Global Counsel

Risks under the radar

Anticipating supply chain risks for the UK food and drink sector

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Contents

Foreword

The management of risk is a crucial index to judge a business and its management. In recent years food and drink supply chains have come under greater scrutiny. Changes to the trading environment have revealed deep complexities. For example, ingredients such as raw materials, part-finished goods and finished goods travel across frontiers many times before reaching the shopper or consumer. Or the differential shelf-life of ingredients, and the impact of the manufacturing process on shelf-life. Or the critical role of certain commodities and the fragile nature of their supply chains.

It may not be entirely surprising that these complexities - and their implications for public policy - come as news to policymakers and regulators, though their lack of knowledge and understanding is a source of concern. However, it is clear that a small number of food manufacturers were also very much in the dark about the ways in which their supply chains could be disrupted. Where true that could be a failure of management.

The 2018 shortage of CO_2 was a wake-up call to our industry. The scale of reliance on CO_2 was underestimated and the extreme fragility of the supply chain delivering CO_2 into this market was revealed to be terrifying.

In the wake of the 2018 crisis, the Food and Drink Federation commissioned Global Counsel to examine the food and drink manufacturing sector to identify other key risks that, like CO_2, that were liable to be underestimated.

This report - Risks Under the Radar – is the result of that study. It should be required reading for all those with responsibility for corporate risk. That includes not only risk managers and non-executive members of company risk committees, but also CEOs, CFOs and the whole leadership team. Investors and employees expect their corporate leaders to have a firm grasp of all the eventualities which their business might encounter. Not to have it is a reason to question management competence.

I would like to thank the many FDF members companies who contributed to this report and, of course, Global Counsel for shining such a bright light on this often overlooked aspect of business management.

Ian Wright CBE
Director General
Food and Drink Federation (FDF)

Executive summary: risks under the radar

For the food and drink industry, managing supply chains is an integral part of doing business. Risk assessment is an important and necessary tool for effective supply chain management. Last year's CO_2 crisis in the UK food and drink sector emphasised the ways in which even a highly sophisticated sector can find itself impacted by unpredicted shortages – risks that have developed 'under the radar'.

The CO_2 model for supply chain risk

For most businesses impacted by the CO_2 shortage, CO_2 was a commodity that was below the radar but was vital for their work. In analysing the CO_2 shortage, the GC report, Falling Flat: lessons from the 2018 CO_2 shortage identified five factors which made CO_2 particularly vulnerable. These factors were (and are): a lack of easy substitutes, a disconnect between supply and demand, a small number of producers, and difficulty in either transport and storage.

In this report, we develop this risk analysis into a methodology that can be applied to assess products in the UK food and drink sector which may be at similar risk of disruption. This isolates a series of tests that can be applied to supply and demand dynamics, transport and storage logistics and product substitution (Table 1).

Table 1: Risk predictors

Is it difficult to substitute?	The product cannot be easily substituted with other substances.
Is there a disconnect between supply and demand drivers?	The product is a by-product of another substance or is heavily reliant on the supply of inputs which are not stimulated by demand for the product.
Are there a small number of producers?	There are a small number of producers of the product and therefore it is difficult to find other sources.
Is it difficult and costly to transport?	The product has certain requirements for transport which make it difficult and/or costly to transport over long distances.
Is it difficult and costly to store?	The product has certain characteristics that make either long term storage or large quantity storage difficult or costly.

In order to test whether this methodology could be effective at screening for 'under the radar' risks we identified products throughout the supply chain which possess at least one or more of the risk predictors which combined in the CO_2 shortage. Through an initial screening for these risk predictors we identified four products to explore. These are - glycerine, phosphate, ammonia and ADN (Table 2). We aimed to explore products of importance at various stages of the supply chain and with diverse applications in order to assess whether the methodology was more effective for some areas than others

This methodology and the analysis emphasise several important points about these supply chains. Risk in these supply chains is both a question of isolated variables, and the way in which risks can interact and compound. Even when all risk predictors are not present, an approach of this type can be effective at highlighting risk.

Table 2: Products at risk?

	Difficult to substitute	Disconnect supply/ demand	Small # of producers	Difficult transport	Difficult storage
Glycerine: A by-product of oil/biodiesel production. Plant-based sources are primarily palm and soy. Synthetic glycerol is cost prohibitive.	Partial	Yes	No	No	No
Phosphate: Crucial for the agricultural fertiliser industry. Produced in a small number of countries, who are exposed to potential political instability.	Partial	Partial	Yes	Partial	No
Ammonia: The pressure to reduce reliance on fossil fuels will result in pressure to move away from natural gas/hydrogen derived ammonia.	Yes	Partial	Yes	Yes	Yes
ADN: Polymers produced by only six companies in the world, used in key applications which require heat resistance and resistance to oil/grease.	Yes	Partial	Yes	Yes	Yes

Yes Partial No

The plastic model for 'known unknowns'

The second section of this report is more speculative and turns to 'known unknowns'. The purpose is to identify areas where unexpected legislative or regulatory change could take those active in managing UK supply chain risk by surprise. It starts with an actual experience of policy framework change for the food and drink sector: the rapid shift in policy on single use plastic.

It is possible to derive from the shift on single use plastics a set of basic tests that can help identify the scope for – and risk of - rapid policy change. We identify three basic tests. Two identify the basic conditions in which rapid policy change is most politically feasible and likely. The final criteria considers the likely trigger for such change (Table 3).

Table 3: Criteria for rapid policy change

Consumer support for change?	Broad, latent (or vocal) consumer support for policy change.
Any legal barriers to policy change?	The absence of international legal restrictions (eg WTO rules) or otherwise (eg domestic or EU law) which could obstruct rapid action.
A political imperative to act?	A major political or practical change that disrupts the previous political equilibrium and creates the imperative to act. The disruption could be a wide range of events, including policy or political change, natural disaster or sudden change to the supply chain.

Using this framework, we have considered three areas where these criteria are potentially present: future value-added tax (VAT) differentiation, food safety protocols at the UK border with the EU and politically-driven changes to the UK Most Favoured Nation (MFN) tariff for food. The conclusion here is not that these particular outcomes are necessarily likely – although none are implausible.

What they demonstrate is the way in which shifting public attitudes (in this case, to meat consumption), structural changes in the UK regulatory framework (potential exit from the EU SPS regime) and idiosyncratic behaviour in the UK's trading partners that forces UK retaliation under WTO rules (MFN tariffs on food imports) could potentially generate rapid disruptive change in the months or years ahead. This could be either supply shocks, or rapid changes to domestic regulation that the food and drink industry needs to anticipate and be able to manage.

The case studies in this report are not predictions, nor are they intended to be exhaustive or comprehensive. Rather, they are intended to encourage consideration of a set of complex supply chain risks that can easily pass under the radar. For a highly globalised sector like the UK food and drink industry, risk management is second nature. This report simply illustrates the extent to which this discipline must remain central to its approach to serving its customers and protecting its reputation and value.

Coming up short: screening products for supply risk

Last summer saw the UK and other parts of Europe experience a critical shortage of CO_2, which impacted businesses large and small across the food and drink industry. Most companies had little to no forewarning of supply disruptions and did not receive supplies for weeks. This critical shortage had a range of causes. Due to the narrow base of the UK's supply chain, only a few sources provided CO_2 for thousands of businesses and millions of end-users. CO_2 supply was particularly thin during the summer months when production facilities in the UK and Europe were closed for maintenance. The increase in demand for CO_2 due to hotter summer temperatures could not be met. Through adaptation measures, businesses were able to limit the worst impacts but for many the financial costs were significant. The shortage shed light on the structural weaknesses of the supply chain, but also how actors in the chain could improve resilience to avoid future crises.

Methodology

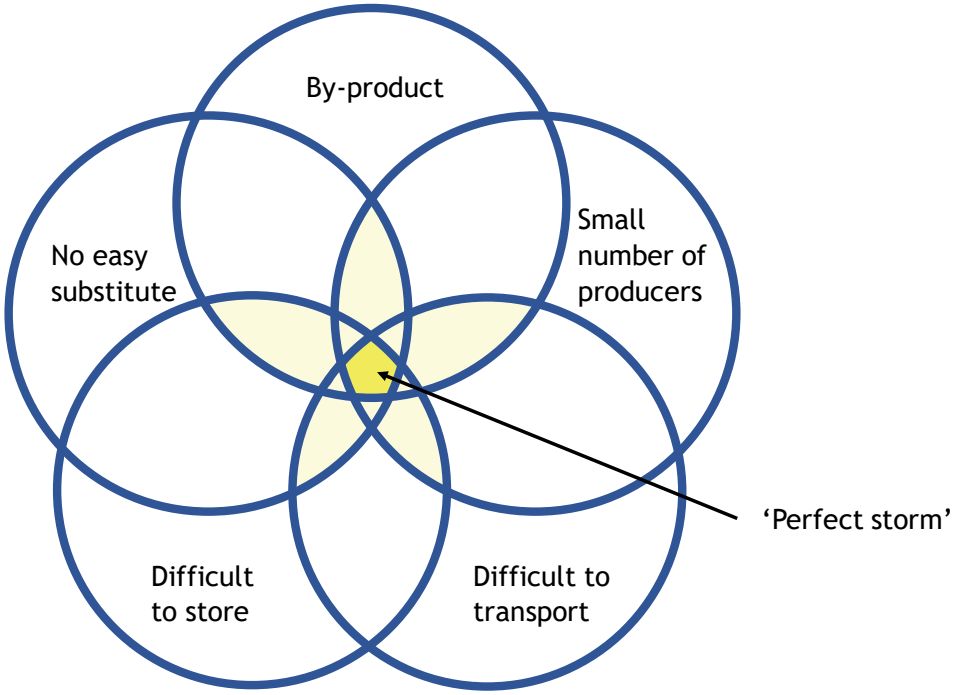
In analysing the CO_2 shortage, the report '[Falling Flat: Lessons from the CO_2 shortage]' identified five factors which made CO_2 particularly vulnerable to any changes in supply and demand.

Table 4: Criteria for assessing risk

Is it difficult to substitute?	The product cannot be easily substituted with other substances. *CO_2 cannot be replaced at the same cost and volume. Although some businesses used nitrogen in place of CO_2 during the shortage, nitrogen's higher cost limited the amount that could be replaced.*
Is there a disconnect between supply and demand drivers?	The product is a by-product of another substance or is heavily reliant on the supply of inputs which are not stimulated by demand for the product. *CO_2 is a low value item and is only commercially viable as a by-product of ammonia and bioethanol. Being a by-product, it is exposed to a set of market drivers unconnected to its own market dynamics. An increase in CO_2 demand would not necessarily translate into an increase in supply, making it more difficult to adjust and respond to sudden spikes in demand.*
Are there a small number of producers?	There are a small number of producers of the product and therefore it is difficult to find other sources. *The CO_2 supply chain is an inverted pyramid in which millions of consumers and thousands of purchasers are reliant on a handful of producers and suppliers. Users have less leverage and often have long-term contracts with suppliers that make flexibility more difficult.*
Is it difficult and costly to transport?	The product has certain requirements for transport which make it difficult and/or costly to transport over long distances. *Transporting CO_2 requires specialised transport and trained drivers to operate specially equipped trucks or ships. Transport over long distances is, therefore, uneconomic.*
Is it difficult and costly to store?	The product has certain characteristics that make either long-term storage or large quantity storage difficult or costly. *Long term storage of CO_2 is not possible, due to the fast natural evaporation rate of CO_2. Although some businesses have shorter-term storage facilities, the commercial viability of CO_2 storage is limited.*

These factors provide a framework for determining what products might be at risk of shortages in the UK food and drink supply chain. These criteria are explained on the previous page, with examples from the CO_2 shortage to illustrate how, when these factors are combined, they can create enhanced vulnerability.

Figure 1: Methodology of product risk with five criteria



Products at risk?

This section includes four examples of applying the risk screening methodology as outlined in figure 1. The four examples were chosen through initial screening to identify products presenting at least one or more of the risk factors, which then presents varying risks at different stages of the supply chain. Each product is assessed against the five criteria with a resulting discussion of how forthcoming policy or political changes could exacerbate some of the weaknesses explored.

Table 5: Assessing risk

	Difficult to substitute	Disconnect supply/ demand	Small # of producers	Difficult to transport	Difficult storage
Glycerine Dairy products, processed meat, grains, condiments	Partial	Yes	No	No	No
Phosphate Fertiliser, fizzy drinks, processed meat/fish, instant sauces, bakery products, processed cheese	Partial	Partial	Yes	Partial	No
Ammonia Fertiliser	Yes	Partial	Yes	Yes	Yes
ADN Microwaveable food packaging, boil-in-the-bag sachets, packaging for processed meat and cheeses	Yes	Partial	Yes	Yes	Yes

Yes ■ Partial ■ No □

For each product, a visual is included which outlines the specific actors within the food and drink supply chain which would be most impacted by a shortage and examples of specific products. In some cases there are multiple stages of the supply chain which will be affected. In this case, we have indicated the part of the supply chain most at risk. Actors in the UK's food and drink supply chain have been grouped as:

- **Farmers**
  Producers of raw materials used in the manufacturing of other products - for example, livestock or grain farming.
- **Primary processors**
  Converters of raw materials into food commodities – for example, milling wheat into flour.
- **Secondary processors**
  Converters of primary products into another product – for example, turning wheat flour into bread.
- **Retailers**
  Vending of finished products to the consumer.

Glycerine

Difficult to substitute	Disconnect supply/demand	Small # of producers	Difficult transport	Difficult storage

Overview

Glycerine, also known as glycerol, is colourless, odourless and a water-soluble liquid. It has many uses in the food and drink sector, primarily as a sweetener and moisture adding agent (humectant), but also for animal feed, as an energy source to replace corn. It is used in dairy products including cheese and yogurt, grains and baked goods like rolled oats, tapioca pudding, pre-cooked pasta and breakfast cereals as just a few examples. Glycerol is also used as a preservative and filler in low-fat foods and a thickening agent in liquors.

Figure 2: Glycerine supply chain risks

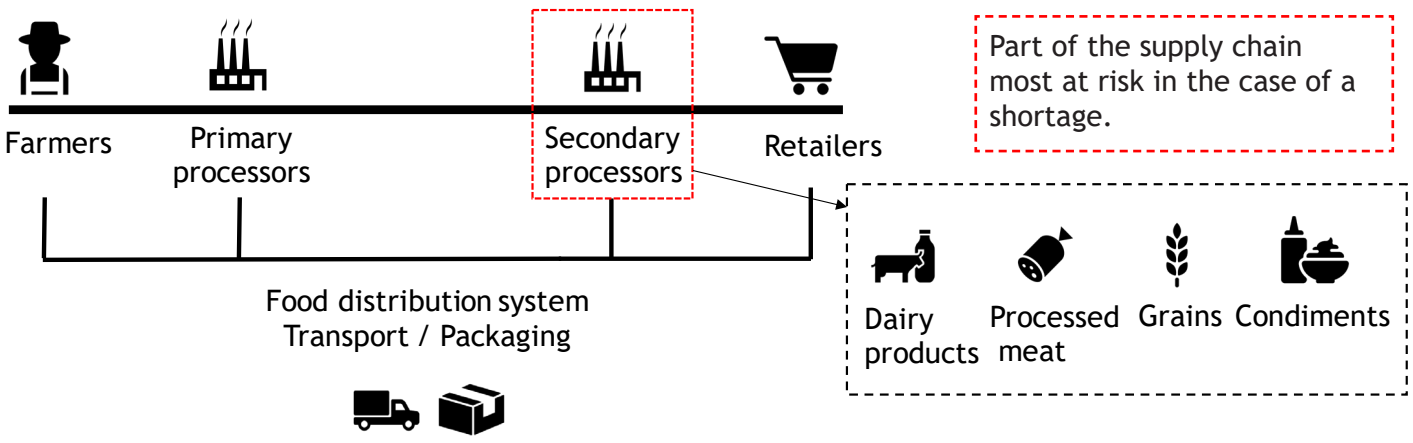
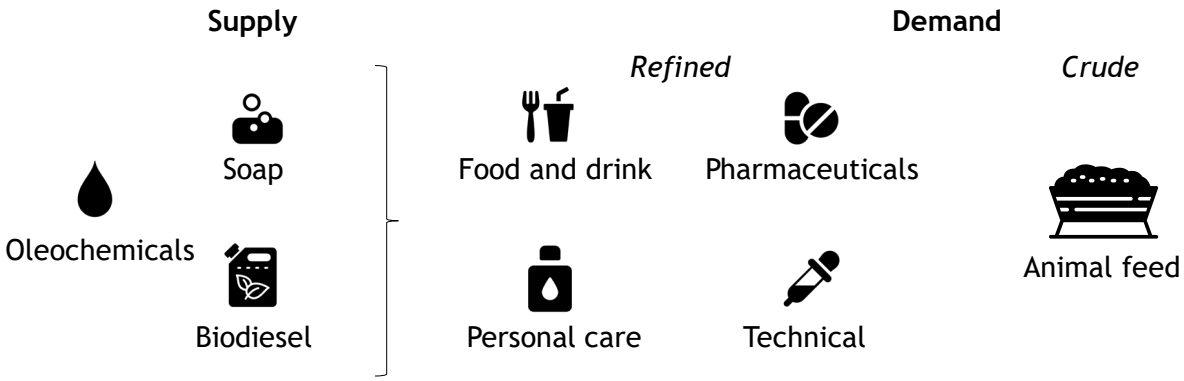


Figure 3: Glycerine supply chain



Glycerol can be obtained from four major sources – oleochemicals, animal fats, soap and biodiesel production. All four sources require different chemical processes where glycerol is obtained as a co- or by-product.

Difficult to substitute: partial

There are many substitutes for glycerine depending on the use. When used as a sweetener it can be replaced by corn syrup or vegetable oil for moisture. However, it is seen as more desirable than some of its substitutions because it is less sweet than sucrose (though higher in calories than sugar) and does not cause tooth decay to the same extent. With the increased supply – and lower price – of glycerine in recent years resulting from biodiesel production, glycerine is now being used as a substitute for higher priced inputs, for example for the production of propylene glycol or antifreeze.

Disconnect between supply and demand: yes

Glycerine is produced as the co/by-product of either soap and fatty acid (through hydrolysis) or of biodiesel (through transesterification). There are three grades of glycerine – one for chemical use, USP or United States Pharmacopeia which is suitable for all food and pharmaceuticals, and Kosher grade which is from plant-based sources. While crude glycerine is produced on a large scale, the crude product is of variable quality and not suitable for the food and drink sector. Crude glycerine is primarily used for animal feed and biogas production.

Prior to the large-scale production of biodiesel in the early 2000s, glycerine came primarily from the soap industry. Today 66% of the world's glycerine supply comes from biodiesel production[1]. With the sharp increase in biodiesel production over the last decade, supply of glycerine has more than doubled – an amount that the market could not absorb initially.

However, recently the number of applications for glycerine have been increasing, particularly as it is used as a substitute for higher priced products. 18% of refined glycerine consumption is from new applications. 24% of all glycerine is used in food products and the rest split among personal care, hygiene and pharmaceuticals[2]. With living standards increasing across the world, this demand is expected to increase.

Since glycerine is a by-product, an increase in demand from the food and drink sector or from a particular region will not mean that there is necessarily an increase in supply unless demand for biodiesel or other sources also increases.

Glycerine supply is shifting and not necessarily aligned with demand, since the supply is mostly driven by biodiesel production and associated government mandates, rather than demand for glycerine. For example, supply is increasing in the Americas and South East Asia, while reaching maturity in the US

1 Vantage Oleochemicals. 'Glycerine Structural Shift. ICIS Pan American Conference', 2018
2 GreenEA. Glycerine market: lack of interdependence between supply and demand, 2015

and decreasing in Europe. However, in the short term there is plenty of feedstock available due to the oversupply of palm oil, particularly in Indonesia.

Small number of producers: no

Production of glycerine within the UK comes from fat rendering (slaughterhouses), biodiesel production and rapeseed/canola production. Globally, glycerine is produced in large quantities as a by-product of palm, soy and other oil crop production and biodiesel production throughout the world.

Difficult to transport: no

Glycerine is not difficult to transport but it is a combustible liquid which can become ignited under the right conditions.

Difficult to store: no

Pure glycerine storage needs to be in stainless steel or 99.5% pure aluminium, epoxy resin lined or glass lined tanks or drums. If not stored in this type of material, it can result in rapid deterioration, which requires re-processing to restore to the original purity and would be very costly.

There are a range of challenges with the storage of biodiesel including from water contamination where the growth of bacteria occurs resulting in filter plugging, and from cold flow problems where stored at temperatures lower than 10° celsius, and many others. These challenges are one of the reasons why there is an increasing shift away from biodiesel to renewable diesel which does not present the same problems.

Evolution of risks

The risks outlined above relate to the disconnect of supply and demand, lack of easy substitutions could also be exacerbated or come together at a crisis point, particularly considering current policy/political trends.

- *Significant sources of supply are falling out of favour*. Biodiesel's popularity in Europe and the UK has probably peaked, particularly as Europe shifts to a focus on electric and renewable diesel (which does not yield glycerine). Oleochemicals like palm and soy are also facing increasing pressure as consumer campaigns target these for their perceived impact on deforestation and climate change. Animal fat rendering may be at risk as meat consumption declines. There is likely to be a significant decrease in overall supply within the next few years which, as a result, will make it increasingly important for the food and drink sector to diversify supply between oleochemical and biodiesel sources and to develop strategic supplier relationships, particularly with vertically integrated producers in order to reduce the impact of a spike in prices and potential short-term shortage.

- *Substitutions may become increasingly less favourable*. With increasing attention on health, particularly around sugars and trans fats, glycerine is attractive for the food and drink sector because it has favourable properties – filler in lower-fat goods, and lower sweetness than sucrose - compared with the easy substitutes. This could make it hard for brands already making these claims to switch quickly in the face of a sudden change in supply/demand.

Phosphate

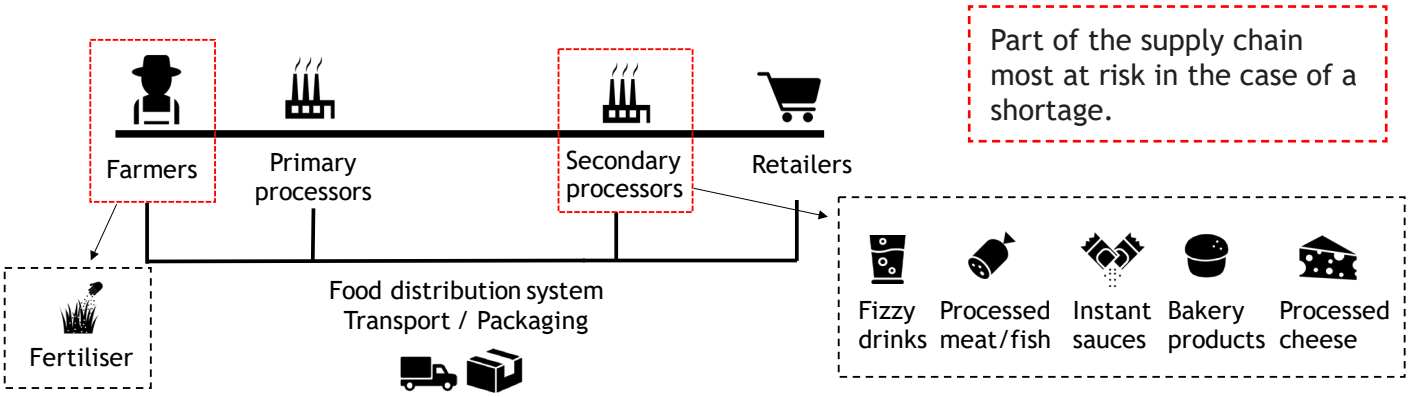
Difficult to substitute	Disconnect supply/demand	Small # of producers	Difficult transport	Difficult storage

Overview

Phosphate is an essential mineral for humans, animals and plants. It plays a critical role in cell development and in the storage of energy. Agricultural fertiliser accounts for 90% of the global phosphate market and is a key component to soil based food and drink supply chains. In the agriculture sector it is also used in animal feed for livestock and poultry.

There are different forms of phosphate additive, including phosphoric acid (E338), sodium phosphates (E339) and diphosphates (E450) which are added to a range of proccessed food and drinks as a preservative and to add flavour. These are used in processed meat, fish and cheese, fizzy drinks, bakery products, instant sauces, puddings and instant mash potato. More broadly, it has variety of uses, from softening water to giving fluorescent lights their vivid glow.

Figure 4: Phosphate supply chain risks



Difficult to substitute: partial

Although there is no synthetic alternative to phosphate available, opportunities exist in recycling and reuse in the fertiliser industry. This includes recycling phosphate through human sewage, manure and abattoir waste, and reducing overall phosphate application through new plant breeds and soil monitoring technologies. In animal feed, phytase enzymes are being explored as an alternative additive to release a usable form of inorganic phosphorus from grains and oils. For fizzy drinks, sodium citrate or citric acid can be used as a replacement for phosphoric acid. There are a variety of alternatives that can replace its role as a preservative - including, polysaccharides. Its uses in wider industrial applications, such as detergents, can be replaced by alternatives such as zeolites, sodium carbonate and citric acid.

Disconnect between supply and demand: partial

Phosphate production is not disconnected from its drivers of supply and demand in the way CO_2 is. However, it is dependent on oil and gas. Sulphur and ammonia are important elements in processing phosphate rock into soluble form, phosphoric acid. As by-products of oil and gas they are subject to any knock-on supply/price fluctuations.

3 Investing News, 'Top Phosphate Mining Production by Country', 2019

Figure 5: World phosphate mine reserves
In thousand metric tons

Source: U.S. Geological Survey, Mineral Commodity Summaries, February 2019

Small number of producers: yes

Phosphate reserves are concentrated in a small number of countries, which makes the level of risk of disruption to the supply chain high. Increasing global demand for phosphates and diminishing, finite reserves are intensifying competition for the resource. While nearly 30 countries produce phosphate rock, China, the United States and North Africa are the largest producers and are thought to have among the largest remaining suppliers[3]. Export restrictions and political disruption in these regions can quickly and unpredictably arise, shutting down the supply chain. Supplies from these regions are already tightening, with export limitations in China, political instability in Syria, Jordan and Tunisia and dwindling reserves in the US impacting global availability. Dynamics around the US-China trade dispute adds a further element of uncertainty around supply and price. The process of opening new mines is expensive and time-consuming, with new mines taking between 5–20 years to become operational.

Difficult to transport: partial

The UK has no domestic supply of phosphorous. Within the EU, Finland is the only country with phosphate reserves. The majority of imports to the UK and the EU are mined in Russia and Morocco. The EU also imports smaller amounts from Tunisia and Syria[4]. The distance that phosphate travels to reach the UK means that it is sensitive to fluctuations in energy prices.

Difficult to store: no

There are no difficulties in the storage of phosphates.

Evolution of risks

The risks outlined above related to the small number of producers and a lack of easy substitutions could all be exacerbated or come together at a crisis point, particularly considering current policy/political trends.

- *Incoming regulation will make the small pool of phosphate producers get smaller.* EU regulation coming into place in 2022 aims to tackle environmental and health concerns related to the impact of

4 The Hague Centre for Strategic Studies, 'Risks and Opportunities in the Global Phosphate Rock Market', 2012

excessive phosphate application which can lead to eutrophication and the spreading of carcinogens. The regulation limits cadmium (carcinogenic mineral in phosphate) content in phosphate in the EU to 60mg/kg – with plans to decrease this to 40mg/kg after three years, and to 20mg/kg after 12 years. Phosphates from Morocco largely exceed these limits, meaning the regulation would further restrict the EU market. Russia is one of the few countries whose phosphate naturally falls below the stated cadmium levels. Reliance on Russian supply would increase if innovation in reuse and recycling has not reached required capacity. One caveat is that it remains unclear whether post-Brexit, the UK will align its regulations with the EU.

- *In the face of supply issues, the impact on the UK would be mixed*. Due to residual soil phosphorus levels, the UK is not reliant upon phosphorus in the same way that countries and regions with lower residual phosphorus levels, such as India and Africa are. Phosphate consumption in the UK remains stable (halving since the 1980s and remaining stable over the last five years). As such, the most immediate impact for the UK food and drink sector would be related to potentially lower yields/ higher costs for agricultural products produced in countries reliant on phosphate fertiliser. In England, those most reliant on phosphate fertiliser are horticulture and cereal farms. Usage is particularly prevalent in the North East, Yorkshire and Humber[5], followed by the East Midlands and the East of England. These sections of the farming community would be the hardest hit.

Ammonia

Difficult to substitute	Disconnect supply/demand	Small # of producers	Difficult transport	Difficult storage

Overview

Ammonia is crucial for agricultural fertiliser in the UK. Globally, 50% of current food production relies on ammonia-based fertilisers[6] with the aim of increasing yields.

Ammonia (NH_3) is a compound made up of hydrogen and nitrogen and is a colourless gas with a characteristic odour. Ammonia is found in trace quantities in the atmosphere and in fertile soil and seawater. It is synthetically produced on an industrial-scale through the Haber-Bosch process[7], from which approximately 80% of it is used as fertiliser in salt or solution form. Ammonia helps increase yields of crops as inorganic nitrogen fertiliser, which can take the form of ammonia nitrate and urea.

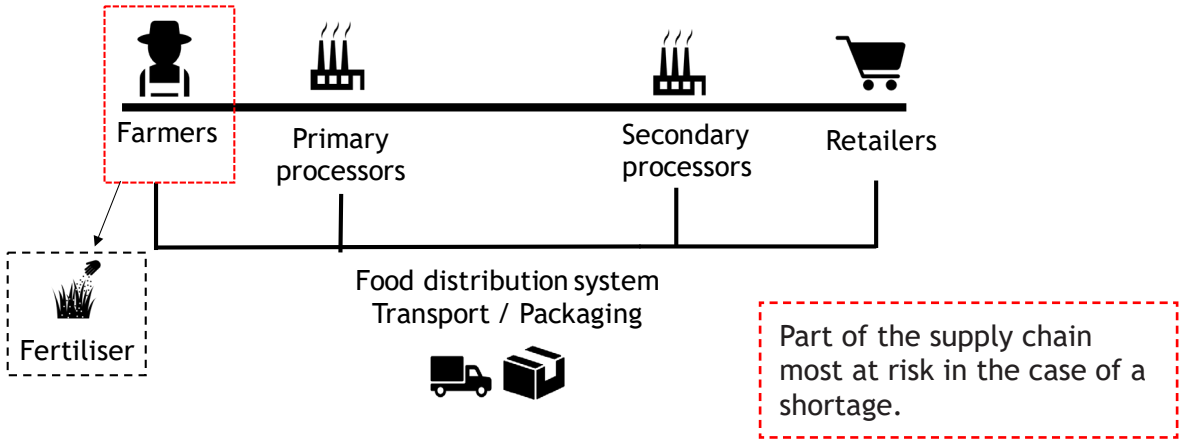
Ammonium nitrate is manufactured by reacting anhydrous ammonia with nitric acid and concentrating and coating the reacted material to prevent from caking. Urea is created by reacting ammonia with carbon dioxide and has the highest percentage of nitrogen, but this can be lost when it reacts with water. Urea has been replacing ammonium nitrate use, as it is less expensive and easier to store and maintain.

Difficult to substitute: yes

There are currently no simple substitutes for ammonia-based fertiliser on the same scale. Organic manures and bio-fertilisers have limited availability and comparatively low efficacy. 'Green ammonia' or decarbonised ammonia using electrolysis to derive hydrogen is being explored but there are still barriers to large-scale production. There are firms such as Siemens[8] which are beginning to invest in pilot projects for green ammonia production, but this method is not expected to become widespread in the short term.

5 Department for Environment, Food and Rural Affairs 'Fertiliser usage on farms: Results from the Farm Business Survey', 2019
6 Boerner, Leigh, 'Industrial ammonia production emits more Co2 than any other chemical making reaction. Chemists want to change that', 15 June 2019
7 Mordor Intelligence, 'Ammonia market- growth, trends and forecast (2019-2024)', 2019
8 Guardian, 'Siemens pilots the use of ammonia for green energy storage', 17 June 2018

Figure 6: Ammonia supply chain risks



Disconnect between supply and demand: partial

Ammonia production is not a by-product of another material but is partially disconnected from its drivers of supply and demand due to its heavy dependence on natural gas prices and market dynamics. Natural gas is the key cost driver for ammonia production, as ammonia uses hydrogen derived from natural gas. Price spikes in the past have led to a dampening of fertiliser production, such as in the winter of 2006-07 when UK fertiliser plants suspended production due to high gas prices. Decreased global gas supply is estimated to begin in the 2030s and the fertiliser industry may feel the impact as supply starts to decrease and global demand, particularly from China, increases[9].

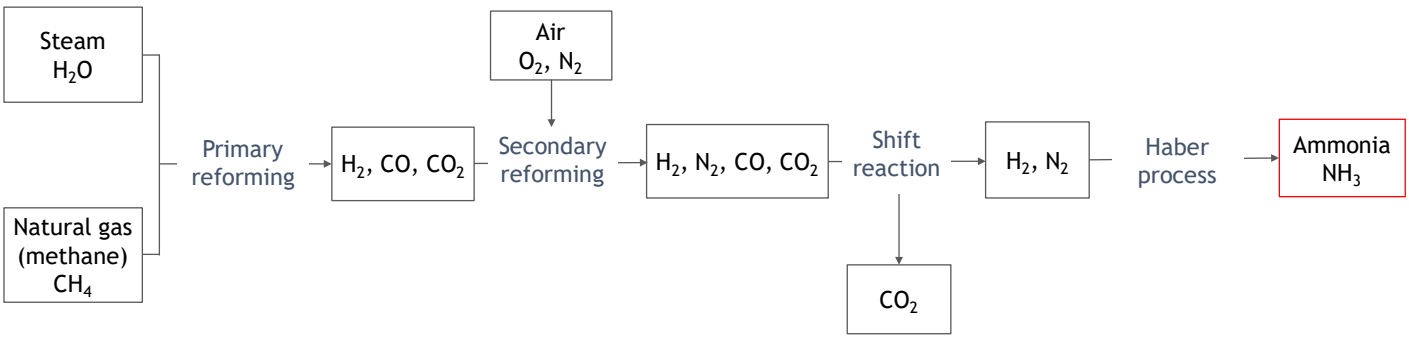
Small number of producers: yes

Ammonia production is concentrated in a small number of producers, which makes the level of risk of disruption to the supply chain high. This was one of the main underlying reasons for last year's CO_2 shortage. Two plants dominate ammonia production in the UK, produced for use in ammonia nitrate fertiliser. They are both owned by CF Fertilisers and are located in Billingham, Cleveland and Ince, Cheshire.

Difficult to transport: yes

Ammonia is difficult to transport. In the form of ammonium nitrate fertiliser it is classified as an explosive and has strict requirements for transportation. Transport is regulated under the European Agreement Concerning the International Carriage of Dangerous Goods by Road as well as the UK Department for Transport. It is highly combustible, explosive and can release toxic gases if it decomposes during transport. There have been many past cases of accidents during transportation, including a truck explosion in the US in 2019 which resulted in the death of the driver and evacuation of the surrounding area.

Figure 7: Ammonia production process



9 McKinsey Energy Insights, 'Global gas & LNG outlook to 2035- H1 2019', September 2019

Difficult to store: yes

Ammonia is difficult to store due to the above characteristics. Ammonium nitrate can become toxic if it decomposes and storage facilities must comply with strict requirements under the Health and Safety at Work Act 1974.

Evolution of risks

The risks outlined above related to a lack of easy substitutions, small number of producers and difficulties to transport and store could all be exacerbated or come together at a crisis point, particularly considering current policy/political trends.

- *Ammonia fertiliser has come under pressure due to its dependence on natural gas and its climate implications*. Ammonia production is responsible for 1-2% of global energy consumption[10] and 3-5% of world natural gas consumption[11], contributing significantly to carbon emissions. The UK's 2050 net-zero carbon emissions target means that there will be increasing pressure to move away from fossil fuels. This may result in pressure to decrease domestic production of ammonia and the difficulty in transporting ammonia from abroad could exacerbate any potential shortages.

- *The UK government's increasing concern regarding ammonia as a major air pollutant means there will be greater pressure to reduce ammonia-based fertiliser usage*. The policy focus continues to be on the dairy and beef cattle sectors' ammonia emissions[12]. Cattle farms account for 44% of total UK ammonia emissions. Defra's 25 Year Environment Plan proposes introducing a framework to limit inputs of nitrogen-rich fertilisers. The UK is already legally obliged to reduce ammonia emissions by 8% by 2020 and by 16% by 2030 compared to a 2005 baseline[13], under international obligations under the UNCE Gothenburg Protocol and the National Emissions Ceilings Directive.

Adiponitrile polymers

Difficult to substitute	Disconnect supply/demand	Small # of producers	Difficult transport	Difficult storage

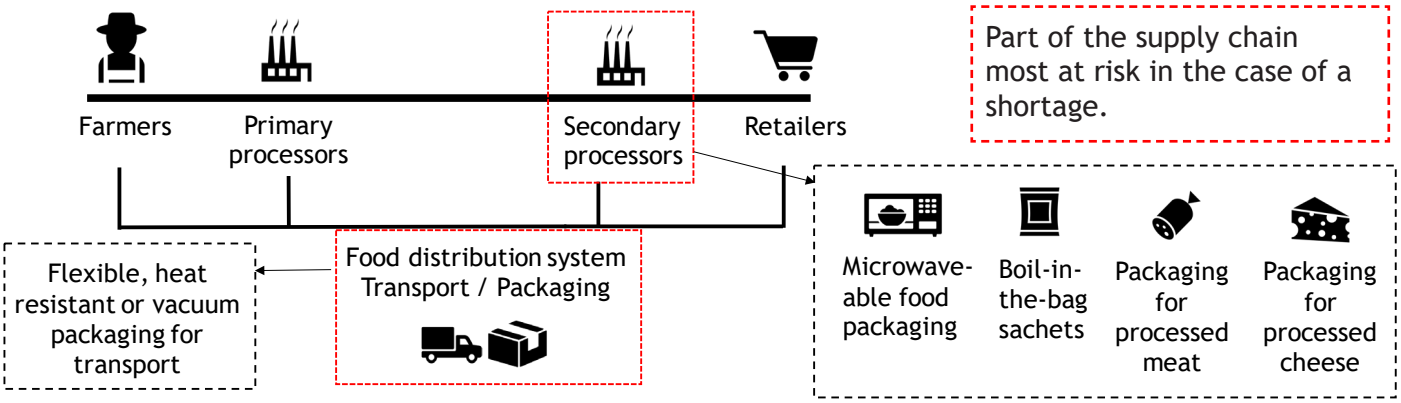
Overview

Adiponitrile (ADN) is a key component in the creation of nylon 66, a synthetic material which is commmonly used to make plastic and textiles. Nylon 66 is a thermoplastic (can be heated and cooled without changing its chemical or mechnical properties). As a result it is commonly used in the UK food and drink sector as packaging for ready meals, boil-in-the-bag items (such as rice), and proccessed meat (sausages, bacon) and cheese. More widely, nylon 66 is used in the automotive, electronics and clothing industries.

ADN production is highly globalised, involving only a small number of producers with production facilities scattered all over the world. Therefore, the supply chain is vulnerable to disruption caused by spikes of demand, various production gaps and external factors such as weather or political instability. Demand for ADN is growing 3-4% per year due to rising demand for nylon 66 fibres and resins across the globe. Between 2016 and 2018, nylon 66 prices went up by more than 50% due to shortages.[15]

10 Mordor Intelligence, 'Ammonia market- growth, trends and forecast' (2019-2024), 2019
11 University of Tokyo, 'Researchers dramatically clean up ammonia production and cut costs', 24 April 2019
12 National Farmers Union, 'Ammonia and dairy: Setting the scene', April 2018
13 Defra, 'Clean Air Strategy 2019', 14 January 2019
14 Polyestertime, 'The world-class adiponitrile plant settled in Shanghai, why is the localization road difficult?', 2019
15 Craftech Industries, 'Three top reasons there is a shortage of nylon 6/6', 2019

Figure 8: ADN supply chain risks



Difficult to substitute: yes

There is no easy substitute for ADN that matches its cost, and specifications for performance and processing. Although suppliers of nylon 66 have explored alternative polymers for short-term usage in the case of a sudden shortage, there is currently no alternative that can provide all of the above characteristics in the same way. For the food and drink industry, the best alternative is the nylon 6 polymer which has similar properties to nylon 66 of being able to withstand exposure to water and extremely high temperatures. The automotive industry uses the substitutes aliphatic polyketone (POK), polybutylene terephthalate (PBT) and polyphthalamide (PPA) but they are more costly and less efficient due to the need to import from other parts of the world.

Disconnect between supply and demand: partial

Though ADN is not a by-product and thus is produced based on demand, it is also produced from petroleum. Increased petroleum costs or any supply restriction would negatively impact ADN production[16].

Small number of producers: yes

There are a small number of producers of ADN due to the high specialisation and high cost of production plants. There are only 14 world-scale plants making 100% of global nylon 66 supply, whilst only three firms - Ascend Performance Materials, Invista and Butachimie - produce ADN. Any disruption of these plants will affect the supply of nylon 66. Producers are increasing their production volumes but will not be fast enough to meet growing global demand, due to their small number. ADN supply is forecast to continue to be limited as a result of shortages until 2021.

Difficult to transport: yes

ADN is difficult to transport as it can be dangerous in case of contact with skin. It is highly combustible and releases toxic fumes when exposed to fire. Its vapor is heavier than air and can cause fire or explosions far from the source. In 2018 an explosion in a Shandong Runxing-owned ADN plant in China killed 170 people (a plant which produced 18% of Global ADN capacity).

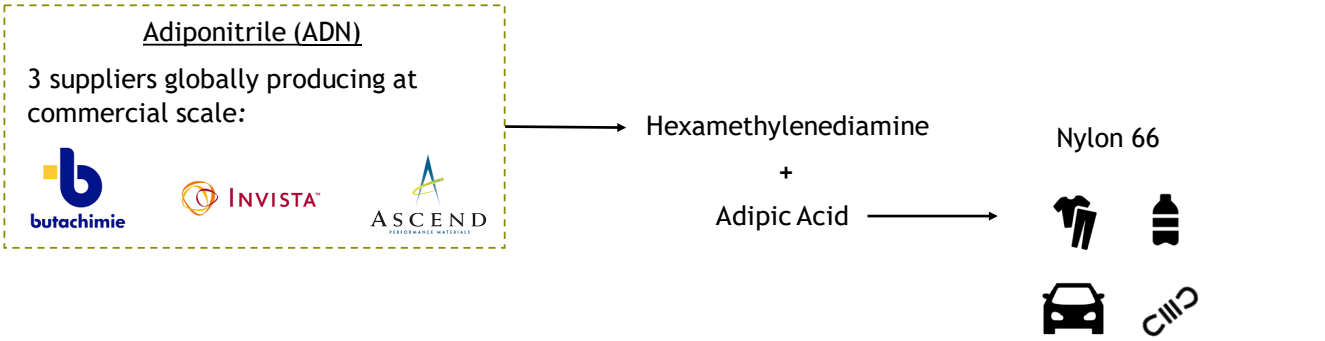
Difficult to store: yes

ADN is difficult to store due to its toxic and flammable qualities. It must meet particular storage and health and safety regulations and can only be handled by trained workers. Storage regulations include requirements to be held in tightly closed containers in a cool, well-ventilated area away from certain oxidizing agents and acids[17].

16 Invista and Butachimie produce adiponitrile by reacting butadiene with hydrogen cyanide. Butadiene is produced as a by-product of the steam cracking process of petrochemicals (chemical products obtained in petroleum refining) used to produce ethylene and other alkenes. Ascend uses an electrochemical process that starts with acrylonitrile. Acrylonitrile is created through reacting propylene with ammonia. As such, both production methods are subject to market fluctuations in the price and availability of these products.

17 NJ Health. '[Right to Know: Hazardous Substances fact sheet](#)', 2009

Figure 9: Nylon 66 production



Source: Chemical & engineering news, October 2018

Evolution of risks

The risks outlined above related to a lack of easy substitutions, small number of producers and difficulties to transport and store could all be exacerbated or come together at a crisis point, particularly considering current policy/political trends.

- *Shifting demand may mean higher prices/shortage for the food and drink sector.* The robust growth of automotive, electronics and textile sectors across the globe is boosting demand for nylon 66, which, in turn, is fuelling the ADN market. The Asia Pacific region is projected to lead the market in the next five years largely due to the growing automotive industry in China. In the case of a future shortage, interviews as part of our research indicated that the food and drink sector would be first hit, with sectors such as the automotive industry able to pay for ADN at a higher cost.

- *Pressure to increase recyclability of packaging and light-weighting of products may further increase demand*. The demand for high-performance thermoplastics, with longer life spans, is growing. There are increasing demands for thermoplastics in vehicles and machine production due to energy savings through light-weighting. This means that the ADN landscape is likely to grow more competitive with further differentiation among products. As a thermoplastic (as opposed to thermoset) material it can be heated to melting point, cooled and reheated without degradation - making it easily recyclable.

Anticipating rapid policy change to supply frameworks for UK food and drink

The second half of the report considers the wider challenge of potentially rapid change to UK supply chain frameworks for food and drink. Food and drink producers routinely deal with supply chain uncertainty – good and bad harvests, shifts in commodity prices, for example. However, there is an additional form of uncertainty or volatility that can be generated by rapid policy change.

This section looks at risks deriving from 'catalytic' change to UK supply frameworks. These are areas which may be well known by the food and drink sector, but where there may be a lack of focus on the conditions which may create rapid and unexpected legislative or regulatory change in a way that could take UK supply change planners by surprise. Some of this change may be – in principle – temporary. Some may be more secular – defining the parameters of UK supply for the foreseeable future. Some of these changes may ultimately be socially and environmentally valuable and necessary. Some may be responses to less desirable changes in markets of supply. What matters for the analysis here is that they happen quickly enough to pose material challenges for supply chain management.

Lessons from plastics

A good example is what we have seen with plastics over the last two years. Changes to the regulatory frameworks for single use plastics emerged relatively quickly. Although there has long been an understanding of negative impacts of plastic and the link between plastic-use and rising marine pollution - from the early 1970s scientific reports described the prevalence of plastic pellets in the North Atlantic[18] - there was limited sense of any political urgency or legislative attention on any large scale prior to 2017. Yet by 2019 from Chile and Kenya to the UK, countries had passed largely uncontested legislation to tackle plastic waste. Some of these frameworks covered single item phase outs like plastic bags and straws, while others took much wider action against all single use plastics.

This raises the question ,what created this rapid shift? No individual factor is responsible so much as a confluence of factors. Sir David Attenborough's high-profile Blue Planet documentary and a rising mood of activism and environmental awareness, not least among younger voters clearly played an important catalysing role. As with CO_2, it was a network of factors working together that mattered.

Based on the experience with plastics, we can identify three key factors which together create the conditions for rapid unexpected change of the kind we see with both CO_2 and plastics. The first two conditions are essentially facilitative, structural features of the system that make government action politically and practically feasible. The most important of these are:

- There was **latent public support for change**, even when it imposes behavioural costs on consumers or in some other way. Consumers were primed to accept the demands of behavioural change around single use plastics and not mobilised or mobilisable against such change; this played out both directly in politicians' engagement with the public, and indirectly in the support that retailers and others provided for change.

- There was **no legal impediment to rapid change** in the form of domestic framework law, EU law (in the case of the UK or other EU states) or international public law that made it problematic for the governments to move quickly.

18 Peter H.Ryan, 'A Brief History of Marine Litter Research', 2015

These latent conditions for change required a trigger event:

- There was **the presence of an event or events that generated a political interest or even perceived imperative for action**. With supportive public opinion and no legal or practical obstacles to change; politicians can move very quickly to advocacy and action.

These three factors, and their variants in the plastics case, are set out in Table 6.

Table 6: Factors in determining risk

Consumer support for change?	Broad latent or vocal consumer support for change, backed by evidence of changing consumer preferences. *The combination of the 'Blue Planet effect', available alternatives to plastics (stainless steel water bottles and bamboo straws), with the ability to take individual action through purchasing decisions ticked all of the boxes for creating wide-scale consumer support.*
No legal barriers?	There is no international legal restriction (eg WTO rules) or otherwise (eg EU law) which would restrict action. *While there may not be a specific international legal barrier (eg WTO rule) or otherwise (eg EU law), which would restrict action, care should be taken to enact any legislation in a non-discriminatory way in order to avoid coming up against WTO rules.*
Imperative to act?	A major political or practical change that disrupts the status quo and creates the imperative to act. The disruption could be a wide range of events, including policy or political change, natural disaster or sudden change to the supply chain. *In 2017, China announced a ban on imports of 24 categories of waste, including plastics and mixed papers, from January 2018 onwards, with further plans to completely phase out waste imports by 2019. China was previously the world's largest importer – receiving more than 70% of plastic waste and 37% of paper waste produced globally – and the ban has had a large impact on the global waste market. As a large exporter, the ban forced the UK to reassess current waste exports and domestic sorting capacity.*

Using this framework, we have considered three areas where this combination of factors is potentially present – VAT differentiation, food safety (SPS) and politically-driven changes to the UK MFN tariff. The conclusion here is not that these particular outcomes are necessarily likely – although none are implausible. Rather that they demonstrate the way in which shifting public attitudes (meat), structural changes in the UK regulatory framework (exit from the EU SPS regime) and idiosyncratic behaviour in the UK's trading partners (MFN tariffs on food imports) could potentially generate either supply shocks, or rapid changes to domestic regulation of a kind that the food and drink industry needs to anticipate and be able to manage.

‘Sin-taxing’? VAT differentiation

The patterns of VAT application to food products in the UK is highly irregular. Peanuts are not taxed until they are shelled. Biscuits are not taxed unless they are covered in chocolate. The UK government introduces VAT on food products for a number of reasons. In some cases, that seeks to discourage the consumption of products that can have negative impacts for health and the environment, in some cases the incentive is revenue raising, or the political dividend that comes with choosing not to tax a product. Importantly, VAT on a product can be quickly changed within a new budget.

Placing a VAT on meat has been discussed recently in the UK on both health and environmental grounds. The primary cited aims have been addressing obesity and reducing greenhouse gas emissions. However, the issue remains highly contentious and not an area that many would consider for near term political attention. Could a meat tax be conceived and implemented quickly in the UK?

Broad consumer support: partial

Consumer attitudes and behaviours towards meat are definitely changing in the UK[19], with an uptake of vegetarian and vegan diets, particularly among younger consumers – although some evidence suggests that voters over 65 actually eat the least meat of any cohort[20]. Practical alternatives to meat products are currently available at comparable prices and constitute a fast-growing industry. A growing number of actors, including celebrities, thought leaders and think tanks have called on government to intervene in meat and dairy consumption, supporting the introduction of a VAT.

The UK government has previously erred on the side of caution in implementing taxes and levies. In 2012, an attempt by the government to impose VAT on hot food such as Cornish pasties provoked an outcry that few could have anticipated – resulting in the government swiftly dropping the policy. This attitude appears to be changing. Public support for ‘point of sale’ taxes following on from the 2015 plastic bag levy, have made the introduction of consumer facing taxes for environmental or health issues more likely.

The obvious precedent for policymakers will be the 2018 Soft Drinks Industry Levy (SDIL) or ‘sugar tax’. When this was introduced as a part of the government’s childhood obesity strategy it provoked little public resistance and generated £153.8m in the first seven months. It is seen by many observers – not entirely consistently – as having proved its triple efficiency as a normative signal, a revenue raiser and a behaviour changer.

Legal barriers to action: no

While constrained – as of October 2019 - in some respects by EU frameworks for VAT, the UK government has no serious regulatory barriers to the rapid adaptation of its VAT framework. As in the case of the ‘pasty tax’, VAT can be adapted quickly within a budget with no parliamentary engagement or consultation, although the passing of a finance bill – generally a formality for a government able to command a majority - is required for implementation. As long as such taxes are levied at the point of consumption in the same way for imported and domestically produced goods, there is no legal obstacle to their implementation in WTO rules or other UK commitments.

Imperative to act?

VAT on meat is very unlikely to be chosen solely as a revenue raiser. It will be attractive chiefly as a striking gesture of intent on either climate change mitigation or dietary change. Such a measure could emerge out of a growing political desire for a package of ‘ambitious’ UK commitments in either area – including a likely political desire to outflank the EU’s green credentials.

19 The BSA Natcen was commissioned in 2016 to poll Britons on their attitudes to meat consumption. Almost 1 in 3 Britons reported having reduced meat consumption over the previous twelve months. Natcen, ‘British Social Attitudes: Are we eating less meat?’, 2016

20 Eating Better, ‘Public attitudes to meat consumption’, 2019

While policymakers would be cautious of perceptions of raising costs in the household supply chain – or depressing demand for a commodity whose domestic supply will matter even more after Brexit – it is not impossible that meat taxes gain wider traction. The liberalisation of the UK meat supply chain through trade policy choices might conversely make the idea of meat taxes more attractive, especially if policymakers seek to deflect any sense that such liberalisation comes at the cost of lower UK product standards.

Nevertheless, it is not simple to see the train of events that would lead British politicians to conclude rapidly and with limited warning that meat taxes were desirable and necessary. Such a move is much more likely to emerge from a longer consultation process. However, the ease with which such change could be implemented, and the fact that the underlying landscape of public opinion is shifting means that this is an area that demands careful monitoring.

SPS controls on EU supply chains

Food safety and associated controls are well established in the food and drink sector. At present both the UK's domestic sanitary and phytosanitary policy framework and its application of SPS protocols at its external (i.e. ex-EU) frontier are governed by EU policy. The response of UK authorities to outbreaks of animal diseases both with human health implications (such as Avian influenza and Bovine Spongiform Encephalitis) and without (such as swine fever and foot and mouth disease) is governed by EU directives and policed through the European Commission. Given the high level of trade integration in the EU single market, crisis responses are focused in general on biosecurity, stock isolation and treatment or destruction.

For third countries beyond the EU (like that of most other OECD states), disease control can be a blunter instrument when it is implemented at the border. While bans are in principle subject to WTO SPS rules, even within this framework, states will routinely exercise the prerogative to limit live animal and animal product movements completely, at least in a first instance.

If the UK is outside the EU this will give it a new potential set of responses to disease outbreaks in the EU food chain. With the UK heavily dependent (at least on current supply patterns) on imported meat[21] for processing, and to a lesser extent, direct retail consumption, government decisions on border measures take on an even greater relevance than they would when operating inside the EU's SPS framework. While both frameworks can produce decisions to limit movements between the SPS zones of the UK and continental Europe, such limitations on trade are on balance more likely between the EU and a third country.

After a possible UK exit from the EU, some of the risk of trade controls could, in principle, be mitigated by comprehensive SPS cooperation between the EU and the UK and a high level of mutual trust in systems that are likely in most respects to remain closely aligned. However, the degrading of this trust and cooperation could make it harder to resist pressure to move to trade bans in the event of high-profile disease outbreaks. If the EU resorts to similar measures, this will inevitably make it harder for UK policymakers not to do the same.

Broad consumer support: yes

Consumer sensitivity to food health and safety can be highly volatile, and can be easily shaped by media reporting, social media behaviour and public health statements from officials. This is a source of pride for the UK and the average UK consumer supports – in principle - maintaining or even improving existing standards[22] even at a higher cost. In the intense circumstances of a major disease outbreak in continental

21 The British Meat Packers Association estimates that the UK imports around 25% of the meat it processes for retail consumption. Beef is the largest component of this (c50%), followed by pork (c30%) and lamb (c20%).
22 Financial Times, 'Consumers will not sacrifice food standards after Brexit, says Tesco boss', 2019

or Irish food supply markets, there is little reason to believe that public opinion would not back tough action by UK authorities, and UK authorities will no longer have recourse to the argument that they must in the first instance fall back on the collective risk management systems of the EU single market.

Legal barriers to action: partial

At least in principle, the UK food security regime would have a new degree of autonomy from EU frameworks after Brexit (setting aside the unique potential situation of Northern Ireland). An EU-UK FTA can be expected to cement a series of procedural protocols for trade management that elaborate on the core obligation of transparency and proportionality in the WTO SPS Agreement.

However, the EU itself prefers to maintain a clear element of prerogative for action in defence of public health, and the UK can be expected to claim the same. In practice, the constraints on the UK implementing clearly defined and evidenced bans – even if these are subject to EU challenge - on EU imports will be minimal.

Imperative to act?

The experience with past food safety threats including Avian influenza (bird flu) and BSE, or more recent issues around the labelling of beef products containing non-beef meat suggest that this will be an area where rapid shifts in public or media sentiment will require careful management if they are not to result in pressure on supply chains.

Trade dispute escalation

One of the important potential consequences of the UK's exit from the EU's common commercial policy would be the return of control of the UK's external tariff to London. This provides an important opportunity for the UK to calibrate its import tax regime in a way that reflects the right balance of consumer and producer interests.

In principle, this new calibration will be robust at the level of the UK's Most Favoured Nation (MFN) trade. Once set, these new tax levels should be treated by government as stable, and should be subject to minimal change or volatility[23]. However, it is important to recognise that there remain circumstances in which these tariffs could be subject to sudden rises.

The most salient of these is a hypothetical scenario in which one of the UK's large trading partners were to take action against UK exports in a way that breaches (at least prima facie) their WTO commitments, as the current US administration has done. Where this action takes the form of restrictions or impositions on UK exports the UK government will find itself under both internal and external pressure to take retaliatory action. Under WTO rules, this can take the form of counterbalancing rises in tariffs on imports.

Broad consumer support: yes

Where UK exports are being subject to punitive tariffs by a partner, such as the US, there would be inevitable pressure for the UK to respond in kind. Like their EU peers in similar contexts, UK policymakers are unlikely to be willing to allow an aggressive approach to UK exports to trigger no UK reaction. It is not hard to imagine public opinion settling behind such a response.

23 In principle, unless bound by a new multilateral trade round, there may be a difference between the UK's applied MFN tariffs and the 'bound' rates in its WTO schedule that it could apply in principle. The UK has opted for a possible sharp reduction in its applied tariffs after a possible no-deal Brexit, while maintaining the prerogative of returning these tariffs to their higher bound levels. After a period of review of the optimal level for the UK outside of the EU Common Commercial Policy, the UK government should aim to establish new levels at a high level of stability.

Legal barrier to action: partial

The UK, as a WTO member, is subject to defined protocols with respect to its capacity to take retaliatory action against other WTO states, even when they are breaking WTO obligations. However, there is relatively broad scope for the UK to take countermeasures in the face of non-compliant restrictions from others.

Imperative to act?

This scenario remains highly hypothetical. However, the US administration of 2016-2020 has demonstrated how quickly a major trading partner under idiosyncratic leadership can pivot to an unorthodox approach to basic WTO protections such as the MFN principle. It is difficult in practice for other WTO members not to retaliate in turn.

Future UK governments – like their current EU equivalents – can be expected to design such retaliations with a careful eye on consumer price impacts. But there remains a material prospect that food and drink products are captured by such measures. For example, the EU's retaliatory tariffs on the current US Section 232 steel and aluminium tariffs include 25% tariffs on sweetcorn, rice, peanut butter, orange and cranberry juices[24].

24 Full EU retaliation list here: http://trade.ec.europa.eu/doclib/docs/2018/may/tradoc_156909.pdf

Conclusion

The case studies in this report are not predictions. Nor are they intended to be exhaustive or comprehensive. The methodologies used here have obvious limitations. The report does not attempt to rank or rate risks, absolutely or relatively. It needs to be used with these caveats in mind.

The report is intended to encourage consideration of a complex supply chain risks that can easily pass under the radar.

Both the CO_2 crisis and the rapid change in attitudes to, and regulation of, single use plastics are good examples of the way in which a confluence of factors can stress UK supply chains, or impose rapid transformation in UK food and drink markets and supply chains. In retrospect, it is easy to see how variables in both cases compounded to produce serious supply shocks or almost overnight regulatory change. Assessing the possibility of such change prospectively is obviously more challenging.

A number of general conclusions can be drawn from this analysis:

- First, the greatest risks of unexpected supply shocks arise from a compounding effect from multiple variables. What made the CO_2 crisis so dramatic (at least for planners in the food and drink industry) was the compounding of climate, supply, transport and storage factors into a serious problem of supply. Mapping this interaction of factors is inherently complex, but not impossible.

- Second, there are risks that arise from the idiosyncratic operation of individual variables. A good example of this is glycerine -which is a by-product of biodiesel. While glycerine is only exposed to the single issue of its supply/demand dynamic, this is potentially serious. An increase in glycerine demand will not send a market signal to suppliers to increase production – or will do so only very imperfectly. Understanding these quirks of the demand signalling mechanism matters.

- Third, it is vital to be alert to the way in which public opinion is operating as a backdrop to policy change. Latent awareness of plastic's impact on the environment had been present in some part of the public mind since at least the 1970s. How and why it reached a tipping point in 2018 is a complex but vital question to answer. Combined with the relative absence of legal constraints to changes in plastic regulation, this public support made rapid policy change feasible in a way it might otherwise not have been.

- Fourth, the way imperatives operate on policymakers is key both to anticipating potential issues and dealing with problems when they arise. Policymakers are involved in a complicated balancing act of reading and responding to public sentiment, political positioning and acting to protect the public interest. As our analysis of wider risks here makes clear, the events to which they are responding can in some cases be in markets of supply in which their toolkit for dealing with risk can be blunt by necessity.

For a highly globalised sector like the UK food and drink industry, risk management is second nature. This report illustrates the extent to which this discipline must remain central to its approach to serving its customers and protecting its reputation and value.

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About Global Counsel

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