Rising input prices add unwanted pressure on the already fragile global food economy

Josef Schmidhuber
Bing Qiao

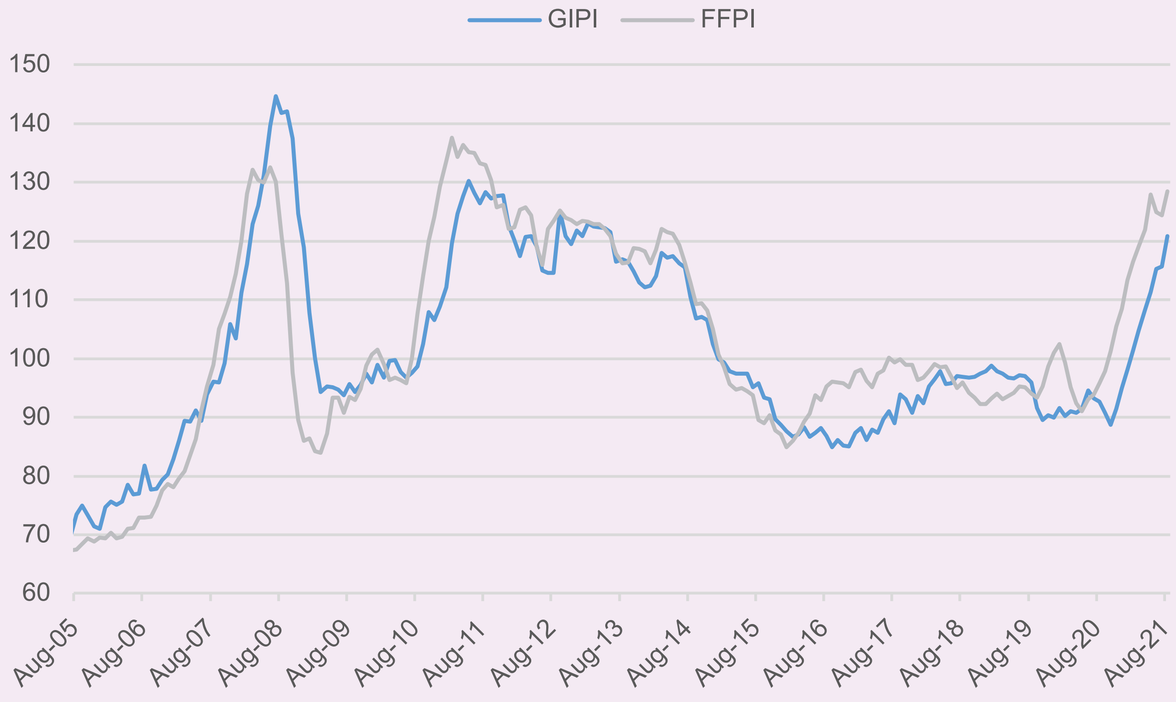
The context

The recent upsurge in agricultural input prices has triggered considerable alarm about rising costs of food production, which in a free market economy will be typically passed onto consumers through higher food prices. Already, the impacts on prices are captured by the rising FAO Food Price Index (FFPI), which reached a ten-year high in August 2021. This appears to be supported by developments in input prices, as evidenced by the newly constructed Global Input Price Index (GIPI, see Box and Figure 1).

This Special Feature examines the pathways and impacts of rapidly rising input prices, especially those of energy derived from fossil fuels, which can have detrimental effects on the global food economy in terms of their influence on food prices and future price developments, as well as their likely consequences for global food security. In addition, emphasis is duly placed on those most likely to be hit the hardest – consumers in economically-vulnerable, import-dependent countries, given that much of their income is spent on food and energy, bringing about high exposure.

A number of fundamental features of agricultural markets emerge from Figure 1. **Firstly,** the rapid rise and the current multiyear high in international food prices are bewing accompanied by an equally rapid rise and a multiyear high in (variable) production costs. The near synchronous change in revenues and costs keeps overall farm profitability in check. **Secondly,** this co-movement between agricultural product prices and agricultural input prices is a general

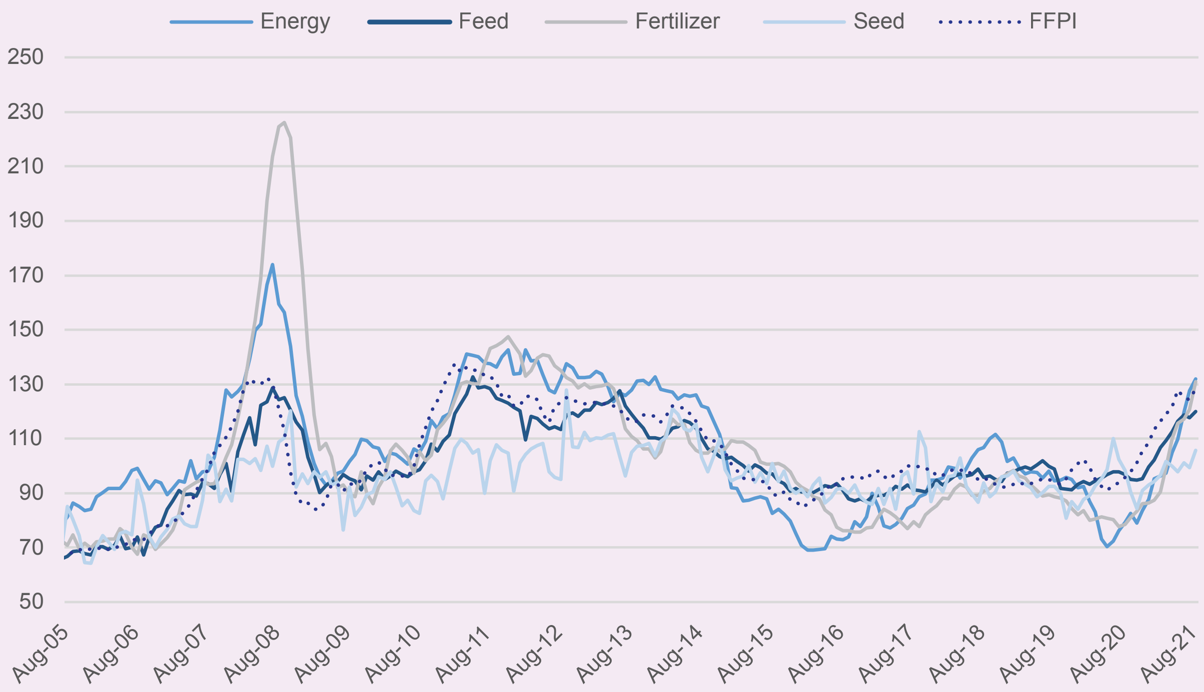
Figure 1. Monthly Global Input Price Index versus the FFPI (2014–16 = 100), August 2005 to August 2021



Source: FAO Food Price Index (FFPI), FAOSTAT, Trade Data Monitor (TDM), authors' calculations feature that has characterized international markets for the past decades.[1] **Thirdly**, the difference between the food price and the input price indices should not be construed as absolute (gross) margins; it can merely capture changes in gross margins. As such, its evolution over time suggests that all other things being equal, producer benefits from two lines only captures changes in gross margins, not in the net margins themselves.

Figure 2 underscores the global tendencies of Figure 1, by way of presenting subindices for energy, fertilizers, feed and seed prices (which form the GIPI), where it is shown that their current momentum is matching that of the FFPI.[2]

Figure 2. Monthly GIPI by input and the FFPI (2014–16 = 100), August 2005 to August 2021



Source: FAO Food Price Index (FFPI), FAOSTAT, Trade Data Monitor (TDM), authors' calculations

rising farm and food prices are swiftly offset by rapidly rising costs/input prices. **Fourthly**, while changes in production costs generally lead the changes in output prices, a closer inspection of the two series suggests that input costs can also follow output prices. To gain better insights into "causality" between input and output price, a deeper econometric analysis will be required. **Fifthly**, the aggregate, global picture is likely to mask large regional and sector-specific differences within agriculture. For instance, most soybean producers are presently operating at relatively large positive gross margins, facing lower needs of currently expensive (nitrogen) N-fertilizer and, at the same time, enjoying high product prices. Pig producers, by contrast, face low meat prices and high feed costs, often resulting in low gross margins and even negative net margins. **Finally**, it needs to be emphasized that the GIPI only captures variable costs, such that the movement in the difference between the

[1] The strong co-movement of the GIPI and the FFPI can be partly explained by the relatively high weight of feeds in the GIPI. The FFPI covers the same or similar commodities as food items, notably a number of grains and oil meals.

What is driving the GIPI?

Table 1 presents 12-month changes in the GIPI constituents, as well as the FFPI. It shows that in the past 12 months for which data are available (Jun/Aug 2020 to Jun/Aug 2021), all indexed prices of (internationally traded) inputs have increased, with energy (66 percent) and fertilizers (56 percent) standing out, but also a significant increase in feed (22 percent). Over this same period, the FFPI rose by 34 percent, while the GIPI increased overall by 25 percent.

Table 1. Absolute change in input price subindices, the overall GIPI and the FFPI (%)

	Energy	Feed	Fertilizer	Seed	GIPI	FFPI
Jun/Aug 2019 to Jun/Aug 2020	-21	-3	-11	13	-3	-1
Jun/Aug 2020 to Jun/Aug 2021	66	22	56	0	25	34

Source: FAO Food Price Index (FFPI), Trade Data Monitor (TDM), authors' calculations

[2] Both the FFPI and GIPI are depicted in nominal terms.

Box. A Global Input Price Index for agriculture

Agriculture is an input-intensive industry. Food feed and fibre production require large amounts of energy, i.e., fuel in the form of natural gas, electricity and petroleum products, as well as numerous agrichemicals, such as fertilizers, pesticides and lubricants. The prices of these inputs vary widely, and changes in them critically affect the costs of production and ultimately the prices of food and fibre. While FAO produces regular updates of the evolution of food and agricultural prices, no such information is currently available for agricultural inputs. The Global Input Price Index (GIPI) aims to fill this gap.

Data for the GIPI are sourced from Trade Data Monitor (TDM), from which global import unit values (IUVs) of the inputs are calculated. To ensure the coherence and representativeness of the IUVs, spot prices of the various inputs were tested for correlation with their counterpart IUVs (see annex). The findings show a very high degree of correlation, justifying the use of IUVs as a benchmark indicator, notably for inputs where indicative prices are not readily available (for example, for seeds).

The GIPI is an aggregate input price index, with subcomponents consisting of energy, feed, fertilizers and seed. These subcomponents are weighted by their relative 'utilization' shares, which in turn are derived from FAOSTAT commodity balances. The initial quantities are converted into values, applying corresponding IUVs, based on TDM. Given the time lag in reporting by FAOSTAT, and that data are annual, a Laspeyres construct was employed to derive the GIPI.

Specifically, the calculations involve the following steps. In a first step, average monthly trade-weighted IUV for each input product (i) is calculated as follows:

$$\overline{IUV}_{i,t} = \frac{\sum_j IUV_{i,t,j} \times VAL_{i,t,j}^{trade}}{\sum_j VAL_{i,t,j}^{trade}}$$

where $IUV_{i,t,j}$ denotes the import unit value of input *i* in trade flow *j* at time *t*. $VAL_{i,t,j}^{trade}$ is the trade flow, expressed in values for flow *j*.

Next, the average IUVs are aggregated into input price indices, which measure changes in trade prices for a given agricultural input and region. The generalized formulation of the GIPI as a Laspeyres index with fixed weights at t_0 is:

$$GIPI_t = \frac{\sum_i \overline{IUV}_{i,t} \times QTY_{i,t_0}}{\sum_i \overline{IUV}_{i,t_0} \times QTY_{i,t_0}} = \frac{\sum_i \frac{\overline{IUV}_{i,t}}{\overline{IUV}_{i,t_0}} \times VAL_{i,t_0}}{\sum_i VAL_{i,t_0}},$$

$$i \in agricultural\ inputs$$

where t_0 denotes the base year, i.e. 2014–2016. $VAL_{i,t0}$ denotes the value share of input (i) in the total value of agricultural inputs used. Analogously, the global GIPIs for individual subgroups of inputs can be calculated as:

$$GIPI_t^{Sub} = \frac{\sum_i \frac{\overline{IUV}_{i,t}}{\overline{IUV}_{i,t_0}} \times VAL_{i,t_0}}{\sum_i VAL_{i,t_0}}, i \in Given\ subgroup\ of$$

where the subgroups of inputs are energy, fertilizers, pesticides, feeds and seeds.

Box. A Global Input Price Index for agriculture

Then, a set of regional input price indices (RIPIs) are extracted as:

$$RIPI_t^{Reg} = \frac{\sum_i \frac{\overline{IUV}_{i,t}}{\overline{IUV}_{i,t_0}} \times VAL_{reg,i,t_0}}{\sum_i VAL_{reg,i,t_0}}, i \in agricultural\ inputs$$

where $VAL_{reg,cmd,t0}$ are total costs of agricultural input *i* within a given region *reg*.

Utilization of agricultural inputs is available in metric tonnes for fertilizers, pesticides, feeds and seeds, and in terajoules/kilowatt-hour for energy. To obtain the value share of each input product in the total value of agricultural inputs, the quantities are converted into values (USD), applying trade-weighted IUVs. This process can be described as follows:

$$VAL_{t_0}^{Sub} = \sum_i \overline{IUV}_{i,t_0} \times QTY_{i,t_0}, i \in Given\ subgroup\ of\ inputs$$

Overall, the index covers the following inputs:

INPUT SUBGROUPS	DESCRIPTIONS
Energy	**Motor gasoline, gas-diesel oil, natural gas, fuel oil, liquefied petroleum gas, electricity, coal**
Fertilizers	**Inorganic (chemical or mineral) fertilizer products covered by FAOSTAT, e.g., diammonium phosphate, urea, potassium chloride, compounds**
Pesticides	**Herbicides, fungicides, insecticides, rodenticides, disinfectants, and similar products**
Feeds*	**Major feedstuffs from cereals, oilseeds, roots, pulses**
Seeds	**Seeds for grains, oilseeds covered in FAO food balance sheet, e.g., cereals, oil crops and potatoes**

*Minor feedstuffs including dairy products and powders, or fruits and vegetables are not included.

With the FFPI (output prices) rising at a faster rate than the GIPI (input prices), this could, as alluded to earlier, portend a potential improvement in the profit margins of some farmers.3 However, it should be noted that the GIPI does not take into account variable costs of other inputs, such as labour and land rents, nor does it capture fixed costs such as those of capital goods, for example 'structures', tractors, implements and machinery more generally.

By contrast, the preceding 12-month period was characterized by across-the-board falls in all prices, except for seeds. While prices of seeds have historically exhibited high intra-year volatility, as evidenced in Figure 2, year-to-year absolute changes have been moderate, but nonetheless positive. The unit price of imported seeds is the largest of all input prices included in the GIPI.

[3] On the assumption that price pass through between global and local markets is full.

Why rising energy prices have become so important for food markets

Agriculture is an energy-intensive sector, absorbing high amounts of energy, either directly through petroleum, natural gas and electricity use or, indirectly, using agrichemicals such as fertilizers, pesticides and lubricants, all of which have large, embodied shares of energy. Energy is also required to manufacture feed ingredients, such as the crushing of oilseeds to produce oilmeals and the milling of grains to manufacture feedstuffs (pellets, flours and compound materials). When it comes to food processing, the price of energy features heavily in the cost schedule. Examples include the milling of cereals into flours, the crushing of oilseeds into vegetable oils, the production of processed meat and dairy products, and the drying, preservation and refrigeration of many perishable foodstuffs. Higher energy prices will also lead to higher

Figure 3. Energy and food markets, tightly linked through input and output markets

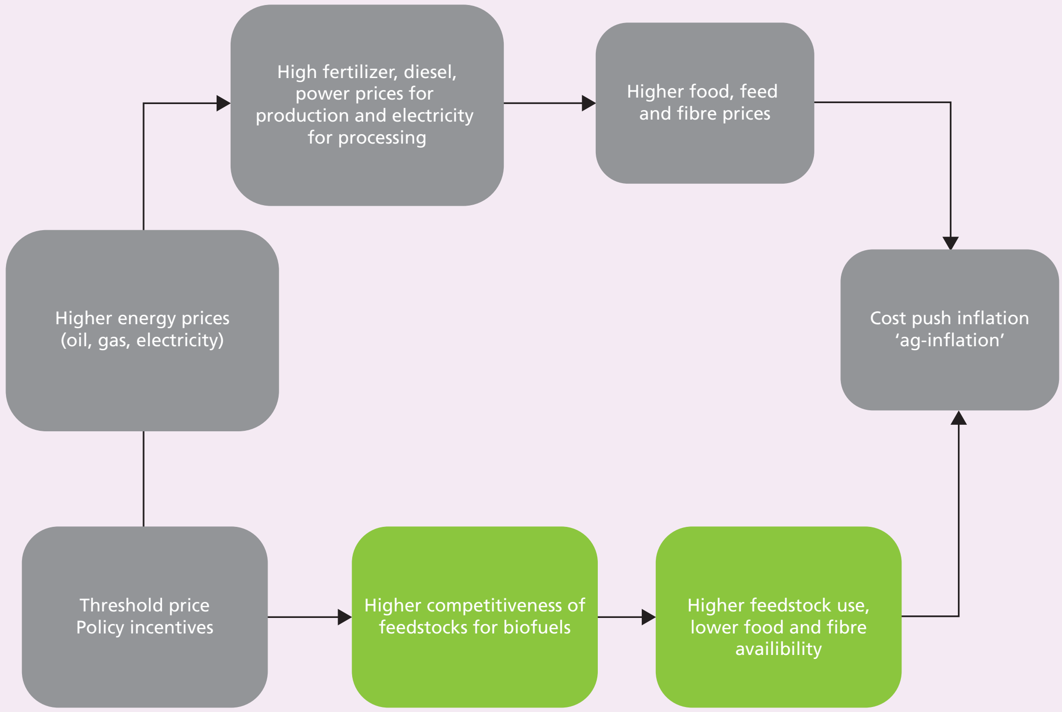
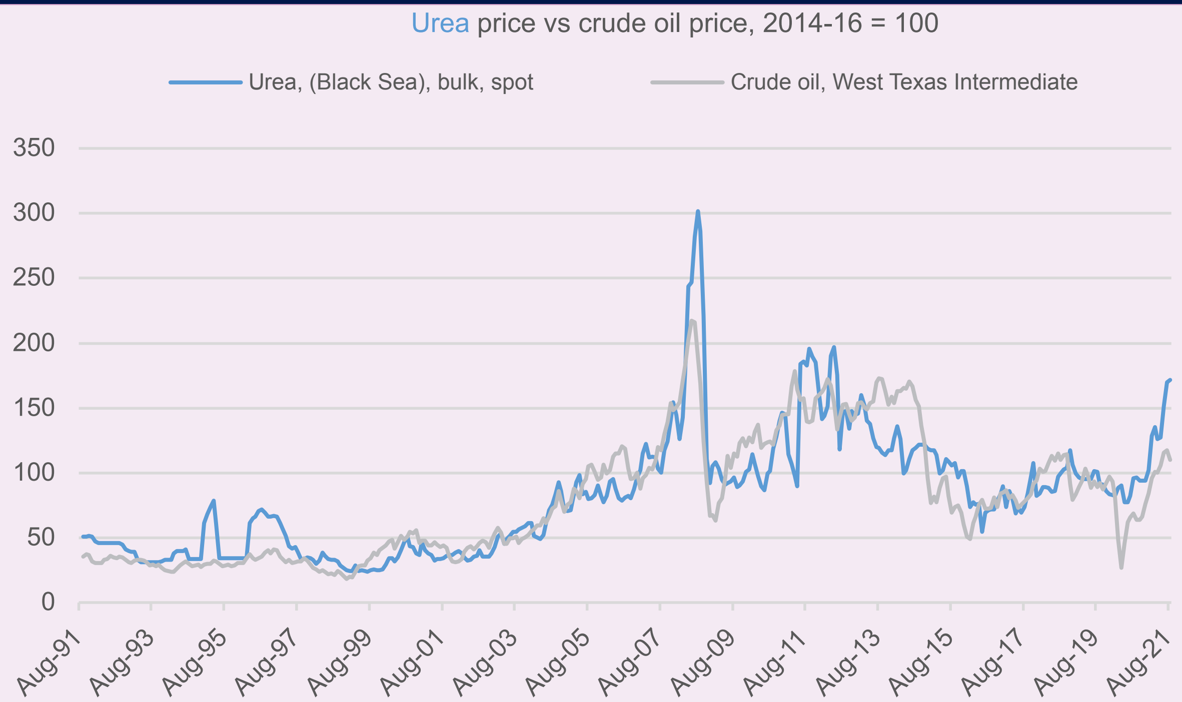
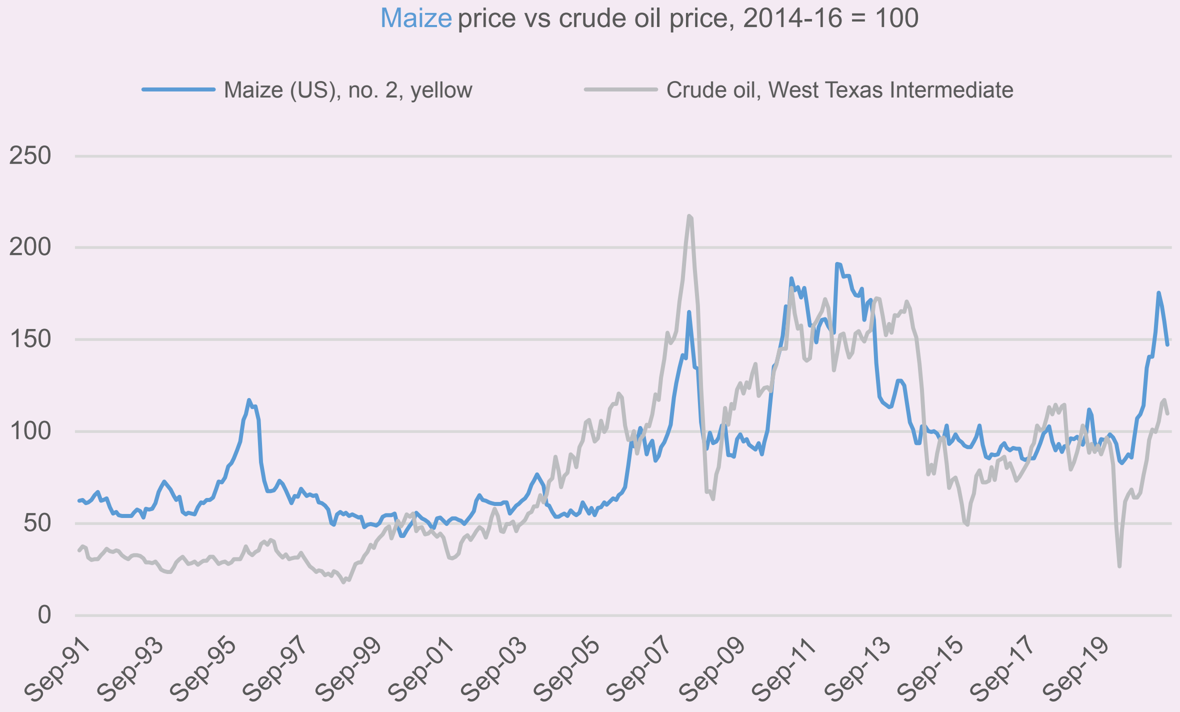


Figure 4. Energy and agricultural input price links



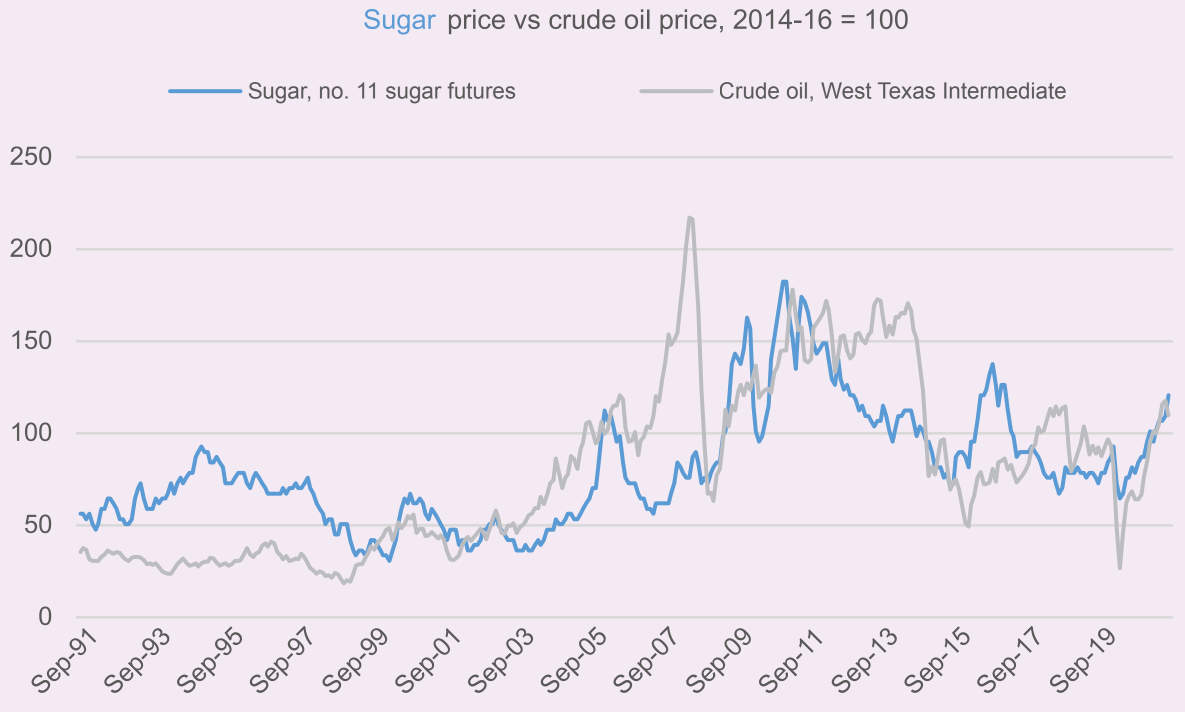
Source: IndexMundi

Figure 5. Energy and maize prices



Source: IndexMundi

Figure 6. Energy and sugar prices



Source: IndexMundi

transport, distribution and retail costs, which will again be reflected in consumer prices.

Globally, estimates of direct and indirect energy consumption vary widely across countries. In highly developed agricultural economies, they can exceed 30 percent for direct use and 15 percent for indirect consumption. These high shares mean that higher prices of these inputs will inevitably translate into higher production costs, and eventually into higher food prices (see Figure 4 for crude oil and urea prices). This link through the input side is well established and well documented.

The lessons from the last global food price crisis in 2007/08 showed that under scarcity, the diversion of food crops to non-food uses can drive up food prices markedly. To better understand the impact pathways of energy costs on food prices, Figure 3 provides a schematic illustration of the linkages and 'pass throughs' to food markets. In addition to the links through the input prices, food and fuel prices are increasingly linked through output prices.

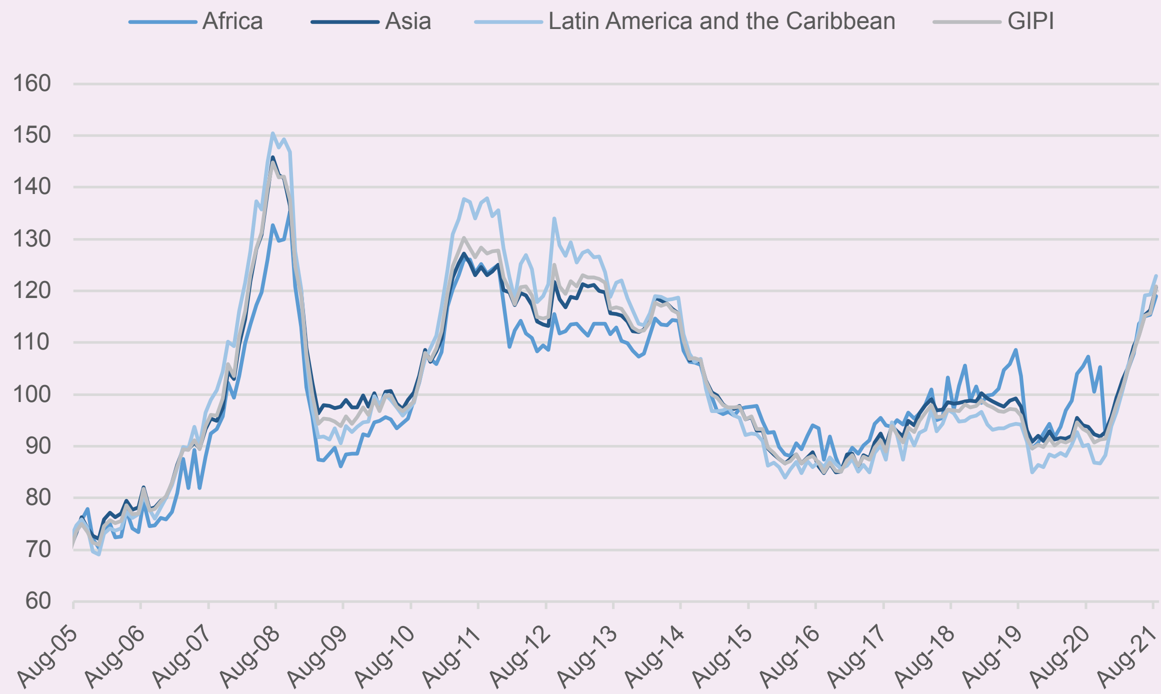
Two principal channels create the links on the output side. The first involves biofuel policies, which, through mandates, tariff protection or price incentives entice biofuel producers to use a certain and rather inflexible amount of feedstocks for the production of biofuels. Maize, sugar and oilseeds (vegetable oils) are the most common feedstocks, and ethanol and biodiesel are the most popular biofuels. These mandated or incentivized quantities are largely independent of energy prices. The second channel of transmission goes directly through energy prices. When energy prices rise, there is a threshold at which the production of biofuels from food crops, especially maize, sugar and oilseeds (vegetable oils), becomes competitive. Higher energy prices make more and larger quantities of agricultural feedstocks competitive for conversion into energy and, given the large size of the energy market relative to the food market, pull food prices up. The food price rise is capped again where agricultural feedstocks become so expensive that they can no longer compete in the energy market (see Figure 5 for crude oil and maize prices and Figure 6 for crude oil and sugar prices).

How are developing regions affected?

Figure 7 depicts the Input Price Index for developing regions compared with the GIPI. In later years, the aggregate indices of the regions show a marked tendency to correlate in both level and change between one another, as well as with the GIPI. However, this does not show the dependency on imported inputs, and risk of inflationary pressures.

Indeed, in countries that are heavily dependent on imported agricultural inputs, and where food and imported energy expenditures constitute a large share of their GDP – which typically characterize many of the most economically

Figure 7. Developing regions' input price index and the GIPI, nominal, 2014–16 = 100



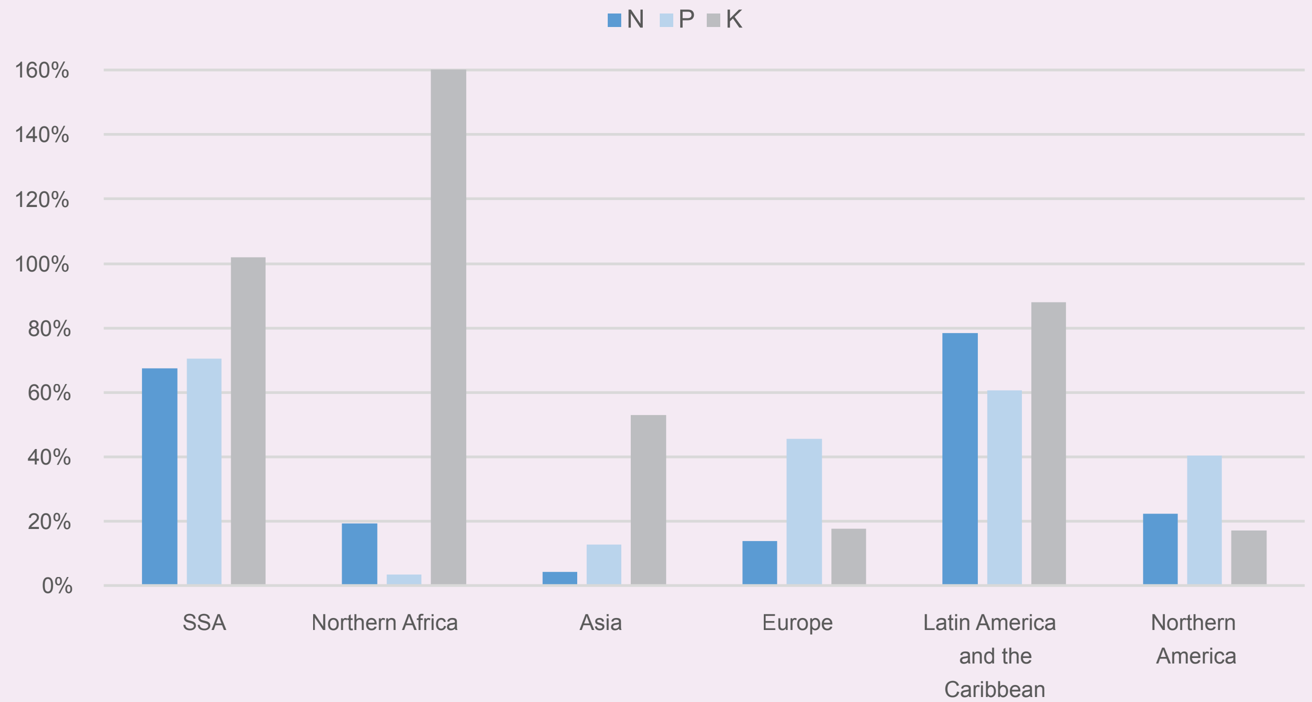
Source: FAOSTAT, Trade Data Monitor (TDM), authors' calculations vulnerable nations in the world – rising prices of imported energy and inputs can trigger inflation, as shown in Figure 3.

Using mineral fertilizers for illustration, Figure 8 shows Import Dependency Ratios (IDRs) [4] for the primary nutrients – nitrogen (N), phosphorous (P) and potassium (K) for all regions, with Africa divided into North Africa and sub-Saharan Africa (SSA). This is due to the concentration of large producers and exporters of fertilizers, especially nitrogen and phosphorous, in North Africa.

The figure is telling, in that SSA is among the most import-dependent regions in the world for phosphorous and nitrogen, with dependency rates for both at around 70 percent. The price of nitrogen is principally driven by fossil fuels, in the form of gas, and with the region being also heavily dependent on imported energy, these factors could all lead to higher food production costs and food inflation.

Figure 9 ranks consumer spending on food, as well as fuel, water and housing across the most exposed countries to large expenditure shares in these categories. Even at the rather low food and fuel prices of 2017, 30 countries spent 60 percent or more of their income on these necessities. Preliminary estimates for 2021 suggest that another 23 countries have joined this group and that the average expenditure shares in these 53 countries (30 plus 23 new ones in 2021) have risen from 62 percent in 2017 to 69 percent in 2021. Figure 10 provides a summary of these findings, offering a population-weighted global average. It is seen that food expenditure shares have risen sharply from 2017, increasing countries' exposure in general.

Figure 8. Import Dependency Ratios (IDRs) for fertilizers across regions, 2017–19



Source: FAOSTAT, Trade Data Monitor (TDM), authors' calculations

For many consumers, this may mean either lower quantities or qualities of food consumption, and hence hunger and malnutrition, or less money for other necessities such as health or the schooling of their children. Curtailing such important expenditures could send communities into a vicious cycle of deepening food insecurity and poverty, with potentially irreversible effects.

So what about the prospects?

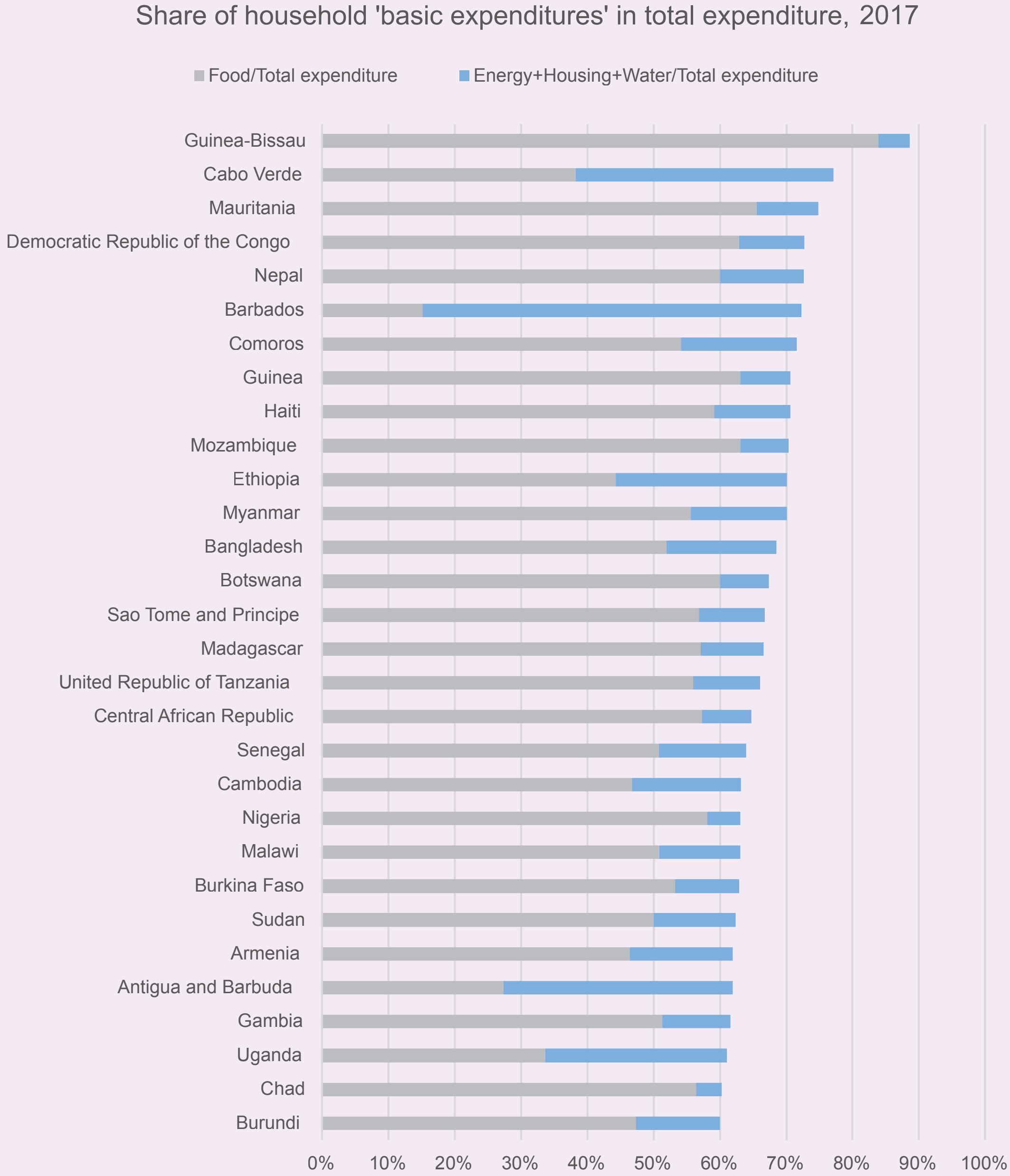
Just as many parts of the world have reopened their economies in the aftermath of the COVID-19 pandemic to stimulate economic growth – even though the pandemic remains unchecked due to very low vaccination rates, especially in developing regions – the current rise in food and fuel prices is highly regressive in the case of poor consumers, compounding economic stress and exerting a

[4] The IDR is calculated as

$$IDR = \frac{imports}{production + imports - exports} \times 100\%$$

excluding intra-regional trade for regional aggregates.

Figure 9. Consumers in lower-income countries spend a large share of their income on food and energy



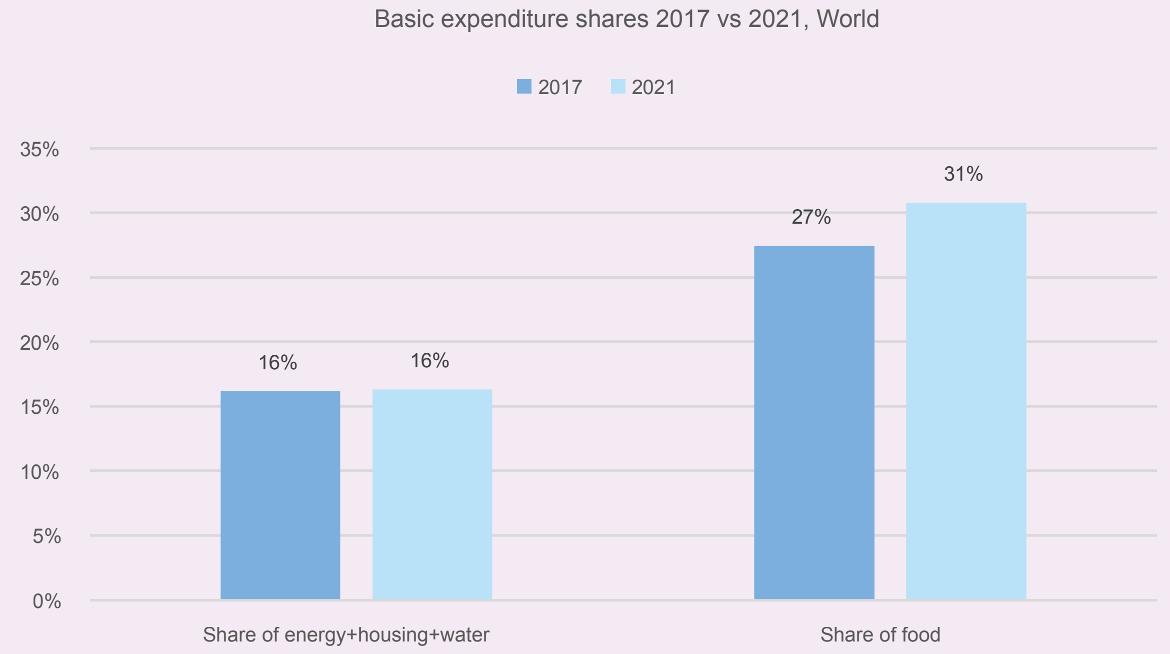
Source: World Bank, authors' calculations

negative impact on their livelihoods.

While the world is still far from the territory of past food price crises, such as the episodes between 2006 and 2012, vigilance is now of the utmost importance. Why?

- As the Northern Hemisphere approaches winter, the demand for heating from fossil fuel derivatives will rise. This is not unexpected, but with the possibility of climate variability giving rise to unprecedented temperatures below seasonal averages, the demand for energy for heating purposes is far from predictable. Energy shocks from the heating sector would also be transmitted into agri-inputs, energy itself and nitrate fertilizers, eventually resulting in higher food prices.
- China, being a significant force in global markets, constitutes a further element of uncertainty. In recent weeks, factories in 20 out of 23 of Mainland China's provinces have reportedly undergone electricity outages under imposed rationing, forcing many to shut down production for extended periods. The upshot is that agriprocessing in China may undergo a slowdown, resulting in shortages in the face of strong demand. This would instigate inflationary

Figure 10. Changes in aggregate exposure to the cost of basic necessities



Source: World Bank, authors' calculations

pressures, and a realistic possibility that China would be procuring intermediate and final products (such as soybean oil and meal, and cereal flour) from global markets, which could result in further international price hikes for traded foodstuffs.[5]

Wrapping it all up

The construction of a Global Input Price Index makes it possible to track the evolution of agricultural input costs at the global and aggregate scale, i.e., at industry-wide level. With the caveat of the need for econometric analysis, its juxtaposition with global product prices, here represented by the FAO Food Price Index, suggests that changes in production costs – input prices – readily translate into changes in product prices, and hence food prices. For producers, it means that potentially larger profit margins are generally evaporated by higher production costs. While this is expected conceptually, it is astounding to see how much the theoretical postulate is confirmed by empirical observations, including those regarding the current price boom. For consumers, it means that food prices will inevitably rise with higher production costs, and do so without significant delays. This also holds for the current price rise, particularly exposing those consumers who are already exposed to high expenditure shares for food and fuel. For policy-makers, it means that rising costs for agricultural inputs, notably all forms of energy, will inevitably translate into higher food prices, unless new forms of production can be identified that make agriculture less energy-intensive and, importantly, less energy-dependent on fossil fuels.

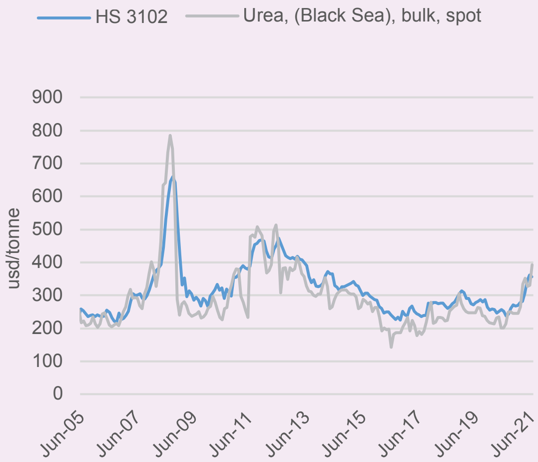
The analysis presented here constitutes an initial attempt to assess and track global input costs; it is limited to presenting the global and industry-wide picture. It appears that the aggregate picture that has emerged from the analysis masks large differences across regions and within the global food economy. In a second step, therefore, the regional and sector-specific details could be analysed and assessed. Drilling deeper into regions and sectors would require detailed cost of production data and activity-specific intensity levels. If and where such information is available, this would allow analysts to spot and track opportunities for producers. It could also help policy-makers to promote particularly profitable activities or identify potential bottlenecks within an agricultural industry.

[5] Energy shortages are also being felt worldwide, especially in the United States of America and in Europe.

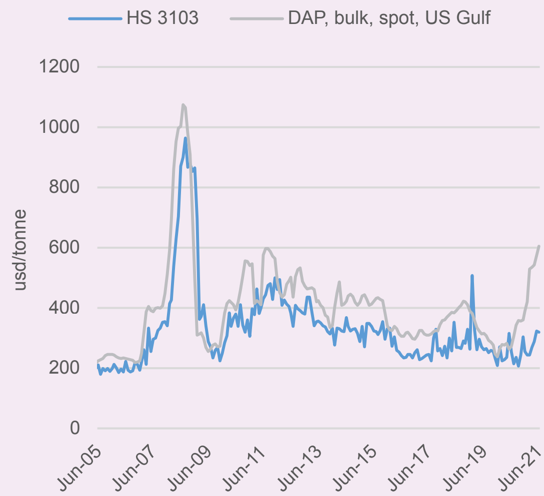
Annex

Trade-weighted IUVs vs indicator prices

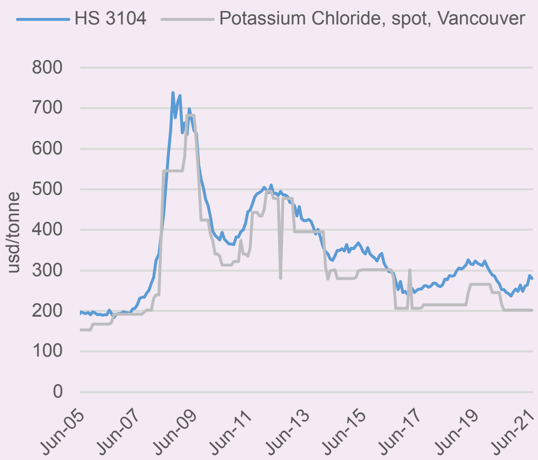
Urea indicator price vs IUV



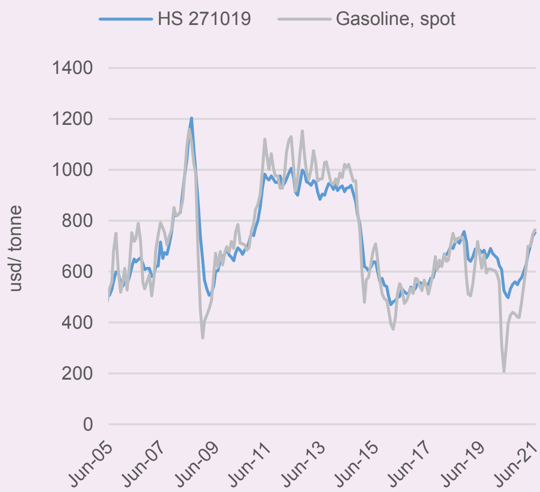
DAP indicator pirce vs IUV



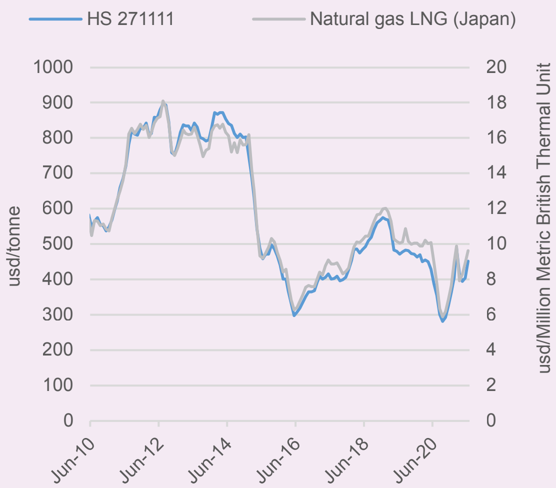
KCL indicator price vs IUV



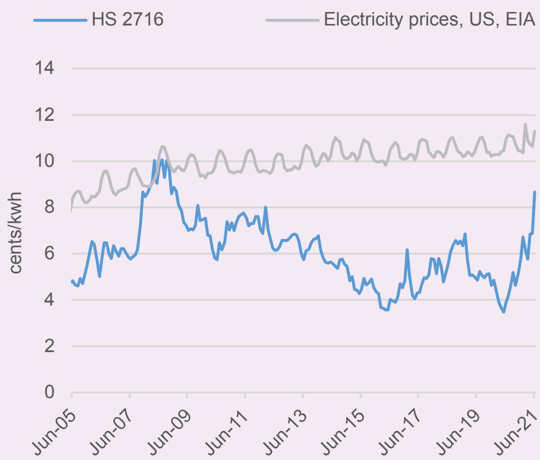
Gasoline indicator price vs IUV



Natural gas indicator price vs IUV



US domestic electricity vs global IUV



Note: HS 3102, HS 3103, HS 3104, HS 271019, HS 271111, and HS 2716 refer to the respective commodity codes under the Harmonized Commodity Description and Coding System (HS).

Source: Trade Data Monitor (TDM), IndexMundi, authors' calculations

Special Feature