutional quality is about 5 percentage points (Figure 1.SF.6, panel 2). This could indicate that strong institutions help buffer the negative economic effects of a persistent decline in extraction activity. While explaining what determines the quality of institutions is beyond the scope of this analysis, the economic literature on the resource curse emphasizes that resource booms can lead to a deterioration in the quality of institutions. What happens, however, in the reverse, a resource extraction bust? The exercise shows that a decline in extraction activity does *not* restore the quality of institutions, not even a decade after the shock. This suggests a hysteresis effect and an asymmetric response of institutions to shocks: once institutions are damaged, improving them is hard (see Figure 1.SF.7).

Anticipation: It could bias the results toward a smaller estimated impact if the regression does not capture earlier adjustment. To explore anticipation, projections of commodity production in IMF Article IV reports are reviewed and compared with actual production. Out of 26 decline episodes with Article IV coverage, only 4 were anticipated. In the other 22, extraction was expected either to increase or to remain stable (or in a few cases, it was not mentioned). The lack of anticipation, in turn, suggests that uncertainty about the size and persistence of the ensuing contraction may have delayed the economic adjustment needed, surprising the country's policymakers and private sector alike. In fact, both private and public consumption initially increase, declining only with a delay to a 4 percent lower level. This suggests that the shock was typically not fully anticipated, or income-side policies are implemented to buffer the initial impact, or both. Accordingly, the exchange rate moves in only a modest and statistically nonsignificant way.

A More Challenging Energy Transition: Countries at risk of declining fossil fuel output need to address the possibility of a challenging structural adjustment. To do so, they can improve public finances and the quality of their institutions (for example, by enhancing the management of public sector institutions and the regulatory business environment), diversify their economies (Cherif and others 2022), set up sovereign wealth funds, and facilitate the reallocation of production factors. Possible policies for accomplishing these goals include ameliorating the business environment to attract investment in new, productive, higher-value-added sectors; modernizing infrastructure and attracting foreign direct investment in research and development; and improving the human capital stock of the labor force by investing in education.

The pace and direction of the clean energy transition as well as the price outlook depend on the policy mix. This creates great uncertainty in countries that produce fossil fuels. If fossil fuel prices decline because of a climate policy mix that works mostly through the demand side, high-cost producers will need to shut down production. If those prices instead rise based on a climate policy mix that relies on supply cuts, local production declines will depend on domestic policy decisions (see the Special Feature in the April 2022 *World Economic Outlook*). Climate policy certainty, at the country and global levels, could make adjustments more predictable and less costly.