Food in the digital platform economy – making sense of a dynamic ecosystem

Evidence assessment and policy recommendations, May 2021

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Abstract

Rapid innovation in digital technologies is reshaping the UK food system in many ways. FSA needs to stay abreast of these changes and develop regulatory responses to ensure emerging digital marketplaces and other innovations do not compromise food safety and public health. This report presents a rapid evidence assessment of these innovations and identifies the most salient emerging trends. These are: Online third-party platforms for food and beverage ordering and delivery; Online marketplaces connecting buyers and food vendors; Direct producer-to-consumer commerce, bypassing traditional intermediaries; Dark kitchens, with no customer-facing storefront; and Rapid on-demand delivery solutions including autonomous deliveries. These innovations are already rapidly transforming the traditional linear value chain of the food system into a highly dynamic networked ecosystem of actors, enabling consumers to access food directly at various stages along the value chain via interaction with digital platforms. Risks and opportunities arise from these innovations. The risks are of numerous unapproved vendors often with only a virtual presence, and some with even only a minimal digital trace, operating under the radar of FSA, compromising food safety, and raising the potential for food fraud. Furthermore, the increased numbers of actors and their rapid and dynamic interactions with different parts of supply chains increases the likelihood of systemic risks. Moreover, the rise and dominance of platform monopolies has the potential to reduce the power of regulators to protect society against these risks. However, digital platform technologies also offer opportunities for food safety. The inherently networked nature of emerging digital commerce platforms means that there are identifiable key interaction points (nodes and hubs) where most new businesses and market entrants are expected to want to engage with to gain access to the market; namely, the major online delivery platforms and online marketplaces, dark kitchen providers, and technology solution providers. It is recommended that FSA should focus on these main convergence nodes and hubs in the emerging ecosystem for best effect. FSA will need to take a proactive anticipatory role in supporting industry to build food safety into its fabric from the start as novel platforms and business models emerge. Changes to the regulatory

framework are recommended to ensure that the major platforms are held responsible for upholding high food safety standards.

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Abbreviations

Abbreviation	Definition
C2C	Consumer-to-Consumer
D2C	Direct-to-Consumer
EPOS	Electronic point of sale
FHRS	Food Hygiene Rating Scheme
FSA	Food Standards Agency
HACCP	Hazard Analysis and Critical Control Point
LA	Local Authority
CPG	Packaged Consumer Goods

Executive Summary

The food services sector has been evolving rapidly over the past decade, accelerated significantly by the ongoing Covid-19 pandemic, with significant investment and innovation across the world. This has led to an increasingly dynamic and efficient innovation ecosystem of food service business models and online solutions. The traditional linear model of food producers selling through wholesalers to brick and mortar retailers, restaurants and hospitality venues is increasingly being displaced by complex interactive digital ecosystems of online food services providers. Consumers are increasingly able to access food directly at various stages along the traditional value chain via interaction with digital platforms and rapid home-delivery networks, realising greater convenience, more variety in food products and services from a dynamic start-up scene, and overall enhanced value. FSA needs to stay abreast of these changes and develop regulatory responses to ensure these innovations are aligned with the public good and do not compromise food safety and public health.

This report presents a rapid evidence assessment of the implications of these innovations on the UK food buying and selling system over the coming years. This report is a synthesis of desk research based on a review of the academic and grey literature and assimilation of previous FSA reports. Analysis and review were undertaken using standard rapid evidence review protocols, and qualitative analysis where necessary.

Findings

This review identified five key trends in food buying and selling in the digital platform economy.

Online third-party platforms for food ordering and delivery

These are aggregating platforms that enable consumers to browse a range of vendor offerings, place orders online, and arrange on-demand delivery within a certain geographic radius. Some of these platforms are well established, with brands such as Deliveroo, Uber Eats, Just Eat, and others, being already global household

names. They are expanding rapidly and extending their reach into other areas of the food sector, including groceries deliveries, and provision of numerous new virtual restaurants. These platforms are enabling traditional brick and mortar businesses to easily enter the online economy and are facilitating a wealth of new entrants including online-only brands and home kitchens to enter the food sector.

Online marketplaces connecting buyers and food vendors.

Online marketplaces provide a venue for vendors to promote their products and services and act as an intermediary between buyers and sellers to facilitate transactions. These can be food marketplaces focusing exclusively on offering food products and services (e.g., focusing on speciality foods); Food event marketplaces offering culinary and experiential events such as supper-clubs and food tastings; General marketplaces where food and beverages are just a sub-set of the product range (e.g., Amazon); Social/open marketplaces that operate within a social media platform and facilitate peer-to-peer connections and exchanges; and Redistribution marketplaces that seek to redistribute surplus food from farmers, producers, retailers, restaurants and consumers to reduce food waste. These marketplaces are enabling a wide array of new entrants to participate in the food sector.

Direct producer/wholesaler to consumer commerce

The past five years has seen a steep rise in the number of food producers and wholesalers developing direct-to-consumer (usually online) sales channels. These innovations bypass traditional intermediaries, shorten supply-chains, and enable consumers to connect directly with producers such as local farms and specialty ingredient suppliers. Notable innovations in this space include farm drops (providing fresh produce direct from the farm), and a wide range of recipe boxes and meal boxes that are redefining the boundaries between traditional grocery shopping and ready-made meals and delivering an experiential aspect for consumers.

Dark kitchens

Dark kitchens, alternatively known as cloud kitchens or ghost kitchens, are large-scale restaurant style food preparation spaces that do not have a customer-facing store front and operate a B2B model by making the space available/outsourced to restaurants and brands that require extra capacity. They are typically located in low-

cost but central areas in the urban environment, to enable rapid servicing of their local markets. Facilities have minimal staffing levels, and are optimised for high through-put, with the ability to be reconfigured quickly and easily to react to emerging market trends. Dark kitchens may be wholly owned by an existing brick and mortar establishment to augment capacity, or as is increasingly the case, are online-only operating as virtual brands, multi-brand kitchens, or providing third-party food services to other operators under franchise models. Several major players are entering this market in the UK offering outsourced dark kitchens much like co-working spaces, enabling food entrepreneurs to enter the market with minimal setup costs and risk.

Rapid on-demand delivery solutions

The industry is building quick-commerce, or q-commerce solutions, that aim to cut on-demand delivery times to 15 minutes or less to make home-delivery the preferred choice for consumer food and convenience needs. This is being achieved through a combination of locally positioned restaurants and stores, leveraging dark kitchens and dark stores (centrally located fulfilment warehouses), and local courier networks. Use of innovative transport solutions such as e-scooters, autonomous robots and aerial drones are already being tested or are in operation offering rapid and low-carbon deliveries. These developments are transforming the traditional food buying and selling infrastructure into a dynamic network ecosystem of digital transaction hubs that will be able to quickly respond to novel consumer demands and trends across a wide range of sectors of the economy.

Longer-term trends

Looking forward over the next five years the existing literature reports that the current trends identified above are here to stay and will intensify, and continue to reshape business models and the food buying and selling ecosystem, augmented by several broader trends:

- E-commerce: continued strong growth in online services, and q-commerce.
- Ecosystem transformation: growth in convenience, discount, and specialty stores; major grocers to move further into take-away and home-delivery market; while delivery aggregators and platforms will move further into retail;

pureplay online players will look to develop offline services; direct to consumer commerce, and social commerce will continue to grow rapidly.

- Data analytics/AI: will deliver rapid technological advances, and big data will grow ever more important to the consumer experience and competitive advantage.
- Food as a service: including recipe boxes and personalised nutrition; and a growing focus on personalised nutrition.
- Health and sustainability: organic, nutrition, provenance, local, food waste reduction, and environmental performance.

Future new trends are expected to emerge from within the current ecosystem through dynamic interactions and network effects between each of these trends creating new entrants, and more leverage for some players while driving other players out of business. Traditional roles and business models will increasingly intersect, with producers, vendors and consumers interacting at multiple points in the value chain in a highly dynamic digital ecosystem. The buying and selling typologies identified in this report, while relevant over the short to medium term, may need to be reconceptualised in the years ahead to reflect these dynamics. Identifying the convergence points, the hubs and nodes in the system is key to policy design and implementation.

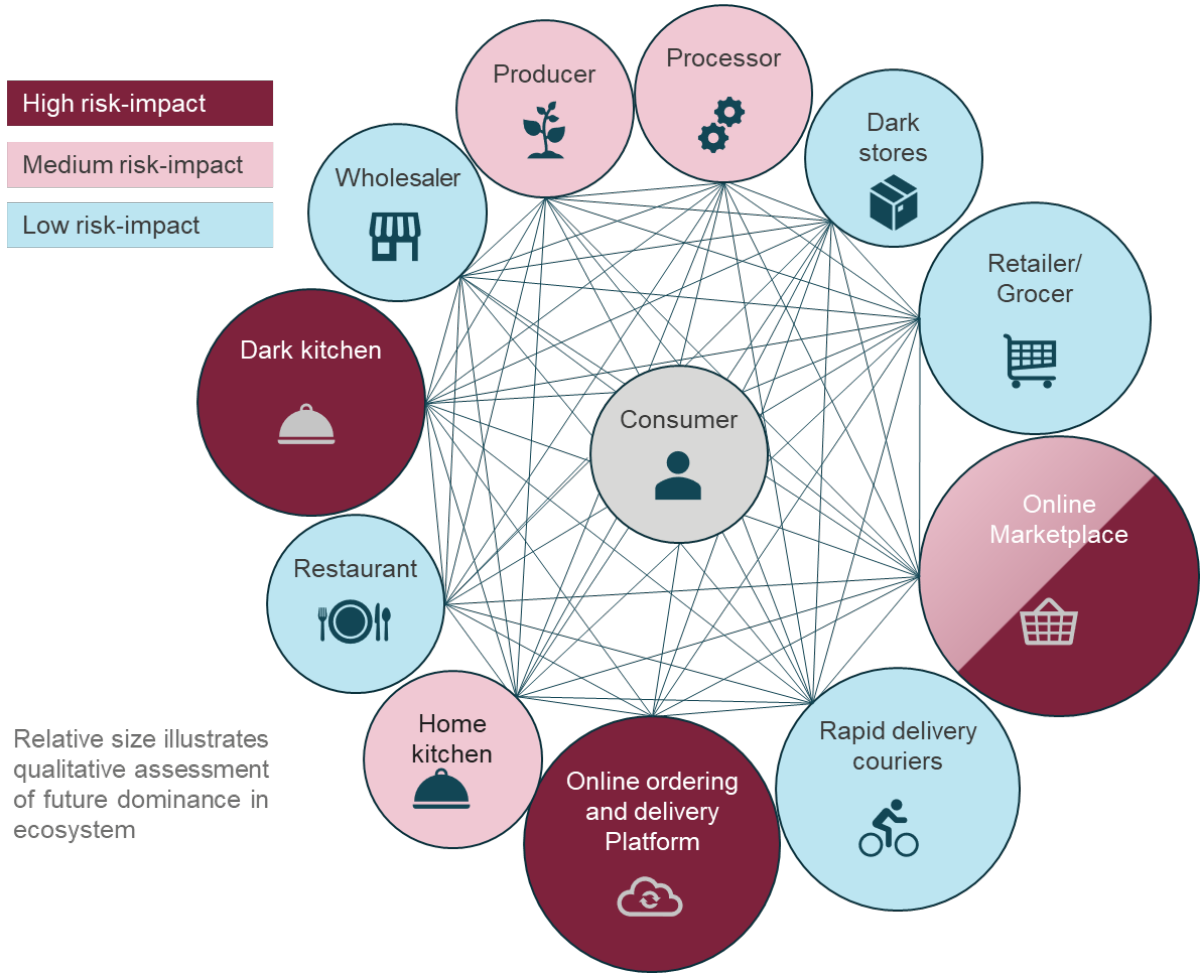
Implications for food safety and the regulatory framework

These innovations are bringing a broad range of benefits in terms of convenience, choice, and enhanced value for consumers, and are enabling an array of entrepreneurs to enter the market quickly and affordably to experiment and bring new product ranges to market. However, with so many new entrants and ad-hoc traders in the market, often with only a small virtual presence and operating from dark kitchens or home kitchens, monitoring and oversight becomes challenging. The risk of uncertified vendors, particularly small, local, and least-networked hubs, operating under the radar of FSA and local authorities is high in certain parts of the ecosystem and raises concerns over food safety and/or food fraud/crime. Across the ecosystem the larger actors hold sway and if producers bypass them through

emerging D2C or C2C channels, they may get away with selling the food without any registration and compliance with FHRS etc.

Furthermore, the increased complexity in highly networked supply chains increases the likelihood of systemic risks, and the potential for incidents at a small part of the supply chain to have far reaching consequences throughout the food supply system beyond the locality of the incident. Additionally, the rise and dominance of platform monopolies has the potential to reduce the power of regulators to intervene, and so reduce the regulators ability to protect society against these emerging risks.

As the food ecosystem evolves and digital platforms grow and D2C and C2C channels increase, the ecosystem will evolve further towards the networked value interaction model as illustrated below, where there is continuous dynamic interaction between all points of the network. The figure illustrates the nodes in the system most likely to gain dominance based on current information, and provides a top-level assessment of the likely areas of food safety risk and their potential for large scale impact in the emerging ecosystem.



Representation of future value interaction network of the food system

(For simplicity figure does not illustrate the potential convergence and over-lapping of roles in the future network, and food sharing/distribution as well as other offline actors are not included)

High risk impact:

- Dark kitchen
- Online marketplace
- Online ordering and delivery platform

Medium risk impact:

- Producer
- Processor
- Home Kitchen

- Online marketplace

Low risk impact:

- Wholesaler
- Dark stores
- Retailer/Grocer
- Rapid Delivery Couriers
- Restaurant

Recommendations

Focus on convergence nodes and hubs

The nature of emerging digital networks means there are key points where most new businesses and market entrants are expected to engage with the market where risk might be mitigated; namely:

- The major online delivery platforms and online marketplaces (hubs)
- Local specialist online delivery platforms and online marketplaces (nodes)
- Dark kitchen providers (nodes with potential to develop into hubs)
- Processing and gastronomy technology solution providers (system levers)

Platforms that are major nodes and hubs within the digital ecosystem effectively act as gatekeepers to the food system and are well positioned to fulfil a quasi-regulatory role in the sector, and through careful curation of vendors and ongoing monitoring can mitigate the risk for consumers from unsafe and fraudulent vendors. It is recommended that FSA should focus on these main convergence nodes, hubs and levers at major entry points into the ecosystem.

- By working with these platforms and dark kitchen providers, the FSA can create levers for compliance in the food ecosystem to ensure food hygiene standards are enforced, and safeguard against potential food fraud.

- Beyond monitoring and oversight, FSA should work with these nodes to develop enhanced training programmes, education for new food entrepreneurs, and perhaps consider developing new standards for dark kitchen operations to optimise processes for food safety.

- As restaurants and other food facilities adopt technology it emerges that software companies that specialise in tools for food buying and selling, selection, production, and processing (e.g., electronic point of sales systems, production control, inventory management and supply-chain management tools), are well placed to integrate compliance factors and traceability into their products. This creates an opportunity for FSA to work with these

developers to make compliance a built-in element of standard food business software.

While focusing on these key system connectors (nodes, hubs and levers) will not address every non-compliant vendor, it should capture the majority, and certainly those with the larger potential for wider influence in the food system.

Risks are also identified in the more fragmented, obscure parts, or modules, of the food system, where there are concerns over new entrants without adequate food hygiene standards, food fraud, and traceability (such as consumer-to-consumer transactions on social media platforms). Mitigating these risks is more challenging but the impact of these vendors on the overall food system is low. For these segments of the market it is recommended:

- Focus on public awareness campaigns to educate vendors and consumers on the certification requirements and risks of non-compliance, and educate consumers on how to take more responsibility for buying decisions, their rights and what they should expect of vendors, and where to go to raise a complaint or concern over vendors.

Regulatory oversight

While the digital platform economy offers many new opportunities for the food sector, regulators should be cognisant of systemic issues platforms can present. As seen with digital platforms in other sectors, particularly social media platforms, weak regulation can have significant implications. When attempting to implement standards in a digitally networked ecosystem there is a need for continuous engagement with the system. Unlike linear supply chains, digital platform ecosystems can rapidly create unforeseen novel network effects and challenges for regulation that might affect large parts of the food system. There is therefore a need for developing comprehensive analytical tools to enable FSA to continuously monitor and understand the impact of such changes on food safety.

Exactly because of the complexity and dynamics of the digital platform economy, robustness of the regulatory framework is essential for its ability to respond to challenges. As platforms increasingly move into new market areas, with overlapping roles, the responsibilities for food safety and consumer protection are likely to

become blurred. Therefore, FSA should consider building similar approaches to those developed for cyber security and data regulation to ensure ground rules are set and food safety is an inherent part of the system.

In order to take the next steps towards developing the framework for a new approach to policy design for the digital food commerce sector we recommend the following considerations:

- Change the status of food platforms from technology companies to food business operators.
- Raise the status and visibility of food safety in the industry to compare with cyber security in the technology industry.
- Shift responsibility from vendors that are listed on those platforms to the platforms themselves (for allergens, hygiene ratings etc.).
- Currently most risk mitigating actions to be taken by platforms that trade in food in the UK are deemed to be voluntary. Consider making key measures obligatory which may help with enforcing others.

Further research

This review was based on the extant literature and is believed to accurately represent the latest views on the topic. However, the academic literature was found to be surprisingly sparse on the topic of digital platforms in the food sector, and there are notable gaps in the knowledge base. Several important areas for further research are recommended to better understand the emerging risks and opportunities:

- Quantifying food safety risks arising from online platforms.
- How do curation and vendor monitoring practices of online platforms help to ensure food safety across vendor base.
- How does the business model/functionality of the platform impact on food safety for consumers.
- The impact of social media platforms on food safety and consumption.
- The boundaries of regulatory responsibility in the platform economy.
- How to build food safety into the ecosystem function – identifying parallels with information and data security regulatory models.

During this review three related trends were identified that seem potentially at odds with the future predicted evolution of these digital ecosystems and convenience-orientated home-delivery systems. These are:

- Public health and nutrition concerns around the convenience food culture.
- Chemical contamination from plastic packaging and microplastics.
- Environmental impact and sustainability issues with respect to carbon emissions, packaging waste and food waste.

FSA should consider how these issues might best be addressed in the future evolution of how food is bought and sold in the UK.

Summary

In summary, significant change is anticipated in the way we buy and sell food online over the coming years. As digital platforms and retailers increasingly move into new market areas, with overlapping roles, the responsibilities for food safety and consumer protection are becoming blurred. It is therefore recommended that FSA adopt a highly proactive anticipatory role in supporting industry to build food safety into its fabric from the start as novel business models and processes increasingly replace traditional ones. It is recommended to adopt a systems approach to regulation, perhaps integrating conceptual input from the field of network science to capture the realities of an increasingly dynamic, interactive and networked food system.

1 Introduction

1.1 Background

The use of online platforms has become an embedded part of the UK food system over the past fifteen years, bringing a range of risks and opportunities to producers and food businesses, consumers, and the regulatory regime. The fast pace of change in digital platform technologies, their multiple network effects, and rapid adoption rates means this sector is likely to evolve at a pace not seen in other elements of the food sector previously. Some of the changes to how and where food is bought and sold using online platform technologies are potentially short-term, others may be longer-term trends, and others may introduce new standards across the industry remaining here to stay.

Pushed by the Covid-19 pandemic, established business models have changed fast, with wholesalers opening online retail operations, restaurants converting to takeaways, or catering businesses offering online meal ordering and delivery, while many operations were forced to close permanently when not able to find ways to adapt. During the pandemic online shopping markedly increased, and supermarkets started to sell products destined for restaurants, while demand for local food boxes such as fruit and vegetable and fresh meat schemes sold from farms direct to the consumer soared. Meanwhile, peer-to-peer and business-to-consumer selling via digital platforms such as Facebook marketplace increased significantly.

Due to their highly dynamic nature and unpredictable network effects these trends present challenges in how they can best be analysed and monitored as to assess how and where online food selling and buying presents opportunities and risks to the food system. Only a clear understanding of the structural and dynamic properties of these technology-driven trends will allow identification of effective leverage points for intervention, ensuring that FSA can fulfil its regulatory obligations.

1.2 Objectives

The focus of this report is on the increasingly distributed, and disruptive modes of getting food from producers to consumers based on digital technologies, and the implications of these changes for the FSA.

This report presents findings of a rapid evidence assessment of the most salient changes to online buying, selling, and sharing of food – assimilating and synthesising existing research. It highlights what the literature assesses will be the likely longer-term impact on the UK food system. It describes the types of online platforms operating in the UK food system and their differing business models, their operating characteristics, and who operates them, who they serve, their high-level functionality, and the value they create. These factors have a bearing on where and how the FSA can apply its policy levers in relation to these platforms most effectively. Moreover, expected developments in the digital platform ecosystem over the next 5 years are presented, and conclusions are drawn from this assessment to formulate specific policy recommendations for the FSA.

This report will also highlight emerging changes in offline food selling and buying only as far as they are mentioned in the reviewed evidence on digital trends. The focus here is on buying, selling, and sharing online and where transactions create a digital trace. The FSA has made provision elsewhere to examine examples of offline selling and sharing, such as food banks, community fridges and shared premises such as community kitchens, hence these are not covered in this report.

1.3 Key research questions

This rapid assessment report seeks to address the following six research questions.

1. What are the most salient emerging changes to where and how food is bought, sold, and shared?

2. What does the literature assess the likely longer-term impact of these changes on UK food system across the producer to consumer cycle?

3. What are the operating characteristics of different online platforms – who operates them, who they service and how they function?

4. What is the current typology of online platforms in the UK food system?

5. How does the literature assess this typology is likely to evolve in the next 5 years?

6. What risks and opportunities have been identified regarding the use of online food platforms for: a) consumers, and b) the regulatory system.

1.4 Methodology

This research was carried out as a rapid evidence assessment of the available academic and grey literature and a review of the food delivery sector and start-up scene, including synthesis of extensive evidence already generated within the FSA. The research process consisted of desk-based research, and analysis and review were undertaken using standard rapid evidence review protocols, and qualitative analysis where necessary.

Academic databases were interrogated for the academic literature searches, but the literature was found to be surprisingly sparse on the topic of online food platforms. As a result, this research draws in some parts on previously generated FSA reports (namely, Bolanos, 2021; Brice, 2018; Hart, 2021; and Prost, 2018,), and grey literature, such as news articles, industry reports including several important reports prepared by Foundry4 for FSA, and several specific food sector start-up focused databases (e.g. Food Navigator, 2021; Forward Fooding, 2021). Where possible, we sought to identify multiple, most recent articles on each topic of interest to ensure a balanced perspective, and gave preference to more highly cited articles, or those from leading global food institutions and research groups, and government agencies when applicable. Corporate material was generally avoided due to the potential for marketing bias.

The analysis in this report reflects how the situation presents itself according to the existing literature. What stands out is that a traditional linear analysis of food buying and selling is inadequate to fully understand the system interactions, dependencies,

and the implications for food safety. Therefore, in order to effectively analyse the emerging food system, it is necessary to take a dynamic networked ecosystems view of the digital platform world.

1.5 Definitions of key terms

In the context of this report, we use the following definitions:

Brick and mortar: Refer to physical retail shops, dine-in restaurants, hospitality venues, etc (as opposed to online operations, with no customer-facing physical facilities).

Community fridge: A communal refrigerator located in a public space that enables surplus food to be shared within a community.

Convenience store: A shop with extended opening hours, stocking a limited range of household goods and groceries.

Curated platform: An online platform where the administrators apply a degree of selectivity to the choice of vendors to meet some pre-defined standards. Platforms may be low-curation where there are minimal requirements for engagement with the platform, to high-curation where platforms are highly selective in the vendors they allow to participate and the regulatory compliance they demand. Factors may include FHRS rating, type of cuisine, allergen-free, and so on.

Dark kitchen: Refers to food preparation kitchens without a storefront that are optimized for delivery. (Also referred to as ghost, cloud, or delivery-only kitchens).

Dark store: A large retail facility that resembles a conventional supermarket or convenience store but is not open to the public, housing goods used to fulfil orders placed online. (Also referred to as cloud stores). Usually centrally located to facilitate rapid delivery to consumers, as opposed to traditional brick and mortar and e-commerce warehouses that are often far outside the urban centre.

Delivery: The act of delivering a product to the consumer through some means of transportation.

Direct-to-consumer: Selling products directly to consumers by farmers and manufacturers, by-passing third-party retailers, wholesalers, and other intermediaries.

e-Commerce: Online commerce, including online ordering and delivery services.

FHRS: Food Hygiene Rating Scheme provides information on the standards of hygiene found in food businesses at the time they are inspected (on a rating of 1 – 5, low – high). A rating of 3 is generally satisfactory.

Food: In this report we use 'food' to refer to all food products in general as a grouping (as in food sector), or more specifically to refer to prepared meals (as distinct from groceries).

Food safety: Relates to a) Contamination risk: pathogens, bacteria, parasites, viruses, cross-contamination, physical hazards such as glass, hair, etc.; b) allergen risk: 90% of all food allergenic reactions are caused by eight food types: milk, wheat, peanuts, tree nuts, fish, shellfish, soy, and eggs.

Food fraud: Adulteration, misuse of additives, mislabelling, out-dated or past use-by-date, origin, and authenticity issues.

Food hygiene: Refers to the requirements for food vendors to comply with Regulation (EC) No. 852/2004 to meet basic hygiene requirements for all aspects of the business, from premises and facilities to the personal hygiene of staff. The food vendors make, pack or sell must be safe to eat.

Food surplus redistribution platform: Online and, or offline platform facilitating the sharing of surplus food and groceries between retailers and consumers, or consumer to consumer. Can be sharing for-profit, for charity (such as food banks), or voluntary/ donation-based peer-to-peer exchange.

Groceries: Pre-packaged food, fruit and vegetables, ingredient boxes, beverages, etc.

Hub: A hub is a point or actor in a network (a node) with a number of links that greatly exceeds the average, giving it greater centrality and, or influence in the

network. Emergence of hubs is a consequence of a scale-free property of networks. (In this report examples of hubs are the major online delivery platforms and marketplace platforms)

Node: A point, or actor in a network where activities and actions intersect (For example, local and, or specialist platforms including home cooks).

Online Platform: A digital service that facilitates interactions between two or more distinct but interdependent sets of users (business to business, or business to consumer) who interact through the service via the Internet.

Online third-party food delivery platform: Facilitates the ordering and delivery of ready-to-eat food to the consumer, with rapid on-demand delivery within a limited geographical radius of the consumer. A vendor-to-consumer delivery platform is where the vendor arranges the delivery transport themselves; platform-to-consumer is where the platform arranges the delivery service).

Online marketplace: e-Commerce sites that allow third-party vendors to register and sell or rent products and services to other users. In an online marketplace, the administrator facilitates the transaction and earns via commission, or other service fees.

Quick commerce: Next generation of e-Commerce, responding to the number of small or single-person households who want products delivered in small quantities, with the ordering and delivery cycle completed in under an hour.

Vendor: Entity offering take-away ready to eat meals or packaged foods for sale. In this report, vendor includes producers, manufacturers, processors, restaurants, innovators and new experimental products and services, etc. This is distinct from a retailer that sells a broad range of goods and services produced by third parties.

Virtual restaurant: An online-only restaurant brand (also referred to as a virtual brand, or virtual kitchen).

1.6 Structure of the Report

The following section, 2, presents an overview of the current industrial context to buying and selling of food in the digital economy, followed by a detailed synthesis of the literature on the most salient emerging trends and services in the food system. Section 3 then explores how the literature anticipates the ongoing evolution of digital platforms, the implications for the UK food sector, and the risks and opportunities that these emerging trends present for consumers and the regulatory framework. The conclusions in Section 4 offer a deeper analysis and synthesis of the information and set the scene for recommendations in Section 5.

2 Buying and selling of food in the digital platform economy

2.1 Industry context

The global food delivery system is undergoing rapid transformation by enabling consumers to access food directly at various stages of preparedness/processing along the value chain via interaction with digital platforms. The traditional linear model of producers selling through wholesalers to brick and mortar retailers, restaurants and hospitality venues for the buying and selling of food is increasingly being displaced by complex interactive digital ecosystems of online food services providers (e.g. Hart, 2021; Prost, 2018). Digital technologies are enabling new direct to consumer models of business, online aggregated ordering and home delivery services, and online marketplaces that collectively are reshaping traditional food value chains.

Third-party aggregating digital platforms enable conventional brick and mortar food vendors, and new pure-play virtual brands (online only businesses with no physical consumer-facing premises) to join the e-commerce world quickly and easily, with minimal marketing costs, no need for their own delivery infrastructure, and to benefit from immediate access to a large customer base. Network effects are important, whereby as the platform expands it becomes ever more attractive to both vendors and consumers. The dominant platforms have grown rapidly, aggregating prepared-food service offerings with rapid delivery of groceries and other convenience items, and increasingly aggregating the food preparation sector with provision of additional kitchen capacity in so-called “dark kitchens” (discussed later) to drive down costs and expand the food options on offer, and enhance the consumer value proposition (Deloitte, 2019).

Technological advances and well-funded business model experimentation, combined with growing consumer demand for online services and enhanced convenience and greater choice, are driving this transition (Deloitte, 2019). Figure 1 presents an overview of how the services of traditional food vendors are augmented and

changed by these industry innovations.

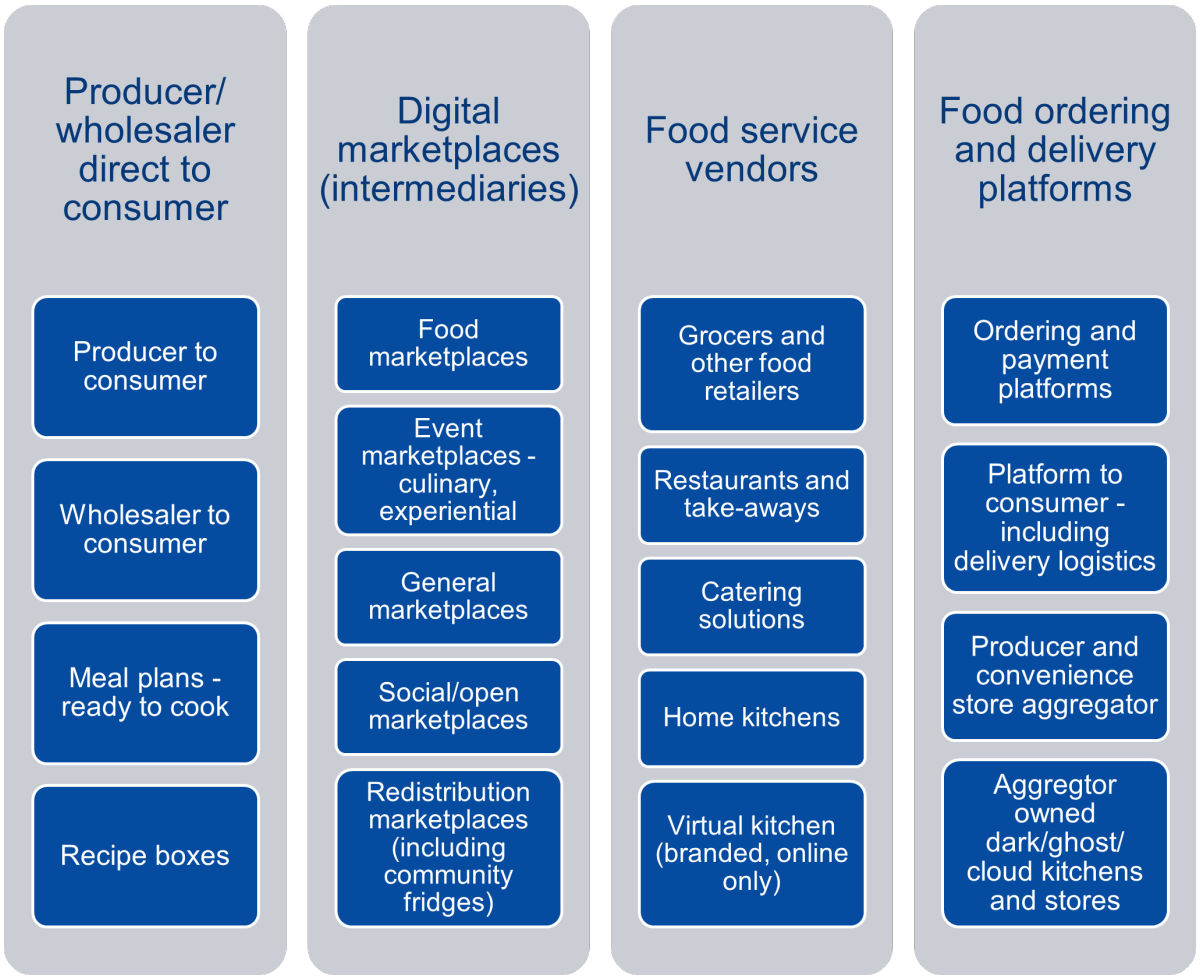


Figure 1 Typology of food services based on digital innovations

As described in the current literature; developed from Bolanos (2021) and Hart (2021).

The image shows the following information:

Producer/wholesaler direct to consumer:

- Producer to consumer
- Wholesaler to consumer
- Meal plans: ready to cook
- Recipe boxes

Digital marketplaces (intermediaries):

- Food marketplaces

- Event marketplaces: culinary experiential
- General marketplaces
- Social/open marketplaces
- Redistribution marketplaces (including community fridges)

Food service vendors:

- Grocers and other food retailers
- Restaurants and take-aways
- Catering solutions
- Home kitchens
- Virtual kitchen (branded, online only)

Food ordering and delivery platforms:

- Ordering and payment platforms
- Platform to consumer – including delivery logistics
- Producer and convenience store aggregator
- Aggregator owned dark/ghost/could kitchens and stores

In 2020 the prepared-food delivery sector in the UK was estimated to have grown by £3.7bn to reach £11.4bn (BigHospitality, 2021). While demand is anticipated to drop back once the pandemic restrictions ease off, the industry expects to remain at notably higher levels of business than in 2019 anticipating a permanent shift in consumer behaviour. Home delivery of packaged meals, ready-to-eat meals, and meal kits are anticipated to have a strong future (e.g., Lockhart, 2021). Online grocery shopping is also rising fast in the UK, estimated to have grown by 30% in 2020 to about £14.3bn, representing about 11% of the overall groceries market. This figure might well have been substantially greater if it were not for capacity constraints in the sector (ResearchAndMarkets, 2020). Furthermore, producers, from large, consumer packaged goods (CPG) companies, down to small artisan operations, who previously may have only sold through retailers and distributers are now embracing direct producer-to-consumer (D2C) channels. Online D2C sales rose from 3% to 15% of overall sales in 2020 (MarketProphets, 2020).

2.2 Overview of the most salient emerging trends and service models

The “digital transformation” has been underway for almost two decades, but the shift to online buying and selling of food has been accelerated significantly by the Covid-19 pandemic restrictions on traditional brick and mortar food service providers and retailers. The hospitality sector particularly has had to adapt rapidly to stay in business, with bakeries, cafes, pubs, and restaurants scrambling to implement some form of take-away offerings to survive the national lockdowns, either using digital platforms or implementing their own direct to consumer (D2C) solutions.

Food retail ordering and delivery platforms such as online shopping with large food retailers such as Tesco, Waitrose and online-only grocery Ocado are well established in the UK and continue to expand. As these platforms of established retailers are well known and understood entities, they are not a specific focus of this report. It is also worth noting that there is another competing trend in the rise of discount food retailers, such as Aldi, Lidl and others which to date have little online presence, but are growing rapidly in the UK, and may eat into the growth online. Beyond these big retailers, several key areas are redefining the food and groceries delivery ecosystem that require closer attention (based on: BigHospitality, 2021; Businesswire, 2021; Hart, 2021; StartUs, 2020):

- Online third-party platforms for food and beverage ordering and delivery.
- Online marketplaces connecting buyers and food vendors.
- Direct producer to consumer (D2C), bypassing traditional intermediaries.
- Dark kitchens – with no customer-facing storefront.
- Rapid on-demand delivery solutions, including autonomous deliveries.

Each of these areas are discussed in the following sub-sections, along with an assessment of their implications for industry, for consumers, and the risks and opportunities for food safety and regulation.

2.3 Online third-party food ordering and delivery platforms

Online third-party food ordering and delivery platforms are aggregating platforms that enable consumers to browse a range of vendor offerings, place orders and arrange on-demand delivery. The dominant industry players include Deliveroo, Delivery Hero and Just Eat. These platforms often operate at a national or global level in terms of operations, data management, marketing, etc; and a local level where they operate delivery networks and work with local restaurants and stores with limited reach – tending to focus on more densely populated urban areas. These platforms partner, often on an exclusive basis, with restaurants, virtual restaurants, home kitchens, and retailers including grocers, off-licences, and convenience stores to offer a wide range of prepared foods, beverages, and goods. A key feature of these platforms is rapid on-demand delivery within a certain geographic radius of the consumer, as opposed to slower scheduled deliveries of conventional e-commerce.

Predominantly these platforms sell ready-to-eat meals like traditional take-aways, ranging from mainstream fare from established brick and mortar restaurants, to numerous niche platforms specialising in virtual brands or speciality cuisines (e.g., HomeCooked, which enables consumers to order authentic home-cooked cuisine produced by individuals in their home kitchens). Increasingly, delivery platforms are now including frozen meals, groceries and other convenience items (Hart, 2021). For example, in retail, Deliveroo have a partnership with Co-op for local delivery of groceries, A plethora of new start-ups have emerged over the past five years offering app-based delivery services to fulfil the demand for rapid on-demand delivery of groceries (for example, Weezy, Gorillas) which are discussed later in this report.

Vendors on these platforms benefit from access to new off-premises opportunities for sales, while consumers benefit from convenience, new home-delivery options, and visibility of restaurants that they might otherwise not be aware of (Deloitte, 2019). In addition to vendor partnerships, these platforms are also increasingly establishing their own virtual brands (for example, Deliveroo Editions), offering dark kitchens to rent to third-party vendors for creating food that is sold through the platform, and dark stores (warehouses) to support direct order fulfilment of convenience items.

These third-party platforms, as shown in Figure 2, can be either order processing only, with the food vendor arranging delivery; order processing with the platform arranging delivery (known as platform to consumer) either through their own network of couriers, or through third-party couriers; or simple click and collect at the vendor's site (Brice, 2018). In each case, the platform provides the marketing and promotion and the digital infrastructure, and takes a commission on the sale, and in addition may also charge a subscription and, or delivery and service charges to the consumer.

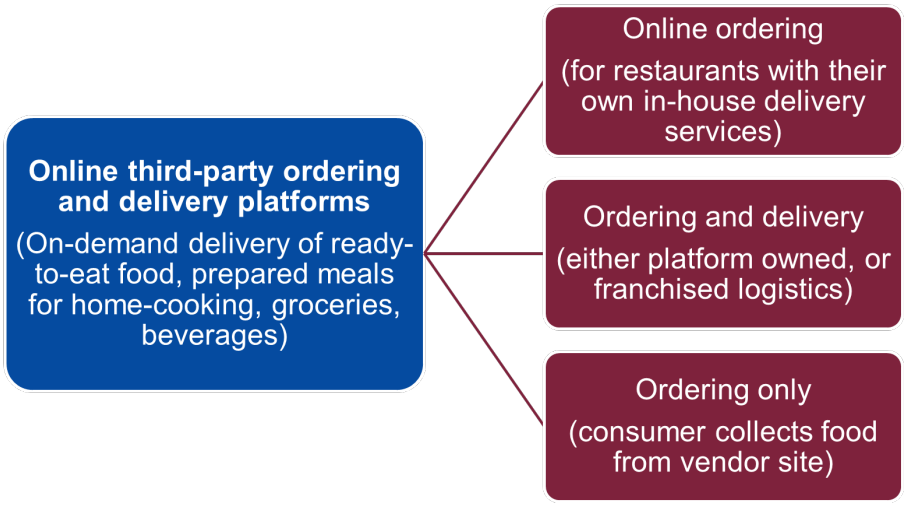


Figure 2 Typology of online takeaway ordering platforms (based on Brice 2018)
The image contains the following information:

Online third-party ordering and delivery platforms (on-demand delivery of ready-to-eat food, prepared meals for home-cooking, groceries, beverages)

- **Online ordering:** for restaurants with their own in-house delivery services)
- **Ordering and delivery:** (either platform owned, or franchised logistics)
- **Ordering only:** (consumer collects food from vendor site)

2.3.1 Impact on industry

Third-party platforms bring significant benefits to vendors and consumers, as discussed above. There are however mounting concerns over the dominant positions of the market-leading platforms and the potential for monopolistic behaviour as network effects increasingly give vendors (and consumers) little option but to participate in the platform, and make it increasingly difficult for new platforms

or independent vendors to gain a foothold and thrive in the market. A fundamental challenge for the industry arises because food items are generally low value items, making delivery charges a large percentage of the costs. Platform fees have hence become a source of contention in the sector, with US regulators recently attempting to cap delivery fees that can be 40%-50% of the food cost (e.g., BBC News, 2020; Forman, 2021). There are also concerns over the power of platforms to exclude vendors without due process, and also the risk of reputational damage that may occur due to poor delivery services that are often beyond the control of the vendor (Bregman, 2021). Furthermore, home-delivery services are often less profitable for the restaurant than on-premises service where a premium can be charged for the dining-in experience, undermining the profitability of participating brick and mortar restaurants.

2.3.2 Impact on consumers

Digital online platforms have dramatically increased choice, availability, and convenience of on-demand home-delivery food products. Many food options that were previously impossible to obtain as take-away or home-delivery are now readily available through platforms. Online platforms can also curate vendors to offer product ranges satisfying specific consumer demands such as vegetarian, or allergen free.

These benefits are not cost-free though, and as discussed above, consumers are paying a significant premium in some cases for these delivery services. As the platforms move further up the supply chain and disrupt the vendor base further, the impact on conventional brick and mortar venues may be significant with implications for traditional dining-out and shopping – this is discussed in more depth later in this report in section 2.6 Dark kitchens.

2.3.3 Impact on food safety

Food safety issues with online delivery platforms can be grouped into two categories a) vendor food preparation, and b) delivery. With regards to a) all vendors selling through a platform are required to register as a food business and have appropriate food hygiene certification. Even home cooks operating from domestic kitchens are required to have certification (e.g., HomeCooked, requests a level 2 certificate in

food safety and hygiene and that cooks register their premises with their respective local authorities). The larger aggregating platforms can play an important role in curating vendors and monitoring ongoing performance to ensure compliance with food safety standards, and some of the larger platforms claim to undertake inspections more frequently than the mandated local authority inspections to ensure standards are maintained. Conversely, platforms with low curation, may present a food safety risk as vendors may fall short of the necessary food safety standards.

The levels of platform curation should offer a basic proxy for risk (Brice, 2018); however, curation levels and the criteria applied by each platform are not necessarily visible which makes comparison across platforms difficult. It is possible to have a highly curated platform, such as a niche cuisine platform, which by the nature of its small vendors, may have a higher food safety risk than a non-curated platform selling food from large vendors. Overall, though, the platforms have a vested interest in ensuring quality to protect their reputation, so these aggregating platforms are probably relatively low risk.

The extent of food safety risk in b) delivery depends partially on the online platform model – if it is click and collect then delivery, other than the choice of packaging and the consumer's own care of the food product, is a relative non-issue. The primary concerns for food safety in delivery relate to: cross-contamination of foods, packaging and protection, failure to maintain safe temperatures for the food during transport, and particularly in the case of platform to consumer, the risk of mix-up of orders (Brice, 2018). Responsibility for the food safety when in the hands of couriers seems to be rather a grey area.

2.3.4 Impact on regulation

Currently digital platforms are regulated as technology companies, not as food providers, and they have no legal responsibility for the quality and safety of the food products sold through the platform, and cannot easily be held accountable for unsafe or fraudulent activity through the platform. Regulation of vendors selling through the platforms falls under the remit of local authorities (LA) and vendors are required to have a food hygiene rating scheme (FHRS) certification. Online sales of food are subject to regulation on distance selling, mail order and delivery. To comply with these requirements vendors must register with their local authority 28 days before

opening. All products must meet defined packaging requirements and be delivered in a manner that does not risk the food becoming unfit to eat – this may mean refrigeration, or insulation, etc. FSA provides guidance on food safety, record keeping, product withdrawal, product recall, good hygiene, labelling, specific to the type of food that is sold. The main concern is the condition of the food when it reaches the purchaser (FSA, 2020). The challenge for regulators is in identifying firms that are operating under the radar of FSA and the local authorities, potentially non-compliant with food safety requirements, and, or committing food fraud/crime.

2.4 Online marketplaces

Online marketplaces provide a venue for vendors to promote their products and services, and for consumers to purchase food from a wide array of products and vendors. These marketplaces act as an intermediary between buyers and sellers to facilitate transactions, but, unlike conventional aggregator retailers such as supermarkets, do not usually take legal ownership of the goods offered for sale. These marketplaces differ from online ordering and delivery platforms, in that the products are usually pre-packaged foods and services, dispatched by scheduled delivery over a period of days from a much wider geographic region, rather than on-demand orders fulfilled locally. There is usually a looser commercial relationship between the vendors and the platform, with a lower level of curation and vetting of vendors in some cases. That said, the distinction between online ordering platforms and marketplaces is becoming increasingly blurred as the former move further into the provision of convenience store goods and other non-food products. Some of the literature groups these digital platforms together under the term intermediaries (e.g., Brice, 2018). However, there are distinct operating differences between their business models, and they present different challenges for food safety and regulation, so it is useful to consider them separately.

The revenue models of platforms may involve a subscription fee, commission on transactions (as is the case on eBay and Amazon marketplace) or may be free to use with the platform making money from data and advertising (such as Gumtree). Marketplace platforms can be grouped under five broad categories (Hart, 2021):

- Food marketplaces – focused exclusively on offering food products and services, often with a local, artisan, organic, speciality cuisine such as vegan, and, or sustainability focus. Examples include Farmdrop and Good Sixty. They offer highly curated offerings with respect to their speciality area (such as veganism, etc.) which benefits authenticity, but on the other hand, they may lack curation in other areas such as food safety as artisanal vendors tend to be small and may lack professional food safety processes.

- Food event marketplaces – could be considered a sub-set of food marketplaces, these facilitate the exchange of culinary, and experiential events – such as catering, supper-clubs, and food tastings (examples include Eatwith and YHangry, with events hosted at the chef's venue, or renting a chef to cook in the customers home). There is little aggregation in this sector, and the ad-hoc and dispersed nature of events, often at a host's or a customer's own home, presents food safety concerns. However, the direct nature of the interaction means consumers should be able to obtain detailed information on ingredients, allergens, etc.

- General marketplaces – that sell a range of products, where food and beverages are just part of the offering. These platforms range from curated boutique marketplaces such as Not on the Highstreet, to much broader marketplaces such as Amazon marketplace and eBay. These marketplaces tend to be large and have specific vendor guidelines in place, but may lack curation and vetting of vendors, and lack the necessary focus on food specific requirements, such as declaring allergens, food origin, exact ingredients, etc.

- Social/open marketplaces – marketplaces within social media platforms, such as Facebook Marketplace, that facilitate peer-to-peer connections and exchanges. Shoppers are able to buy directly on these platforms, sell onto their friends and family, and can even set up their own virtual storefronts, in what is being called consumer-to-consumer commerce (C2C) (IGD, 2019). Platform oversight seems to be limited, and C2C sales through social media messaging fall outside any regulatory oversight, so is a likely high-risk area for food safety and food fraud.

- Redistribution marketplaces – seek to redistribute surplus food and groceries (those that would not otherwise be used before their expiry date) from farmers, producers, retailers, restaurants, and consumers, often to people in need and specifically to reduce food waste. Various marketplaces exist, including sharing for-profit business models where items are promoted on the platform and sold at a discount; sharing for-charity where items are donated to virtual or brick and mortar food banks for offline distribution; and peer-to-peer community sharing models (Michelini et al., 2018). Dozens of redistribution businesses are in operation across the US, UK, and Europe, e.g., Olio, and Too Good To Go.

  These redistribution platforms often combine an online platform with offline activities such as a network of volunteers to collect and distribute food and groceries, and community fridges for sharing. However, they do not necessarily have an online element at all, in which case there may be little or no digital trace or visibility of the activity from the regulators' perspective. Where retailers and food vendors are participants, they should be compliant with FHRS requirements, but food hygiene requirements are otherwise often minimal, particularly for consumer-to-consumer sharing schemes. The primary risk in these marketplaces is exchange of food that is contaminated, has not been transported or stored correctly, or is past its use-by date. There are obvious risks, but the frequency of issues arising, and the scale of the risk in practice is not known.

Much of the previous discussion on online third-party delivery platforms applies equally to marketplaces, so the following focuses primarily on any notable differences.

2.4.1 Impact on industry

These marketplace platforms offer vendors an accessible route to market with minimal financial investment and risks, and attract a broad range of vendors. Prost (2018) observes platforms are particularly well suited to aspiring food entrepreneurs who might not trade from a registered food business establishment, such as those trading from home kitchens, or trading only intermittently, and who might lack the resources and volumes to establish their own online presence. Numerous speciality

food marketplaces are emerging, and the major digital marketplaces such as Amazon are expected to take a much larger role in the food sector in the future. Redistribution markets are a small but growing niche in the food sector, driven by rising concerns over food waste and landfill, and perhaps increasing demand for foodbanks during the pandemic and economic downturns. Large retailers in some countries, e.g., France, have mandatory obligations to donate surplus food to redistribution platforms, and a similar approach may be anticipated for the UK.

2.4.2 Impact on consumers

From the consumer's perspective these platforms offer variety and access, secure payment systems, and eliminate the need to shop around multiple websites or physical stores. However, according to Prost (2018) relatively little is known about the vendors on these platforms and their background and food safety practices, particularly the social media marketplaces, and therefore they present a high potential risk for food safety and food fraud to consumers.

2.4.3 Impact on food safety

The risk associated with marketplace platforms as indicated in the above discussion, depends to a large extent on the level of curation and oversight of the platform, and the type of vendor and products involved. While the marketplace type does determine these factors to some degree, it is informative to understand the marketplace typology at a more granular level. To this end, Figure 3 presents a typology of marketplace platforms based on categorisation by vendor type/product type, rather than just marketplace type.

2.4.4 Impact on regulation

The regulatory challenges are like those previously discussed for online delivery platforms, with one significant difference – the numbers of vendors on a marketplace platform may be orders of magnitude higher and the size of operations of these vendors can be very different. A vendor on a marketplace may be a single artisan producer selling only occasionally through the platform. Many of these smaller vendors may be trading without FHRS certification – either they do not need FHRS certification, or perhaps do not realise they need certification, or they trade too

infrequently to make certification viable. Regulation and oversight of the vendor base for marketplaces can therefore be significantly more challenging.

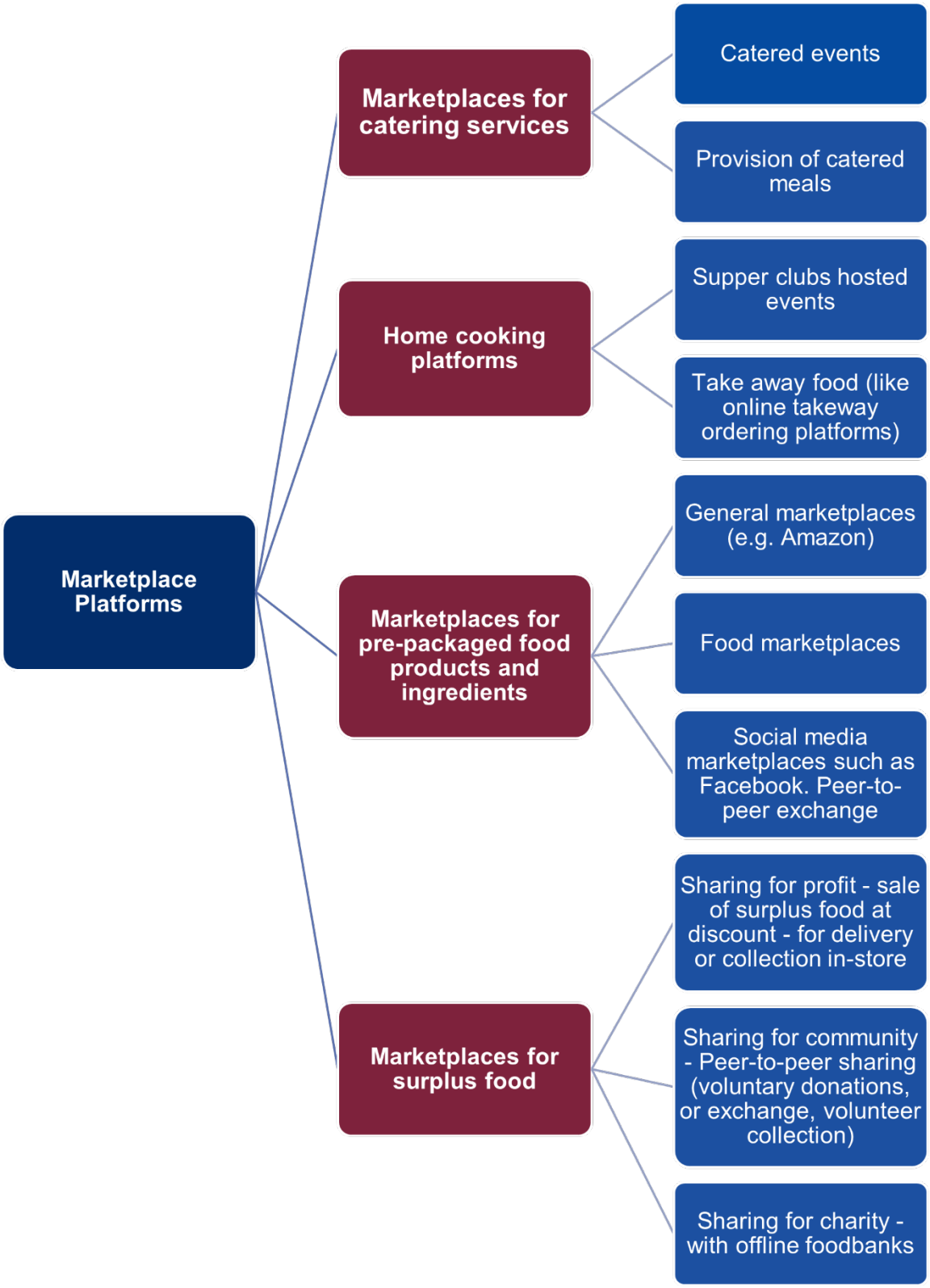


Figure 3 Digital marketplace platforms typology (Based on Brice 2018 and Hart 2021)

Image contains the following information:

Marketplace platforms	Detailed type
Marketplaces for catering services	• Catered events • Provision of catered meals
Home cooking platforms	• Supper clubs hosted events • Take away food (like online takeaway ordering platforms)
Marketplaces for pre-packaged food products and ingredients	• General marketplaces (for example, Amazon) • Food marketplaces • Social media marketplaces such as Facebook. Peer-to-peer exchange.
Marketplaces for surplus food	• Sharing for profit – sale of surplus food at discount for delivery or collection in-store. • Sharing for community – peer-to-peer sharing voluntary donations or exchange, volunteer collection). • Sharing for charity – with offline foodbanks.

2.5 Direct to consumer sales

As producers and consumers have become more willing and able to engage with online shopping there has been a big increase in producer direct to consumer (D2C) and wholesaler direct to consumer sales – bypassing traditional retailers. The past five years has seen significant growth in this area (Hart, 2021), accelerated in part by the Covid-19 pandemic that forced many producers and wholesalers that usually supply the hospitality sector to seek out new markets. Consumers are also increasingly interested in connecting directly with producers such as local farms and specialty ingredient suppliers, buying locally, and shortening supply-chains for health and sustainability benefits. Products and services include fruit and vegetable boxes, ready-to-cook meal plans, and recipe kits for preparation at home. Examples in the UK include Hello Fresh and Mindful Chef that provide curated ingredients boxes with

recipe instructions for customers to follow, with a different box delivered each week on a subscription basis. These offerings are redefining the boundaries between traditional grocery shopping and ready-made meals, delivering an experiential element for consumers, and also claiming to tackle the problems of food waste and packaging waste. Demand for these services has risen dramatically during the lockdowns of 2020 and 2021, though how far that will continue post-Covid is not yet clear. Major consumer packaged goods (CPG) companies such as Unilever are also increasingly using D2C channels for their goods, offering exclusive products, discounts and subscription services for regularly used products (IGD, 2019).

2.5.1 Impact on industry

Traditional intermediaries such as wholesalers and retailers are, as in other industries, increasingly displaced in the food sector by producers undertaking the full marketing and sales cycle, delivering operating efficiencies and cutting costs, and an enhanced customer experience. In the longer-term this could profoundly reshape the traditional value chain and the buying and selling of food. Part of the motivation for these initiatives is to enable producers to gather valuable data on their customer usage and preferences, much of which is inaccessible to producers when selling through retailers and online aggregation platforms.

2.5.2 Impact on consumers

For consumers, the growth of direct-to-consumer business potentially offers more competitive pricing, a wide range of innovative new product offerings, opportunities for fresher and less-processed products, and perhaps a closer engagement with the food supply system and the brands.

2.5.3 Impact on food safety

The companies offering direct to consumer solutions generally should be low risk as there is one specific business responsible for most of the supply chain. Companies selling food direct to consumers are by law required to register with local authorities and comply with food hygiene requirements. On the other hand, if that business is not registered then the risk can be high as there are few points of contact with the wider ecosystem that might force compliance.

2.5.4 Impact on regulation

As for online platforms, D2C online sales of food are subject to regulation on distance selling, mail order and delivery. To comply with these requirements vendors must register with their local council 28 days before opening. All products must meet defined packaging requirements and be delivered in a manner that does not risk the food becoming unfit to eat – this may mean refrigeration, or insulation, etc. FSA provides guidance on food safety, record keeping, product withdrawal, product recall, good hygiene, labelling, specific to the type of food that is sold. The main concern is the condition of the food when it reaches the purchaser (FSA, 2020). Where producers are selling directly to consumers there may be limited visibility to the regulators and local authorities, and hence potential to operate under the radar without the correct food hygiene certification and operating practices. This presents a challenge for regulators, particularly overseeing new entrants and smaller vendors.

2.6 Dark kitchens

As digital third-party food platforms have grown in influence and reach, a further recent trend is now underway, with the emergence of virtual restaurants (an online-only restaurant), and the use of so-called “dark kitchens” (alternatively referred to as “cloud kitchens” or “ghost kitchens”), and “dark stores”.

Dark kitchens are large-scale restaurant-style food preparation spaces that do not have a customer-facing store front, and operate a B2B business model by making the space available/outsourced to restaurants and brands that require extra capacity. They are typically located away from expensive high street locations, on trading estates or other low-cost but central areas in the urban environment, and facilities may take the form of low-cost prefabricated, shipping container-like structures. Facilities have minimal staffing levels, make use of digital technologies to optimise for higher throughput than conventional restaurants, and they are designed with the ability to be reconfigured quickly and easily to react to emerging consumer trends. Dark kitchens aim to improve customer service through offering new options in previously under-served markets and enabling rapid fulfilment services, and at the same time, achieve competitive pricing through higher asset utilisation and lower supply-chain costs than traditional kitchens (Chern & Ahmad, 2020; Deloitte, 2019).

Dark kitchens may be wholly owned by an existing brick and mortar establishment to provide additional capacity, or as is increasingly the case, are online-only operations operating as virtual brands, leased to users, or providing food services to other operators. Dark kitchens operate under a number of different business models (based on Deliverect, 2019; Hart, 2021):

1. A single brand owns or rents a single kitchen without a store front. (this simple model of a traditional catering kitchen has been around for decades, e.g., Dephna).
2. White-brand kitchen, as above, preparing food for catering and hospitality venues.
3. Multi-brand dark kitchen with several brand/cuisine types operating from the same kitchen (either in parallel, or at different times during the day).
4. Dark kitchen with take away desk where customers can wait for their food.
5. Aggregator-owned dark kitchen, offering empty kitchen space that a brand can rent, or use based on a commission on sales, complete with the ordering and delivery services provided by the aggregator (for example, Deliveroo Editions).
6. Aggregator-owned plus model, where the aggregator provides a fully equipped kitchen, and possibly a front-of-house takeaway desk. This model has similarities with the way office co-working spaces operate, with users paying a monthly membership fee for use, and renting kitchen space by the hour or shifts, with the operator providing supporting services, cleaning, etc. (e.g., Karma kitchens).
7. Outsourced dark kitchen, to a business that specialises in food preparation and delivery, where the final seller has little or no involvement in the actual cooking. Such a model enables a successful brand to rapidly expand regionally for example.
8. Franchise model, e.g., KBox, that finds and uses excess capacity in conventional restaurants and hotels as well as dark kitchens, providing full

ingredient kits or frozen meals to the kitchen for cooking. In India and parts of Asia home kitchens are increasingly used to provide this type of capacity.

A related concept is that of “dark stores”, a term used to describe stores without a customer-facing store front. In some cases, these are traditional retail stores that have been converted to local fulfilment centres, but otherwise are effectively large warehouses in central urban locations used to support online shopping and rapid delivery of convenience store groceries and consumer goods. Growth in this segment is accelerating rapidly led by companies such as Delivery Hero and Deliveroo (Nuttall, 2021).

2.6.1 Impact on industry

Dark kitchens are still a relatively new addition to the UK food scene but are well established in other parts of the world. They have significant potential to reshape the food landscape by lowering the barriers to entry for new food entrepreneurs, increasing the number of smaller operators in the market, and making it easier to experiment with new service offerings and a broader value proposition for consumers. For larger dark kitchen operations, a centralised pre-production kitchen might be combined with several satellite kitchens to effectively industrialise the food preparation process and deliver significant efficiency and productivity improvements. Such operations may considerably undercut existing brick and mortar restaurants, and in the same way that online retail has undermined the high street retail sector, concerns are growing over the dominance of digital platforms and their use of dark kitchens and the potential impact on brick and mortar restaurants (Chern & Ahmad, 2020; Shenker, 2021). The growth of platform-owned dark stores serving the convenience market presents a similar existential threat to traditional grocers (e.g., BetterRetailing, 2020).

2.6.2 Impact on consumers

The main promise of dark kitchens for consumers is to bring greater variety to the local culinary scene, particularly for areas underserved by conventional restaurants. Multi-brand kitchens can produce a wide range of different cuisines, with reduced costs and shorter delivery times. The flipside is that consumers have no visibility of where their food is prepared, often have very little information on the ingredients and

nutritional content and allergen information, and in most cases have little or no connection with the brand (Chern & Ahmad, 2020). Consumers value the experiential aspect of dining-out, and in the longer-term there is a risk for consumers that dining-out choices on the high street decline as competition from dark kitchens pushes conventional establishments out of the market.

2.6.3 Impact on food safety

From a food safety perspective, concerns have been raised over visibility and accountability when restaurants, or rather cooking facilities, are hidden from public scrutiny. Industrialised kitchens, particularly multi-brand kitchens, need to maintain separate work areas, and be designed for safety and ease of operation for every level of training, along with standardisation for safety and consistent quality (FSCI, 2021). Managed well and using the latest technologies these kitchens may be much safer than older lower-throughput conventional kitchens. Additionally, the dominant role of the large digital platforms potentially offers a strong degree of curation and oversight to ensure high food safety standards are maintained in these kitchens.

However, intense competition and cost-cutting within these operations, inexperienced entrepreneurs and staff, or perhaps high turnover of temporary workers, and multi-brand co-working practices, raise concerns over maintaining food safety standards.

Use of home kitchens either as a franchisee, or a stand-alone virtual business presents additional concerns over food safety as these operators will not generally have industrial grade equipment and may not even be fully aware of the food hygiene requirements. That said, although home kitchens appear to present a high risk, the bigger risk may be with the large industrialised dark kitchens – operating at often far higher through-put than conventional restaurants (e.g., a dark kitchen may process 2,000 meals per day), the risk of a serious food event affecting hundreds or even thousands of consumers could be relatively high compared to a conventional restaurant.

2.6.4 Impact on regulation

Dark kitchens make it easier for new food vendors to enter the market, but this may also lead to higher churn in the industry as entrepreneurs come and go quickly. This

presents a challenge for the regulators to stay abreast of the sector and ensure certification of the industry. Particular challenges for certification may arise from small ad-hoc operators – perhaps renting kitchen space for just a few hours at a time. Multi-brand kitchens, where more than one operator or business entity is using shared facilities, present additional complications for managing food safety certification and monitoring. Moreover, without a physical store front and often no brand or even an online presence of their own, these operations are far less visible to the local authorities and regulators than conventional kitchens. The dominant position of the delivery platforms, and aggregator kitchens run by a single entity position them to effectively act as gatekeepers to the industry, presenting an opportunity to provide quasi-regulation of the sector (Brice, 2018).

2.7 Rapid on-demand delivery solutions

Delivery times are key to successful ready-to-eat food delivery services, with surveys finding that most consumers are unwilling to wait more than 40 minutes for a delivery. Moreover, long delivery times risk food arriving cold or not fresh, resulting in disappointed consumers and poor reviews, and loss of repeat custom, and potential food safety issues. In response to this need, the industry has coined the new term of quick-commerce, or q-commerce, that is distinct from e-commerce in that it aims for much more rapid delivery, targeting delivery times of 15 minutes or less (e.g., Davey et al., 2021).

In addition to the major delivery platforms, numerous app-based delivery services are emerging to fulfil the demand for rapid on-demand delivery of groceries (e.g., Weezy, Gorilla). These emerging services are based on a four-sided business model, whereby the app makes money from the customer through delivery and service fees, from the retailer in the form of a commission on sales, from the couriers, typically classified as contractors, thus subsidising the cost of delivery, and from the food producers/manufacturers who pay for in-app advertising and customer data (Wallace, 2021).

Building the capacity to provide rapid on-demand delivery and efficient last-mile delivery solutions is essential to the long-term success of these online delivery platforms. This requires a combination of locally positioned restaurants and stores

(leveraging dark kitchens and urban fulfilment centres or dark stores), and suitable local courier networks able to respond rapidly. The rise in demand for delivery of groceries and convenience store items is now starting to reshape offline retailers, and according to Jonathan Eley (2021) supermarkets across the UK are reducing all-day opening hours in order to use the store downtime to pick orders for online delivery services. Use of electric bicycles, cargo bicycles, electric scooters, electric delivery vans, and other innovations are already being tested or are in operation to improve delivery performance. Trials are also underway with robot deliveries e.g., Starship technologies' six-wheeled delivery boxes, being trialled in Milton Keynes, recently achieved a milestone of 1.5 million deliveries worldwide (Richings, 2021); and various aerial drone delivery solutions are in development in partnership with big players such as Amazon, UPS, DHL and others (Stevens, 2020).

2.7.1 Impact on industry

With short on-demand delivery times, q-commerce is now an increasingly viable alternative for the consumer instead of going out shopping themselves. Already, shopping in big out-of-town supermarkets is declining, and this expansion of rapid, small size, on-demand delivery is likely to cut into the markets of traditional brick and mortar convenience stores, further reshaping the high street and the way consumers buy food and goods. In the longer-term these delivery companies appear to have their sights set on the entire food delivery ecosystem, and the far broader delivery markets associated with life-style, urbanisation, and convenience (e.g., Delivery Hero, 2019). These developments are likely to transform the traditional food buying and selling infrastructure into a dynamic network ecosystem of digital transaction hubs that will be able to quickly respond to novel consumer demands and trends across a wide range of sectors of the economy.

2.7.2 Impact on consumers

For consumers, the implications for these innovations should mean a step change in convenience levels.

2.7.3 Impact on food safety

Shorter delivery times should mean food arrives fresher and with less potential for spoilage. However, aggregating of deliveries to optimise productivity may introduce cross-contamination risks between food and non-food goods.

2.7.4 Impact on regulation

Regulatory issues are similar to those discussed above for online delivery platforms and marketplaces. Possibly an additional consideration is the potential for mixed food and non-food deliveries that seem to be emerging through these rapid delivery services. New regulation may be needed to prevent cross-contamination issues. Emerging novel delivery technologies such as autonomous delivery systems and aerial drones will also necessitate new regulation to ensure food safety is adequately addressed.

3 Implications for the UK food system

3.1 Likely longer-term impact on the UK food system

The past year under the Covid-19 pandemic restrictions has seen a major shift in how food is bought and sold in the UK. Although some of this was temporary, the consensus is that many consumers, having experienced the convenience of online ordering and food home delivery during the pandemic, may now be converts for life. Food buying and selling through online supermarkets, ordering and delivery platforms, and online marketplaces looks set to expand at pace over the coming years, and it does not seem too unrealistic to envisage a UK where physically visiting a store for food and grocery shopping becomes uncommon, particularly in metropolitan areas. Food delivery costs are however still a challenge for the industry, and the development of affordable solutions to maintain profitability and attract further consumers will be key to expansion.

The out-of-home dining sector witnessed sustained growth over the decade prior to the pandemic, and that growth, driven particularly by younger demographics, is expected to resume strongly post-Covid (D'angelo et al., 2020). The grocery sector and the delivery aggregators will therefore be under intense pressure with the resurgence in hospitality and will work hard to seek out new sources of revenue and growth.

The pandemic also changed the way food producers interact with consumers. Food producers who previously might have avoided selling direct to consumers for fear of upsetting relationships with retailers, are now embracing omnichannel shopping (Lockhart, 2021). Moreover, a host of new start-ups have entered the market with innovative D2C offerings such as recipe boxes and a wide array of fresh and healthy produce, possibly changing the way consumers think about shopping for ingredients and cooking at home. Sustained growth in the producer and wholesaler direct-to-consumer business will continue to disrupt the UK food system and traditional value chains, and D2C may prove one of the more significant shifts in the coming years.

The longer-term impacts of these changes are likely to be an increasingly competitive marketplace for food that will generate more choices, greater convenience, and greater value for the consumer, and possibly a quite fundamental shift in the types of food products consumers buy. On the other hand, as discussed in section 2, the transition that is underway introduces possible food safety risks for consumers, and also raises significant concerns over monopolistic power and a lack of accountability and responsibility of the big platforms.

Several dominant platforms are competing to capture the market, and in the process will likely displace many existing restaurants and retailers. While the future for the hospitality sector is probably somewhat safer as the experiential aspect of dining out will likely remain important to consumers, it is difficult to predict the impact that dark kitchens and virtual brands might have on the sector, and high fees and predatory practices imposed by platforms may push many brick and mortar operations out of business. In the longer term the loss of diversity of small independents and local shopping and dining opportunities may have negative implications for consumers, employment, and broader society.

3.2 Structural changes to the food value chain

Traditional linear food value-chains, illustrated in Figure 4, are already significantly disrupted, with the platform economy taking an increasingly important role in buying and selling within a more networked value chain, as illustrated in Figure 5.

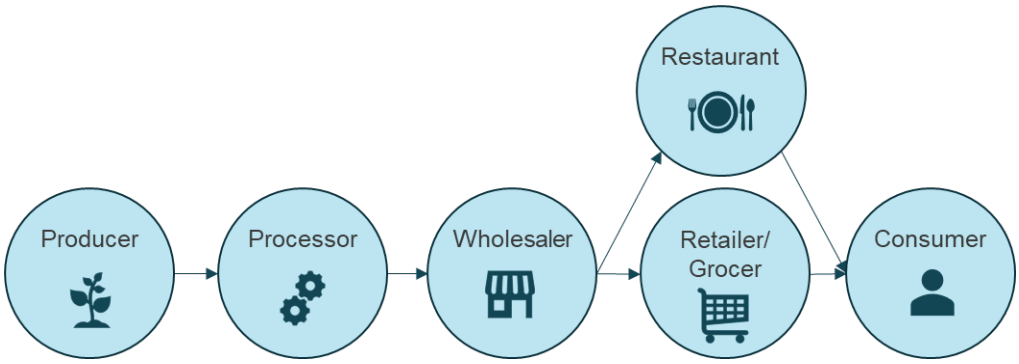


Figure 4 Traditional linear value-chain of the food sector

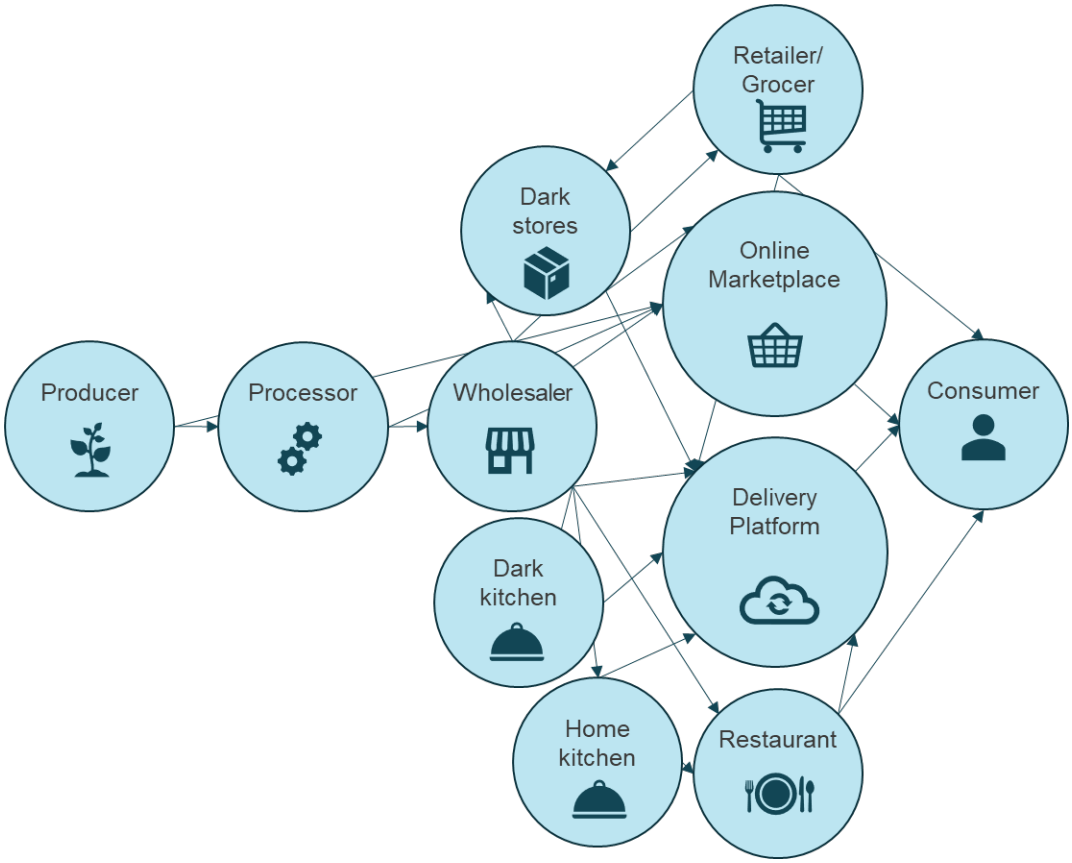


Figure 5 Platform dominated value-chain of the food sector (For simplicity D2C is excluded from this figure)

3.3 Likely evolution over the next five years

The literature presents various forecasts for the evolution of food retail and hospitality over the coming years as the industry seeks to address the emerging competitive challenges and meet consumer demands. Below, and summarised in Figure 6, we present a synthesis of key forecasts based on a wide range of reports from industry commentators and business consultancies (including, Gerckens et al., 2021; IGD, 2019; Labine-Romain et al., 2019; Ruffieux, 2020; TheGrocer, 2020, 2021; Thoughtworks, 2018). The Covid-19 pandemic has caused general economic disruption, but also accelerated the changes already under way, and has not fundamentally changed any of the forward predictions for the industry.

Key Trends	**Food sector types**
E-commerce growth	• Online services

	• Quick Commerce
Ecosystem transformation	• Growth in convenience, discount, and speciality stores • Grocers move into take-away and delivery • Platforms move further into groceries and retail • Pureplay businesses move into offline • Growth in D2C • Rapid expansion in social commerce
Digitisation	• Digital technology advances • Consumer data and analytics
Food as a service	• Personalised nutrition • Recipe and meal boxes

Figure 6 Summary of key trends forecast by the literature for the food sector

3.3.1 E-commerce growth

- Online services in the food sector will continue to grow rapidly with the major players investing heavily to expand fulfilment and delivery capabilities and capacities. Notably, the big discount supermarkets, who have until now lagged in e-commerce, are expected to embrace online shopping within 2021 (TheGrocer, 2021).

- Quick commerce offering delivery in under an hour is anticipated to become increasingly important particularly in urban areas. The rapid delivery systems offered by food delivery firms could be extended to serve many other sectors within the economy delivering a step change in convenience for consumers. Online retailers and delivery services will explore many alternatives over the coming years to try to optimise these delivery services, particularly last-mile delivery that is often prohibitively expensive. Among other things, consolidated deliveries of take-away food together with groceries and a wide array of other consumer goods look likely, along with innovative new transport solutions to improve asset utilisation and productivity.

3.3.2 Ecosystem transformation

- Growth in convenience, discount, online, minimarket and speciality stores is anticipated, with traditional brick and mortar supermarkets losing market share. The traditional grocers, in search of growth, will among other things seek to enhance the in-store experience and expand their in-house restaurant services, and move further into offering take-away and ready-to-eat home-delivery services.

- The delivery aggregators and other actors will continue to expand their networks of dark kitchens and dark stores to increase their presence in the food and groceries markets, either through deepening partnerships, or becoming food vendors and retailers themselves. The big online marketplaces such as Amazon will also continue to expand their presence in the food sector. The implications for existing brick and mortar businesses may be significant, and some will struggle to survive.

- Some commentators suggest that successful pureplay online operators will seek to develop an offline presence, through building new stores, acquisitions, or alliances, to enable them to expand their offerings, add experiential brick and mortar operations, and reach a broader consumer base (This cyclical dynamic has been observed in other sectors, e.g., Apple stores, and Google's recently announced first physical retail store (Davey et al., 2021)).

- D2C business will continue to grow significantly, driven by a search for cost savings and supply-chain efficiencies, and a desire for closer engagement and stronger relationships with end consumers. This might be consolidated under a new ordering platform to obtain efficiencies and drive cross-shopping.

- Social commerce, already well developed in Asia, is anticipated to go global over the coming years and drive a further restructuring of the food ecosystem by enabling small vendors and home kitchens to play a much larger and direct role in the food system and facilitate growth in C2C business. The potential significance of social commerce and C2C business in the UK is not yet well understood.

3.3.3 Digitisation

- Advanced digital technologies will be deployed to help brick and mortar stores better engage with consumers and close the gap with pure online operations. Technologies will include artificial intelligence, automation, check-out free retail, slicker click and collect services, automated ordering and delivery, and remote delivery. These will enhance the instore shopping experience and make it simpler and quicker to shop, while also reducing costs.

- The ability to capture and use consumer data and performance indicators effectively will be a key objective for all players in the food ecosystem to offer enhanced consumer value and create competitive advantage. Those that are shut out from gathering data, such as vendors trading through the large digital platforms may lose out. This has significant implications – for example, platforms may press vendors on pricing in inter-platform competition, while also making money by selling their data. Platforms will also be far better able to identify market trends and opportunities and out-compete existing vendors on the platform with their own in-house offerings.

3.3.4 Food as a service

Innovations such as recipe boxes, although still very niche at present, illustrate a reshaping of the way consumers buy and prepare food. Other emerging technologies such as health apps, genomics and microbiome-based personalised nutrition, 3D food printing, and functional foods may further shift the food industry towards the concept of “food as a service”, rather than the traditional grocery model. This might include offering highly personalised diets, produce/supply/farm drops, subscription and replenishment services, and other value-added services. This shift has implications for all parts of the food system.

3.3.5 Health and sustainability

The food industry is under pressure to adapt to growing consumer demands for healthier, affordable, and more sustainable food solutions, and to begin to tackle the pressing issues around food-miles, carbon emissions, plastic waste, and food waste in the industry. This will necessitate a plethora of new food offerings, and some commentators suggest these trends may work against the online and home delivery

services in the longer term, and lead to a resurgence in demand for artisanal, regional, and local produce and services.

3.3.6 Summary

Looking forward to the next five years, the literature agrees that the current trends are here to stay and will intensify and continue to reshape business models and the food buying and selling ecosystem.

Future new trends will likely emerge from within the current ecosystem through interactions between each of these trends and dynamic network effects that will create new entrants, and create more leverage for some players while driving others out of business. Competition for consumer attention forces new entrants to focus the competition on the Achilles heel of the incumbent: For example, supermarkets have expensive operations and are slow to respond, and established delivery start-ups rely on gig economy workers to maintain their lean operations hence the quality of their customer service tends to be low. The new entrants take these weaknesses and come up with a high-quality customer service offered by trained employees and reduce the time to delivery to less than 15 minutes. On the way they introduce a few innovations, such as dark stores, focus on lower item variety at the cost of speed but use data to stock high demand items based on local area inhabitants social fabric and habits (Wallace, 2021).

Traditional roles and business models will increasingly intersect, with producers, vendors and consumers interacting at multiple points in the value chain in a highly dynamic digital ecosystem. The distinction between producers, conventional retailers, restaurants, delivery aggregators, and online marketplaces may blur as these entities increasingly expand and integrate their business models across different sectors of commerce. For example, online delivery service providers and logistics companies may become retailers, and, or start to look more like online marketplaces; traditional brick and mortar retailers will increasingly try to emulate delivery aggregators, and hospitality players; while online marketplaces will seek to displace existing retail solutions; and so on. Vertical integration up and down the traditional value chain is also likely and is already seen with delivery platforms developing their own dark kitchens and virtual brands.

Emerging technologies could take this much further, for example, integrating production and retail through initiatives such as in-store indoor farming (already in use on a small scale), or 3D-food printing in store, etc. Moreover, the potential for wider ecosystem evolution, with retailers and delivery platforms expanding into other non-food related sectors to augment food, and vice versa, are already underway, and may further redefine typologies.

These shifts in the ecosystem structure may mean that the buying and selling typologies identified in this report, while relevant over the short to medium term, will probably need to be reconceptualised in the years ahead. Identifying the convergence points, the hubs and nodes in the system becomes key to policy design and implementation.

3.4 Risk and opportunities for food safety and the regulatory system

To understand the risk in a complex and multi-layered ecosystem such as the emerging digital platform-based food system, Brice (2018) proposes looking at three aspects of a platform:

- Marketplace curation: This is a choice the platform makes enforcing the consequences on vendors. High curation platforms are directive while low curation platforms are non-directive (see Table 1).
- Type of vendor: Different types of vendors may have different levels of compliance and the platforms they choose to display their goods and services will amplify their level of compliance. Here the vendor is the driver by choosing to go with a high or low curation platform (see Table 2).
- Type of goods or services: The context of where, when, and how food is reaching the consumer will have an impact on risk level. This means the same food product can be higher or lower risk in the context of a different service type (see Table 3).

In Table 1, Table 2 and Table 3 we present a review of these three aspects and the implications and impact of each on the consumer and food safety.

Additionally, Bolanos (2021) identifies systemic roles within the food ecosystem, including vendors, information platforms, and intermediary platforms. Each of these roles introduces risk types into the ecosystem (see Table 4). Vendors and intermediary platforms (online ordering and delivery, and marketplace platforms) have a direct role in risk and risk management. Information platforms such as bloggers, review sites, and advertising platforms for food products or services from external vendors, that are not involved in the transaction and delivery may have an indirect impact on risk.

Building upon studies by Hart (2021) we then present in Table 5, a more granular assessment of the implications and impacts broken down by the platform typology discussed in Section 2.

Table 1 Degree of platform/marketplace curation of vendors *(Based on: Brice, 2018)*

Degree of platform/ marketplace curation	Food Safety Implications	Impact
Low Curation	No standard requirements, open to any vendor (unless explicitly prohibited from trading). No active compliance checks (rely on review of FHRS ratings)	Maximise competitiveness and consumer choice. Smaller platforms more likely to have lower curation standards to attract vendors to their platform. Likely to have vendors with low or no FHRS rating.
High Curation	Build reputation for high quality vendors and goods. Likely to require new vendors to meet standards in excess of legal minimum, to check documents, perform on-site inspection, and ongoing monitoring.	A high degree of variation in the curation process and stringency of curation taken by different platforms/vendors (curation alone cannot be relied on as a measure of good compliance).

Table 2 Types of food vendors *(Based on: Brice, 2018)*

Type of vendors	Food Safety Implications	Impact
Conventional food services (restaurants, take-aways)	To be eligible to trade on platform should be registered with LA and be FHRS rated. Platforms most likely to review FHRS ratings for compliance monitoring.	High compliance.
Home cooks	Unlikely that all vendors trading will meet threshold of regulatory to be classified as food business.	Unregistered vendors on platform and no FHRS rating.
Food producers and retailers	Small producers/retailers with no offline retail operations may have no FHRS rating.	Low compliance, and unrated FHRS vendors. Larger brands represent low risk

Table 3 Type of goods or services sold*(Based on: Brice, 2018)*

Type of goods or services	Food Safety Implications	Impact
Takeaway meals	Vendors unlikely to provide full ingredient list For allergens some platforms direct consumers to contact vendor.	High risk of allergen and unknown ingredient risk.
Events with food intake	Platform provides only indicative list of allergens Meals consumed onsite enabling access to other information sources for consumer.	Medium risk. Shifts responsibility to consumer to enquire (on site via verbal enquiry, menus etc.)
Surplus Food	Type of food available changes daily, with resulting heavy reliance on existing physical labelling if food is packaged. Limited, if any food hygiene and safety control.	High risk associated with tampering and use by date when foods that do not have packaging and labelling. Low oversight of food hygiene presents further risk.
Pre-packaged food products	Platforms likely to require vendors to submit complete list of ingredients and allergens. However, general marketplaces may lack the processes to display this information for consumers, and social media platforms may have less stringent requirements.	Low risk: enough information is likely to exist for the consumer to make informed choices on the bigger marketplace and delivery platforms. High risk: On social media and peer-to-peer platforms information and labelling may be less adequate.

Table 4 Systemic role types*(Based on: Bolanos, 2021)*

Types of Systemic Role	Characteristics	Impact
Online Vendor	Sell or trade own food products or services online- encompass any size of vendor from a person selling goods to micro and small businesses to large companies.	Mixed risk due to different size of the businesses: Mode of access to customers differ widely between the types of vendors in this group. From C2C on social media to use of delivery platforms and direct delivery to consumer for large vendors with own logistics.
Information Platform	Introduce or advertise food products or services from external vendors. Not involved in transaction and delivery.	Medium risk. As long as the sites maintain a certain factual accuracy about product and service information they promote the risk can remain low. However, the risk increases as the bloggers may not necessarily have full information themselves or are commissioned by the vendor. This can create a biased information portal.
Intermediary Platform	Sell or facilitate exchange of products and services of other vendors.	Mixed risk but to different size and type of vendors, models of operation, level of direct involvement with actual processing, sales and delivery of a product.

Table 5 Food safety risk and impact assessment*(Based on: Hart, 2021)*

Online food order and delivery

Service provider	Food Safety Implications	Impact
Restaurants and take-aways	Usually trading through larger delivery platform so high curation behaviour requiring registration as food business and FHRS rating of 2 or more. Through technology can to some extent continuously monitor compliance.	Lower risk when larger platforms – have a high stake in making sure their reputation is kept intact therefore they tend to demand compliance. Medium to high risk: when obscure self-styled local platforms/deliverers work for restaurants they serve
Virtual restaurants (Delivery only brand)	This is a mixed group of businesses creating a mixed risk profile. From organised virtual restaurant businesses (Taster in London) to new small independent brands. Large numbers of virtual restaurants are leased from the big platform providers giving some additional degree of control over vendors. (The modern takeaway; brick and mortar traditional takeaways may also fall in this category as working with delivery businesses)	It is hard to gain an overview of this group due to variations in setup and ownership structures. Delivery platforms such as Deliveroo that list these outlets are possibly the best access points for enforcing regulations – if the delivery platform is high curation with high demands for compliance, then the small outlets that rely on it need to comply.
Home kitchens	The sign-up process for these is less focused on FHRS and more on food safety qualifications. Volatile sector with short-lived businesses.	Same as above, a diffuse sector. Best way to access is through home cook ordering and delivery platforms.
Retailers (Not including Ocado and brick and mortar retailer delivery arm)	Focus on demand fast delivery. The model is similar to Just Eat and Deliveroo - a pickup service and delivery no role in earlier parts of the supply chain. Dark stores (local fulfilment centres) are how larger businesses compete with these platforms, as the key	When partnering with brands large retailers are bypassed and brands can test new products on consumers- this means if a brand is new and not registered or a novel food not validated for human consumption this is a loophole that can be exploited:

	element is speed of delivery to consumer from the moment they place an order.	who is responsible if something goes wrong? Platform or brand owner?

Market Places

Service provider	Food Safety Implications	Impact
Food	An online version of physical food marketplace. May have local, organic, or sustainability theme.	Widens access for vendors operating from physical marketplaces. The platform can play a role in enforcing compliance by a fair degree of curation.
Event	These are events created around food. These are often in small formats organised at home or a specific location.	They have a dispersed nature, and each platform/website may represent a specific chef or a few chefs. There are only limited aggregating entry points to this cluster such as delivery platforms as much of it is a time and location bound event happening in a certain place in a specific time window.
General	Food and other items are sold so it is a mixed marketplace. Main characteristic is that product information is often required, and vendors can use free text fields to add information examples include Amazon, eBay and Etsy as well as Not on the Highstreet etc.	The risk depends on the platform. Risk will be low to medium risk on platforms that are curated but may be higher risk on certain platforms such as eBay. The main loophole is reliance on what information the vendor supplies. Need to understand the exact criteria these platforms have for food products and maybe work with platforms to increase food product curation level to increase compliance.

Service provider	Food Safety Implications	Impact
Social	This is a highly diffuse group of food sales activity encompassing packaged goods to hot meals. The connector of vendor and consumer is a social platform – informal and not necessarily set up for any degree of oversight on buying and selling, although may facilitate that with payment options, makes it opaque while volume and pace of transactions may be high.	High risk, due to opacity of operation of such networks. The facilitating social network is not set up to exert any control on safety and quality of the food, and consumers who buy via these channels may be least aware (the focus is on socialising and not necessarily on shopping?). Further research is needed to better understand the scope and scale of risk in these marketplaces.
Redistribution	Focuses on discount or free exchange in order to use surplus food and reduce food waste. Sharing apps also help individuals exchange excess food within the community (use of community fridges)	High risk when exchange is individual to individual as there are no safety requirements. Medium to low risk for businesses as FHRS rating of 3 or more required.

Other new models

Service provider	Food Safety Implications	Impact
Dark Kitchens/Cloud Kitchen/Crowd Kitchen/Ghost Kitchen	The dark kitchen is primarily a property owner that rents out their space. Restaurants, virtual restaurants, and food innovators access capacity through this model. It can be compared with office spaces in serviced facilities because the dark kitchen provides equipment both for cooking and business connectivity.	Medium to low risk: Dark kitchens are predominantly associated with a specific delivery platform. The delivery platform can become a leverage point for compliance. The risk level depends on reputability of delivery platform. The franchise model (Kbox) adds an extra layer in the chain as the ingredients come from another business

Service provider	Food Safety Implications	Impact
	It takes out the cost of front of house of a restaurant making prices cheaper for consumer, can be set ergonomically to increase scale dramatically and reduce delivery times by centralising point of delivery	and the kitchen only cooks it – the kitchen does not source the ingredients so probably does not see themselves responsible for authenticity and safety.
Direct to consumer model	Cutting out brick and mortar retailer and directly launching online Can control the end-to-end process of creating, marketing, and distributing the goods they sell.	Low risk as there is one specific business responsible for a good part of the supply chain. If that business is not registered, then the risk is high as there are not many points of contact with the wider ecosystem that would force compliance.
Delivery and distribution	Only provider of technology to restaurants and food businesses but do not actively do the work. Adapts the restaurant or food seller's website to receive and process orders. Sometimes this is part of the deal when a restaurant joins a delivery system such as Just Eat and Uber Eats.	An opportunity that these offer is: Some of these tech specialise for the food industry (e.g., Kafoodle – enables vendors to create interactive menus for personalised diets, with search and filters for allergens. Such software can be used to enable vendors that are willing to access regulated status more easily.

4 Conclusions

4.1 Summary of trends in the food platform ecosystem evolution

The shift towards online buying and selling of food in the digital platform economy is continuing at pace and will reshape much of the current UK food industry over the coming years. The past year under the Covid-19 pandemic restrictions has seen a dramatic acceleration of this trend, and although some of this was temporary, the consensus is that many of these changes will endure beyond the disruption of the pandemic. Several key areas of ongoing innovation and growth have been discussed in this report that will further redefine how food is bought and sold in the UK.

- Online third-party platforms for food and beverage ordering and delivery.
- Online marketplaces connecting buyers and food vendors.
- Direct producer to consumer (D2C), bypassing traditional intermediaries.
- Dark kitchens – with no customer-facing storefront.
- Rapid on-demand delivery solutions, including autonomous deliveries.

These innovations are bringing a broad range of benefits in convenience, choice, and enhanced value for consumers, and are enabling a broad array of entrepreneurs to enter the market quickly and affordably to experiment and bring new product ranges to market. Among other things, these are satisfying emerging consumer demands for improved nutrition, specialist dietary requirements, and sustainability. However, with so many new entrants in the market, often with only a virtual presence, and some with even only a minimal digital trace, monitoring and oversight becomes challenging, and raises concerns over food safety and food fraud. Food offerings can be particularly opaque in some digital online marketplaces, and even the leading online ordering and delivery platforms are still failing to fulfil basic requirements such as providing full details on ingredients, nutrition, and allergens.

4.2 A systems approach to addressing risk in a digitally networked food ecosystem

The networked nature of the emerging food system necessitates a systems approach to understanding and addressing food safety risk. The food ecosystem can be conceived as made up of hubs, nodes, and dynamic, often simultaneous transactions between several parts of a distributed network. The actors interact within the network, linked by contractual arrangements, flows of goods and services, communication, and data flows. As the number of actors increases and the degree of connection increases, the value of the network increases (known as network effects).

Figure 7. shows an example representation of the relationships between hubs and nodes in an ecosystem. Mapping of the ecosystem also shows that areas of closer connectivity form identifiable sub-structures, or modules, within the wider network. This modular nature of the network might require design of more granular policy that is particularly relevant to the needs of a specific module or market segment. Some elements of the ecosystem may be connected to it only transiently/intermittently, or are not well defined with respect to their digital trace/accessibility (for example, intermittently trading producers or vendors, or actors with an offline component in their transactions), and therefore regulatory access might not be possible through standard processes.

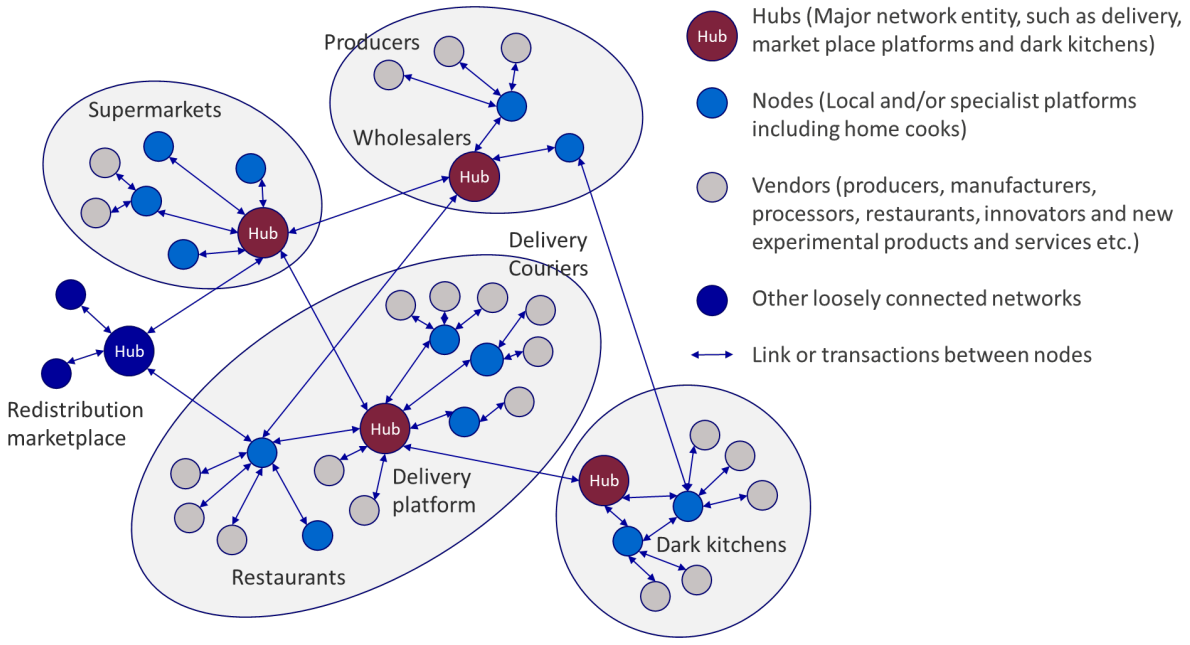


Figure 7 Representation of relationship between hubs and nodes (Based on: Grayson, 2018)

Taking a systems perspective, several overarching observations emerge:

- Platforms that control distribution emerge as critical gatekeepers by enforcing regulation through their curation level. For example, a platform can be highly curated and demand vendors to be registered and to adhere to a certain level of compliance with food safety standards such as FHRS ratings. In doing so, non-compliant vendors could be excluded at source from the market.
- Small, local, and least-networked nodes that operate through the production, preparation and distribution are difficult to identify and if they are not enforcing any standards at the production or preparation level then they will also fall under the radar of FSA.
- Across the ecosystem the larger actors hold sway and if producers bypass them through D2C channels, they may get away with selling the food without any registration and compliance with FHRS etc.
- Dark kitchens and the franchise model become nodes where food businesses are connected, and therefore can play a similar role as food delivery platforms and marketplace platforms as gatekeepers to the ecosystem. If they demand registration as food businesses as well as FHRS and other compliance factors, they can become hubs (dominant nodes) for regulatory enforcement.

Based on this, it seems apparent that regulators should focus on the main convergence hubs, and potential nodes for specialist or small local actors within the ecosystem. These are points where most new businesses and market entrants are expected wanting to engage with the market in order to reach customers quickly, namely, the major online delivery platforms and online marketplaces, and dark kitchen providers. While focusing on these nodes will not address every non-compliant vendor, it should capture the majority, and certainly those with the greater potential for wider impact on consumers and the food industry.

4.3 The future of a networked food ecosystem

Traditional linear food value-chains, as discussed in section 3.3.2, are already significantly disrupted. As the ecosystem evolves and digital platforms grow and D2C and C2C channels increase, the ecosystem will evolve further towards the networked value model as illustrated in Figure 8, where there is continuous dynamic interaction between all points of the network, and the value of the network increases with its size and number of connections.

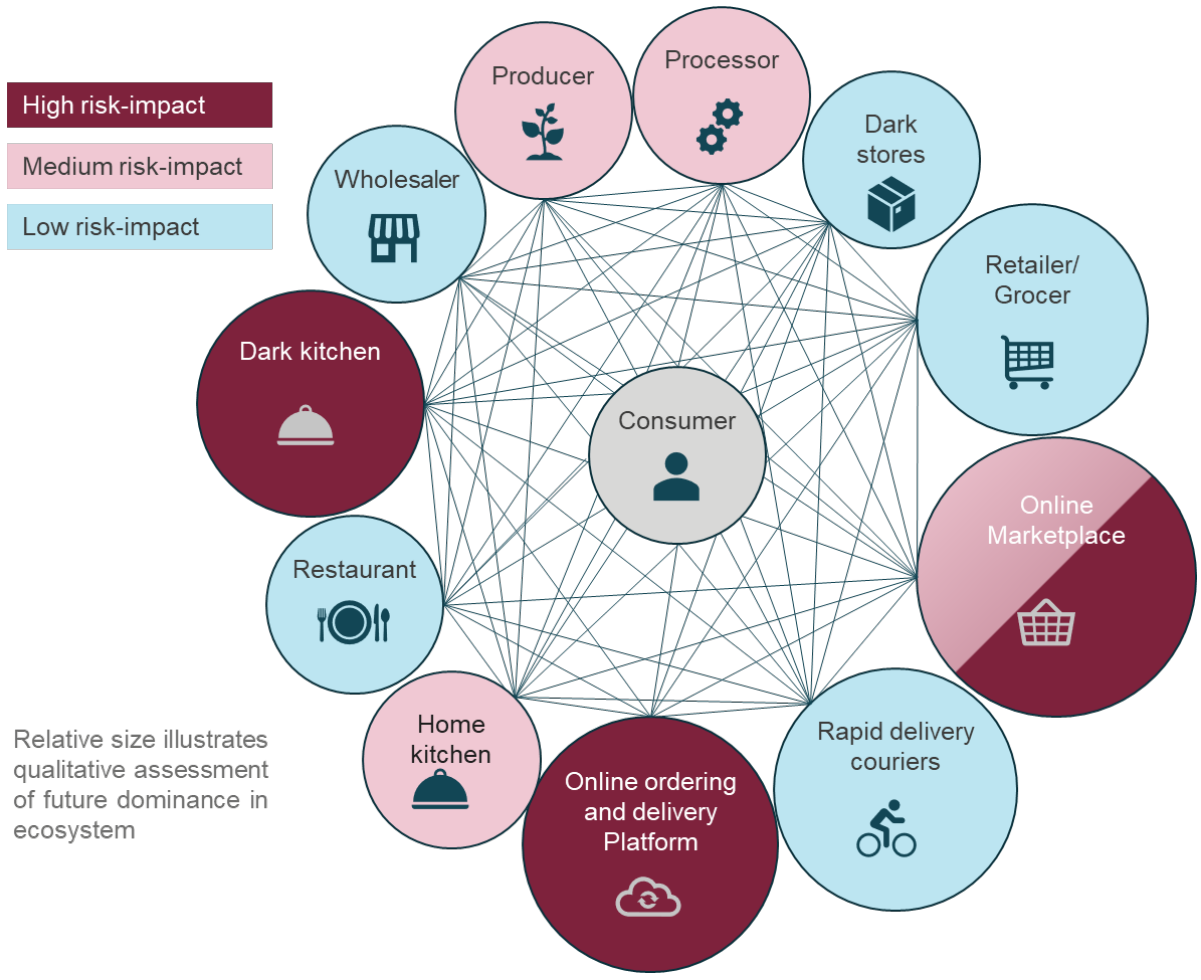


Figure 8 Representation of future value interaction network of the food system

(For simplicity figure does not illustrate the potential convergence and over-lapping of roles in the future network, and food sharing/distribution as well as other offline actors are not included)

High risk impact:

- Dark kitchen
- Online marketplace
- Online ordering and delivery platform

Medium risk impact:

- Producer
- Processor
- Home Kitchen
- Online marketplace

Low risk impact:

- Wholesaler
- Dark stores
- Retailer/Grocer
- Rapid Delivery Couriers
- Restaurant

The relative size and significance of the actors in the ecosystem can only be predicted with limited accuracy for snapshots in time, as these parameters can change rapidly within the network (in timeframes of a few weeks). Figure 8 attempts a basic illustration of our assessment of the nodes in the system most likely to gain dominance based on current information. There seems little doubt that the online delivery platforms and online marketplaces will continue to grow in significance. Currently, dark kitchens are a small but growing niche phenomenon, but they have significant potential to become important hubs in the network in the coming years, bringing new levels of efficiency and productivity to the traditional food preparation sector. As the ecosystem evolves in the future, the distinction between actors will probably blur as they consolidate and merge and increasingly expand and integrate

their business models across different sectors of commerce as has already happened in Asia. For example, Chinese platforms such as Taobao (owned by Alibaba), completely dominate commerce across sectors from food to cars and property, banking or insurance, all traded via one platform interface. Due to their optimisation towards high levels of consumer convenience and rapid transaction times (delivery of a new car to your door within a few hours) it is very likely that consumers will continue to drive the trend for consolidation of different platform players into few dominant incumbents.

Figure 8 also presents a top-level assessment of the likely areas of food safety risk and their potential scale of impact in the emerging ecosystem – that is, where there is a risk of food hygiene and safety issues, and/or food fraud/crime, and the potential for large scale impact on the food system. Risk may arise from uncertified, or fraudulent vendors, or from selling food without, or wrong, information on its origin, ingredients, allergens etc. Dark kitchens, online delivery platforms, and online food and general marketplaces are considered to have generally high potential for negative impact (maybe only medium risk in themselves, but their scale means impacts may be wide) Medium impact areas are considered to be home kitchens, and smaller direct-to-consumer producers and processors, and social media marketplaces and community food sharing platforms facilitating consumer-to-consumer exchanges. These actors have low visibility and high potential for trading without adequate food hygiene approvals or adequate processes so represent a higher risk individually, although their reach will likely be small in terms of number of affected consumers.

4.4 Priorities for FSA risk mitigation actions

Building on the systems perspective discussed above, and on the risk profile presented in Figure 8, we suggest an aggregated assessment of the risks and a summary of the priority target areas for FSA intervention as shown in Figure 9.

	Potential for broad system-level impact: Low overall system-level impact	**Potential for broad system-level impact:** High overall system-level impact
Risk level for food safety and food fraud/crime: Medium/High risk	**Fragmented segment, difficult to track actors, high individual risk, but small impact overall. Regulators may need to rely on raising vendor and public awareness to tackle food safety/fraud (1)** - Direct to Consumer sales from new start-ups, small producers and processors, home kitchens, small online-only vendors. - Peer-to-peer food sharing redistribution platforms (maybe offline – for example, food banks and community fridges). - Vendors selling through small and obscure local platforms. - Consumer-to-consumer buying /selling on social media platforms, and food events involving uncertified hosts.	**Potential of rapid spread of issues through the food system due to large network impact. Regulation focus on convergence hubs and nodes where regulators can efficiently access and influence multiple vendors/operators to control food safety (2)** Primary concern over uncertified or fraudulent vendors selling through platforms possibly to a wide audience. Regulate by working with: - The larger online platforms (delivery, and marketplaces, major hubs, and specialist or local nodes). - Major dark kitchen providers. - Technology solution providers to the food sector.

	Potential for broad system-level impact: Low overall system-level impact	**Potential for broad system-level impact:** High overall system-level impact
Risk level for food safety and food fraud/crime: Low risk	**Low risk, and limited potential for impact. Existing regulatory approach and local authority oversight should suffice (3)** - Brick and mortar restaurants selling direct to consumers. Have physical facilities requiring regulatory oversight and compliance with FHRS. - Redistribution platforms working predominantly with large FHRS fully certified supermarkets to distribute surplus food. - Delivery couriers are generally low risk to food safety - subject to appropriate training and optimal delivery conditions.	**Low risk, but scale of operations means any impact could be widespread. Existing regulatory approach generally should suffice (3)** - Large D2C brands such as the CPG multinationals, established producers and processors with a known physical offline presence. - Larger well-established brick and mortar restaurants operating through platforms. - Retailers/grocers, wholesalers operating under FHRS requirements. - Dark stores operating under FHRS requirements.

Figure 9 Priority target areas for FSA intervention

Actions to address risk mitigation through larger hubs and nodes of the food system:

- Work with major national/global platforms and local specialist platforms to enhance regulation, compliance, and monitoring (to exclude non-compliant vendors from platform).
- Work with start-up incubators and VCs to influence compliance early on of any new start-up platforms.
- On-going scanning by local authorities for more obscure start-up platforms.

Actions to address risk mitigation in fragmented parts, or modules, of the food system, where there are concerns over new entrants without adequate food hygiene standards, food fraud, and traceability:

- Work with developers to integrate food safety and traceability into software products such as EPOS (Electronic point of sales) systems, and software products for production control, inventory management, supply-chain traceability, etc. so that food safety is built in even for micro and small businesses.
- Focus on public awareness campaigns to educate vendors and consumers on the certification requirements and risks of non-compliance.
- Consumers to be educated about how to take more responsibility for buying decisions, their rights and what they should expect of vendors, and where to go to raise a complaint or concern over vendors.

Actions to address risk mitigation in low risk categories:

- As above, integrate food safety and traceability into software products to automate compliance.
- Ongoing due diligence by Local Authorities (LA) to monitor and ensure FHRS are observed.

Notwithstanding the above, which provides an instructive general overview, it is apparent from deeper analysis that risks and impact cannot truly be neatly grouped at the aggregate level. Risk and impact always depend on a number of interrelated factors:

- Type of products and services aggregated
- Type and size of vendors
- Channels to market
- Geographic reach of the platform, and size of the network they represent
- Business model underpinning the platform
- Degree of influence a platform exerts on its network (e.g., curation level)

Therefore, for example, the risk and impacts in D2C depend on the size and type of vendor, and the type of product, and where else they are in contact with the food system (e.g. if selling in parallel through major retailers the risk is clearly much lower).

Table 6 illustrates in more granular detail how risk may vary by actor type and context. Most actors can of course have a high-risk category if actors deliberately set out to act fraudulently, but the potential for fraudulent actors can be constrained by the chosen channel to market –for example, unable to trade through a major retailer or highly curated platform.

Table 6 Risk assessment by actor type

System actor	Low risk	Medium risk	High risk
Producer	Large players with established offline presence (or already selling through large retailers/wholesalers)	Smaller players with limited or no offline presence, D2C only	Small start-ups with no offline presence or track record, non-FHRS compliant.
Processor	Large players with established offline presence (or selling through large retailers/wholesalers)	Smaller players with limited or no offline presence, D2C only	Small start-ups with no offline presence, non-FHRS compliant
Wholesaler	Established brick and mortar retailer	New unknown online only retailer	-
Retailer/ Grocer	Established brick and mortar retailer	New online only retailer	-
Dark stores	Owned and operated by large market players (either platform, supermarket brand, etc)	Smaller operations that may not be applying FHRS fully or selective over products	Small online only retailer could have potential for food fraud
Home kitchen	Can be low risk when compliant	FHRS certified home cooks, but lacking professional equipment and formal safety protocols	Uncertified, ad-hoc home cooks, unknown to local authorities, non-FHRS compliant
Restaurants	Established bricks and mortar operations with proven track record	New, online only smaller operators that lack visibility	Non FHRS-certified operations deliberately operating below the radar of FSA
Dark kitchen	Large-scale kitchens operated under FHRS regulation, selling through high-curation platform	Multi-use shared kitchen space, new, inexperienced food entrepreneurs	Uncertified operations, hidden from public scrutiny, ad-hoc operations

System actor	Low risk	Medium risk	High risk
Online marketplace (Food, general, social, redistribution)	Highly curated food and general platforms. Redistribution platforms working with FHRS retailers.	Low curation platforms – food, general. Redistribution platforms working with non-FHRS partners and non-certified volunteers	Social media platform (peer-to-peer C2C commerce); redistribution platforms C2C, community e.g., fridges; peer-to-peer food events
Online ordering/ delivery platforms	High-curation platforms focused on food safety and FHRS ratings	Low-curation platforms, smaller, more obscure platforms	
Delivery couriers	Generally low risk part of the system (subject to appropriate training and optimal delivery conditions		

4.5 Limitations of study

This report is believed to have captured the most salient business models and online platforms immediately relevant to the UK food system and to FSA. The findings reflect expert opinions on the emerging online platforms, and the risks and opportunities these present, but there may be other risks, as of yet, unrecognised. This report has attempted to prioritise areas of potential risk and opportunity based on the available information, but this should be viewed as guidance only. More in-depth study is needed to more precisely determine the risk profiles and stay abreast of emerging trends to develop a detailed regulatory response.

4.6 Recommendations for future research and analysis

This rapid evidence assessment reviewed the extant academic and grey literature on the topic of buying and selling of food online in the UK. Aside from a few key papers commissioned by the FSA in the past, the academic literature was found to be surprisingly sparse. Digital platforms in general have received much attention in the literature, including business studies on for example their different business models

and financing, but their applications in the food sector does not appear to have been explored in great depth. There are significant gaps in the literature around how these platforms manage food safety risks, the effectiveness of their business policies, and the effectiveness of the current food safety regulatory framework. This limits the ability to pinpoint the most salient risk areas and makes it difficult to comment concretely on which characteristics of emerging buying and selling platforms should be encouraged or curtailed.

Further empirical research to explore operating practices of emerging food service providers is required to better understand the food safety implications of these emerging platforms and to develop appropriate policy responses. Table 7 summarises several recommended areas for further research.

Table 7 Recommendations for future research and analysis

Recommended further research	Comments
Quantifying food safety risks arising from online platforms	There is little data on the prevalence of food risk – food safety (non-compliance with food hygiene requirements, contamination, etc)/food fraud/food crime across the emerging platforms for food sales and delivery in the UK. A deeper investigation is needed to better understand the extent of the problem, where these problems occur most frequently (e.g., in ingredients, in food production, with which types of vendors, or in delivery) to more precisely categorise and prioritise risks within the food system.
How to build food safety into the ecosystem function	Further work is required to identify how food safety can be embedded into the ecosystem function. This might involve identifying parallels with information and data security regulatory models.
How do curation and vendor monitoring practices of online platforms help to ensure food safety across vendor base	Intuitively high platform curation is positive for food safety. There is however no real evidence-based research showing that curation indeed reduces risk. Research is recommended to better understand curation policies and monitoring practices, and to explore in greater depth where the strengths and weaknesses might be. Specifically, what are best practices that regulators should enact, and where are the gaps/failings in these policies?

How does the business model/functionality of the platform impact on food safety for consumers	There is little empirical evidence of how different platform functionalities impact on food safety. E.g., the way in which information is presented to consumers, incentives and pricing models for vendors and consumers, different delivery systems, etc. Further research is required to better understand best-practice characteristics and what should be encouraged or curtailed by FSA.
The impact of social media platforms on food safety and consumption	The role of social media platforms and peer-to-peer food exchanges is very poorly understood to date. Research is required to better understand these exchanges, the potential market size of these interactions in the UK, the potential implications for food safety and public health, and how the risks might be mitigated. Insights might be learnt from markets in Asia where B2C and C2C via social media markets is much more developed.
The boundaries of regulatory responsibility	As platforms and retailers increasingly move into new areas of commerce, with intersecting roles, the responsibilities for food safety and consumer protection become blurred. Further work is needed in this area to better determine how and where regulatory change might be needed in the emerging new ecosystems to ensure adequate accountability. Lessons should be learnt from previous problems seen with digital platforms in other sectors of the economy.

4.7 Related emerging risks for further consideration

This rapid evidence assessment focused on the digital innovations in buying and selling of food, but during the research several related emerging risks were identified that FSA should consider in the context of future public and environmental health. These include:

4.7.1 Public health and nutrition

Non-communicable diet-related diseases such as obesity, heart disease and diabetes caused by poor nutrition and poor food choices are a growing public health issue in the UK. The growing preference for on-demand home-delivery of pre-cooked convenience meals, often with limited information on the included ingredients, nutrition, and calories, in place of traditional home-cooking could have potentially profound implications for the nation's health. Academic evidence of a link between online shopping and home food delivery platforms and changes in consumer diets is

limited; however, food prepared outside the home tends to be less healthy and have higher calorific content (higher salt, fat, sugar, etc), and recent research indicates a bias towards unhealthier and discretionary items on most of the leading platforms (Partridge et al., 2020; Skovgaard et al., 2021).

Online platforms are well positioned to address the food quality issue through consumer education, providing more nutritional information, nudge strategies, and choice editing to influence consumer food choices and dietary behaviour. Indeed, platforms are emerging that offer highly selective food offerings catering to specific dietary requirements. To date though, aside from a few niche platforms, action appears limited. While this is not specifically a food safety issue, regulators should consider how best to work with the industry to drive change to protect long-term public health.

4.7.2 Chemical and micro-plastics contamination from food packaging

As consumers shift towards more home-delivered meals the need for extensive and possibly novel packaging to provide protection and transport of hot meals will increase. However, researchers are now highlighting the effects of long-term exposure to hazardous chemicals, such as endocrine disruptors, carcinogens, or substances that bioaccumulate, collectively referred to as “chemicals of concern”, that can transfer from food-adjacent packaging into food, together with other unknown or toxicologically uncharacterized chemicals (Bansal & Gupta, 2020; Muncke, 2021). Recent advances in understanding of the endocrine-disrupting chemicals (EDCs) found in many industrial materials suggest there may be risks (Alavian-Ghavanini & Rüegg, 2018), and there are suggestions the industry deliberately hid details of harmful forever-chemicals such as 6:2 FTOH that are regularly used in takeaway packaging such as pizza boxes (Perkins, 2021). The implications of this ongoing research could be profound for the way food is prepared, packaged and delivered in the future. FSA will need to consider how to respond to this emerging issue and what role regulation should play in facilitating a pre-emptive shift to safer packaging materials.

4.7.3 Environmental impact and sustainability

The growth in home-delivery ready to eat meals and pre-packaged convenience foods present concerns over single-use plastic packaging waste and environmental impact (Li et al., 2020; Wozniacka, 2020). Regulators should consider what actions may be required to tackle the urgent and growing problems of plastic waste. This may have an impact on how food is delivered in the future – perhaps necessitating greater use of returnable, reusable packaging such as metal and glass containers in the industry, which had a long history in Asia until recently also switching to plastic. This may in turn have other implications for food safety that regulators will need to address.

The environmental impact of delivery services, and in particular last-mile logistics is also an area of concern. Aggregated home deliveries can be better for the environment than consumers using private cars for shopping, particularly where couriers use electric vehicles and bicycles, but the impact depends on many factors such as the size and frequency of deliveries, the urban density, and the modes of transportation used. As consumers grow accustomed to placing high-frequency small orders rather than consolidated weekly shopping, the impact may rise. One notable area that appears to worsen carbon emissions is the use of refrigerated deliveries of fresh groceries (Heldt et al., 2019). As the UK pursues zero-carbon goals, the environmental impact of food delivery may require further scrutiny.

Food delivery services present an additional sustainability concern related to food waste, although the impact is still poorly understood (Li et al., 2020). Potential for food waste occurs when consumers either dislike the food ordered, or order too much, although this may be offset by reduced waste during food preparation when undertaken by professional kitchens. This issue requires further investigation, and platforms and vendors might consider how best to reduce this potential for waste, for example, by providing better information on portion sizes at the point of sale.

5 Recommendations for Policy and Regulation Strategy

Given the rapid advances in technology and increasing zeal in commercialising technology there is an expectation that regulators take on a role of promoters of innovation and technology solutions. This approach may have its merits to a large extent; however, good regulation needs to strike a balance between enabling economic and commercial activity while fulfilling the commitment to safeguarding the society and consumers against risks and potential harm.

To that effect regulators are increasingly required to engage with state-of-the-art business models and technologies to support the emergence and growth of new products and services while fulfilling their safeguarding role.

5.1 Focus on the convergence hubs and nodes in the food ecosystem

This review has highlighted the systemic nature of the rapidly changing landscape of how consumers access food. Technology plays a fundamental role by enabling creation of virtual processing, aggregation and distribution centres and generating a network effect in the food industry. However, the differentiating factor between the players is not the nature of their technology because in the overwhelming number of cases the technology supporting these connectivity platforms is very similar. The differentiating factors are:

- Type of products and services aggregated
- Type of vendors a platform represents
- Geographic reach of the platform
- Size of the network they represent
- Business model underpinning the platform
- Degree of influence a platform exerts on its network (e.g., curation level)

This means there are key convergence hubs and nodes in the food ecosystem that can be fundamental levers for policy and regulation design. These are often the points where most businesses, and market entrants are expected to engage with the market, namely:

- The major online delivery platforms and online marketplaces (hubs)
- Local specialist online delivery platforms and online marketplaces (nodes)
- Dark kitchen providers (node with potential to develop into hubs)
- Processing and gastronomy technology solution providers (system levers)

A new business using a delivery platform benefits from access to a huge customer base, access to logistics of delivery, and low upfront costs for market entry, such as no marketing or investment in their own web presence. Similarly, new businesses engage with dark kitchens to remove the need for capital expenditure and long-term leases, paying only for the time a premise is used; will get some business services and support from the community; and may find collaborators, new ingredients etc. These benefits are compelling reasons for vendors to join these nodes and hubs. As platforms grow and benefit from network effects, this preference as a route to market only grows stronger. Technology solution providers offering software products for business optimisation in the food sector can play a slightly different role with considerable impact. Use of digital technology for increasing operational efficiency of food processing, preparation and gastronomy is spreading fast throughout the industry reaching SMEs and dictating the flow of daily routine for the operations. Increasingly software products either have a quality and safety option or provide stand-alone quality control. Such software can act as a lever for spreading and embedding food safety standards and any new requirements/regulations in the industry. Examples are FoodDocs, prodSmart, and Jolt.

- Platforms that are nodes and hubs effectively act as gatekeepers to the food ecosystem and are well positioned to fulfil a quasi-regulatory function of the sector, and through careful curation of vendors and on-going monitoring through the online platforms and dark kitchen provider, can mitigate the risk for consumers from unsafe and fraudulent vendors.

- By working with a select but influential group of these platforms and dark kitchen providers, the FSA can create levers for compliance in the food ecosystem engage efficiently across multiple sites and, or operators to ensure food hygiene standards are enforced, and safeguard against potential food fraud.

- It is recommended that FSA should focus on these main convergence nodes, hubs and levers in the emerging ecosystem, and take a proactive and collaborative approach to regulation, working closely with the major digital platforms, and leading dark kitchen providers to manage compliance issues and ensure best practices are developed and observed.

- Additionally, beyond monitoring and oversight, FSA should work with these nodes to develop enhanced training programmes, a programme of education for new food entrepreneurs, and perhaps consider developing new standards for dark kitchen equipment, etc. to optimise operations for food safety.

- As restaurants and other food facilities adopt technology it emerges that software companies that specialise in tools for food selection are well-placed to integrate compliance factors into their products for food organisations. This creates an opportunity for FSA to work with these developers to make compliance a built-in element of standard food business software for micro and small businesses (as successfully seen for accounting standards and tax collection that were improved through the mandatory use of software).

While focusing on these key system connections (nodes, hubs and levers) will not address every non-compliant vendor, it should capture the majority, and certainly those with the larger potential for wider influence in the food industry.

5.2 Ongoing monitoring and intervention

Taking account of the increasingly complex and interrelated ecosystem that is changing the traditional linear food supply chain, FSA faces opportunities, as discussed above, as well as challenges. When attempting to influence a digitally networked ecosystem there is a need for continuous engagement with the system, because unlike linear supply chains it is constantly changing. There is a need for

developing comprehensive analytical tools to enable FSA to continuously monitor change in the digital food ecosystem. Areas that require careful exploration are:

- Legal limitations on how and where FSA can directly intervene at the point of platform setup.
- Changing the status of food related platforms from technology companies to requiring them to register as food businesses will require direct engagement with the platforms and careful design of incentives for change in the industry.
- Enforcement of the requirement for transparency will require careful consideration as platform owners may cite data privacy concerns as reasons for not needing to be transparent.
- Low barriers to entry into the food supply ecosystem will put pressure on FSA to keep up with rapid change in the industry and will require continuous engagement with gatekeepers and main players. Building such relationships should not impact fair competition or lead to concentrating more power in the hands of larger players.
- FSA will need to develop and adapt to a new operational model to be able to successfully engage with industry, resulting in design of relevant regulation and implementation and enforcement of the new regulation.

5.3 Managing societal risk during the digital transformation of the food sector

Alongside the opportunities that are created through the rise of platforms in the food supply chain such as convenience and choice for consumers, access to markets for food entrepreneurs and expansion of operations and volume sales for established businesses, there are also rising challenges. The increased number of actors and stakeholders will increase the complexity of the supply chain and make oversight more difficult for regulatory bodies. The systemic effect of highly networked supply chains in turn increases the likelihood of systemic risks. Due to the networked nature of supply, access at scale, and speed of delivery to consumer, any incidents at a small part of the supply chain can potentially have far reaching consequences

throughout the food supply system beyond the locality of the incident. And finally, reduced competition due to the rise and dominance of monopolies has the potential to reduce the power of regulators to set standards and enforce them. Hence, FSA has a key role to play to protect the consumer through this industry digitisation transition.

Unlike other technology-heavy industries, the power of platforms is not necessarily in the sophistication and novel capabilities of the underlying technology, rather the main power levers, which are technology enabled, are mainly in their network effects, geographic access, lean operations, generation of highly granular and valuable customer data, and their subscription business models leading to customer loyalty and lock-in. Similar to other industries these powerful levers put platforms above the reach of regulators, and they are finding it very challenging to strike a balance between consumer interests and the free reign of platform interests. The cumulative effect of these factors leads to similar effects seen with companies driven by complex technology applications (Taeihagh et al., 2021). These are:

- Asymmetry in information: In case of tech driven companies most social actors have limited knowledge about how these advanced technologies work, and what their possible applications and the consequences of their deployment are. When it comes to platforms the complexity lies in understanding the power and leverage of a platform in the industry ecosystem, its many connections with other actors, and the unseen secondary layers of power that come from scale, such as highly valuable consumer data. This means platforms too will have monopolistic power on information across agents and at multiple levels of the industry and society causing challenges for policy design.
- Policy uncertainty: in the technology sector policy and regulation design takes place under high levels of uncertainty. This is relevant to platform regulation policy design where often governments and their respective agencies are either not entirely aware of the nature of the policy problem to be addressed or do not have the technical skills to understand the complex systems (technical, economic, and socio-behavioural) resulting from systemic applications of advanced high-tech technologies. For example, in the case of

FSA and the food industry, despite the fairly defined policy problem the uncertainty challenge lies in identifying the right points of interaction and leverage in a fast changing and dynamic ecosystem. This in itself requires adaptation to new ways of interacting with an industry and a deeper understanding of dynamic complex systems.

- Structural power dynamics: deployment of technology and platform business models impacts different parts of the society differently. Some sectors may benefit disproportionately positively while other sectors may lose out.

Another level of complexity arises when the power of networks and data ownership converge to dominate food production, distribution, and access. The systemic effects, and social impact of such convergence can be unexpectedly high when leading to consolidation of the industry into a few dominant players that might consider themselves as above the law, or on the other hand, to efforts by small players to carve out a niche deliberately remaining below the radar of law. This poses a daunting task for regulators while putting considerable societal responsibility on them, currently not perceived to be part of their remit (Harvard Kennedy School, 2020; James, 2019).

Some of these scenarios are to some extent becoming realities today and are rapidly gaining momentum, and therefore a forward-looking systematic response is required.

5.4 Recommendations/Considerations for policy design

It is recommended that FSA considers reimagining their role as a regulatory body and adopting a more proactive anticipatory role in supporting industry to build food safety into its fabric from the start as novel platforms and business models emerge.

From a regulatory perspective, the scope of food safety will need to be redefined and expanded to encompass systemic risks to human health as well as societal implications of large-scale implementation of novel platforms in the food sector. In order to take the first steps towards developing the framework for a new approach to policy design we recommend the following considerations:

i. **Change the status of digital platforms trading food from technology companies to food business operators**. As there is high potential that this

approach may cause resistance of these platform businesses (to be classified as a technology company is highly lucrative for valuation and fundraising). It is advised to consider creating a combined category where the regulatory obligations applying to food safety need to be implemented also by a technology business when it is operating in the food sector. The biotech and medical devices industry can be a model for inspiration as these industries are technology intensive but also regulation intensive.

- The biotech and medical devices industry can be a model for inspiration as these industries are technology intensive but also regulation intensive.
- Work with other legislative groups to establish other necessary regulation that will enforce platforms to recognise that they are in the food business.
    - When food delivery drivers are employees the business is more likely to be deemed a business of food distribution and obliged to register as such.

ii. **Raise the status of food safety in the industry to compare with cyber security in the technology industry**. Increasingly digital infrastructure and platforms are required to build in cyber security as an inherent part of the system, and the Information Commissioner Office sets a series of ground rules that must be built into the way businesses deal with data. FSA needs to build similar approaches for food safety that can be monitored, and consequences addressed.

iii. **Shift responsibility from vendors that are listed on those platforms to the platforms themselves** (for allergens, hygiene ratings etc.).

- Platforms are the first point of call for customers and they are the trusted point of contact with the food system, hence should maintain that trust by ensuring food safety for their customers.
- Advertising on the platforms must require relevant food safety information.
- Can leverage consequences of reputational damage if an issue arises that can be identified as, or traced back to platform negligence, in particular when affecting a larger part of the ecosystem.

iv. **Consider making key measures obligatory**, which may help enforcing others. Currently most actions to be taken by platforms that trade in food in the UK are

deemed to be voluntary. Measures currently taken voluntarily by some platforms are (Jones, 2021):

- All restaurants and food outlets listed on the platform are FSA registered
- Displaying the official FSA Food Hygiene Rating (FHRS) of restaurants/vendors online and in-app.
- Removing all zero-rated restaurants from the platform.
- Setting a minimum level of hygiene (based on the FHRS) to sign up.
- Enabling customers to filter and sort restaurants by hygiene rating.
- Putting in place a food hygiene and safety policy with their partner restaurants which sets out the standards that restaurants need to meet (adopting Hazard Analysis and Critical Control Point (HACCP) principles).
- Providing information online for consumers about the platform's food hygiene measures, e.g., listing food information such as allergens.

v. **Monitor social trends that will impact the food ecosystem**. Platform businesses, due to having granular customer data at their disposal, are able to respond rapidly to emerging novel customer desires and local trends. This increases the dynamism of the ecosystem as competition for customer attention and loyalty intensifies. Some examples are:
    - Changing consumer habits
    - Environmental sensitivities
    - Worker rights and activism

Finally, we would like to mention that by commissioning previous reports as well as this analysis, FSA has gathered considerable evidence on the actors, shape and dynamics of the digital food platforms ecosystem. While FSA can continue to commission further reports to obtain snapshot assessments of change over time, it is very likely that setting up knowledge management systems to gather and analyse information continuously, in particular for highly dynamic technology trends, will be far more efficient in detecting relevant patterns. Early detection, and proactive, robust response is essential for regulating rapidly growing, highly networked technology trends as developments in other technology sectors have shown recently (e.g., data protection/security/privacy, social media curation, etc.).

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