NOMURA

Global Markets Research

ANCHOR REPORT

Prepare for the next surge in food prices

20 November 2019

- Global food prices have been on a downtrend for the past eight years, but this can quickly change. We discuss three potential triggers of a food price surge, and three amplifier effects to watch.
- We update the Nomura Food Vulnerability Index (NFVI), ranking 110 countries. The 50 most vulnerable economies in our NFVI to a food price surge are largely in EM.
- We show how economies in the more vulnerable NFVI group are more exposed to climate change-induced disruptions and have also experienced a sharp rise in debt to dangerously high levels. This is double trouble.
- We utilise the NFVI scores to assess where sovereign CDS spreads and bond yields are currently most mispriced in the event of a food price surge.
- We also use the NFVI scores to gauge which of the 110 countries are most and least vulnerable to food and oil prices rising in tandem, or alternatively parting ways.

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See Appendix A-1 for analyst certification, important disclosures and the status of non-US analysts.

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Prepare for a food price surge

3 Possible Triggers

- Weather-related shocks
- Sharp USD depreciation
- Oil price surge

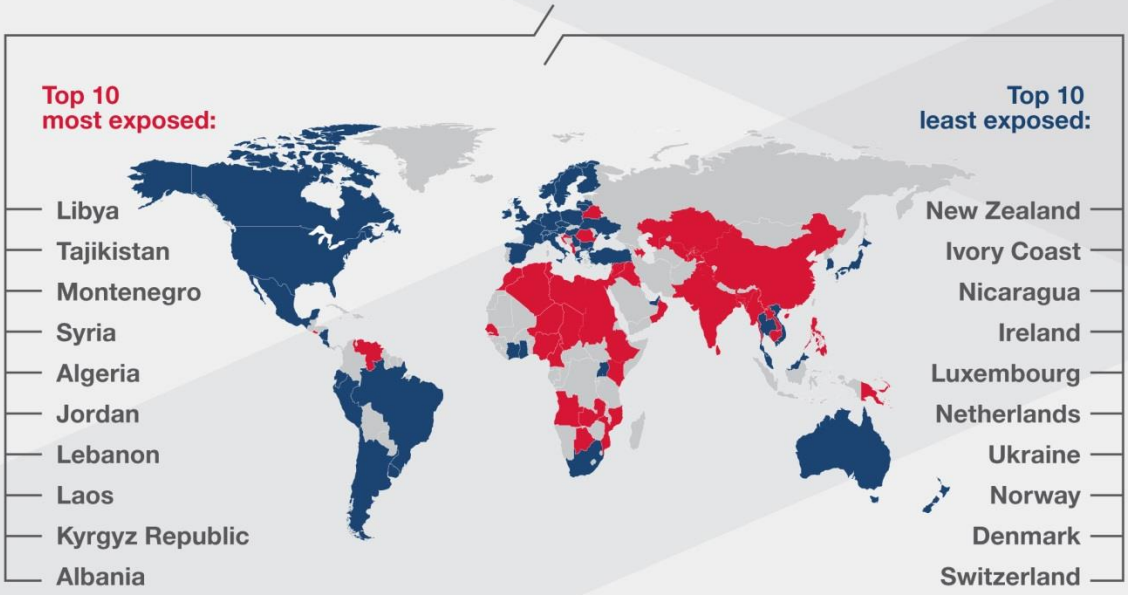
3 Possible Amplifiers

- Trade protectionism
- High & hidden debt in frontier economies
- Speculation & hoarding

Nomura's Food Vulnerability Index, ranking 110 economies. A surge in food prices would drive a wedge between developing economies and advanced economies.

46 out of the 50 economies **MOST** vulnerable to a food price surge are **Developing Economies**

26 out of the 50 economies **LEAST** vulnerable to a food price surge are **Advanced Economies**



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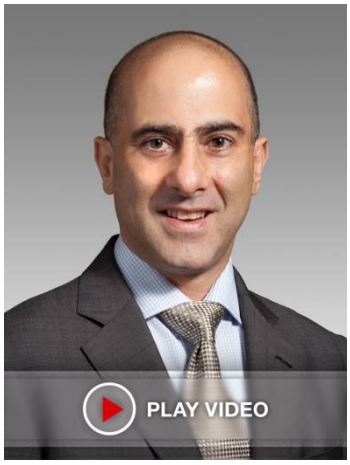


Hear what our analysts have to say

Executive summary

A food price surge is an underappreciated risk

After surging in 2010-11, global food prices have been on a downtrend, but this can quickly change. Structural drivers of food demand – rising EM population and income growth coupled with an increasing appetite for more protein – remain strong. The supply-side of the food equation is also tightening, as the eight-year trend decline in food prices is disincentivising new agricultural investments at a time of decreasing arable land and water supply, and an increasing frequency of extreme weather events. There are hints that global food prices could soon start surging, from the African Swine Fever in China to catastrophic bushfires in Australia to the soaring price of onions in India.

Nomura's Food Vulnerability Index

We update the Nomura Food Vulnerability Index (NFVI), which objectively estimates a country's exposure to large food price swings, depending on nominal GDP per capita, the share of food in household consumption and net food imports. Our ranking of 110 economies highlights Libya, Tajikistan, Montenegro, Syria and Algeria as the five economies most vulnerable to a sustained rise in food prices; while New Zealand, Ivory Coast, Nicaragua, Ireland and Luxembourg could benefit from a surge in food prices. The 50 most vulnerable countries in our NFVI are largely in EM and collectively make up 26.1% of world GDP, and a much greater 59.1% of the world population (i.e., higher food prices increase the risk of geographically broad humanitarian crises).

Three potential triggers and amplifier effects to watch

We see three triggers for a food price surge: weather-related shocks, higher oil prices and sharp USD depreciation. Statistically, the world is overdue for a climate change-induced food supply shock. Once triggered, higher food prices could be amplified by protectionist agricultural trade policies, increased speculation and hoarding by investors, and dangerously high (and hidden) debt in frontier economies.

Frontier economies are most at risk

The top 30 vulnerable countries in our NFVI are nearly all frontier economies. Their outstanding hard currency debt has tripled over the last five years and many also owe 'hidden debt' to China on non-concessionary terms, putting them at risk of being in a debt trap. As these governments have less fiscal space, they could impose trade controls to protect consumers in the event of higher food prices, amplifying the surge in food prices globally.

Our event study confirms the NFVI's classification of the most vulnerable group

Our analysis of the 2010-11 food price surge confirms economic fundamentals deteriorated much more significantly in what the NFVI classified as the 30 most vulnerable economies than in the 30 least vulnerable ones: weaker growth, higher inflation, a wider fiscal deficit and steeper policy rate hikes. We also find a more adverse market reaction: sharper currency depreciation, more rating downgrades, higher sovereign bond yields and wider CDS spreads.

Identifying the movers and shakers in sovereign bonds and CDS

We utilise the NFVI scores for 30 most and least vulnerable groups together with sovereign credit ratings to assess where sovereign CDS spreads and bond yields are currently most mispriced in the event of a food price surge. Our results are strikingly similar for both markets. We also use the NFVI scores to gauge which of the 110 countries are more vulnerable to food and oil prices rising in tandem (Kyrgyz Republic, Lebanon, Jordan), or alternatively which could benefit (Norway). In addition, we look at the most exposed country groups if food and oil prices part ways.

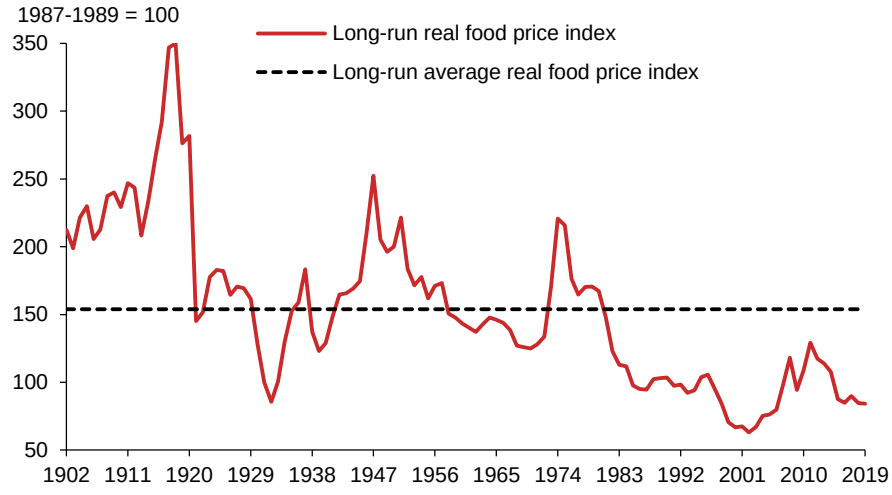
Overall, we would argue that the next food price surge could have a disproportionately larger impact on the more vulnerable NFVI group than in the past, as these economies are more exposed to climate change-induced disruptions and have also experienced a sharp rise in debt to dangerously high levels. This is double trouble.

Introduction

Global food prices have been on a downtrend; they have fallen nearly 28% from their 2011 peak and, in real terms (deflated by the US CPI), are 45% below their 120 year long-run average (Figure 1). Over the last three years, food prices have generally underperformed other commodities and asset classes (Figure 2). Healthy stockpiles of grains and the limited number of climate-related agricultural disasters have helped keep food prices low, but in the context of global climate change, this can change quickly.

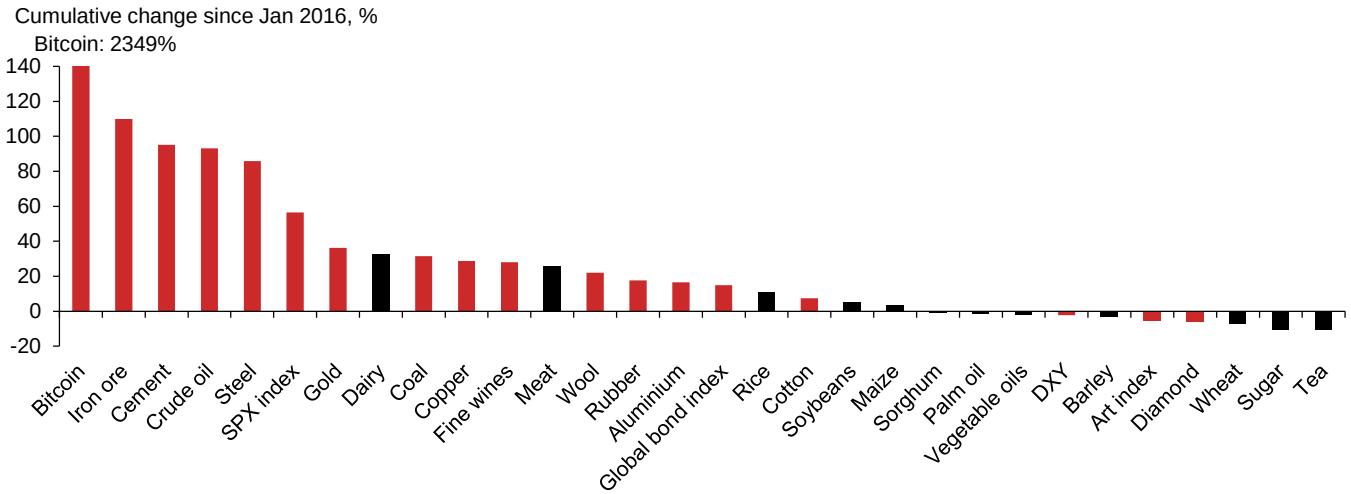
In this report, we discuss how not only the structural drivers of food demand remain strong, but persistently low food prices are discouraging new investments in agriculture which, along with decreasing arable land, is tightening the supply-side of the equation. We believe that a repeat of the 2010-11 food price surge is an underappreciated risk.[1] We discuss three potential triggers – including how statistically the world is overdue for a climate change-induced supply shock – and three amplifier effects. We update the Nomura food vulnerability index (NFVI) for 110 economies showing the ones that are most and least vulnerable to another food price surge. We detail how the 2010-11 food price surge had a more severe impact on the thirty most vulnerable economies than the thirty least vulnerable ones from our NFVI. Finally, we utilise our NFVI to analyse the exposure of CDS and sovereign bond markets to a food price surge scenario.

Fig. 1: Food price index



Note: From 1961 onwards, we deflated FAO's nominal food price index with US CPI to obtain a series for real food price index. To extend the series before 1961, we spliced IMF staff Thomas Helbing and Shaun Roache's long-run real food price index onto our deflated FAO real food price index. Source: Helbing and Roache (2011), FAO, CEIC and Nomura.

Fig. 2: Prices of commodities and asset classes



Note: Data reflects the cumulative change from January 2016 to October 2019 for all commodities and asset classes except for the art index, which reflects the cumulative change from January 2016 to July 2019. Global bond index refers to Bloomberg Barclays Total Return Global Bond Index. Source: FAO, IMF, World Bank, Bloomberg, Artprice.com and Nomura.

1. For example, the projection in the OECD-FAO Agricultural Outlook 2019-2028 report is that real food prices will remain at, or below, current levels over the coming decade.

Drivers of food prices

Demand

The two main drivers of food demand are population and income growth which, on a global level, are expected to decline. However, it would be a mistake to conclude that food demand will weaken, as the elasticity of the demand for food is much higher in emerging markets (EM) than developed markets (DM), and it is in EM where the action is.

- **EM young population growth.** In 2018, EM's total population grew by 1.2%, three times faster than the DM population, with Africa recording 2.5% population growth. EM's population growth is much higher largely because it has younger populations – in 2018, the median-age was 29 in EM versus 42 in DM – and it is well established that the young eat more than the old. EM's total population of 6.6bn is 86% of the world population, and going forward will contribute nearly all of future world population growth (Figure 3).
- **EM income elasticity sweet spot for food demand.** By 2050, the FAO projects that the world will need 70% more food production globally[2], and the most important reason is rising EM population and income. EM economies have been growing 2-3x faster than DM economies, lifting tens of millions out of extreme poverty each year (Figure 4). And, unlike other commodities, the sensitivity of the demand for food to an increase in income is much greater for the poor than the rich. In economists' parlance, the highest income elasticity of demand for food is in the low-to-middle income bracket. Richer consumers spend increased income on discretionary items instead (including weight-loss programs!). It is common practice to use GDP per capita of a country to measure food demand. This is appropriate for a normal income distribution, where mean income equals median income. But high income inequality skews the income distribution (e.g., China; Figures 5 and 6), and when the income elasticity of demand is much higher for poorer households than richer ones – as in the case of food – then, statistically, the median income is more accurate than the mean income.[3] For example, China's average GDP per capita at market exchange rates was USD9,776 in 2018. If household income was normally distributed, half of China's total population, or 698m people, would be below USD 9,776. But allowing for income inequality we estimate that a much larger 1,044m people are below USD9,776.[4] In other words, after correcting for the income skew, there are 346m more people (1,044m-698m) in the food "sweet spot" of low income elasticity of food demand, and this is just for China.
- **Protein-demand**: As incomes rise, EM consumers are eating more expensive protein- and nutrient-rich foods – such as meat, dairy products and seafood. This changing pattern of per capita food consumption is clear within countries, as incomes rise over time, and across different countries with different levels of income (Figure 7). We estimate ~2.5 billion people (or 32% of the world's total population) are in the income elasticity 'sweet spot' where demand for meat will increase strongly as incomes rise (Figure 8; shaded area). The FAO expects world meat demand to increase by 70% by 2050, mostly from EM countries[5]. This will have compounding effects. Increased demand for meat drives up demand for livestock feed as it takes, on average, 3kg of grain to produce 1kg of meat. Of course, as a result, society is turning more environment and health conscious, with a rising number of non-meat eaters and lab-based cultured meat alternatives – but how fast that takes hold remains to be seen.
- **Biofuel demand**: Environmental concerns over the use of fossil fuels have led governments to encourage greater use of crops to produce biofuels – maize and sugar cane (bioethanol), and vegetable and nut oils and fats (biodiesel) – as an alternative energy source. Biofuel production competes directly with human food demand – just how much will depend on factors like the level of oil prices, technological innovations and the extent of environmental degradation. The FAO projects that, by 2028, global ethanol production will use 14% and 24% of maize and sugarcane output, respectively, with vegetable oil remaining the feedstock of choice for biodiesel production.[6]

[2] See page 25: http://www.fao.org/3/i1688e/i1688e.pdf

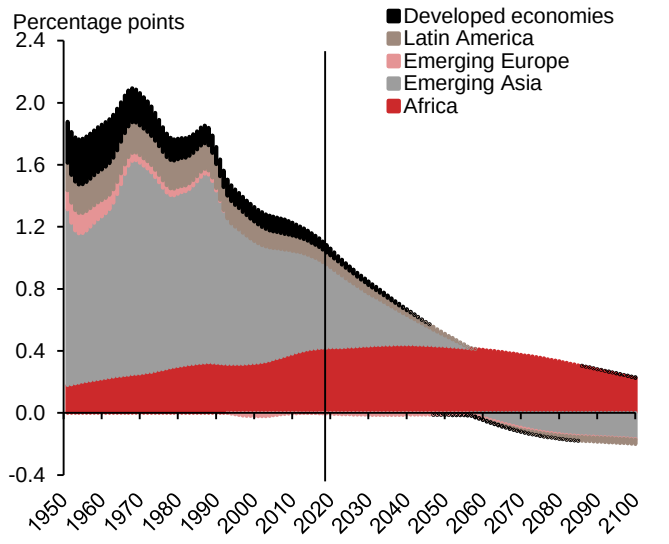
[3] For example, the FAO in its projections of global food demand uses GDP per capita, but acknowledges pitfalls of using this measure, see Box 1.4 in OECD-FAO Agricultural Outlook 2019-2028.

[4] We use China's household income distribution data (Figures 5 and 6) from which we estimate that 57.7% of the urban population (831m) and all of the rural population (564m) have incomes below USD9,776.

[5] See: http://www.fao.org/livestock-environment/en/

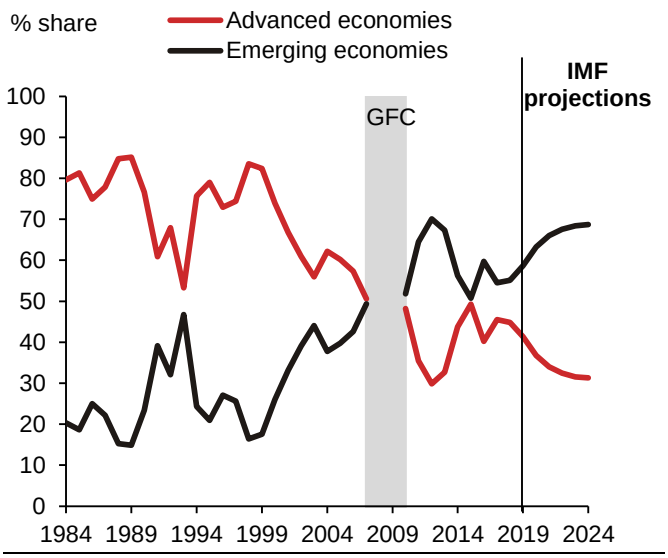
[6] See page 209 in OECD-FAO Agricultural Outlook 2019-2028

Fig. 3: Contributions to global population growth



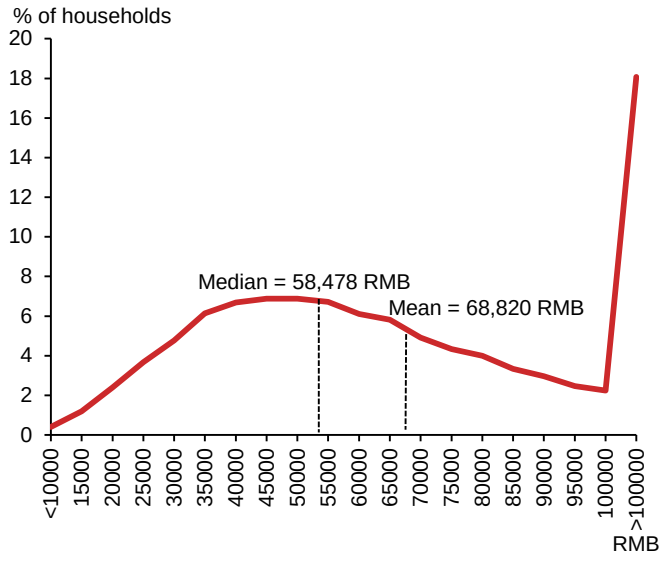
Source: United Nations World Population Prospects 2019 and Nomura.

Fig. 4: Contribution shares to global GDP growth



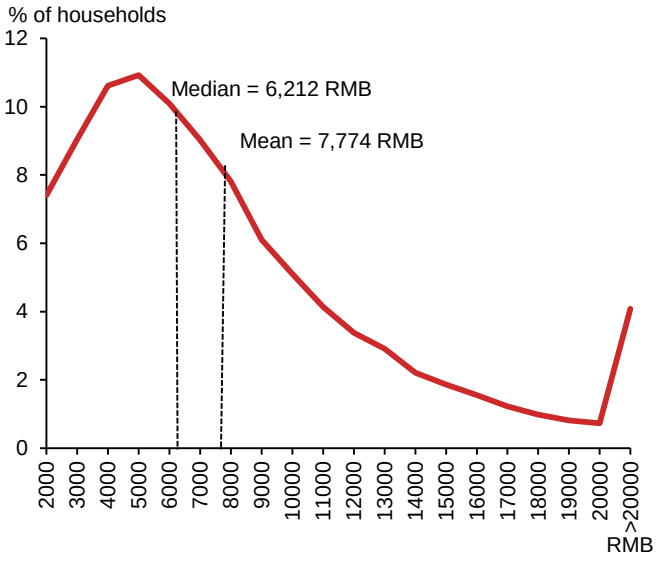
Note: The contribution shares in 2009 are meaningless because the combined GDP growth rate of the advanced economies turned negative. Source: IMF and Nomura.

Fig. 5: China's 2011 urban household income distribution



Source: CEIC and Nomura.

Fig. 6: China's 2011 rural household net income distribution



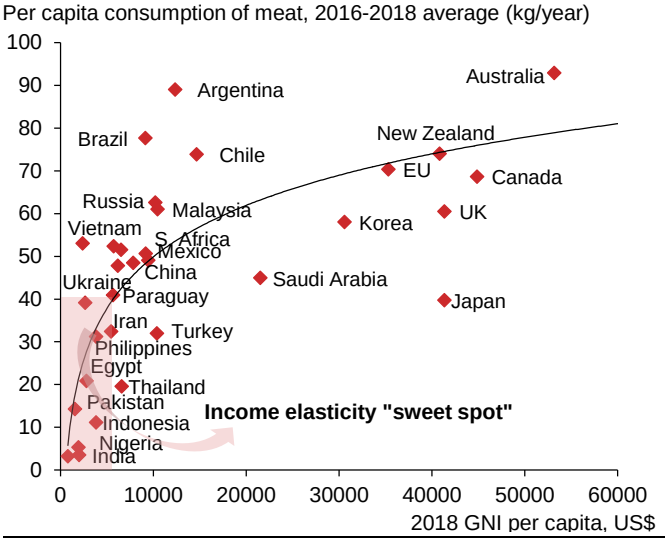
Source: CEIC and Nomura.

Fig. 7: Food consumption in Taiwan and China

kg/capita	Grain	Vegetables	Fruits	Meat	Milk
Taiwan					
1975	167	99	54	34	16
1980	139	130	66	48	29
1985	116	128	80	59	35
1990	109	106	108	66	39
1995	98	120	117	76	52
2000	104	134	114	83	45
2005	106	113	112	79	36
2010	105	111	118	78	37
2013	109	111	116	78	42
China					
2013	149	98	41	33	12
2014	141	97	42	34	13
2015	134	98	44	35	12
2016	133	100	48	35	12
2017	130	99	50	36	12

Source: FAO, CEIC and Nomura.

Fig. 8: Meat consumption per capita vs GNI per capita



Source: OECD-FAO Agricultural Outlook 2019-2028, World Bank and Nomura.

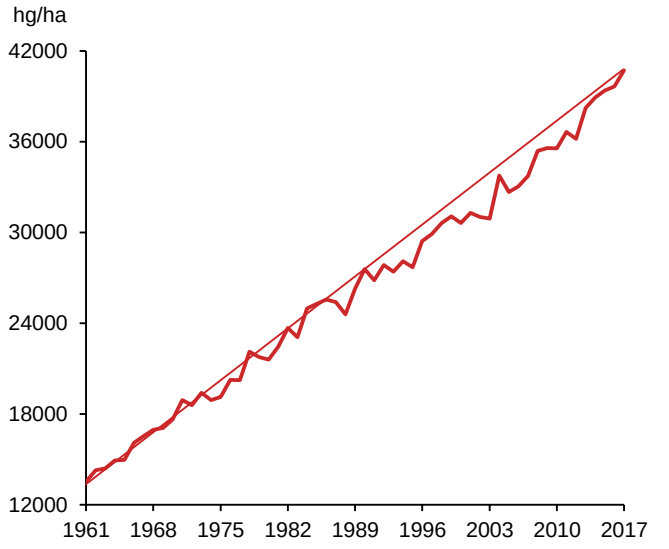
Supply

World grain stockpiles are healthy, but the food supply situation can change quickly.

- **Agricultural productivity**: Over 1960-90, there was strong growth in agricultural productivity – from investing in irrigation and fertilizers – the so-called 'Green Revolution' (Figure 9). However, in the 1990s and 2000s productivity growth slowed. In EM, the small size of farm plots constrained productivity gains, and more rural youth left for the cities (Figure 10). Productivity growth picked up again in the 2010s, as the rise in food prices incentivised new investment in agriculture, including innovations for EM farmers such as rural microfinancing and mobile phones. But meeting continuously growing EM demand for food requires continuous and strong new investment. Yet, many governments now have less scope for investment due to high debt burdens, while private investment in agriculture is heavily influenced by return – i.e., the price of food – which has been on a downtrend since 2012, discouraging new investments and, with a lag, crimping agricultural productivity growth (Figure 11). In the US, farmers are feeling the financial strain from low prices and higher Chinese tariffs, with US wheat farmers poised to plant the lowest acreage of winter crop in 110 years.[7] A surge in food prices may be what is needed to kick-start the next investment upcycle (economists' call this the cobweb model; see *Box 1: Cobweb cycle: India's experience*).
- **Competing demand for land**: While the planet's potential land supply is far from exhausted, increasing the availability of land for agriculture competes against urbanisation and industrialisation, particularly in EM. By 2050, more than two-thirds of the world population is expected to live in urban areas from slightly more than half today[8]. Furthermore, increasing the availability of land-use for agriculture by deforestation can accelerate climate change and land degradation, reducing yields and productivity. Since 1960, the FAO estimates that total agricultural land use (for crop production and grazing) has increased by only 10%, and its projection in the next decade is that land use for agriculture will be, optimistically in our view, flat.[9]
- **Climate change**: According to the Intergovernmental Panel on Climate Change, over 1880-2012 the global temperature rose by ~ 1.0˚C, and is on track to rise by 3.1-3.7˚C by 2100. Pledged Green policies, if fully implemented, would only reduce the increase in temperature to 2.6˚C; much more drastic action is needed to hit the1.5˚C limit set in the 2015 Paris accord. There is an overwhelming consensus among scientists that global warming will increase the frequency of severe droughts and floods, decreasing yields (Figure 12). In the US, natural disasters and the damage they cause are near an all-time high (Figure 13). World stockpiles of grains are currently healthy (Figure 14) but this can quickly change with extreme weather events occurring with increasing frequency.
- **Water scarcity**: This is set to emerge as the biggest long-term challenge to food supply, as agriculture accounts for 70% of global water consumption, and as high as 95% in some EM countries.[10] In addition to global warming depleting water supply, agricultural demand for water is growing rapidly, as EM farm dependence on irrigated land increases and as consumers demand higher protein food (it takes about 15,000 litres of water to produce 1kg of beef).[11]
- **Diseases:** Plant and animal diseases are impossible to predict but can spread rapidly from country to country and have a large impact on food supply. In August 2018, China first reported the outbreak of African Swine Fever (ASF), which has since led to a 41% decline in hog stock based on data from the Ministry of Agriculture and Rural Affairs (China had 428m pigs as of end 2018, ~58% of the world's pig population, according to data from the USDA). By the end of this year, China will likely have lost half of its pig stock, and the ASF is spreading to other countries, including Vietnam, Cambodia, Laos, South Korea, Russia and the Philippines.[12] In October, China's pork prices were up 101.3% y-o-y and, in Q3, its imports of pork and beef surged by 84.3% and 54.4%, respectively. How much ASF spreads, drives up global pork prices and drives demand substitution to alternative meats should not be underestimated (see *Box 2: China's pork prices are surging on the spread of ASF*).

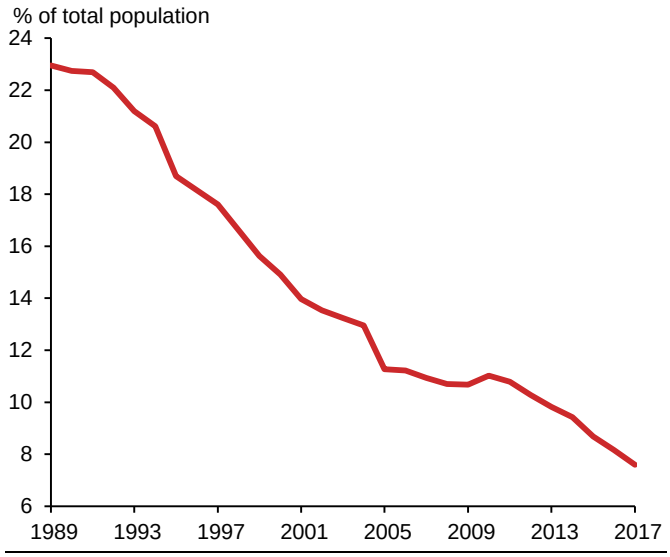
7. See *Bloomberg* news survey on 29 October 2019 and *Farmaid* on 8 October 2019
8. See World Urbanization Prospects 2018: https://population.un.org/wup/
9. See page 40 in OECD-FAO Agricultural Outlook 2019-2028.
10. http://www.fao.org/3/ap505e/ap505e.pdf
11. http://www.fao.org/3/a-i7959e.pdf
12. See *https://www.vox.com/2019/6/6/18655460/china-african-swine-fever-pig-ebola*

Fig. 9: Cereal yield



Source: FAO and Nomura.

Fig. 10: China's rural population aged 15-29

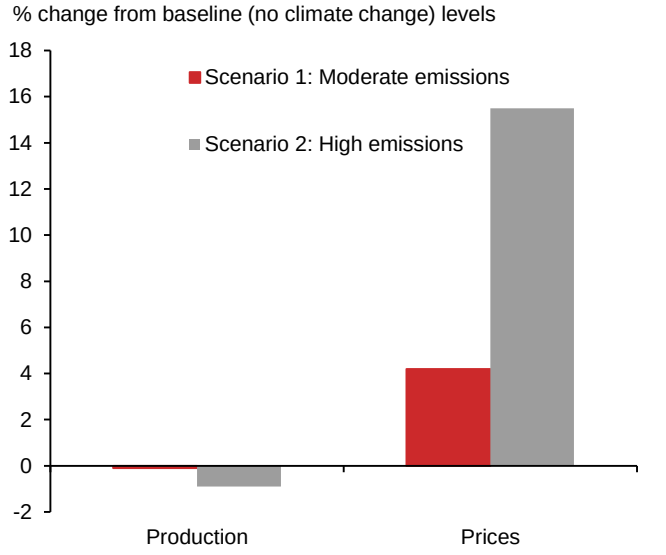


Source: CEIC and Nomura.

Fig. 11: US investment in agriculture and global food prices

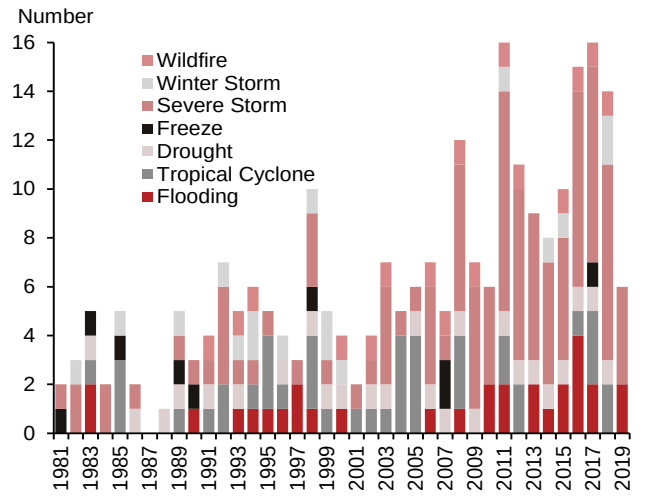
Source: FAO, CEIC and Nomura.

Fig. 12: Climate change impact on agriculture in 2050



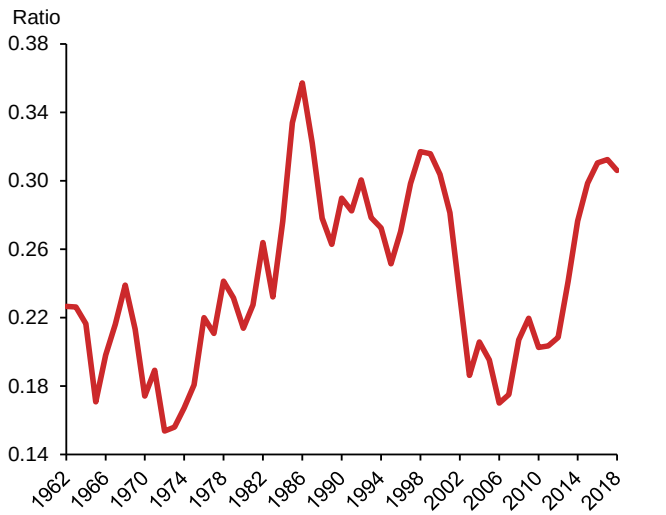
Note: Crops included in this analysis are coarse grains, wheat, oilseeds, rice and sugar. Scenario 1 is modelled on a world with modest population and income growth, and slow trade liberalisation. Scenario 2 is modelled on a world with high population growth, low income growth and a fragmented trade fabric. Source: "*Climate change impacts on agriculture in 2050 under a range of plausible socioeconomic and emissions scenarios*", Wiebe et al, 2015.

Fig. 13: US natural disasters with losses exceeding USD1bn



Note: The losses of over USD1bn are measured in real CPI-inflation adjusted terms.
Source: NOAA National Centers for Environmental Information and Nomura.

Fig. 14: Cereal stock-to-use ratio



Source: USDA and Nomura.

Box 1: Cobweb cycle: India's experience

India's food price inflation has started to rise sharply after a multi-year decline – from an average of 8.5% y-o-y during 2012-15 to an average of 2.4% during 2016-19 (until September). A number of demand- and supply-side factors have been disinflationary including low global food prices, improved supply management, weak rural demand and improved farm yields. Yet another important factor has been a food supply glut, triggered by elevated food prices in 2012-15, a phenomenon known as the cobweb cycle.

Lurking cobwebs: in theory and practice

Theoretically, the link between food production and inflation is governed by the 'cobweb cycle' (i.e., falls in the price of a crop in the previous year lead farmers to be more conservative in their sowing). In the second phase, lower production lays the foundations for higher prices which, in turn, incentivises farmers to expand their sowing. The resulting higher production causes the price of the crop to fall, thereby completing the cycle.

In practice though, the cobweb cycle in India has faced a number of disruptions. Counter-cyclical minimum support price (MSP) announcements by the government (higher MSP for crops facing lower prices can encourage production), trade policies (export and import restrictions can influence domestic supply) and monsoon rains have sometimes interfered with the market forces of the cobweb cycle.

Cobweb cycles in India

In India's case, we have seen the cobweb cycle most pronounced in pulses and sugar.

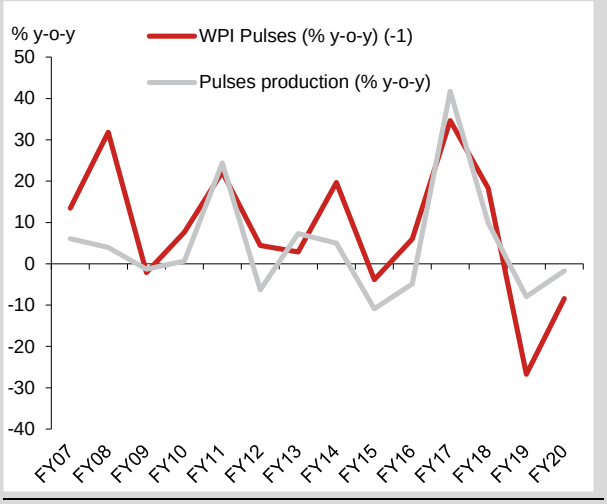
Pulses: The correlation between pulses production and lagged pulses (WPI) inflation is an elevated ~0.72 (Figure 15). The pulses price inflation cycle has typically lasted for two years, with the latest down-cycle between FY16 and FY18 corresponding to a fall in production growth between FY17 and FY19. Since FY19 though, the start of the second phase of the cobweb cycle seems to be kicking in, with lower production growth causing a revival in pulses price inflation back towards double-digits.

Other food crops: For other food items, the relationship is less immediate. In the case of sugarcane, there have been phases where higher inflation in the prior year has not been accompanied by higher production. However in recent years, we have seen some evidence; lower WPI sugar inflation in FY18 and FY19 has been accompanied by lower production in FY19 and FY20 (Figure 16). For other crops – particularly cereals – we find it difficult to discern the impact of the cobweb cycle, possibly because domestic prices are additionally determined by international prices, as well as surplus stocks that the government holds as part of its public distribution system (PDS) operations.

Implications for the future

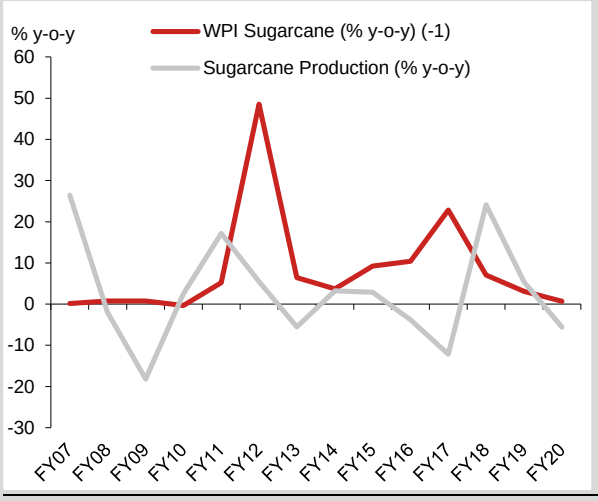
Pulses and sugar account for ~6% and ~3%, respectively, of the food basket in the CPI. The last 2-3 years of low food prices have resulted in lower production and this is setting the stage for higher inflationary pressures in FY20. Supplemented by rising inflation among cereals and proteins, we expect food & beverages price inflation to rise to 3.7% y-o-y in 2020 from 2.8% in 2019. The pulses and sugar-driven jump and slump in food prices should come full circle.

Fig. 15: Inflation vs production cycle for pulses



Source: CEIC and Nomura Global Economics

Fig. 16: Inflation vs production cycle for sugarcane



Source: CEIC and Nomura Global Economics

Box 2: China's pork prices are surging on the spread of ASF

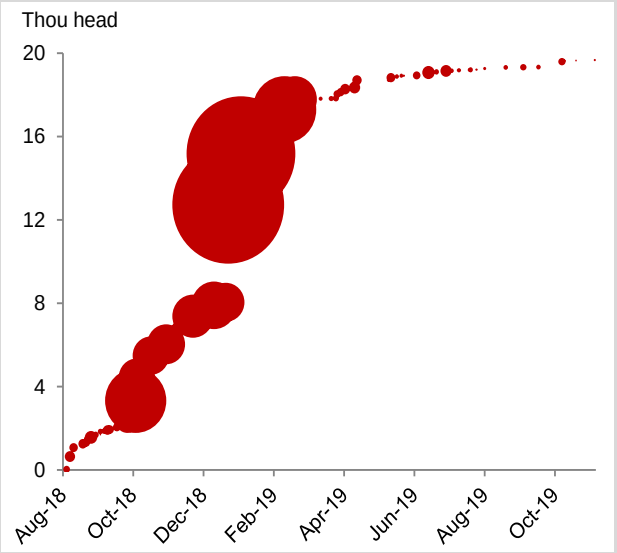
China reported its first African Swine Fever (ASF) outbreak in Liaoning province in August 2018, which was also the first reported case in East Asia. As China accounts for around half of the world's pork production and consumption, and as pork is the country's principal source of dietary protein, the spreading of ASF represents a major threat to China's food security. ASF has two major impacts on the current hog cycle. First, it kills hogs and reduces pork supply directly. Second, despite the rise in pork prices, pig farmers may be reluctant to increase hog stock on concerns about ASF and speed up hog slaughter, in fear of the spreading of ASF. In this regard, the upturn of the hog price cycle could last longer and drive pork prices higher than in previous hog price cycles.

According to Ministry of Agriculture and Rural Affairs (MARA), all 31 provinces in mainland China have reported ASF cases. However, there has been no official update following MARA's April report indicating that a total of 1.02mn ASF-infected hogs had been culled by the government as of 22 April 2019. Although the percentage of hogs culled so far still looks small, the pervasive ASF outbreak and continued spread across the country have alarmed pig farmers and led to a dramatic contraction of hog stocks this year. Based on MARA's survey of 400 counties, year-on-year growth of hog stocks and breeding sow stocks slumped to -41.1% and -38.9%, respectively, in September 2019 from -4.8% y-o-y and -8.3% at end-2018 – both are record lows over the past decade and bode poorly for hog and pork supply in coming quarters.

Pork prices (defined as the average wholesale price of 22 provinces) have already risen to RMB56.0/kg in late October from just RMB20.8/kg at end-2018, much higher than its previous record-high of RMB29.9/kg in May 2016. We now expect pork prices to surge to RMB65-75/kg in H1 2020, with the next peak likely in January 2020, during the lunar new year holiday. Pork prices may remain elevated in H1 2020, given the worsening contraction in hog and breeding sow stocks, the near-term unavailability of an effective ASF vaccine and a lack of efficient channels to substantially increase pork supply despite Beijing's efforts to boost them. We expect CPI inflation to rise to around 4.6% y-o-y in November, and then peak at around 6.0% in January 2020. We see a high probability that CPI inflation will hover above 4.0% y-o-y between November 2019 and mid-2020, and then drop to below 2.0% into January 2021 (see *China: Revising up our CPI inflation forecasts*, 10 November 2019).

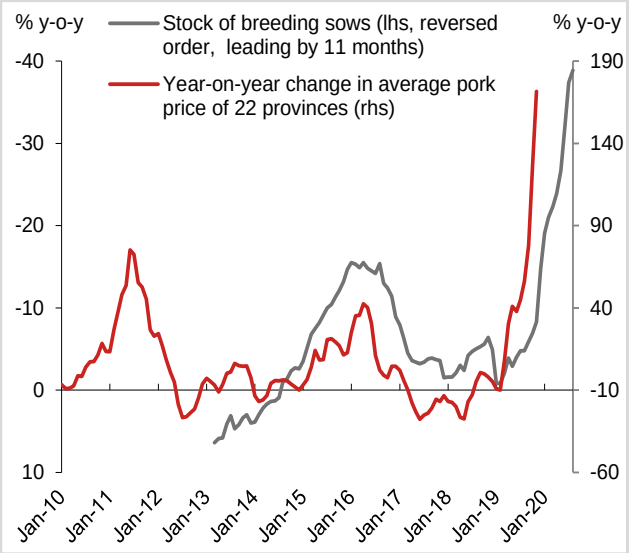
On the policy front, we believe Beijing faces a dilemma of a worsening growth slowdown and a rapid rise in CPI inflation. Although we expect policy easing to sustain given strong growth headwinds, we believe the People's Bank of China (PBoC) could become more reluctant to deliver high-profile policy stimulus in coming months amid surging CPI inflation and an elevated risk of a wage-price spiral, unless inflationary pressures and expectations stabilise.

Fig. 17: The cumulative number of hog infected by ASF



Note: The size of bubbles reflects the stock of pig farms and slaughterhouses reporting the disease breakout. The figure reflects data available as of 10 November 2019. Source: MARA and Nomura Global Economics.

Fig. 18: Breeding sows stock and pork prices



Note: Breeding sows stock data are from MARA which provides monthly time series based on the survey of 400 counties. Pork price data are from CAAA, based on the survey of 22 provinces. Source: WIND and Nomura Global Economics

The Nomura Food Vulnerability Index

The impact of a large, sustained move in food prices on an economy can vary significantly, depending, among other things, on whether the country is rich or poor, whether it is a large net food exporter or importer, and the importance of food in the consumption basket. To objectively estimate a country's exposure to large food price swings, we estimate the Nomura Food Vulnerability Index (NFVI). NFVI comprises three components:

- Nominal GDP per capita in USD at market exchange rates
- The percent share of food in total household consumption spending; and
- Net food exports (exports minus imports) as a percent of GDP.

For 110 economies, we normalise each of these three variables by subtracting the mean and dividing the resulting value by the standard deviation. From these normalised values, we estimate the NFVI for each country as a weighted composite index:

NFVI = 100 – {0.25*(GDP per capita) – 0.25*(food/household consumption) + 0.5*(net food exports/GDP)}

The NFVI scores are highlighted in Figure 17, ranking the 110 countries from the most vulnerable (highest NFVI score) to the least vulnerable (lowest NFVI score) to a food price surge. An economy with low nominal GDP per capita, a high share of food in household consumption and a large net food importer tends to be vulnerable to a surge in food prices, and vice versa.

The latest NFVI scores show Libya, Tajikistan, Montenegro, Syria, Algeria, Jordan, Lebanon, Laos, Kyrgyz Republic and Albania as the 10 economies most vulnerable to a sustained rise in food prices. Many of these are small frontier EM economies and from a humanitarian perspective several are war-torn and suffer from extreme poverty.

These 10 most vulnerable economies are mostly poor countries in which a large share of household income is spent on food, shelter and other necessities with little or none left over for discretionary spending, and hence food demand is inelastic to changes in price. In other words, a food price surge will force households in these countries to spend an even larger share of their limited income on food, at the expense of other necessities. As we shall explain later, the economic effects from a surge in food prices on these most vulnerable economies, in terms of rising CPI inflation, widening fiscal and trade deficits and slowing GDP growth, are likely to be substantial.

If we extend the list to the top 50 most vulnerable countries in our NFVI we find the vulnerability to a food price surge is very much an EM phenomenon – all but four are EM countries. Of these 50 vulnerable countries, 16 are in Africa (including Libya, Angola, Nigeria and Kenya), 13 are in the Middle East and Central Asia (including Syria, Iraq, Egypt and Uzbekistan), 12 are in Asia (including Laos, Bangladesh, the Philippines, Mongolia, Pakistan, India and China), 6 are in Europe (including Croatia, Romania and Russia) and 3 are in Latin America (including Venezuela).

The countries most vulnerable to a surge in food prices account for a small portion of the world economy, but make up a much larger share of the world population. A sustained surge in food prices is unlikely to cause a global economic recession, but it could cause a humanitarian crisis on a global scale. The 10 most vulnerable countries in our NFVI collectively make up just 0.4% of world GDP, but a larger 1.4% of the world population. The 50 most vulnerable countries in our NFVI collectively make up 26% of world GDP, and a much greater 59% of the world population.

At the other end of the spectrum, New Zealand, Ivory Coast, Nicaragua, Ireland, Luxembourg, the Netherlands, Ukraine, Norway, Denmark and Switzerland are the top 10 countries in our NFVI whose economies could gain from a surge in food prices, and 7 of the 10 are advanced economies. In fact, 26 of the 50 least vulnerable countries are advanced economies, and collectively these 50 countries account for 67.8% of the world economy and only 26.6% of the world population.

Fig. 19: Nomura's food vulnerability index and its sub-components

		Nomura's Food Vulnerability index	2018 GDP per capita	2018 Household spending on food	2017 Net food exports			Nomura's Food Vulnerability index	2018 GDP per capita	2018 Household spending on food	2017 Net food exports
		Index	USD	% of household expenditure	% of GDP			Index	USD	% of household expenditure	% of GDP
1	Libya	101.7	6692	53.0	-9.1	56	Indonesia	100.0	3871	32.8	2.1
2	Tajikistan	101.6	826	57.6	-7.1	57	Bolivia	99.9	3682	27.1	1.5
3	Montenegro	101.6	8652	33.2	-11.1	58	Guatemala	99.9	4575	41.4	3.4
4	Syria	101.5	789	39.9	-8.8	59	Tanzania	99.9	1134	38.5	3.4
5	Algeria	101.1	4238	43.1	-5.4	60	Colombia	99.9	6684	18.0	0.1
6	Jordan	101.0	4278	33.4	-6.3	61	Mexico	99.9	9807	23.4	0.6
7	Lebanon	101.0	9257	20.6	-8.3	62	Latvia	99.9	18032	26.2	0.3
8	Laos	101.0	2720	50.8	-3.5	63	Turkey	99.9	9346	21.1	0.5
9	Kyrgyz Republic	100.9	1268	44.9	-3.6	64	South Africa	99.9	6377	20.0	0.6
10	Albania	100.9	5289	44.1	-4.0	65	UAE	99.9	40711	13.1	-3.2
11	Senegal	100.9	1474	53.6	-2.2	66	Greece	99.8	20408	16.6	-0.6
12	Bangladesh	100.9	1745	55.6	-1.7	67	Czech Republic	99.8	22850	16.6	-0.6
13	Jamaica	100.8	5392	37.4	-4.0	68	Vietnam	99.8	2551	36.1	4.0
14	Uzbekistan	100.8	1263	58.1	-0.6	69	Peru	99.8	7002	27.5	2.7
15	Iraq	100.8	5930	35.0	-4.0	70	Korea	99.7	31346	13.4	-1.4
16	Egypt	100.8	2573	39.9	-3.0	71	Ghana	99.7	2206	43.9	5.5
17	Nigeria	100.7	2049	51.8	-1.2	72	Japan	99.7	39306	15.2	-1.3
18	Sudan	100.7	808	52.9	-0.7	73	Israel	99.7	41644	16.1	-1.2
19	Cameroon	100.7	1548	46.3	-1.3	74	Bulgaria	99.7	9267	18.7	2.0
20	Niger	100.7	477	43.4	-1.6	75	Serbia	99.7	7243	26.0	3.2
21	Azerbaijan	100.7	4569	41.0	-2.3	76	Thailand	99.6	7187	24.1	3.2
22	Angola	100.7	3669	43.6	-1.8	77	Malaysia	99.6	10942	21.0	2.7
23	Philippines	100.6	3104	42.2	-1.5	78	Brazil	99.6	8968	24.5	3.3
24	Chad	100.6	874	44.2	-0.9	79	Uganda	99.6	724	28.5	4.7
25	Ethiopia	100.6	853	56.8	0.9	80	Italy	99.6	34260	14.2	-0.1
26	Zambia	100.6	1417	53.5	0.6	81	Poland	99.6	15431	16.9	1.9
27	Mozambique	100.5	476	31.3	-2.3	82	Lithuania	99.6	19143	21.6	2.4
28	Cambodia	100.5	1509	44.8	-0.3	83	Finland	99.5	49845	12.0	-1.6
29	Papua N. Guinea	100.5	2530	34.9	-1.6	84	Argentina	99.5	11627	36.5	5.2
30	El Salvador	100.5	3924	26.3	-2.9	85	Hungary	99.5	15924	18.2	2.4
31	Mongolia	100.4	4026	20.2	-3.4	86	United Kingdom	99.5	42558	8.1	-1.3
32	Pakistan	100.4	1555	34.8	-0.9	87	Costa Rica	99.5	11744	22.1	3.6
33	Myanmar	100.4	1298	58.5	2.4	88	Sweden	99.5	53873	12.5	-1.3
34	Tunisia	100.4	3423	28.1	-2.0	89	Spain	99.5	30697	13.4	0.9
35	Venezuela	100.4	3374	32.2	-1.1	90	France	99.4	42878	13.4	0.3
36	Morocco	100.4	3359	41.5	0.2	91	Germany	99.4	48264	10.5	-0.4
37	Kenya	100.3	1857	36.0	-0.2	92	Chile	99.3	16079	16.5	3.7
38	Oman	100.3	19302	23.9	-3.4	93	Austria	99.3	51509	9.9	-0.2
39	Botswana	100.3	8137	16.5	-3.2	94	Belgium	99.3	46724	13.3	0.9
40	Croatia	100.3	14816	29.5	-2.0	95	Singapore	99.2	64041	6.9	-0.9
41	Kazakhstan	100.3	9237	35.1	-0.6	96	Canada	99.2	46261	9.2	1.1
42	Hong Kong	100.3	48517	27.3	-4.9	97	United States	99.1	62606	6.4	0.1
43	Romania	100.2	12285	36.0	-0.3	98	Ecuador	99.1	6316	22.5	7.3
44	India	100.2	2036	30.6	0.3	99	Uruguay	99.1	17165	26.1	6.9
45	Russia	100.2	11327	29.5	-0.5	100	Australia	99.0	56352	9.8	1.5
46	China	100.2	9608	28.7	-0.5	101	Switzerland	99.0	82950	8.9	-0.7
47	Bahrain	100.1	25851	15.7	-3.5	102	Denmark	98.9	60692	11.3	2.4
48	Kuwait	100.1	30839	16.7	-3.7	103	Norway	98.8	81695	12.5	1.2
49	Sri Lanka	100.1	4068	27.0	0.2	104	Ukraine	98.8	2963	40.3	12.0
50	Belarus	100.1	6306	33.4	1.1	105	Netherlands	98.8	53106	11.7	3.7
51	Saudi Arabia	100.0	23566	18.8	-2.1	106	Luxembourg	98.8	114234	8.9	-2.0
52	Slovakia	100.0	19582	17.8	-1.7	107	Ireland	98.8	76099	9.5	1.5
53	Dominican Rep	100.0	7881	24.0	0.2	108	Nicaragua	98.7	2108	32.5	12.2
54	Slovenia	100.0	26234	15.4	-2.6	109	Ivory Coast	98.4	1680	24.8	13.3
55	Portugal	100.0	23186	17.0	-1.9	110	New Zealand	98.2	41267	13.8	9.5

Note: Nomura's Food Vulnerability Index (NFVI) is a weighted construct of three components: GDP per capita (25%), food share in household expenditure (25%) and net food exports (50%). To create the index, every component is normalised such that a higher value for the component represents higher vulnerability to rising food prices. The normalised components are then weighted and added to 100 to create the NFVI. By construction, the higher the NFVI for a country, the more vulnerable a country is to rising food prices. Latest available data are used. GDP per capita are 2018 IMF estimates for all countries except Syria (2017). Data on household spending on food are from the EIU's 2018 Global Food Security index for all countries except for Albania, Croatia, Jamaica, Hong Kong, Kyrgyz Republic, Libya, Lebanon, Latvia, Lithuania, Luxembourg, Mongolia, Montenegro, Papua New Guinea and Slovenia, where data are from these countries' respective household budget surveys. Net food exports are 2017 data from the World Bank for all countries except Angola, Bangladesh, Costa Rica, Ethiopia, Guatemala, Iraq, Laos, Lebanon, Libya, Morocco, Papua New Guinea, Niger, Saudi Arabia, Serbia, Sudan, Syria, Tajikistan, Thailand, Uzbekistan, Venezuela, Vietnam, Bahrain, Cambodia, Chad, where data are for 2016 and from the Food and Agriculture Organization. Source: World Bank, Economic Intelligence Unit's 2018 Global Food Security Index, FAO, IMF, CEIC, national sources and Nomura.

Triggers and amplifiers of a price surge

Healthy stockpiles of grains and limited catastrophic climate-related disasters affecting agriculture have helped keep food prices low over the past seven years, but things can change quickly. We explained how not only the structural drivers of food demand remain strong, but persistently low food prices may start to contribute to insufficient new investment in agriculture which, along with decreasing arable land, is tightening the supply-side of the equation. Below we outline three potential triggers of the next food price surge and three amplifier effects to watch out for.

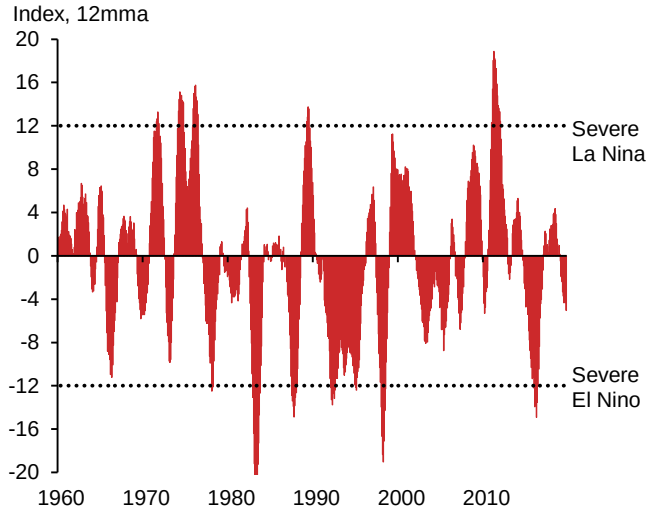
Three triggers

1. Weather-related shocks: Weather-related shocks are unpredictable and are the single-most important factor affecting agricultural output.[13] There is a broad consensus among scientists that global warming will increase the frequency of natural disasters, from bushfires and droughts to hurricanes and floods. From this vantage point, and if history is any guide, the world seems overdue for a severe weather-related shock.

Take El Niño and La Niña.[14] El Niño is an abnormal weather pattern that can lead to droughts in Australia, Southeast Asia, South Africa and India; severe flooding in South America; and winter storms in southern US. La Niña has the reverse effects. The Southern Oscillation Index (SOI) is one of the key atmospheric indices used by meteorologists to gauge the strength of El Niño and La Niña. Sustained negative values of the SOI below −7 typically indicate El Niño, while sustained positive values above +7 indicate La Niña. Values between +7 and −7 indicate neutral weather conditions.

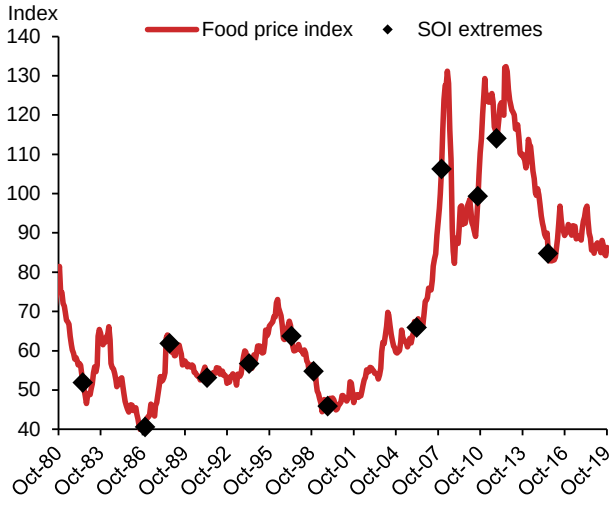
We use a more extreme measure – when the 12-month average SOI fluctuates beyond +/-12 for two or more consecutive months – to capture severe episodes of El Niño and La Niña. The last severe El Niño (SOI < -12) was in 2015-16 and the last severe La Niña (SOI > +12) was in 2010-11. There have only been two severe episodes (one severe El Niño and one severe La Niña) over the last 20 years, whereas in the 20 years prior (1980-1999) there were six, and 20 years prior again (1960-1979) there were four (Figure 18). These severe episodes usually precede a surge in food prices (Figure 19). From this vantage point and considering the rising risks from global warming it seems the world is overdue an increased frequency of severe weather-related shocks.

Fig. 20: Severe El Niño and La Niña



Source: Australia Bureau of Meteorology and Nomura.

Fig. 21: Global food prices and severe El Niño and La Niña



Note: We define SOI extremes when the SOI rises above 12 (severe La Niña) or falls below 12 (severe El Niño) for two consecutive months. If the SOI breaches +/-12 again within 12 months of a previous severe El Niño or La Niña, it is regarded as part of the previous El Niño / La Niña and does not show up as an additional diamond on the chart. Source: World Bank, Australia Bureau of Meteorology and Nomura.

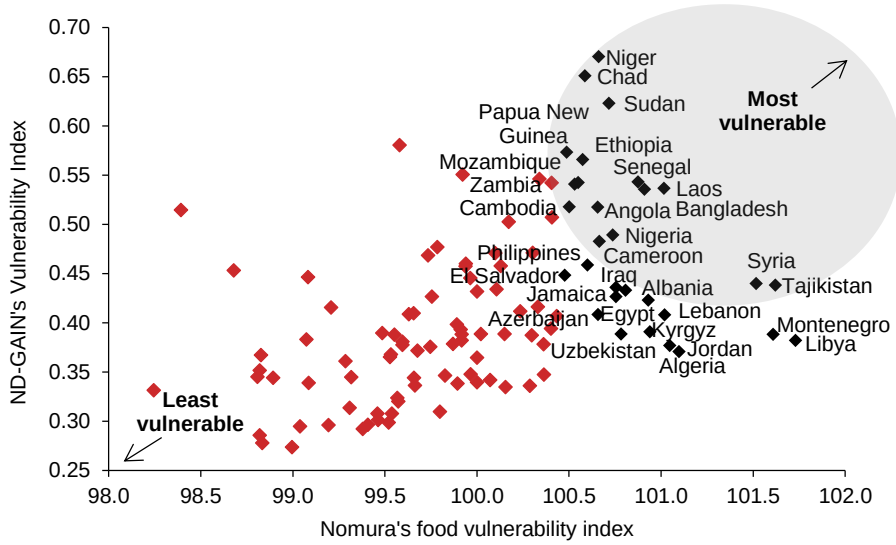
13. According to the FAO some 80% of the world's cultivated area of 1.6bn hectares are rainfed, see http://www.fao.org/3/i1688e/i1688e03.pdf

14. El Niño translates into Spanish as "the boy-child", and La Niña "the little-girl". Peruvian fisherman originally used the term to describe the appearance, around Christmas, of a warm ocean current off the South American coast. Nowadays, the term refers to the extensive warming of the central and eastern Pacific that can lead to a major shift in global weather patterns.

The University of Notre Dame has developed a composite index that ranks the overall vulnerability to climate change-induced disruptions for 181 countries.[15] It assesses the vulnerability of a country by considering six life-supporting sectors: food, water, health, ecosystem services, human habitat and infrastructure.

We plot the University of Notre Dame's climate change vulnerability index against our NFVI, and we find a positive relationship (Figure 20).[16] Ominously, the countries more vulnerable to climate change-induced disruptions are generally the ones that are also more vulnerable to a surge in food prices (high NFVI scores). In fact, of the 30 countries with the highest NFVI scores, 15 are also in the top 30 of the University of Notre Dame's climate change vulnerability index. These countries are Niger, Chad, Sudan, Papua New Guinea, Ethiopia, Bangladesh, Zambia, Mozambique, Laos, Senegal, Cambodia, Angola, Nigeria, Cameroon and the Philippines. They are all poor countries, predominantly in Africa that appear particularly exposed to weather-related shocks to food prices.

Fig. 22: Notre Dame's vulnerability index vs Nomura's food vulnerability index



Note: Top 30 most vulnerable countries in Nomura's Food Vulnerability Index are in black. ND-GAIN refers to the Notre Dame Global Adaptation Initiative and its Vulnerability index measures a country's exposure, sensitivity and ability to adapt to the negative impact of climate change. For details on Nomura's Food Vulnerability Index, refer to Figure 19. Source: Notre Dame Global Adaptation Initiative, World Bank, Economic Intelligence Unit's 2018 Global Food Security Index, FAO, IMF, CEIC, national sources and Nomura.

2. Oil prices. We found that the link between movements in oil prices and food prices tends to tighten when oil prices surge above USD80/bbl (Figure 23). One reason for this is the modernisation in agriculture, particularly in EM, with food production relying more on machinery, irrigation systems, transportation and cold storage, all of which increase the sensitivity of food prices to higher energy costs. Furthermore, fertilisers that are by-products of crude oil or made from natural gas are another large cost component of producing food. The World Bank estimates that globally energy constitutes more than 10% of the cost of agricultural production, 4-5 times the energy intensity of manufacturing production (Figure 24).[17]

Another reason is that the higher the price of oil, the more economically viable it is to substitute corn, soybean, sugarcane and palm oil for more environment-friendly biofuel production at the expense of food production, and this reduction in food supply exerts upward pressure on food prices. By historical standards, the price of crude Brent oil has been stable this year, ranging most of the time between USD60/bbl and USD70/bbl. But this masks powerful, countervailing forces: downward price pressure from weakening global growth and US shale production and upward price pressure from some oil-producing countries (e.g. Venezuela and Iran) facing economic crises, the OPEC cartel largely adhering to its output quotas and a risk premium from geopolitical tensions

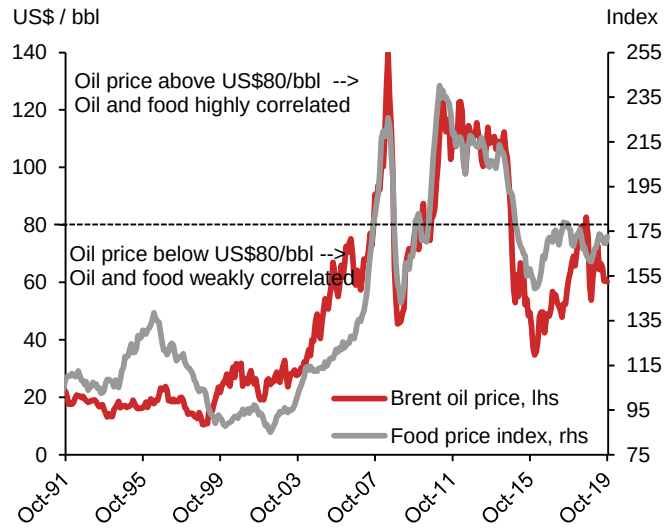
15. See https://gain.nd.edu/our-work/country-index/rankings/

16. The sample includes 109 countries that feature in both NFVI and University of Notre Dame's climate change vulnerability index; the exception is Hong Kong.

17. See "From energy prices to food prices: moving in tandem?", World Bank Commodity Markets Outlook, July 2016.

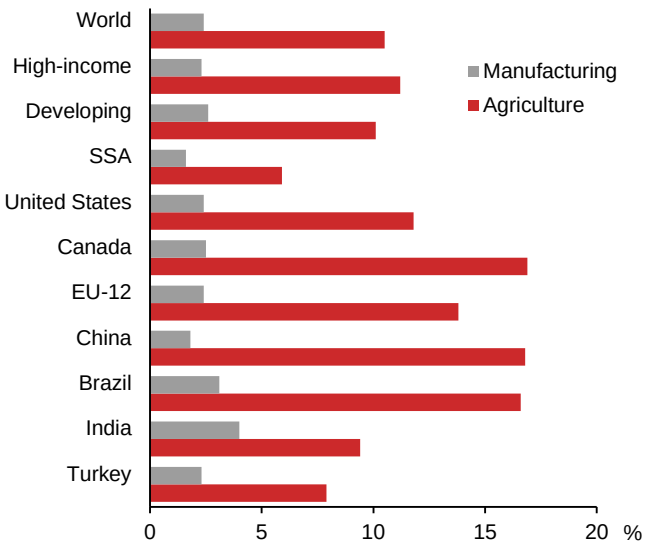
between Iran and Saudi Arabia. With the US seemingly wanting to pull back from the region, tensions in the Middle East could spill over into a full-blown crisis, causing oil prices to skyrocket and being a trigger for a surge in food prices.

Fig. 23: Relationship between oil and food prices



Source: Bloomberg, FAO and Nomura.

Fig. 24: Cost of energy component



Note: SSA = Sub-Saharan Africa. The energy intensity reflects the energy cost component of agriculture and manufacturing industries and accounts for both direct and indirect use of energy.

Source: World Bank calculations based on the GTAP database.

3. Sharp USD depreciation: The inverse relationship between USD and food prices is empirically well established.[18] As commodities are mostly valued in USD, a sharp USD depreciation lowers the cost of imported food in local currency terms (and vice versa) in the short term. Over time, net food exporters react to the prospect of lower local currency revenues by stockpiling and reducing world food supply, while net food importers are incentivised to increase their demand.

On a trade-weighted basis, the level of the USD is already at a historically strong level, raising the risk that it depreciates sharply back toward equilibrium levels – perhaps due to economic growth in Europe and Asia starting to recover, or the US Administration directly intervening to weaken the dollar. A sharp USD depreciation could be a trigger for a surge in food prices.

Three amplifiers

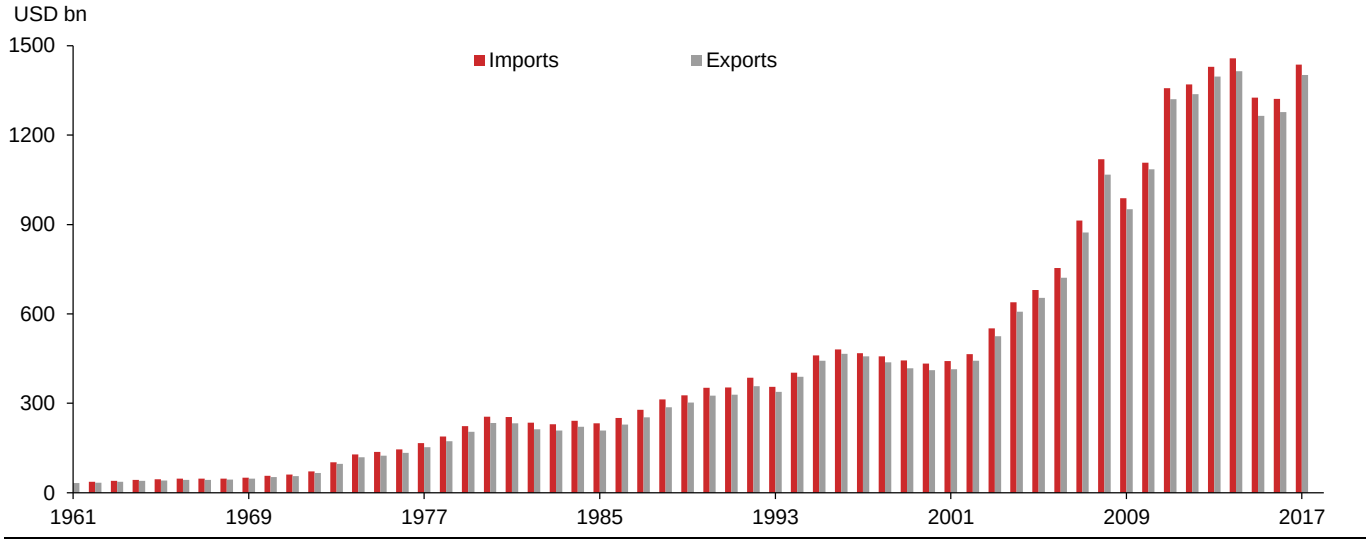
1. Trade protectionism: Food, more than perhaps any other commodity, is of national importance, particularly for EM. In the event of a food price surge, concerns over food security – and by extension social unrest – can impel governments to intervene in agriculture markets by imposing price controls and trade protection. At the individual country level such government policies are aimed at providing relief to the most vulnerable segments of the population from higher global food prices, but several countries simultaneously intervening can inadvertently exacerbate the global food price surge. Cases in point are the food price surges of 2007-08 and 2010-11. In these two episodes governments in many low-income countries – including Argentina, Egypt, India, Indonesia, Kazakhstan, Pakistan, Ukraine, Russia and Vietnam – reacted in their own country's self-interest. They imposed local food price controls and complete bans on exports of some food items (e.g. wheat in Russia and rice in India). These protectionist policies reduced the incentives of producers to increase output and the incentives of consumers to ration demand, and overall reduced international trade in agriculture. At the global level, the unintended consequence was a worsening in the global food supply-demand imbalance, which amplified the food price surge. The World Bank estimates that protectionist policies introduced during the 2010-11 food price spike accounted for about

[18] According to the World Bank (2016), a 10% USD depreciation, on average, is associated with a 5% rise in food prices, see http://pubdocs.worldbank.org/en/642011469546341568/CMO-July-2016-Special-Focus.pdf

40% of the increase in the world price of wheat and 25% of the rise in the world price of maize at that time.[19]

The total value of international trade in agriculture remains close to an all-time high (Figure 25), suggesting that the amplifier effects on global food prices from another round of agricultural trade protectionism could be even larger than in 2010-11. On top of this, many countries are experiencing a rise in populist governments, trade protectionism globally has accelerated and the rules-based, multilateral trading system appears to be breaking down. It may not take much of a rise in global food prices for trade protectionism in agriculture to return with a vengeance.

Fig. 25: Total world value of agricultural imports and exports



Source: FAO and Nomura.

2. High and hidden debt in frontier economies: More than a decade of ultra-loose monetary policies and quantitative easing by the world's major central banks have pushed global investors to search for higher yield in low-income frontier economies[20]. This search for yield, along with China's enormous Belt and Road Initiative (BRI) of investment and loans in 152 countries, has contributed to a surge in government, corporate and external debt in many small, low-income economies. These frontier economies with large debt bills are disproportionately affected in the event of a global risk aversion shock. The IMF in its October 2019 Global Financial Stability Report (see Chapter 4: Emerging and frontier markets: mind the debt) warned that almost half of frontier market economies are either at high risk of falling into debt distress or are already distressed, up from zero as recently as 2014.[21] The IMF backs up its warning with data showing that over the past five years, outstanding hard currency debt of frontier markets has tripled to reach more than USD200bn as of mid-2019. The IMF also finds that the sensitivity of frontier markets' credit spreads to external shocks has risen, in part because of the changing investor base to "flighty" benchmark-driven private investors. The IMF estimates that a 100bp increase in US BBB corporate spreads could widen spreads of B-rated emerging market bonds by more than 200bp, compared with only 50bp for A-rated emerging market issuers.

We concur and show that a number of these frontier economies that are at risk of being in a debt trap happen to also exhibit high vulnerability to a surge in food prices (i.e. the top 30 countries in our NFVI denoted in black in Figure 26). In a smaller sub-set of timelier data the Institute of International Finance has computed that total debt (private and public) for 30 frontier economies has swelled by over USD630bn since mid-2016 to a record USD3.2trn (115% of GDP) in Q2 2019, with over two-thirds of these economies burdened with total debt of over 100% of GDP.[22]

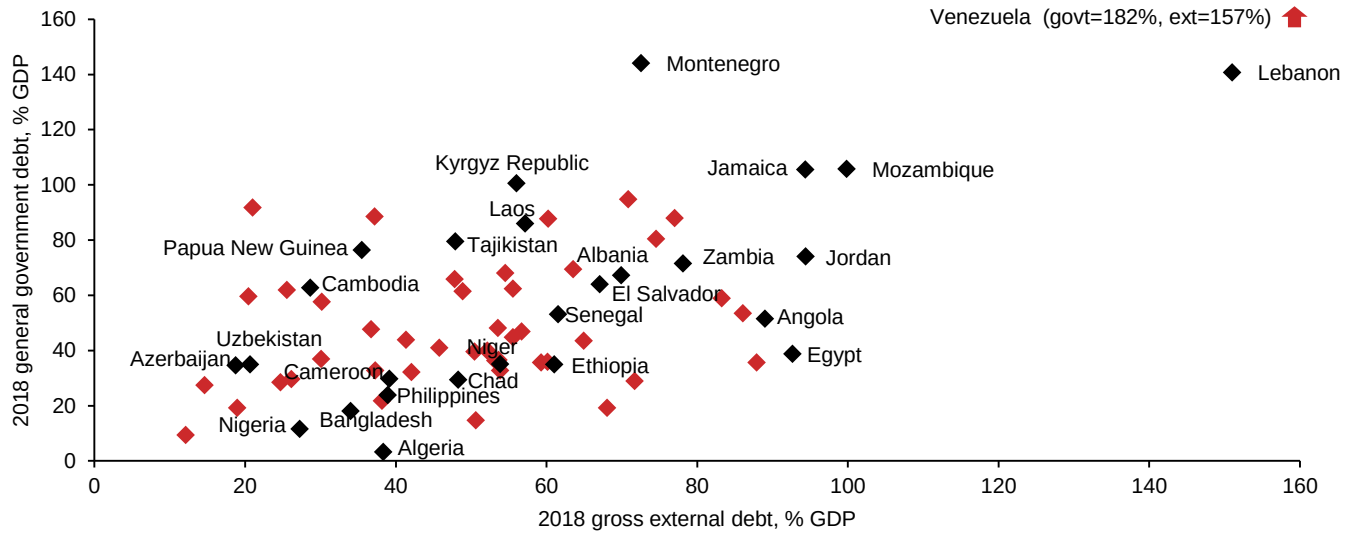
[19]. See page 2 of *World Bank Commodity Markets Outlook* April 2019.

[20]. In 2019 alone, 10-year treasury yields have declined over 100 basis points, boosting inflows to emerging and frontier markets by US$20 billion. See *https://www.imf.org/en/Publications/GFSR/Issues/2019/10/01/global-financial-stability-report-october-2019*

[21]. See "*Chapter 4: Emerging and frontier markets: Mind the debt", IMF Financial Stability Report October 2019*

[22]. See "*Frontier markets debt monitor bubble watch", Institute of International Finance*, 30 October 2019.

Fig. 26: Gross public debt and external debt in EM countries, top 30 countries in NFVI are shown in black.



Note: Top 30 most vulnerable countries in Nomura's Food Vulnerability Index in black. External debt data not available for Bahrain, Iraq, Kuwait, Libya, Oman, Syria and the UAE; General government debt data are not available for Libya, Syria and Mongolia. Source: World Bank, IMF and Nomura.

The growing debt problems in frontier economies run deeper. China's Belt and Road Initiative (BRI)-led lending boom to frontier economies is opaque. Almost all of China's overseas lending is official, meaning that it is undertaken by the Chinese government and state-owned banks and enterprises. China does not report on its official lending, it is not a member of the Paris Club, which tracks sovereign borrowing from official bilateral creditors and commercial providers such as Bloomberg and Dealogic do not keep track of China's official overseas loans.[23] To fill this void, Sebastian Horn, Carmen Reinhart and Christoph Trebesch (2019)[24] canvassed various sources, including individual debt contracts, to assemble a new dataset that covers a total of 1,974 Chinese loans and 2,947 Chinese grants to 152 countries from 1949 to 2017.[25] They found that about one-half of China's total overseas loans outstanding to developing economies are 'hidden', in the sense that they are not recorded in official external debt statistics of the World Bank, and that by 2016 the outstanding hidden loans to EM countries had grown to over USD200bn.

Including the hidden debt, China's overseas lending boom has meant that it has become the world's largest *official* sovereign creditor nation (the largest overall creditor remains the US), and for many low-income countries China has become their larger creditor.[26] The flipside of China's overseas lending boom is a rising debt stock and growing debt service obligations for low-income developing economies.[27] Horn et al provide estimates of 'true' (i.e. including hidden) external debt to China as a share of their GDP for the top

[23] As discussed by Horn et al (2019) one reason for this opacity is the way in which the Chinese government lends abroad. A large share of China's overseas lending is extended via Chinese state-owned entities and the recipients also tend to be state-owned enterprises. This type of company-to-company lending is often not recorded by the statistical offices of developing countries so that official international debt reporting suffers from chronic under-reporting. According to the IMF, fewer than 1 in 10 low-income countries report debt of public corporations that is outside the general government, such that low-income debtor governments themselves have an incomplete picture of how much the country owes to China and under which terms. Another reason is that China's overseas lending is often channelled through offshore financial centres, the flows of which are hard to track. Also for risky debtors, China's state-owned policy banks often choose not to transfer money to accounts controlled by the recipient government, instead the loans are disbursed directly to the Chinese contractor firm that implements the construction project abroad. Because this type of loan is not actually transferred abroad there is nothing to report. The lack of transparency of borrowing by low-income countries is not only a concern in academia, the Institute of International Finance, which represents over 400 financial institutions, is working with EM governments to improve governance and transparency, with support from the G-20.

[24] See "*China's Overseas Lending*", by Sebastian Horn, Carmen Reinhart and Christoph Trebesch in NBER Working Paper Series No. 26050, July 2019.

[25] Horn et al (2019) utilise unpublished data from the World Bank's Debtor Reporting System and data on Bank for International Settlements reported bank claims.

[26] Horn et al (2019) estimate that developing economy sovereigns owe more than USD380bn to China compared with USD246bn in debt owed to the group of 22 Paris Club member governments.

[27] Perhaps the most prominent example to date was Sri Lanka unwilling to service an USD8bn China loan at 6% interest that was used to finance the construction of the Hambantota Port. China agreed in July 2017 to a debt-for-equity swap accompanied by a 99-year lease for managing the port.

50 recipient countries (Figure 27; bars of countries with the highest 30 NFVI scores are in black).[28] For these 50 countries, the size of 'hidden' World Bank external debt data is, on average, 7% of GDP. For a dozen of these countries the hidden debt to China is much more severe, ranging between 10% and 30% of their GDP.[29] What is more, in their forensic study of individual Chinese loans, Horn et al found that unlike most other official creditors and multilateral agencies, they are mostly on non-concessionary terms.[30]

Hidden debt owed to China on non-concessionary terms poses serious challenges for evaluating low-income country sovereign risk and bond pricing.[31] Furthermore, high government debt burdens in countries vulnerable to a food price surge not only make them even more vulnerable, but can also amplify the food price surge. This is because governments will have less fiscal room to shield households from higher food prices through direct food subsidies, coupons, handouts or indirect lowering of import or consumption taxes – as all these policy responses would raise debt levels even higher, heightening the risk of sovereign credit rating downgrades, capital outflows, depreciating currencies, higher interest rates and growth slump. Instead there will be an added incentive for financially constrained governments to impose bans on exporting food, but as discussed in the previous section, at the global level this reduces food supply and can amplify the food price surge. And as we shall explain next, less government support also heightens the risk of panicked hoarding in the private sector.

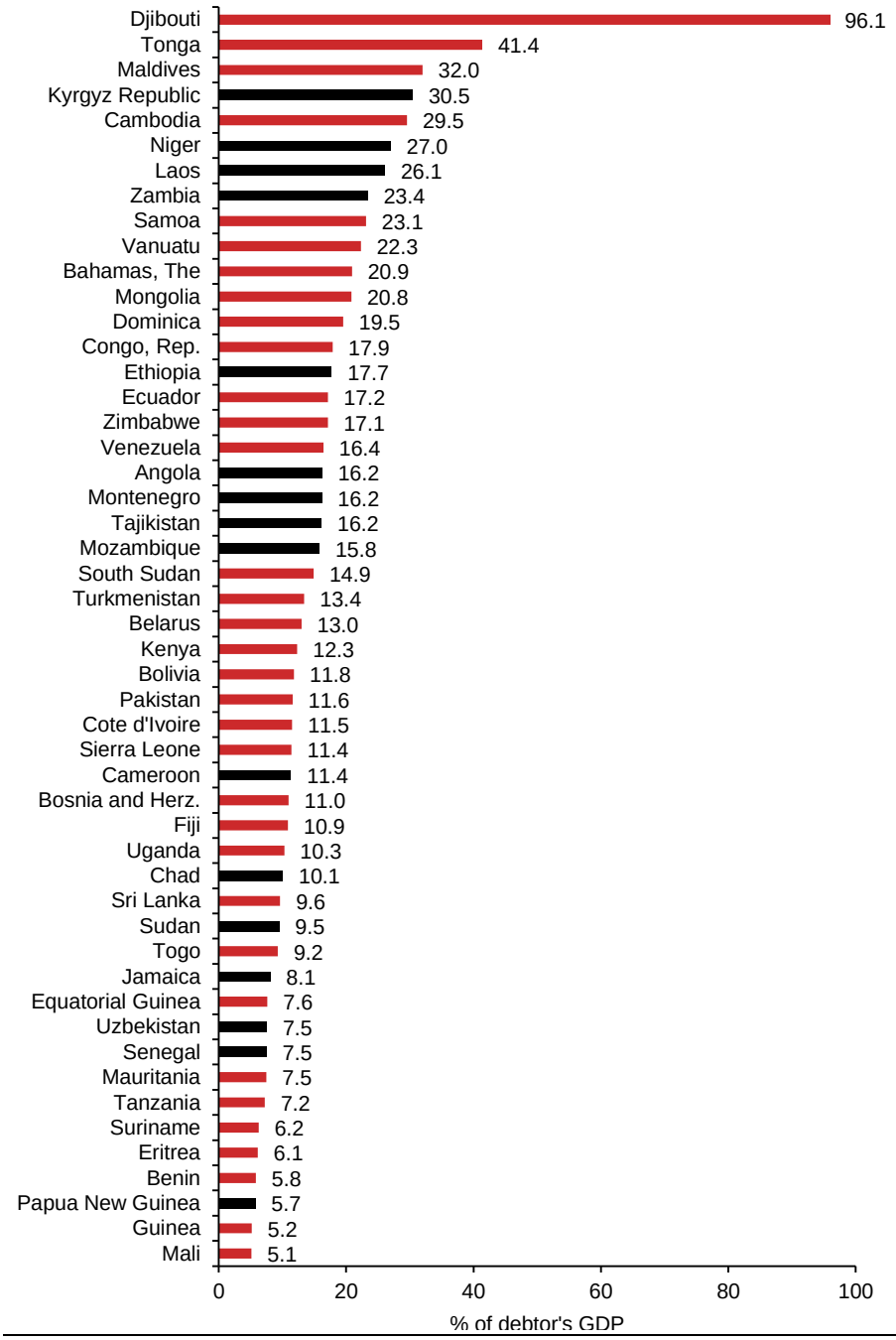
28. Note that the Nomura Food Vulnerability Index for 110 countries does not include many of these 50 frontier economies usually because of the lack of data; and for those not included it is unclear how exposed they are to a surge in food prices.

29. Djibouti is a very small economy, ranking 162nd largest in the world. It is worth highlighting though that it has the highest external debt obligations to China (nearly 100% of its GDP) and its net food imports account for a whopping 30% of its GDP.

30. Official creditors typically lend to developing countries on concessionary terms with long maturities and at below-market interest rates. But for China overseas loans, Horn et al (2019) found that they are often at market terms (with risk premia), shorter maturities, denominated in USD and partly with collateral clauses that secure repayment through commodity export proceeds (e.g. oil).

31. Horn et al (2019) warn that Chinese lending flows share similarities with the lending boom of the 1970s, when resource-rich EM countries received large amounts of syndicated bank loans, and this did not end happily in the 1980s when dozens of EM sovereigns went into default, resulting in a lost decade in Latin America.

Fig. 27: 'True' external debt owed to China as a share of their GDP - top 50 recipient countries



Note: Top 30 most vulnerable countries in Nomura's Food Vulnerability Index in black. This figure shows the stock of total external debt from direct loans owed to China as of 2017, focusing on the 50 countries most indebted to China. Total debt includes loans to public borrowers (PPG debt) and private borrowers (Chinese official loans to private entities abroad amount to less than 10% of total). The estimates are based on the loan-level consensus database. Chinese portfolio debt holdings and short-term trade debt are excluded from these estimates. GDP is from the IMF's WEO database.

Source: *China's overseas lending* by Sebastian Horn, Carmen M. Reinhart and C. Trebesch, NBER Working Paper No. 26050, issued in July 2019.

3. Speculation and hoarding: Commodity exchange markets provide risk-management tools, such as futures and options, to enable commercial participants such as farmers and agricultural traders to hedge against the risk of price fluctuations. There are also non-commercial participants such as speculators and institutional investors, which are also important for the efficient functioning of markets, as they bring liquidity and can take the other side of a risk-shifting trade. However, in the short run an investor might be attracted to the perceived profit opportunities from an upward trend in food futures prices and speculative investments may reinforce this trend, especially if many investors jump on the bandwagon (i.e. herd behaviour).

Hedge funds and Index funds could be examples of such powerful investors, the latter are estimated to hold 25-35% of all agricultural futures contracts. During the 2005-08 food price surge there is some evidence that non-commercial traders increased their net

long open interest positions in some US agricultural futures and options markets, such as maize and sugar, raising concerns that excessive financial speculation was exacerbating the rise in food prices.[32] The results of empirical studies are mixed, however, on whether financial speculation amplifies large swings in food prices. In India, the government was sufficiently convinced of financial speculation that it banned futures trading in rubber, soya oil, potato and chickpeas in 2008. The FAO's conclusion is that "trading in futures markets may have amplified price volatility in the short term only".[33]

While the empirical evidence of financial speculation is inconclusive, there are several anecdotes that physical speculation in EM economies – such as panicked hoarding or ordering more food now in expectation of further prices rises – contributed to past food price surges. If many countries – or individual consumers – act the same way, the hoarding causes a panic and extreme shortages in markets, magnifying the rise in food prices.[34] A recent example is in Thailand, which this year was hit by a severe drought, causing the price of glutinous rice to surge to a more than five-year high. In August 2019, the government issued a warning to sticky rice millers and traders that if they keep on intentionally pushing up the price by building inventories they will be fined THB5,000 or face up to five years in jail.

32. See FAO report: *http://www.fao.org/3/ai482e/ai482e12.htm* and Science direct: *https://www.sciencedirect.com/science/article/pii/S0306919213001188* and UNCTAD: https://unctad.org/meetings/en/Presentation/SUC%20MYEM2015%20Gerdien%20Meijerink.pdf

33. See "*Price surges in food markets: how should organised futures markets be regulated*?" FAO Policy Brief No. 9, June 2010.

34. An example is rice prices in 2007-08. The global rice market is also relatively concentrated, with Thailand, Vietnam, India, the US and Pakistan routinely providing nearly ~80% of available supplies. As concerns grew in 2007 that world rice supplies were limited and prices were rising, several Asian countries reconsidered the wisdom of maintaining low domestic stocks for rice, particularly the Philippines, which proactively built up the nation's stocks. In the words of Charles Timmer (2009) at the FAO, "The psychology of hoarding behaviour is important in explaining why rice prices suddenly shot up starting in late 2007. Decisions by millions of households, farmers, traders and some governments sparked a sudden surge in demand for rice and changed the gradual increase in rice prices from 2002 to 2007 into an explosion. This was "precautionary" demand even if not "speculative" demand". See *http://www.fao.org/3/a-ak232e.pdf*

The 2010-11 surge in food prices redux

To gauge the impact of sizeable moves in food prices on economies, we conduct an event study analysis, comparing the average movement in key economic and financial variables for the two extreme groups in the Nomura Food Vulnerability Index – the most (highest 30 NFVI scores) and least (lowest 30 NFVI scores) vulnerable countries – during the 2010-11 food price surge. The results show notable differences between the two groups, reinforcing that a food price surge does have large economic effects, and the directions are broadly consistent with text book theory (Figure 28).

GDP growth. A surge in food prices affects the income distribution of a country: it is positive for agricultural producers but negative for consumers, especially in low-income countries, where food accounts for the largest share of overall household spending. The most negative impact on GDP growth is likely in the poorest countries that are large net importers of food, and they are also vulnerable to second-round effects, such as social unrest (e.g. the Arab Spring in 2011) or higher interest rates (to combat inflation and defend the exchange rate from capital flight). By contrast, a surge in food prices can have a positive impact on the GDP growth of high-income countries that are large net exporters of food – New Zealand, Ireland, the Netherlands, Norway, Denmark and Australia. From 2010 to 2011, a period when global growth fell by 1.1pp, the average fall in GDP growth was 4.3pp (or -2.0pp if Libya is excluded) in the most vulnerable NFVI group, over 8x the fall in the least vulnerable NFVI group (-0.5pp). Of the 30 countries in the most vulnerable NFVI group, eight suffered a drop in GDP growth of at least 5pp.

CPI inflation. A surge in food prices should lead to higher CPI inflation in EM economies as food tends to have a high weighting in the CPI basket (low-income households spend a larger share of their income on food). Between 2010 and 2011, the average rise in CPI inflation was 2.7 percentage points (pp) in the most vulnerable NFVI group compared with 1.0pp in the least vulnerable NFVI group. From 2010 to 2011, CPI inflation surged by over 5pp in Libya, Tajikistan, Kyrgyz Republic, Sudan, Niger and Ethiopia.

Fiscal balance. As a surge in food prices tends to have a larger negative impact on lower-income EM economies, it is quite common for EM governments to actively intervene – providing greater food subsidies, instilling price controls, reducing taxes and food import tariffs and banning food exports – to protect their poor. The cost of these policy actions is a worsening fiscal position. If EM countries already have a high public debt burden (as we have shown, many do) then a further deterioration in fiscal finances can trigger a sovereign credit rating downgrade and wider credit spreads, exacerbating the growth slowdown. From 2010 to 2011, the average fiscal balance, as a share of GDP, worsened in the most vulnerable group (-0.3pp), but improved in the least vulnerable group (+1.5pp).

Policy interest rate. As discussed, a surge in food prices can lead to a stagflationary environment in the most vulnerable NFVI group. Faced with a growth / inflation trade-off, central banks in emerging economies are typically slow to raise rates to counteract high inflation as they are concerned about accentuating the decline in growth. However, if the surge in food prices is sustained and threatens to de-anchor inflation expectations, EM central banks have no choice but to play catch-up by raising interest rates to avoid a wage-price inflation spiral. In contrast, there should be less need for tighter monetary policy in the least vulnerable group because of less inflationary pressures due to a lower weighting of food in the CPI basket and a higher possibility of currency appreciation. From 2010 to 2011, the policy interest rate in the most vulnerable group increased by an average of 1.23pp, versus a rise of 0.69pp in the least vulnerable group.

Exchange rate. In the most vulnerable group, higher inflation, weaker growth and a deterioration in the current account (larger net food import bill) and fiscal positions all combine to worsen economic fundamentals. All else being equal, currencies in countries facing deteriorating fundamentals are likely to depreciate, unless the policy interest rate is hiked aggressively. From 2010 to 2011, 11 of the 30 countries in the most vulnerable group saw their currencies depreciate against the USD, as opposed to only three of the 30 countries in the least vulnerable group.

Sovereign credit rating. Based on ratings agency Moody's, if we exclude EU countries affected by the 2011 European debt crisis, there was a net total (number of upgrades less downgrades) of six upgrades from 2010 to 2011 in the least vulnerable NFVI group of countries, versus a net total of two downgrades in the most vulnerable group.

Fig. 28: Quantifying the impact of the 2010-11 food price surge on most and least exposed NFVI economies

	Real GDP growth, % y-o-y	CPI inflation, % y-o-y	Fiscal balance, % GDP	Policy rate, %	Local currency / USD
	Change in 2011 from 2010, percentage points			Change in 2011 high from the 2010 low, percentage points	% change to 2011 average from average in 2010
Top 30 most vulnerable economies					
Libya	(69.8)	13.4	(29.8)	0.00	3.3
Tajikistan	0.9	6.0	0.8	2.00	(5.3)
Montenegro	0.5	3.1	(1.9)	0.50	4.8
Syria	n.a.	n.a.	n.a.	n.a.	(3.9)
Algeria	(0.8)	0.6	(0.1)	0.00	1.1
Jordan	0.3	(0.7)	(2.0)	0.25	n.a.
Lebanon	(7.1)	1.0	1.5	0.00	n.a.
Lao P.D.R.	(0.0)	1.6	0.0	1.00	2.8
Kyrgyz republic	6.4	8.7	1.2	12.76	(0.6)
Albania	(1.2)	(0.2)	0.0	0.25	3.0
Senegal	(2.1)	2.2	(1.0)	0.00	4.4
Bangladesh	0.5	2.1	(0.9)	0.00	(6.4)
Jamaica	2.9	(5.1)	(0.1)	0.00	1.6
Uzbekistan	(0.2)	0.1	3.4	(2.00)	(8.1)
Iraq	1.1	3.2	8.9	0.00	0.0
Egypt	(3.4)	(0.6)	(2.2)	1.00	(5.5)
Nigeria	(6.4)	(2.9)	4.6	6.00	(3.2)
Sudan	(6.7)	5.1	(2.4)	n.a.	(10.9)
Cameroon	0.7	1.7	(1.4)	0.00	4.6
Niger	(6.2)	5.7	0.9	0.00	4.4
Azerbaijan	(6.4)	2.1	(3.0)	3.25	1.7
Angola	(1.4)	(1.0)	4.7	0.00	(2.0)
Philippines	(4.0)	0.6	2.0	0.50	4.0
Chad	(13.5)	4.1	6.5	0.00	4.6
Ethiopia	0.8	25.1	(0.3)	n.a.	(17.4)
Zambia	(4.7)	0.2	0.6	6.70	(1.3)
Mozambique	0.4	(1.3)	(1.0)	0.00	15.3
Cambodia	1.1	1.5	(0.9)	0.13	3.0
Papua New Guinea	(9.0)	(0.7)	(0.8)	0.75	12.9
El Salvador	1.7	4.0	0.5	0.11	n.a.
Average	**(4.3)**	**2.7**	**(0.4)**	**1.23**	**0.3**
Median	**(0.8)**	**1.6**	**(0.1)**	**0.11**	**1.6**
Top 30 least vulnerable economies					
New Zealand	(0.1)	1.8	0.5	0.50	8.8
Ivory Coast	(6.9)	3.5	(2.1)	0.00	4.4
Nicaragua	1.9	2.6	0.1	n.a.	(5.0)
Ireland	(1.4)	2.8	19.2	0.50	4.8
Luxembourg	(2.3)	0.9	1.2	0.50	4.8
Netherlands	0.2	1.5	0.8	0.50	4.8
Ukraine	1.4	(1.4)	3.0	0.00	(0.4)
Norway	0.3	(1.1)	2.4	0.50	7.2
Denmark	(0.5)	0.5	0.7	0.50	4.7
Switzerland	(1.0)	(0.5)	0.4	0.09	14.9
Australia	0.4	0.5	0.6	1.00	11.1
Uruguay	(2.6)	1.4	0.1	2.50	3.8
Ecuador	4.3	0.9	1.2	(0.03)	n.a.
United States	(1.0)	1.5	1.3	0.00	n.a.
Canada	0.1	1.1	1.4	0.75	4.0
Singapore	(8.3)	2.4	2.3	0.00	7.8
Belgium	(0.9)	1.0	(0.2)	0.50	4.8
Austria	1.1	1.8	1.9	0.50	4.8
Chile	0.3	1.9	1.8	4.75	5.2
Germany	(0.3)	1.4	3.5	0.50	4.8
France	0.2	0.6	1.7	0.50	4.8
Spain	(1.0)	1.4	(0.3)	0.50	4.8
Sweden	(3.1)	(0.5)	(0.2)	1.75	9.9
Costa Rica	(0.6)	(0.8)	1.1	0.00	3.8
United Kingdom	(0.1)	1.2	1.8	0.00	3.7
Hungary	1.0	(0.9)	(0.9)	1.75	3.3
Argentina	(4.1)	(0.7)	(1.4)	0.00	(5.6)
Finland	(0.4)	1.6	1.6	0.50	4.8
Lithuania	4.4	2.9	(2.0)	0.50	4.8
Poland	1.4	1.7	2.5	1.00	1.7
Average	**(0.6)**	**1.0**	**1.5**	**0.69**	**4.7**
Median	**(0.2)**	**1.3**	**1.1**	**0.50**	**4.8**

Note: Values for CPI inflation, real GDP growth and fiscal balance (% of GDP) are 2011 minus 2010. Values for policy rate are the difference between the high point in 2011 from the low point in 2010. Where data on policy rates are unavailable, we use discount rates from the IMF for Libya, Algeria, Egypt, Cameroon, Angola and Chad, and deposit rates for Ethiopia, Cambodia and El Salvador as a proxy. For currency, a positive value refers to an appreciation of the local currency against the USD in 2011 from 2010, while a negative value indicates that the local currency depreciated in 2011. Source: IMF, Bloomberg, CEIC and Nomura.

Having established that the 2010-11 surge in food prices resulted in a more marked deterioration in the economic fundamentals of the countries in the most vulnerable NFVI group than those in the least vulnerable group, we explore whether this was reflected in market pricing. We conducted the same event study on sovereign bonds and credit default swaps (CDS), but because many frontier economies have illiquid, or no market for these products we expanded the most vulnerable group from 30 to 40 countries to reach a reasonably sized sample of 12 for sovereign bonds and nine for CDS.

Sovereign bond yields. From the low point in 2010 to the high point in 2011, 10yr sovereign bond yields in the most vulnerable NFVI group increased, on average, by 363bp, compared with a rise of 259bp for the least vulnerable group. This divergence is in line with our priors and would probably have been larger had it not been for the European debt crisis in 2011 that led to substantially higher government bond yields in some EU countries (indeed, the median increase for the least vulnerable group is a smaller 131bp).

Sovereign CDS spread: 5yr sovereign CDS spreads in the most vulnerable NFVI group increased, on average, by 81bp versus 35bp for the least vulnerable group from 2010 to 2011. Again, if not for the European debt crisis the latter would have been smaller.

Fig. 29: Quantifying the impact of the 2010-11 food price surge on most and least exposed NFVI economies

	10-year sovereign bond yield (USD or EUR denominated, long term), % Change in 2011 high from 2010 low, percentage points		5-year sovereign CDS spread, bp Change in 2011 from 2010, basis points
From the 40 most vulnerable economies		**From the 40 most vulnerable economies**	
Philippines	1.58	Lebanon	91
El Salvador	4.04	Iraq	(76)
Iraq	2.20	Egypt	164
Lebanon	1.97	Philippines	1
Albania	4.11	El Salvador	20
Tunisia	2.76	Pakistan	234
Pakistan	6.54	Tunisia	91
Venezuela	4.60	Morocco	82
Morocco	1.72	Croatia	120
Egypt	6.92	**Average**	**81**
Croatia	3.89	**Median**	**91**
Montenegro	3.18		
Average	**3.63**		
Median	**3.54**		
From the 30 least vulnerable economies		**From the 30 least vulnerable economies**	
Argentina	3.19	Poland	64
Chile	0.55	Lithuania	1
Costa Rica	1.38	Finland	20
Ecuador	1.80	Argentina	(184)
Finland	1.37	Hungary	102
Belgium	2.98	UK	(1)
Poland	1.92	Costa Rica	42
Spain	2.87	Sweden	6
Ukraine	6.32	Spain	116
United States	1.35	France	59
Uruguay	1.07	Germany	27
Lithuania	1.13	Chile	11
Sweden	0.00	Austria	33
France	1.31	Belgium	106
Germany	1.37	Singapore	23
Austria	1.32	US	7
Netherlands	1.45	Uruguay	(6)
Ireland	9.36	Australia	18
Hungary	9.36	Switzerland	2
Singapore	1.20	Denmark	37
Denmark	3.19	Norway	8
Average	**2.59**	Ukraine	(68)
Median	**1.31**	Netherlands	23
		Ireland	409
		New Zealand	19
		Average	**35**
		Median	**20**

Note: To ensure comparability, the long-term sovereign bond yields included here are all USD or EUR denominated (depending on which is the deeper market) and the maturities are 10-years or longer (Hungary and Poland (15-year), Uruguay (20-year), Iraq (22-year), Argentina (28-year)), with the exceptions of Albania, Montenegro, Denmark (5-year), Lebanon and Sweden (7-8 year)). Singapore and Tunisia's bond yields and CDS spreads refer to those of Temasek – Singapore's sovereign wealth investment company – and the central bank of Tunisia respectively. Due to data limitations (illiquid or no market for government bond yield or CDS), we expanded our "most vulnerable" group from 30 to 40 countries to reach a reasonably sized sample of 12 for sovereign bonds and nine for CDS. Source: Bloomberg and Nomura.

Potential movers and shakers in sovereign CDS and bonds

As highlighted in the previous section, long-term sovereign bond yields and CDS are useful to indicate broad-based changes in a country's economic fundamentals. The combination of a sharp weakening in growth, higher inflation, wider fiscal and trade deficits and larger debt burdens tend to increase the default risk of a country, and markets price this in through higher long-term sovereign bond yields and CDS spreads.[35]

For the next food price surge, the impact on these financial variables in the more vulnerable NFVI group may be proportionately larger than in past surges for two important reasons that we have highlighted in this report. First, the growing challenge from global warming, in which we have shown that the countries more vulnerable to climate change-induced disruptions are also the ones more vulnerable to a surge in food prices, i.e. high NFVI scores (see *Trigger one: weather related shocks*, pages 13-14, and Figure 20 on the Notre Dame's vulnerability index). Second, is the close correlation between countries that have high NFVI scores and have also experienced a sharp rise in debt to dangerously high levels, not to mention their surge in 'hidden debt' owed to China, often on non-concessionary terms (see *Amplifier two: high and hidden debt in frontier economies*, pages 17-20). To evaluate potential movers and shakers in sovereign bonds and CDS we take a two-pronged approach. Our methodology is as follows:

The first step is to classify the 110 countries in our NFVI into buckets according to their Moody's foreign currency long-term sovereign credit ratings (e.g., all AAA rated countries are grouped together; all Aa1 rated countries are grouped together, and so on). Next, for each sovereign rating bucket, we subtracted the average 5yr sovereign CDS spread (as of 8 November 2019) from individual CDS spreads of each country in their respective bucket. We conducted the same exercise for 10yr sovereign government bond yields.[36]

From the above steps we arrived at the 5yr sovereign CDS spread differential and the 10yr sovereign bond yield differential. These differentials can be thought of as rough measures of the initial condition (i.e., whether a country's CDS spread or sovereign bond yield is currently priced high or low relative to its peers with the same sovereign credit rating). This exercise reduced our sample size from 110 to around 80 countries, as several of the frontier economies do not have data on sovereign credit rating, CDS or sovereign bonds.

The final step was to further reduce the sample size by putting the spotlight on those countries that are most vulnerable to a food price surge (highest 30 NFVI scores) and least vulnerable (lowest 30 NFVI scores); the countries in-between were removed. The final results are presented in Figures 30 and 31.

The results are as follows:

Sovereign CDS spread: The results suggest that, in the event of a sustained food price surge, the countries that meet the criteria of a negative CDS differential (initial condition of underpriced CDS spread relative to sovereign credit rating) and have high NFVI scores are Lebanon, Iraq, Egypt, Nigeria, Angola, Philippines, Zambia and El Salvador. If food prices surge, market perceptions of sovereign risk may quickly zoom-in on this group of countries, resulting in a spike in their CDS spreads. At the other extreme are those countries that have a positive CDS differential and low NFVI scores. For countries that satisfy these criteria, the market perception of sovereign risk may fall as food prices rise. Here New Zealand, Ivory Coast, Nicaragua, Ukraine, Ecuador and Argentina stand out as countries that could see CDS spreads narrow, or remain little changed, if food prices surge.

Sovereign bond yield: The results for bond yields are quite consistent with those from the CDS analysis: Iraq, Egypt, Nigeria, the Philippines and El Salvador are countries whose sovereign bonds appear most vulnerable to a food price surge. At the other extreme, New Zealand, Ivory Coast, Ireland, Ukraine and Ecuador could see yields reprice lower during a food price surge.

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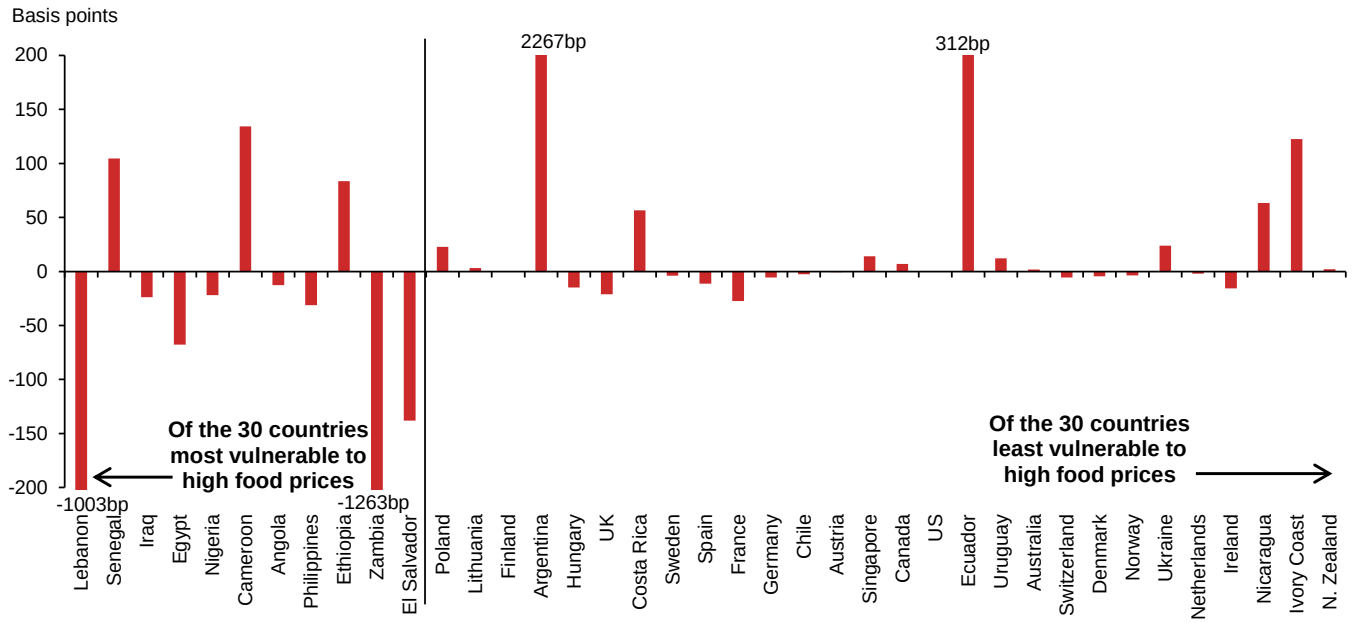
35. Credit default swaps (CDS) are credit protection contracts whereby one party agrees, in exchange for a periodic premium, to make a contingent payment in the case of a defined credit event. The quoting convention for CDS is the annual premium payment as a percentage of the notional value of the reference obligation. Under certain conditions, this CDS premium should be approximately equal to the credit spread (yield minus risk-free rates) of the reference bond of the same maturity.

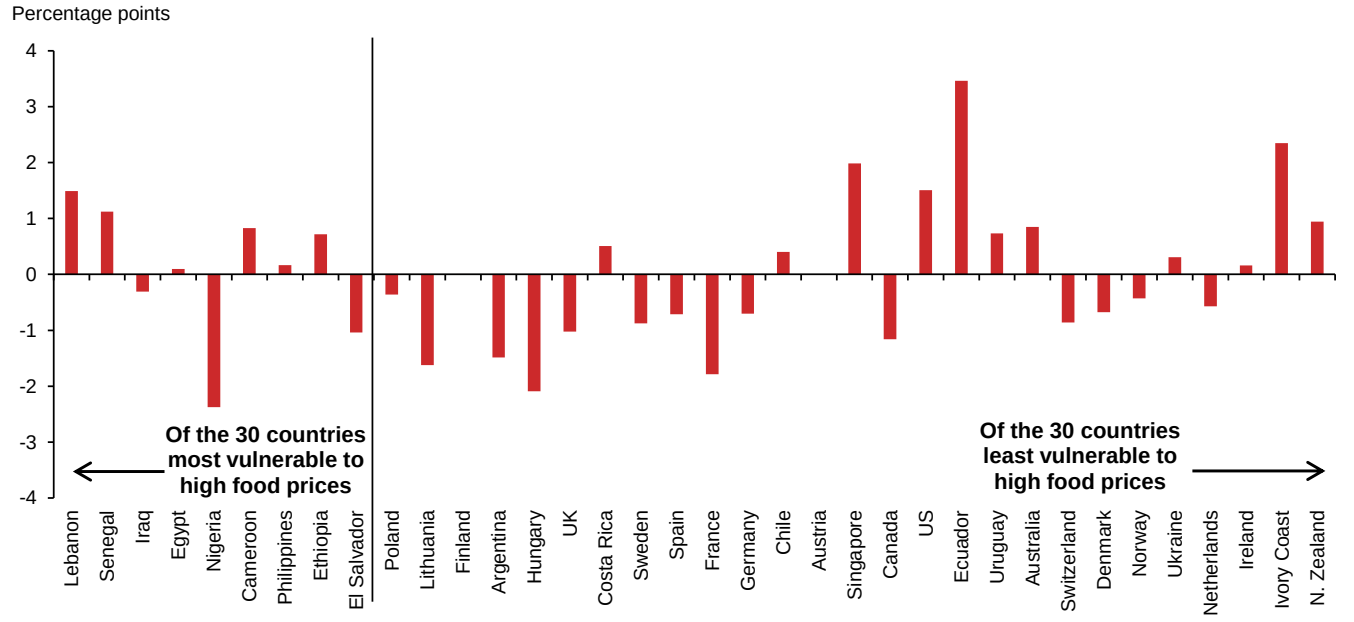
36. For some economies that do not have USD or EUR-denominated sovereign bonds, we used narrower measures if available, such as government pension fund or state bank USD or EUR-denominated bonds.

Fig. 30: Estimated CDS spread differential for countries in the same sovereign rating bucket, as at 8 November 2019



Note: More and less vulnerable to rising food prices is based on the Nomura Food Vulnerability Index. The CDS differential is the difference between each country's 5-year sovereign CDS spread and the average 5yr CDS spread of all the countries in our sample that have the same Moody's sovereign rating as of 8 November 2019. Our sample has been reduced from 110 to 80 economies as the Czech Republic is the only economy in their credit rating bracket (Aa3), and some smaller economies do not have a CDS market or a sovereign credit rating. CDS spread for Singapore refers to the CDS spread for Temasek – Singapore's sovereign wealth investment company. Here we show only, where data are available, the top and bottom 30 countries most vulnerable to high food prices. Source: Bloomberg and Nomura.

Fig. 31: Estimated sovereign bond yield differential for countries in the same sovereign rating bucket, as at 8 November 2019



Note: More and less vulnerable to rising food prices is based on the Nomura Food Vulnerability Index. The bond yield differential is the difference between each country's long-term USD or EUR-denominated bond yield (10yr for most countries, otherwise at least 5 years or longer) and the average long-term USD or EUR-denominated bond yield of all the countries in our sample that have the same Moody's sovereign rating as of 8 November 2019. For some countries that do not have USD or EUR-denominated sovereign bonds, we used very close proxies, such as government pension fund or state bank USD or EUR-denominated bonds. We have used local currency sovereign bond yields for Australia, Switzerland, Denmark, New Zealand and the UK as these countries do not issue USD or EUR-denominated sovereign bonds and we judge that the yields of these local currency bonds are comparable. Despite these adjustments, our sample has still been reduced from 110 to 76 economies as the Czech Republic is the only country in its credit rating bracket (Aa3), and some smaller economies do not have a long-term USD or EUR-denominated bond yield or a sovereign credit rating. Here we show, where data are available, only the top and bottom 30 countries most vulnerable to high food prices. Source: Bloomberg and Nomura.

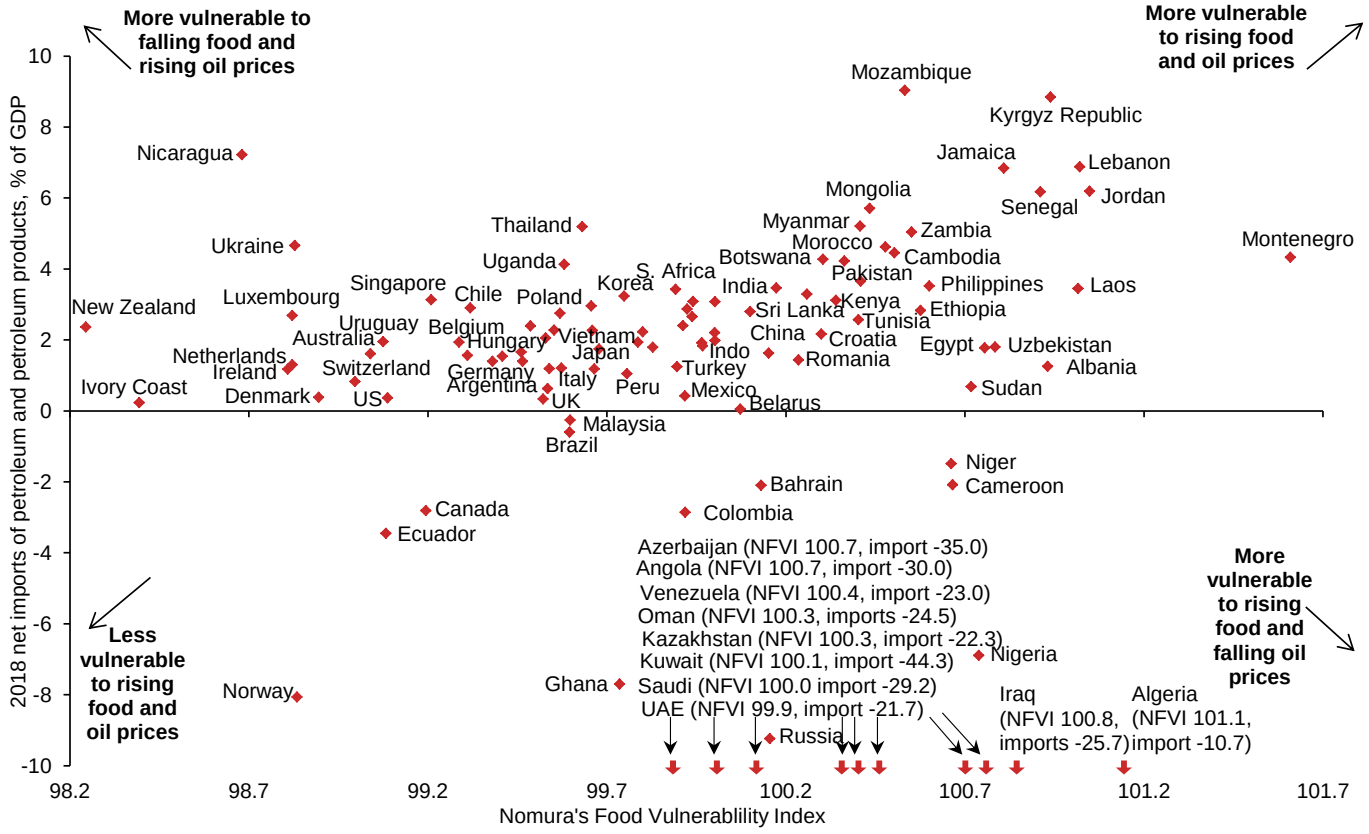
What if food and oil prices part ways?

Compared with other commodities, we found that changes in oil prices are relatively highly correlated with changes in food prices (see Appendix 1). However, there can be situations where the two part ways. For example, food prices may rise (say, triggered by severe weather-related shocks), but oil prices could fall (say, because of a deepening global economic downturn).

Plotting our NFVI scores against net oil exports of each country (Figure 32), it would seem that some of the most vulnerable countries to a scenario of rising food prices but falling oil prices are: Algeria, Iraq, Azerbaijan, Angola, Nigeria, Russia and Venezuela. The countries least vulnerable, or that could benefit from rising food prices but falling oil prices, include Nicaragua, Ukraine, New Zealand, Ivory Coast, Netherlands, Ireland and Luxembourg.

Alternatively, food prices may rise in tandem with oil prices (say, due to a synchronised global economic recovery or a full-blown crisis in the Middle East) in which case some of the most vulnerable countries appear to be the Kyrgyz Republic, Lebanon, Jordan, Montenegro, Jamaica, Senegal, and Laos. By contrast, there is a single country that stands out as a potential beneficiary of rising food and oil prices – Norway.

Fig. 32: Net oil imports vs Nomura's food vulnerability index



Note: Net oil imports refer to net imports of petroleum and petroleum products. Source: UN Comtrade, CEIC and Nomura.

Appendix 1: Correlation matrices of monthly changes in prices

Fig. 33: 2-year correlation matrix of monthly changes in prices

2y correlation matrix, 2017 Nov to 2019 Oct	Food	Oil	Coal	Aluminium	Copper	Cotton	Iron ore	Rubber	Wool	Gold	SPX index	Bond index	Fine wines	Steel	Diamond	Bitcoin	DXY	Cement
Food		0.29	0.01	0.37	0.26	0.22	0.05	0.37	0.16	0.46	0.03	0.16	-0.13	0.15	0.25	-0.04	-0.25	-0.05
Crude oil	0.29		0.24	0.40	0.30	0.25	0.22	-0.13	0.21	-0.15	0.30	-0.39	0.13	0.51	0.30	0.16	0.17	0.09
Coal	0.01	0.24		0.21	-0.05	0.25	-0.17	-0.34	0.54	-0.21	-0.14	-0.19	0.30	0.11	0.08	-0.17	0.07	0.11
Aluminium	0.37	0.40	0.21		0.60	0.23	-0.01	0.03	0.32	0.37	0.07	-0.31	0.17	0.23	0.23	-0.02	0.18	0.12
Copper	0.26	0.30	-0.05	0.60		0.35	0.27	-0.04	0.36	0.35	0.08	-0.27	0.11	0.00	0.42	-0.29	0.10	0.21
Cotton	0.22	0.25	0.25	0.23	0.35		-0.14	-0.12	0.46	-0.18	0.27	0.04	0.18	-0.14	0.35	-0.20	-0.32	0.32
Iron ore	0.05	0.22	-0.17	-0.01	0.27	-0.14		0.23	-0.01	0.31	0.35	0.05	-0.08	0.06	0.02	0.33	-0.12	-0.07
Rubber	0.37	-0.13	-0.34	0.03	-0.04	-0.12	0.23		0.03	0.36	0.09	0.57	-0.28	-0.03	0.15	0.28	-0.43	-0.31
Wool	0.16	0.21	0.54	0.32	0.36	0.46	-0.01	0.03		0.06	0.20	-0.16	0.26	0.03	0.44	-0.31	-0.17	-0.11
Gold	0.46	-0.15	-0.21	0.37	0.35	-0.18	0.31	0.36	0.06		0.18	0.39	-0.06	-0.24	0.25	-0.10	-0.36	-0.33
SPX index	0.03	0.30	-0.14	0.07	0.08	0.27	0.35	0.09	0.20	0.18		0.04	0.25	0.03	0.28	0.01	-0.29	-0.26
Bond index	0.16	-0.39	-0.19	-0.31	-0.27	0.04	0.05	0.57	-0.16	0.39	0.04		0.14	-0.34	-0.16	0.12	-0.65	-0.28
Fine wines	-0.13	0.13	0.30	0.17	0.11	0.18	-0.08	-0.28	0.26	-0.06	0.25	0.14		0.24	0.00	0.09	-0.06	0.14
Steel	0.15	0.51	0.11	0.23	0.00	-0.14	0.06	-0.03	0.03	-0.24	0.03	-0.34	0.24		-0.08	0.51	0.29	0.12
Diamond	0.25	0.30	0.08	0.23	0.42	0.35	0.02	0.15	0.44	0.25	0.28	-0.16	0.00	-0.08		-0.14	-0.33	-0.06
Bitcoin	-0.04	0.16	-0.17	-0.02	-0.29	-0.20	0.33	0.28	-0.31	-0.10	0.01	0.12	0.09	0.51	-0.14		-0.11	0.24
DXY	-0.25	0.17	0.07	0.18	0.10	-0.32	-0.12	-0.43	-0.17	-0.36	-0.29	-0.65	-0.06	0.29	-0.33	-0.11		0.08
Cement	-0.05	0.09	0.11	0.12	0.21	0.32	-0.07	-0.31	-0.11	-0.33	-0.26	-0.28	0.14	0.12	-0.06	0.24	0.08	

Note: Global bond index refers to Bloomberg Barclays Total Return Global Bond Index. Source: FAO, IMF, World Bank, Bloomberg and Nomura.

Fig. 34: 10-year correlation matrix of monthly changes in prices

10y correlation matrix, 2009 Nov to 2019 Oct	Food	Oil	Coal	Aluminium	Copper	Cotton	Iron	Rubber	Wool	Gold	SPX index	Bond index	Fine wines	Steel	Diamond	Bitcoin	DXY	Cement
Food		0.33	0.09	0.32	0.36	0.38	0.19	0.41	0.18	0.18	0.34	0.28	0.24	0.17	0.09	0.15	-0.41	0.04
Oil	0.33		0.22	0.31	0.39	0.27	0.21	0.30	0.19	0.01	0.33	0.01	0.15	0.23	0.16	0.06	-0.15	0.21
Coal	0.09	0.22		0.32	0.32	0.24	0.26	0.24	0.33	0.05	0.01	-0.18	0.41	0.22	0.06	0.07	0.08	0.28
Aluminium	0.32	0.31	0.32		0.67	0.26	0.23	0.39	0.32	0.19	0.22	0.06	0.27	0.31	0.07	0.05	-0.16	0.17
Copper	0.36	0.39	0.32	0.67		0.29	0.45	0.44	0.40	0.21	0.28	0.04	0.31	0.43	0.10	0.05	-0.18	0.17
Cotton	0.38	0.27	0.24	0.26	0.29		0.12	0.38	0.30	0.05	0.23	-0.08	0.50	0.05	0.18	-0.02	-0.09	0.17
Iron ore	0.19	0.21	0.26	0.23	0.45	0.12		0.54	0.26	0.19	0.06	-0.01	0.34	0.52	0.08	0.07	-0.02	0.19
Rubber	0.41	0.30	0.24	0.39	0.44	0.38	0.54		0.27	0.19	0.21	0.05	0.40	0.40	0.08	0.09	-0.13	0.01
Wool	0.18	0.19	0.33	0.32	0.40	0.30	0.26	0.27		0.11	0.13	0.06	0.23	0.17	0.22	0.14	-0.21	-0.13
Gold	0.18	0.01	0.05	0.19	0.21	0.05	0.19	0.19	0.11		-0.06	0.31	0.16	0.01	0.21	-0.03	-0.16	-0.17
SPX index	0.34	0.33	0.01	0.22	0.28	0.23	0.06	0.21	0.13	-0.06		0.20	0.07	0.13	-0.03	0.15	-0.45	-0.04
Bond index	0.28	0.01	-0.18	0.06	0.04	-0.08	-0.01	0.05	0.06	0.31	0.20		-0.07	0.05	-0.07	0.10	-0.73	-0.14
Fine wines	0.24	0.15	0.41	0.27	0.31	0.50	0.34	0.40	0.23	0.16	0.07	-0.07		0.33	0.22	0.06	-0.02	0.35
Steel	0.17	0.23	0.22	0.31	0.43	0.05	0.52	0.40	0.17	0.01	0.13	0.05	0.33		0.08	0.09	-0.19	0.24
Diamond	0.09	0.16	0.06	0.07	0.10	0.18	0.08	0.08	0.22	0.21	-0.03	-0.07	0.22	0.08		0.38	0.01	0.02
Bitcoin	0.15	0.06	0.07	0.05	0.05	-0.02	0.07	0.09	0.14	-0.03	0.15	0.10	0.06	0.09	0.38		-0.10	0.09
DXY	-0.41	-0.15	0.08	-0.16	-0.18	-0.09	-0.02	-0.13	-0.21	-0.16	-0.45	-0.73	-0.02	-0.19	0.01	-0.10		0.00
Cement	0.04	0.21	0.28	0.17	0.17	0.17	0.19	0.01	-0.13	-0.17	-0.04	-0.14	0.35	0.24	0.02	0.09	0.00	

Note: Global bond index refers to Bloomberg Barclays Total Return Global Bond Index. Source: FAO, IMF, World Bank, Bloomberg and Nomura.

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