FOOD SYSTEM RESILIENCE CHALLENGED BY DIVERSE RISKS: EXPLORING THE RESILIENCE THEORY FROM AN ACTOR-BASED LENS

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Abstract

Climate change, natural disasters and social unrest constantly threaten the role of the food system in ensuring adequate access to nutritious food for the population. Resilience is therefore emphasised in the food system in order to continue to function despite disruptions. However, due to the complex nature of the food system, multiple risks are easily transferred from one activity to another, which also exacerbates existing power imbalances between food system actors. Misaligned interests between actors and the food system make it difficult for governance to achieve intended effects, while efforts at the actor level do not necessarily lead to resilient systemic outcomes. Therefore, this thesis explores potential conflicts and coordination between the actor level and food system resilience through theoretical and empirical research in three interrelated papers and a discussion chapter. Paper 1 presents a literature review, aiming to answer the question of which actors contribute to food system resilience and how their efforts contribute to resilience during disruptions. The paper also summarises the supportive roles that help actors to affect the food system, and the underlying mechanisms that enable these actors to exert their influence. Paper 2 examines the resilience of restaurant organisations in Wuhan during the COVID-19 pandemic and explores the implications of organisational resilience for achieving sectoral and food system resilience. Paper 3 examines the effects of governance on the Chinese pork system and the trade-offs between resilience, sustainability and various internal dimensions of resilience, e.g. robustness, recovery and reorientation. Building on three preceding papers, the discussion chapter investigates the challenges of governance for food system resilience and explores strategies for enhancing resilience. Taken together, three papers and one discussion chapter provide insights into the overarching theme of the Ph.D. and offer theoretical and practical contributions to the phronesis (or situated strategic-ethical wisdom) involved in cognising and building food system resilience.

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Author's declaration

I confirm that the thesis is my own work and has not been submitted in substantially the same form for the award of a higher degree elsewhere.

The 6-page abstracts of Paper 2 and Paper 3 have been published at the EurSafe Conference 2022.

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1. Introduction

1.1 Problem statement and research questions

Food system resilience is a matter of paramount – and growing – importance, with even dependable, sustainable access to staples in question in many parts of the world, including populous and economically developed regions. With the multiple social, economic, and ecological processes involved, there are various food system actors operating across spatial, temporal, and jurisdictional scales (Sobal *et al.*, 1998; Tendall *et al.*, 2015). However, the food system is vulnerable to a wide range of shocks and stresses, threatening its capability to deliver those outcomes. Varying in duration and intensity, shocks and stresses can affect single or multiple points of the system individually or interactively, with some even having reciprocal interactions with the food system (Allouche, 2011; Zurek *et al.*, 2020). Moreover, the boundary between what may be defined as a shock or stress is dynamic. Disruptions may repeatedly occur, with shocks converting into stress and new shocks emerging from stress.

Initially developed from ecology (Holling, 1973), resilience has evolved into a social-ecological concept (Folke *et al.*, 2010; Walker *et al.*, 2004). The expectation that food systems should ensure the populace receives adequate nutrition has fueled a movement toward integrating resilience into these systems. Researchers have explored the idea of food system resilience for decades, with the recent consensus being that it relates to the capacity of food systems to deliver desirable outcomes despite disruptions (Tendall *et al.*, 2015; Ingram, 2017). Food systems tasked with providing both healthy and sufficient diets, all while maintaining sustainability across environmental, social, and economic dimensions (Hebinck *et al.*, 2021). Defining the exact nature and proportionality of desirable outcomes poses a challenge, yet the overarching objective remains the provision of a nutritiously sound diet for the public (Tendall *et al.*, 2015). While the debate surrounding the proportions of different desirable outcomes that

contribute to system resilience is complex, it is open to discussion that the delivery of which will make food system resilience desirable.

There are competing interpretations of the connotations of food system resilience. Recovering (i.e., bouncing back) from disruptions has been the most frequently understood connotation (Ingram, 2017; Meyer, 2020; Tendall *et al.*, 2015). Robustness (i.e., the ability to withstand) is regarded as a component of resilience in the broader sense, which was considered a parallel concept connected to resilience in past studies (Anderies *et al.*, 2013; Mumby *et al.*, 2014). Food system resilience has also been related to adaptation and concretized by the adaptive capacity to deal with uncertainty (Meyer, 2020; Tendall *et al.*, 2015). In addition to adapting to disturbances to support the robustness or recovery of the food system, food system resilience is further considered a transformation or reorientation that the food system actively pursues, despite crises, to maintain functionality in the longer-term (Ingram, 2017; Meyer, 2020). An integrated understanding of resilience as a collection of components with shared but varying emphases across these multiple dimensions has become more representative in recent years (Ingram, 2017; Meyer, 2020; Tendall *et al.*, 2015).

Therefore, this thesis agrees that food system resilience should be explained holistically by the system's capability to deliver food system outcomes despite disruptions, and more importantly, demonstrating one or more of the following abilities to stand robustly, adapt well, recover rapidly, and reorient when necessary in favour of the food system delivering the desired outcomes in different situations.

The increasing frequency and complexity of risks to the food system have made building resilience a consensus and feasible solution to deal with devastating disruptions (Aldunce *et al.*, 2016; Marto *et al.*, 2018). However, the diverse actors across sectors and scales in the food system make it difficult to pinpoint the targets being hit by a disturbance. Disturbances can be transmitted from one actor to others through inner or outer connections of the food system (Rotz and Fraser, 2015). More importantly, such a

ripple effect does not only exist in the spread of disturbances: the efforts of any actor to build resilience do not stand alone, with a potential impact on other actors and the food system across scales and geographies, either positively or negatively. Building food system resilience requires the active participation of actors at multiple levels (Bremmers *et al.*, 2007; Sambell *et al.*, 2019). It is thus essential to identify measures that actors can take to help the system achieve resilience against risks or, at least, not transfer vulnerabilities to others. Therefore, further theoretical and empirical exploration is needed to understand the relationship between the food system and its actors, particularly how actors influence food system resilience.

Simultaneously, system resilience is not necessarily a positive characteristic, if the system is not delivering desirable outcomes. governance aimed at increasing resilience may be effective only at certain levels and for a limited time and could even backfire in the long term (Nyström *et al.*, 2019). Actors may benefit or suffer unequally from governance for food system resilience. Trade-offs between various resilience characteristics and other important system goals, such as sustainability, may also arise (Tendall *et al.*, 2015; van Wassenaer *et al.*, 2021). Building resilience in food systems requires cooperation between public authorities and food system actors at multiple levels, but the intricate interactions within and between them can pose significant challenges to effective governance (Bremmers *et al.*, 2007; Sambell *et al.*, 2019). Therefore, actionable insights into governance for resilience must be based on a comprehensive understanding of the causal mechanisms between specific interventions and their effects and the underlying theories (Vogel *et al.*, 2012; Young, 2010).

To fully grasp the concept of resilience in the food system, it is essential to look at the system within a unified and developing context under disturbances. Helfgott (2018) initially posed four pivotal questions to delineate systemic resilience boundaries, a framework later developed by Zurek et al. (2022) within the context of the food system. This thesis will follow and apply these key framing questions to establish its research

scope, with each paper sharing a common but differentiated focus on the questions below, which will be specified in each paper:

(1) Resilience of what?

While individuals may focus on specific activities (e.g., farmers in farming, caterers in catering) and this paper will take an actor's lens, societal-level interest that resilience can contributes to the delivery of food system outcomes will be centred rather than individual activities per se.

(2) Resilience to what?

We examine the severity and frequency of threats confronting the food system, encompassing both external and internal disruptions, as well as short-term shocks and enduring stresses.

(3) Resilience for whom?

Acknowledging diverse perspectives from actors, industry, and society, this study recognises the intricate web of interpretations and the imperative to preserve resilience. However, it also addresses the complex power dynamics and trade-offs between ethics and interests. This thesis will mainly draw on this issue, incorporating the other three questions at the same time.

(4) Over what time period should resilience be built?

In the face of dynamically evolving risk landscapes, strategies boosting short-term resilience may compromise long-term viability. Recognising interactions and temporal mismatches underscores the importance of incorporating a time dimension into resilience measures, which includes not only the duration of the disruptions, but also the longevity of the governance impacts.

Currently, few theoretical and empirical studies can inform the conflicts and coordination between actor-level and food system resilience. Therefore, this thesis will address the following research questions:

1. How do food system actors affect system resilience?

1.1 Who are the influential actors, and through what mechanisms can they affect the food system resilience?

1.2 Does actor-level resilience/non-resilience lead to system-level resilience/non-resilience?

2. How does pursuing food system resilience affect actors?

2.1 What are the challenges of governance for food system resilience?

2.2 Does system resilience come at the cost of actors as expendable?

3. What factors can facilitate resilience in food systems?

3.1 How can other actors or roles support and help?

3.2 How to improve food system resilience while considering actors?

1.2 Research objectives, objects and sites

This thesis aims to shed light on the complex relationships between actors and food systems in pursuing resilience, to explore the conflicts and coordination between the actor level and food system, to identify trade-offs and synergies in building resilience, and to provide recommendations for improving resilience more inclusively while considering the diverse interests and needs of different actors. The thesis adopts a classic three-paper plus one discussion chapter structure besides the introduction and conclusion, consisting of a literature review, two case studies focusing on different actors in the food system and a discussion chapter that brings it all together to explore the above research questions.

This study began in October 2019 with an exploratory approach that evolved over time. The outbreak of COVID-19 in early 2020 has motivated more academic interest in food system resilience, supplementing ample primary source material for the literature review in this paper. The infectious risks and travel restrictions associated with the pandemic have affected not only the global food system but also the selection of research objects and field areas. Given that the author returned to China during the pandemic, fieldwork was thus carried out in China.

Fortunately, China is an ideal location for studying food systems. With the largest population in the world (until 2023), China has been exerting efforts to ensure national food security. However, China's complex food system composition, overlapping environmental pressures, and disaster risks make it challenging to achieve the goal. On the production side, China has been transitioning from smallholder to large-scale farming in food production. On the consumption end, the internet economy and takeaway services have driven innovations in the retail and restaurant sectors over the past decade that are uniquely shaping other associated actors and the food system. Research on China's food system focuses primarily on sustainable production (Deng *et al.*, 2021; Hu *et al.*, 2015; Yan *et al.*, 2020), food security (Dev and Zhong, 2015; Hannum *et al.*, 2014), and dietary transition (He *et al.*, 2018; Hu *et al.*, 2011; Liu *et al.*, 2014), with less attention paid to resilience.

This thesis investigates two case studies, one focusing on a model food product and the other on a model sector, which are representative food system actors of the study site. The thesis chooses pork – the most widely used meat in Chinese recipes and the most consumed meat per capita in China – as the model food for its first case study. In 2021, pork consumption in China reached presumably 25.2 kg per capita per year, accounting for 55.8% of all meat consumption (China Statistical Year Book 2022). As the top producer and consumer of pork in the world, China's food security greatly depends on the stability and sustainability of its pork system. However, this system is often exposed to internal cyclical and external epidemic risks, leading to frequent fluctuations

in yield and prices. Examining how Chinese pork production and supply can be made more resilient is crucial.

On the other hand, the model actor-restaurants, often overlooked in food system studies, have gained increasing importance in China's food system due to the boom in takeaway services in the last decade. Restaurant takeaways are gradually occupying the daily meals for Chinese people. Accordingly, the restaurant industry's share of China's overall GDP has grown from 4.3% in 2014 to around 4.75% in 2019 (China Statistical Yearbook 2020), in which online takeaways accounted for over 20% (State Information Center 2020). The restaurant industry has employed over 7 million people in China. Moreover, due to its inevitable human contact, the restaurant industry has been the most affected by the COVID-19 pandemic and social distance measures. Thus, investigating the restaurants' efforts to pass through the pandemic could provide missing evidence for how actors in this traditional yet increasingly influential sector can affect food system resilience. The selection of research objects in this thesis reflects the author's broad, rather than singular, focus on food system actors, with the aim of exploring cross-sectoral patterns in the food system.

1.3 Research structure

This PhD thesis consists of introduction, three papers and one discussion chapter, and conclusion. The first paper is the literature review and the two other papers are case studies, and the discussion chapter will benefit from the previous papers and make conceptual contribution.
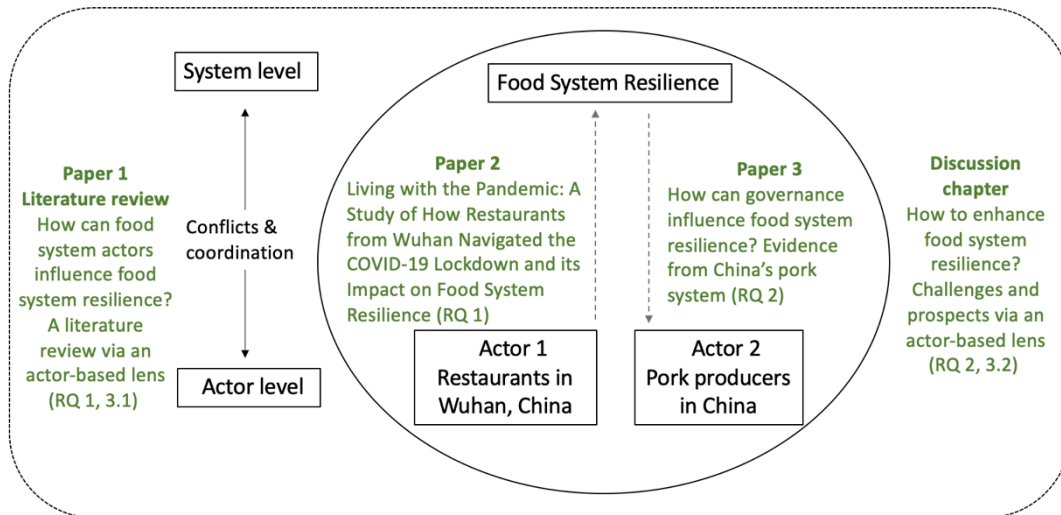
Figure 1.1 The structure of this PhD thesis

Paper 1 is a literature review that aims to answer a novel research question that no other literature review has specifically summarised, namely, which actors contribute to food system resilience, and how do their efforts contribute to resilience during disruptions? This paper focuses on the question of 'resilience for whom' from an actor-based lens and conduct a literature review to identify and analyse the empirical evidence on which actors contribute to building food system resilience and how their efforts help overcome disruptions. The paper summarizes the literature on the influence of producers, intermediaries, and consumers on food system resilience, as well as the supportive systems and fundamental mechanisms that enable these actors to exert influence. This paper addresses research questions 1 and 3.1 with evidence from the literature. this paper will focus on the question of 'resilience for whom' from an actor-based lens and conduct a literature review to identify and analyse the empirical evidence on which actors contribute to building food system resilience and how their efforts help overcome disruptions.

Paper 2 examines the resilience of restaurant organisations in Wuhan, China, across the COVID -19 pandemic. Through semi-structured interviews, the paper applies a dynamic capability perspective, looking at whether and how they perceived threats

and opportunities before the outbreak, seized opportunities by absorbing threats and adapting during the lockdown, and managed threats and underwent a transformation after the lockdown. Through triangulation analysis, this paper also introduces a sectoral and a food system perspective, exploring the impact of organisational resilience on achieving sectoral and food system resilience. From a resilience perspective, this paper explores how restaurants' efforts to maintain themselves functioning during a short-term external shock and in the shift of this short-term shock to a longer-term stress (resilience to what and over what time period) affect their own resilience (resilience of what: the survival of organisations and functioning) as well as that of the food system to deliver desirable outcomes, i.e. providing healthy diets and economic prosperity (resilience of what) in the long run. This paper provides evidence for research question 1 based on new actors that were noted in the Paper 1 literature review as often being neglected in food system research.

Paper 3 looks at the Chinese pork system, which has experienced two major disruptions - the Environmental Protection Campaign and African Swine Fever - from 2014 to 2020. Using the Driver-Pressure-State-Impact-Response model, the paper examines how governance affected sustainability, resilience, and other dimensions of resilience (i.e. robustness, recovery and reorientation). From a resilience perspective, this paper explores how the Chinese government's attempts to promote a more stable and environmentally sustainable transformation of pork production in the past decade (resilience of what, for whom, and over what time period) have been affected by successive shock and stress (resilience to what: EPC and ASF), and how actors' livelihoods and performances in the pork system in this process were shaped jointly by disruptions and governance (resilience for whom). This paper primarily addresses research question 2 and provides evidence to support the discussion chapter.

The discussion chapter looks at whether governance can enhance food system resilience and analyses the challenges faced in governance for food system resilience, with a focus on the tension between system-level and actor-level concerns and from a

perspective that prioritizes the latter even as it highlights the necessity of both. The paper attempts to explain these challenges as well as the potential conflicts between actors and system interests, and makes recommendations on how to enhance food system resilience responsibly. Research questions 2 and 3.2 are primarily addressed in this paper.

Both Paper 2 and Paper 3 contain a theoretical background section relevant to the content of the case study. Although the research objects of the two case studies are different, they are actually both exploring the same topic based on the Paper 1 literature review, namely actor-level and system-level food system resilience. The distinction between these two cases lies in the path of research: Paper 3 tells the story of how efforts to achieve systematic resilience have undermined part of the actor level resilience, while Paper 2 explores an opposite scenario, where the individual actor strives for resilience in the face of a sudden shock, and how the food system resilience is then affected. Based on Paper 1 as a literature review, as such Paper 2 addresses RQ1 while Paper 3 addresses RQ 2, so that together they will contribute to the discussion chapter. In total, the three papers plus one discussion chapter will offer a comprehensive overview and insight into the overarching theme of the PhD.

2 How can food system actors influence food system resilience? A literature review via an actor-based lens

Abstract

The complexity of actors within the food system is a pivotal factor influencing food system resilience, as indicated by a burgeoning body of research. While individual studies have examined the impact of various actors on food system resilience, there is currently no literature review that scrutinises cross-sectoral patterns. This paper addresses this gap by conducting a literature review to analyse empirical evidence on the contribution of different actors in overcoming disruptions and influencing food system resilience, and the mechanisms involved. By reviewing research centred on producers, intermediaries in the supply chain, and consumers, this paper identifies four common mechanisms through which actors influence food system resilience: actors' resilience capability and agency for resilience; diversity of actors and their functions; connectivity and connections among actors; and actors' learning and knowledge. The paper also explores crucial supportive roles that bind actors and the food system together. Food systems traditionally rely on natural systems, energy systems, logistics systems, venue infrastructure, and governance, with an increasing dependence on internet access for digital information sharing among actors. This review underscores the significance of actor scale and geography in determining their impact on food system resilience during crises. Recognising that the interests of actors and food systems may not align, it is imperative to critically assess the motivations and actions of food system actors, fostering resilience-building agency that benefits the system as a whole rather than a select few actors.

2.1 Introduction

The food system encompasses all aspects of food dynamics, from production and processing to transportation, retailing, and consumption. It is a complex adaptive system where food system actors interact continuously at multiple levels and scales (Jones *et al.*, 2022). However, these actors and the subsystems have distinct vulnerabilities to external and internal threats (Snow *et al.*, 2021, p. 2). As the scale of food systems has expanded from locally dispersed to global and highly integrated (Anderson, 2015), it has created complex challenges such as food insecurity, food poverty, unsustainable farming practices, and the effects of climate change on crop yields (Adenle *et al.*, 2017; Ba *et al.*, 2018; Hannum *et al.*, 2014; Maitra and Rao, 2015; Nzwalo and Cliff, 2011). Addressing these challenges requires restructuring, prior planning and developing novel solutions that consider the food system's intricate interdependencies (MacMahon *et al.*, 2015).

Holling (1973) first introduced resilience to describe an ecological system's ability to maintain itself and recover from disruptions. Since then, the resilience concept has been widely used in psychology, engineering, and social-ecological systems. In social-ecological systems, resilience may involve human actions dealing with issues such as overfishing or pollution (Chhetri, 2021; de Abreu-Mota *et al.*, 2018), while for societies, it refers to the ability to cope with various social crises (Adger *et al.*, 2009; Walker *et al.*, 2004). For businesses, resilience could mean dealing with more competition or changing customer needs (Larsson *et al.*, 2016).

Since the 1990s, discussions of resilience in food systems have gained growing attention due to intensifying exposure to various risks with diverse durations, target audiences, and severity. Tendall et al. (2015) provided a representative definition of food system resilience regarding 'the capacity over time of a food system and its units at multiple levels to provide sufficient, appropriate, and accessible food to all, in the face of various and even unforeseen disturbances' (page 19). Apparently, scholarly discussion

of resilience has moved beyond the expectation of keeping the food system operating during crises and has come to emphasise the capability to maintain the functions of the food system despite disruptions. While it is agreed that the provision of adequate and healthy food for the public is the primary objective, the environmental, social and economic impacts of food system activities are also of concern (Hebinck *et al.*, 2021).

Building on previous research, Ingram (2017) further applied the terms of resilience introduced earlier by Holling (1973) to the food system and argued that to understand what is meant by resilience of the food system, there must be consideration of resilience of what (resilience of the overall food system outcomes rather than in the individual activities), to what (shock or stress can be from external and internal to the food system), for what purpose / for whom (depending on which features of the system need to be preserved or changed), and over what time period (depending on dynamically shifting risk environments) (Zurek *et al.*, 2022). They proposed three related but not identical approaches to enhance resilience, including (1) robustness—the ability of the food system to resist disruptions to desired outcomes; (2) recovery—the ability of the food system to return to desired outcomes following disruption; and (3) reorientation—the ability to accept alternative outcomes preceding or following disruption (Ingram, 2017; Zurek *et al.*, 2022). In parallel, numerous case studies examine the challenges of food systems across actors, including adapting to climate change on farms, ensuring food businesses remain operational during natural disasters, utilising local food markets to provide food during pandemics, and coordinating cross-regional and cross-level food supply chains to facilitate food distribution (Hubbard and Onumah, 2001).

While the theoretical and empirical discussions on food system resilience help deepen our understanding of the subject, they also reveal hidden concerns, such as which aspect and who is most significant regarding the resilience of the food system as a whole and whether their interests and efforts are aligned and compatible in promoting it. Brzezina et al. (2016) even argued that the value judgement of what is resilient or vulnerable to what and over what period of time depends on the beneficiaries. In other

words, a key issue concerns the relation between actor- and system-level factors and perspectives.

These worries are not caused by a lack of research but rather by the fact that the food system has multiple actors across different levels. The interconnections of food supply chains and networks allow for risk transmission between actors and levels that such a breakdown at any point may impact the ultimate functioning and functions of the system (Zurek *et al.*, 2022). Furthermore, actors in the food system are embedded in society, and their well-being is linked to the overall social, political, and economic situation. For example, food inaccessibility may result from insufficient income and delayed welfare payments rather than from a failure of the food system (Benker, 2021). It is, therefore, crucial to consider the broader societal context and stakeholders' interests when examining food system resilience.

Resilience thinking has brought a valuable systems-oriented perspective on socio-ecological change, but it has sometimes overlooked the vital roles played by actors with diverse values, interests, and powers in shaping system resilience (Hoque *et al.*, 2017). Previous literature reviews have explored conceptual and theoretical aspects (Tendall *et al.*, 2015; Zurek *et al.*, 2022), the impact of market power on food system resilience (Merkle *et al.*, 2021) and food supply chain resilience to environmental shocks (Davis *et al.*, 2021). van Wassenaer et al. (2021) employed an ontological perspective on the impossible trinity among agency of individuals, system integrity and system transformability in food system resilience. An additional review is needed to examine the interactions between food system resilience and actors based on empirical evidence.

Therefore, this paper will focus on the question of 'resilience for whom' from an actor-based lens and conduct a literature review to identify and analyse the empirical evidence on which actors contribute to building food system resilience and how their efforts help overcome disruptions. Evidently, this paper is not arguing that either food producers or retailers are more beneficial to food system resilience but rather exploring

how actors across different levels and scales in the same food system activities have affected the resilience of this sector and the system. Therefore, actors will be discussed according to their roles and functions in the food system.

In the subsequent sections, Section 2.2 describes the methods and literature selection process and the results of this paper; Section 2.3 summarises producers, intermediaries and consumers' impacts on food system resilience based on the literature; Section 2.4 sums up the supportive roles that allow food system actors to exert their influence on the food system resilience; Section 2.5 explores the key mechanisms through which actors affect food system resilience. Section 2.6 concludes the review.

2.2 Methods and Materials

2.2.1 Research boundary and questions

For this review, 'food system' refers to levels ranging from local to global, while 'food system actors' include those involved in various aspects of the food production and distribution process, from production and processing to transportation, consumption, and waste disposal. Although the actors within the food system are diverse and heterogeneous, this review focuses on the broader food system rather than on specific food types or subsystems. Food system resilience can be influenced not only by actors, but also relies on a number of key linkages or supports provided by natural, social and economic systems. To ensure comprehensive coverage of the evidence, this paper formulates three research questions that can guide all subsequent stages of the research process. Specifically, this paper seeks to answer three research questions:

(1) What actors have been given attention in research that help to build food system resilience?

(2) How do the efforts of these actors contribute to food system resilience during disruptions?

(3) What are the key supportive roles that link actors and the food system, and contribute to food system resilience?

2.2.2 Data Sources and Search Strategy

This paper adopts Web of Science Core Collection and Scopus databases to assemble publications on actors and food system resilience. The search was restricted to articles in English with publication years from 1994 to November 2022. Non-English language sources were excluded for practical reasons, but this may have missed several relevant papers.

This paper notes the exponential growth of scientific literature focusing on food system resilience and governance following the COVID-19 outbreak in 2020. As food systems and actors perform similar roles in many parts of the world, this paper does not restrict its literature search to a geographical region. This search incorporated quantitative, qualitative and mixed methods articles. A Title-Abstract-Keyword search was conducted in Scopus, while a Topic search was applied in the Web of Science. The search strategy used in this review is (TITLE-ABS-KEY (food AND system AND resilience) AND TITLE-ABS-KEY (actor OR player OR stakeholder OR sector OR participant).

2.2.3 Study selection

In the search, Web of Science returned 858 publications, of which 847 is in English, while Scopus returned 878, 862 of which is in English. In this review, all the abstracts were imported into Zotero, where duplicates can be easily removed, and key points of the papers can be tagged and categorised. In an initial filter through the titles

and abstracts, this review (1) excluded studies that were not based on empirical evidence; (2) excluded studies that did not focus on the food system and its subsystems; (3) excluded studies that merely explored methodology; (4) excluded duplicated studies; (5) excluded studies that were not peer-reviewed; and (6) excluded studies that could not be found or were not accessible to read. After the first step, 133 articles are remained for full-text screening.

Then, this review performed the following standards for paper selection: (1) this review includes papers focusing on the broader food system rather than on specific food types or subsystems; (2) this review keeps only the most comprehensive one for studies that explored the same issue; (3) this review only includes articles that have already explored cross-level influences in their research. By doing so, this review will be better positioned to identify the actors in the food system whose efforts have cross-level effects on system resilience and to describe how these effects occur.

Based on the above standards, 105 articles were eventually identified as relevant and used for exploring the above three research questions. In later sections, this paper will explore how actors affect systemic resilience given their roles in the food system and identify supportive roles.

2.3 Actors' impacts on food system resilience

Existing literature on food system resilience focuses on three connected levels. At the outermost level, a highly industrialized and globalized supply chain is anchored by multinational and domestic food commodity producers, supermarket chains, and the food service sector. The middle level of analysis focuses on regional food systems, which may involve a mix of industrialised products and localized alternative networks. Depending on the specific study, the region may be described as local, urban, or something else. Finally, the third level of analysis centres on community and household resilience. This level encompasses community and household farming and storage

practices, all of which contribute to food system resilience at the grassroots level. In this section, this paper summarises how actors affect systemic resilience based on their roles in the food system, looking at the mainstream actors involved in food system activities, such as producers, processors, transporters, retailers and consumers, as well as emerging actors, such as alternative food networks.

2.3.1 Producers

Food production is the starting point of the food system, providing products for the subsequent value chain, and therefore the resilience of the producers is considered to be the basis for food system resilience. Two interconnected themes emerge in the literature connecting producers and food system resilience: (1) production resilience, i.e. how producers maintain stable food yield in a changing environment (Davis *et al.*, 2021); and (2) livelihood resilience, i.e. how producers ensure a reasonable economic income for producers to secure their livelihoods and thereby contribute to system resilience (Ado *et al.*, 2019).

2.3.1.1 Autonomy of the producers

Studies have shown that food producers with greater autonomy and less external dependence are more operationally resilient and better able to secure supplies to the food system (Helfenstein *et al.*, 2022; Mastronardi *et al.*, 2022; Meuwissen *et al.*, 2021). One typical practice is to internalise all possible activities for production, including reliance on local ecological agricultural production and local sources of inputs (Paganini *et al.*, 2020). Low-input organic agriculture, for example, can better recognise natural resource degradation and regeneration cycles and enhance the resilience of both natural and human resources, thereby ensuring the long-term viability of the farm and the food system as a whole (Brzezina *et al.*, 2016). Food producers with these characteristics have also demonstrated their superior ability to cope with disruptions

like transport disruptions and labour shortages caused by the COVID-19 pandemic (Helfenstein *et al.*, 2022; Paganini *et al.*, 2020). For instance, Mastronardi et al. (2022) found that dairy farmers with a high level of autonomy in feeding—over 90% of the total dry matter supplied locally—did not have to deal with absentee staff and were able to self-regulate their human resources to continue operating during the lockdown. Conversely, capitalised food systems that heavily rely on external inputs are vulnerable to risks beyond their boundaries (Brzezina *et al.*, 2016). Farms that outsourced certain functions (e.g., food processing) prior to the pandemic were more severely impacted by the COVID-19 pandemic (Mastronardi *et al.*, 2022).

2.3.1.2 Diversification of products and producers' business models

Breeding and crop diversity could diversify people's diets, and increase agricultural productivity and resilience (Bailey and Buck, 2016; Davis *et al.*, 2021; Dwivedi *et al.*, 2017; Finckh, 2008), while more specialised and intensive farms are more likely to feel the negative effects of disruptions (Campi *et al.*, 2021). High specialisation makes farmers more efficient in accessing and applying technology, but specialised farms are highly dependent on the commodity markets in which they operate and are more vulnerable to shocks in the supply chain, increasing their economic vulnerability (de Roest *et al.*, 2018; Helfenstein *et al.*, 2022). Furthermore, industrial agri-food systems, mainly consisting of intensive farms, limit farmers' autonomy to resist and adapt to possible ecological and social damages (Abson *et al.*, 2013; Hendrickson, 2015).

In contrast, farms with more diverse and less intensive operations can develop cost complementarities between different crops or livestock species and target products for different, market-specific production segments, which helps the farm's overall profitability and resilience to shocks (de Roest *et al.*, 2018). Land use diversity is essential in ensuring resilient agricultural returns in an uncertain market and environmental context (Abson *et al.*, 2013). Such an effect of diversity was particularly evident during

the COVID-19 pandemic. A study in Italy showed that diversified farms played an essential role in avoiding production and supply chain disruptions at the beginning of the lockdown and safeguarding food security afterwards without raising prices (Mastronardi *et al.*, 2022). In the Zemgale region of Latvia, efforts were also made to incorporate locally made food products in the tourist attraction. This made local food more visible to a broader audience and helped strengthen the social and economic resilience of rural communities during the pandemic (Kaufmane *et al.*, 2021).

Notably, while diversification can help farms stabilise incomes and enhance operational resilience, it also requires the cultivation of farmers' marketing skills and the backing of collaborative networks, including farmers' proactive engagement in developing shorter food chains and rebuilding supportive social and economic networks (de Roest *et al.*, 2018; Grigorescu *et al.*, 2022; Manyise and Dentoni, 2021; Meuwissen *et al.*, 2021).

2.3.1.3 Producers' knowledge and management

Agricultural management in knowledge, techniques and institutions are also recognised as supporting natural systems to support food system resilience. Marten and Helicke's (2015) research found that well-planned farm diversification with techniques such as 'bio-intensive cultivation' could improve sustainability and resilience through enhanced water efficiency and nutrient retention while reducing damage from pests and pathogens. Gramzow (2018) found that introducing improved vegetable species, sound agricultural practices to prevent disease, and integrated pest management practices could reduce negative effects on the environment and make agricultural production and rural livelihoods more resilient to outside shocks like drought and pests. Farms could improve their relationship with the environment by conserving and restoring soil, utilising available local resources efficiently, and respecting and adhering to natural cycles.

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Many scholars have also appealed for a transformation towards ecological agriculture to increase producers' resilience to future shocks (Helfenstein *et al.*, 2022; Rodríguez and González, 2018; Tittonell *et al.*, 2021). Technologies and approaches tailored to the agroecological conditions and climate risks of smallholder farms are increasingly being adopted by public agricultural institutions in many developing regions (Lipper *et al.*, 2014) to support smallholder production and livelihood resilience in climate change (Eakin *et al.*, 2018; Winowiecki *et al.*, 2015). While the duration and type of any future disturbance on individual farms will depend on the geographical and political context, scholars argue that agroecological practices that rely on internal resources and are embedded in local networks could promote resilience mechanisms, such as autonomy, social self-regulation, connectivity and local interdependence, which may foster human resources (Brzezina *et al.*, 2016) and support system's resilience capacity (Perrin and Martin, 2021).

2.3.1.4 Producers' willingness and capability to react

The willingness and ability of producers to respond to risks have also been highlighted in the literature, for example, by proactively adapting to and rapidly altering their commercial channels and establishing closer ties with consumers (Mastronardi *et al.*, 2022; Paganini *et al.*, 2020). A French study found that dairy farms selling their products through short channels received a significant impact from the lockdown even though they had multiple customers. However, the farms developed a variety of new marketing channels based on their strong adaptability, such as drop-off-free service for purchases and farm tours, which ensured their operations and consumers' access to the products they needed (Perrin and Martin, 2021).

A strong 'can-do' spirit in agriculture is an important driver for minimising losses and uncertainty (Snow *et al.*, 2021). In the process, dairy farmers have also strengthened their local interdependencies with other farms to offer their customers an extensive

range of products at one collection point (Perrin and Martin, 2021). Creating direct links between producers and consumers in a crisis can generate income for the farm by reducing the potential for unsold stocks. More importantly, such direct links involve producers in the consumer-facing retail end and minimise intermediaries, enabling fairer prices for both producers and consumers, and allowing consumers to build a perception of locally produced food (Prosser *et al.*, 2021).

2.3.1.5 Self-organisation and association of producers

The degree to which the system is capable of self-organisation is one of the dimensions of resilience (Berkes *et al.*, 2008). Collaboration among food producers can lead to significant economic and non-economic benefits, such as increased knowledge sharing, supportive networks, additional channels of access to customers, positive publicity, and increased regional brand awareness (Prosser *et al.*, 2021). A case study in the Solomon Islands showed that collaboration between fishers could prevent system collapse, sustain whole communities under minimum food security levels, and improve ecological performance, thus enhancing the resilience of the whole system to shocks (Hardy *et al.*, 2016). Similarly, food producer collaborations in Wales provided innovative marketing approaches that maintained trade capacity during the COVID-19 pandemic, supporting local populations most affected by the outbreak and subsequent restrictions, thereby strengthening the brand image and also providing accessible food to the nation (Prosser *et al.*, 2021).

However, the producer-led collaborative model may require more effort and engagement from producers, and the costs and benefits of producers' participation are linked to their contribution level (Prosser *et al.*, 2021). Beyond, the association of producers in more organised forms, such as farmers' unions and producer cooperatives, can bring systemic benefits to small-scale farmers, including the power to negotiate with the government for support and with other value chain actors for fair prices and

reduction in farm management costs through partnerships among farmers (Eidt *et al.*, 2020; Paganini *et al.*, 2020; Soubry *et al.*, 2020). While the decision-making power may be further away from producers than in producer-led collaborations (Prosser *et al.*, 2021), a cross-regional study in Indonesia and Africa found that small-scale farmers need a certain amount of social capital to build their transformative power and good organisation to supplement the supply of local food systems (Paganini *et al.*, 2020). Farmers' unions can help them cope with crises and reorient themselves more effectively, leading to greater overall system resilience (Tittonell *et al.*, 2021).

2.3.1.6 Producers' summary

In summary, the mechanisms by which producers influence food system resilience can be summarised as:

(1) autonomy with low external dependence, allowing producers to be less exposed to shocks and changes;

(2) diversity of products and operations, increasing the flexibility to cope with risks;

(3) knowledge and management, improving production resilience and adaptability;

(4) willingness and capability to react, emphasising the agility and responsiveness and hence agency of producers; and

(5) collaboration and association, integrating producers' knowledge and resources to work with local systems in multiple ways.

All of the preceding can be interpreted as assisting actors in the production system to remain reasonably operational and profitable during a crisis, i.e., to meet the needs of producers while also fulfilling their responsibility to the food system (Cabell and Oelofse, 2012; Perrin and Martin, 2021). The agency of producers is the key joint driving force that enables the above mechanisms. However, several studies have shown

that government support for producers' agency could have been more robust (Paganini *et al.*, 2020), even though producer-driven solutions often have a low threshold and do not call for much in the way of finance or programming. The profitability of small-scale farming is affected by the supply chain dominance of large-scale supermarkets, which place financial strain on the coping strategies deployed by farmers to strengthen their resilience in response to climate change impacts, market pressures, and transport issues (Singh-Peterson and Lawrence, 2017). Consequently, many adaptive transformations based on farmers' motivation face financial barriers between concept and implementation, hence reducing food system resilience (Soubry *et al.*, 2020). While producers have considerable initiative in terms of their own circumstances and resilience, this does not mean that there is not significant room for improvement in mechanisms for support from institutional structures, including those of the state and public authorities; i.e. from bodies who are ultimately tasked with government of the common weal and so the system as a whole at whatever geographical scale.

2.3.2 Intermediaries in the food system

Throughout the food system, the food supply chain connects producers to consumers. The supply chain is also a value chain in which long-term partnerships between actors who produce, transport, process, and sell products or services are essential for the food system to efficiently deliver agricultural products from producers to consumers' tables (Manyise and Dentoni, 2021).

2.3.2.1 Mainstream food supply chain actors

Research exploring actors' impact on food system resilience in supply chains has focused significantly on the retail end close to consumers. Traditional food retail locations such as supermarkets and farmers' markets help the food system to fulfil its function of securing the food supply in a given region, both in times of stability and crisis.

Farmers' markets allow consumers to learn about and connect with local agriculture. Farmers and consumers can learn from each other's feedback, which facilitates mutual understanding of the complex dynamics of the food system and improves their adaptive capacity via influencing consumer choice and farm management. By building bridges between actors, farmers' markets can help build social networks and trusting relationships in the food system, thereby enhancing local food systems' socio-ecological resilience and sustainability (Singh-Peterson and Lawrence, 2017).

In more developed economies, large corporations, such as supermarkets, contribute to securing supply by managing contracts and providing knowledge, capital, and infrastructure (Dunning *et al.*, 2015). Industrial food systems have been highly successful in providing affordable, safe, and diverse food products to growing populations of consumers (Kummu *et al.*, 2020; Matthews, 2020), with supermarkets representing the retail end of the industrial food system. A just-in-time delivery system that depends on long-distance road transport (MacMahon *et al.*, 2015) makes supermarkets well-equipped to handle fresh bulk goods, which helps keep the region's food supply stable and efficient (Merkle *et al.*, 2021). Supermarkets can also exert influence on the supply chain through procurement. Restoring a central market system and mandating that supermarkets purchase fresh products through it is considered one method to ensure that all farmers receive a fair price for their production (Singh-Peterson and Lawrence, 2017).

In the context of regional crises, the scale of a food retailer can be an asset. The power and influence of large corporations such as supermarkets in the food system have been equated to the role of 'keystone species' (Osterblom *et al.*, 2015) that are critical to ecosystem function (Merkle *et al.*, 2021). Global infrastructure and good logistics allow supermarkets to move supplies between regions where they are made (Merkle *et al.*, 2021). Food shortages in one region can be mitigated by sourcing food from other regions, making long food chains that utilise regional or global networks more resilient

to environmental disasters (MacMahon *et al.*, 2015). Researchers also looked at how retailers dealt with food supply problems during the pandemic through collaborative innovation and technological solutions (Prosser *et al.*, 2021). Supermarkets have assisted in selling and distributing food during the crisis by incorporating local suppliers and offering home delivery services (Dunning *et al.*, 2015).

2.3.2.2 Alternative food networks

Beyond the mainstream food supply chain, and building on these reflections, alternative food networks (AFN) are essential and dynamic parts of a resilient food system (O'Connell *et al.*, 2021). Much research has been done on how AFNs affect the food system's functioning and functions in times of crisis (Grigorescu *et al.*, 2022). We categorize the AFN that aids food system resilience into four categories.

2.3.2.2.1 Co-operatives of local food supply chains that skip middlemen and link producers and consumers with shorter connections, e.g. farmer partnerships, consumer cooperatives, food hub social enterprises, etc.

In addition to the associations between producers mentioned in the previous section, many studies have focused on the consumers' associations to ensure their food procurement needs. Vieira et al.(2019) found that the Brisbane Food Hub had established direct links with small-scale farmers and their social networks, making it one of the few places to get fresh food after floods. During the pandemic, Glaros et al.'s (2021) research in Canada found that connecting local producers to urban markets relied on cross-scale mobilisation and extensive collaboration and deployment of resources by civil society and government. Solidarity purchasing organisations in Rome represented a vital food supply channel during the lockdown, as they paid local farms and had greater flexibility and agility in moving and handling goods, contributing to the resilience of local agri-food structures (Tarra *et al.*, 2021). Consumer cooperatives directly connecting producers and consumers in urban areas can serve the impacted populations and

address the growing demand during COVID-19 pandemic (Atalan-Helicke and Abiral, 2021).

2.3.2.2.2 Informal retail to complement mainstream retail and improve food access

Alternative retail networks, also referred to as informal vendors and small traders in some literature studying the global South, tend to be scattered in areas where potential consumers often congregate, such as schools, transport hubs, and lower-income communities (Keck and Etzold, 2013; Kinlocke and Thomas-Hope, 2019; Nickanor *et al.*, 2019). Given that conventional retailing locations for supermarkets or farmers' markets have spatial limits (McEachern *et al.*, 2021; Nickanor *et al.*, 2019), informal retailers are therefore seen as complementary to those not catered for by the conventional formal retail sector, helping to secure their food needs (Nickanor *et al.*, 2019).

A study in Namibia found that informal retailers were thriving by occupying product niches that formal retailers have not yet monopolised, such as cheap meats, wild foods, cooked foods, and offal. However, expanding supermarkets into low-income areas has put informal vendors under pressure to be squeezed out (Nickanor *et al.*, 2019). Similarly, research in Jamaica showed that small informal retailers have played a crucial role in providing relatively cheap food to poor urban households, but they are often subject to regulatory challenges that threaten the sustainability of their trade. Their relief and capacity-building interventions may be limited by insufficient public funding (Kinlocke and Thomas-Hope, 2019). Research in Dhaka showed that informal rice and fish wholesalers were resilient and helped to meet the food needs of households that could not afford supermarket shopping and had not yet received food aid after the flooding. Such informal retailers could do so because they already had trusting customer relationships (Keck *et al.*, 2012). However, a lack of support or even eviction of informal retail by local governments have threatened the resilience of urban

food systems by hindering the ability of informal retailers to operate (Keck and Etzold, 2013).

Informal retailers are not limited to the Global South, but may have different forms of expression in the global North. McEachern et al. (2021)) advocate for establishing community-led food retailers in the United Kingdom. This transformative model can both formalise small traders and engage and unite community members, reintegrating food production and consumption into the social system. By securing space for more minor actors to survive, community-led food retailers in the community food system can help generate ethical, sustainable and resilient solutions at the local level (Turetta *et al.*, 2021). In other words, as noted above, a diversity of sizes of food actors appears to be important and advantageous, at both system and actor levels, and AFNs seem to have promise in the needed rebalancing to a diversity of small actors regarding often highly- concentrated current food systems.

2.3.2.2.3 Social distribution networks, including charities and food banks, primarily supporting vulnerable people and help alleviate food poverty

As traditional food charities, food banks not only help consumers in need of food but also help reduce food waste. The operation of food banks relies on a range of other actors and resources, including donors, public support and government backing. During the pandemic, a number of participatory food security organisations, despite facing initial challenges due to delivery disruptions and lockdowns, also provided special assistance packages for those affected by the COVID-19 pandemic (Dekkinga *et al.*, 2022). While support for food banks is a sign of social solidarity, the increase in recipients may make providing food aid perceived as fragile and unsustainable. There is also criticism that the essence of food charities is that governments across the world, in both rich and poorer countries, have abdicated their obligation to ensure the right to food, leaving the responsibility of providing food to the poor to third-party organisations

(Riches and Silvasti, 2014). When the underlying causes of the need for food aid are not addressed, food aid networks established through food banks may end up undermining the resilience of societies, particularly the ability to ensure dignified access to adequate food (Dekkinga *et al.*, 2022).

2.3.2.2.4 Self-help supply based on smaller units - from urban, community to family farming

Tendall et al.'s (2015) definition of the resilient food system clearly emphasises its 'capacity to provide adequate, appropriate, and accessible food ' rather than the 'realisation of capacity' - the implicit neoliberal connotation here requires consumers also to put in some efforts in order to reach the end of food supply (Benker, 2021). However, the lockdown caused by the pandemic made it hard for people to shop, especially in cities. This has stimulated discussions of super-local supply beyond traditional peri- urban production, encouraging a radical re-thinking of how food system resilience can be reconceptualised and practised on a global to local scale (Turetta *et al.*, 2021). From urban agriculture and community gardening to even family farming, it is possible to re- imagine new scales and systems of food production, distribution, consumption and waste management (Glaros *et al.*, 2021; Langemeyer *et al.*, 2021). Centring on harnessing the capacity of smaller units to participate, such practices can serve as additional security for low-income populations who are particularly marginalized (Piso *et al.*, 2019) and help expand the sources of food supply beyond a scale- hypostatizing/fetishizing food system.

Community food systems seek to build community food resources, including supermarkets, farmers' markets, gardens, transportation, community-based food processing businesses and urban farms, to meet community needs and promote better linkages on local agriculture between farmers and consumers (Turetta *et al.*, 2021). Household-level transformations are also gaining traction. The case of Rome

demonstrates the resilience of small-scale, sustainable family farming coupled with spatially and socially embedded food systems, where grassroots actors played an important role in ensuring food access, availability and distribution, especially for the most vulnerable populations in a context of delayed or insufficient action by mainstream food system actors and institutions (Zollet *et al.*, 2021).

2.3.2.2.5 AFN's summary

Overall, AFNs can play a role in promoting food system resilience based on transparency in the supply chain (Vieira *et al.*, 2019); established trustworthy relationships (Atalan-Helicke and Abiral, 2021; Keck and Etzold, 2013; Vieira *et al.*, 2019); the ability and willingness of actors to adapt to new contexts (Atalan-Helicke and Abiral, 2021; Paganini *et al.*, 2020; Tarra *et al.*, 2021); social capital such as social networks and connections (Keck *et al.*, 2012; McEachern *et al.*, 2021; Paganini *et al.*, 2020; Vieira *et al.*, 2019); civil society supports and bottom-up mobilised securing of government cooperation (Glaros *et al.*, 2021).

Nonetheless, alternative food networks have still been deemed incapable of addressing broad food security challenges due to their limited scale (MacMahon *et al.*, 2015). Even so, diverse sizes of food actors appear to be important and advantageous, at both system and actor levels. There is also a need to go beyond any hypostatized/ fetishized scale, not just the 'global' viz. neoliberal default ideas of 'bigger and more global is better' but also 'local'. AFNs seem to have promise in the needed dynamic rebalancing to a diversity of small actors of varying sizes and reach regarding often highly-concentrated current food systems.

The development of alternative food networks also faces challenges in terms of unequal access to opportunities and support compared to conventional food retailers and distributors. Small-scale and informal food sectors were primarily excluded from government support, unlike mainstream supermarkets (Paganini *et al.*, 2020; Zollet *et*

al., 2021). Even with a large population in great need of more access to food after the floods, the study from Dhaka showed that the local government would shut down informal retailers out of administrative inconvenience and distrust (Keck *et al.*, 2012). Governments' perception that managing AFNs is more troublesome and less cooperative than conventional retailers has affected the unequal distribution of resources and exacerbated existing socio-economic disparities among food system actors. Consequently, either transforming the current mainstream system or mainstreaming AFNs so that they can play a more significant role in the food system would be more difficult (Paganini *et al.*, 2020; Zollet *et al.*, 2021). Therefore, research suggests that the decision-making process should include more diverse actors to increase the possibility of creating different socio-economic models (Vieira *et al.*, 2019). More importantly, the resilience of food systems depends on the whole socio-economic and ecological system in which the food system is embedded. Declining earnings, unemployment, labour shortages, and other challenges caused by crises will likely result in food poverty, which cannot be effectively handled by the complementary functions of the AFN alone (Dekkinga *et al.*, 2022). The cruel truth is there are limits to what even the most resilient food system can deliver.

2.3.2.3 Debates on long and/or short food supply chains

From the discussion of traditional large retailers and alternative local food networks, the debate here centres on whether longer and more industrialised or shorter and more localised food supply chains are more conducive to food system resilience. Overall, supply chain resilience is considered to be built on agility (i.e., the ability to respond quickly and cost-effectively to shocks), visibility (i.e., the identity, location, status, and all necessary information of supply chain transit entities captured in timely messages about incidents), flexibility (i.e., the ability to adapt to changes with minimal time and effort), collaboration (i.e., the adequate capacity to work together to achieve

common goals), and information sharing to mitigate risks (Perrin and Martin, 2021). Of course, given that both non-local and local factors can affect food system resilience, it needs to be acknowledged at the outset that this is not an either/or issue. Resilience and vulnerability exist in both long and short food supply chains (SFSC) (MacMahon *et al.*, 2015), but each has strengths in several of the above characteristics. From a resilience perspective, despite the persistent criticism of food miles caused by global food trade, the ability to provide food whenever needed is an essential feature of a resilient food supply chain (Macfadyen *et al.*, 2015). Consequently, food systems become more global while distribution networks expand significantly to provide food to populations worldwide. Extensive infrastructure, logistics, and technological resources have been developed accordingly (Rotz and Fraser, 2015). Although disruptions, such as production losses due to extreme weather events or pest outbreaks, are also accompanying, global food supply chain can help ensure that agricultural landscapes and food supply are professionally managed to guarantee food availability and withstand such shocks (Macfadyen *et al.*, 2015).

However, a study in Queensland found that long chains supplying retail venues such as supermarkets were vulnerable when the flooding cut off roads, while civic agriculture, despite showing resilience, remained marginal to the food needs of most Queensland consumers (MacMahon *et al.*, 2015). Transportation is not the only challenge; lack of regional production and processing capacity is another reason why regionally based SFSC are unlikely capable of fully replacing traditional food supply chains soon (Marusak *et al.*, 2021). Additionally, SFSC struggle to compete with large grocery groups in terms of convenience, food variety, and low prices (Marusak *et al.*, 2021), suggesting that consumers' shift to AFNs during crises may be only temporary (Zollet *et al.*, 2021).

Other studies have argued that short food supply chains add redundancy and complementary resilience to the food system by letting actors respond quickly and getting help from the local government (Jones *et al.*, 2022; O'Connell *et al.*, 2021). In

contrast to larger systems, local food systems have shifted from primarily livelihood-oriented food production and consumption systems to increasingly complex multi-local networks (Spies, 2018). Many members in SFSC are themselves collectives, groups, or cooperatives with extensive networks so that suppliers affected by disruptions can easily be replaced (McDaniel *et al.*, 2021; Michel-Villarreal *et al.*, 2021). Thus, SFSC based on regional/local food systems also have some equity advantages for local actors due to greater local engagement (Meuwissen *et al.*, 2021), as well as promoting the resilience of local communities by offering political and economic capital and a sense of community pride and belonging (McDaniel *et al.*, 2021).

There has been a significant increase in SFSC research since the COVID-19 pandemic, apparently because the impediment to transportation and mobility caused by the epidemic has driven the expectation that food should come from a source closer to the consumer. Relying on global supply chains, supermarkets have been criticised for crowding out the market and growth space of smaller local competitors. However, such large actors are still seen as more reliable suppliers (Smith and Lawrence, 2018) and thus are favoured by governments to have received more support (Paganini *et al.*, 2020; Zollet *et al.*, 2021). SFSC, characterised by locally engaged actors, are not considered to have the potential to substitute traditional food webs. Instead, they can act as a reinforcement of local food systems. Local food systems, discussed here dialectically at the geographical scale, can improve nutrition and access to quality food for urban populations while increasing the incomes of household farmers (Sambuichi *et al.*, 2020). Moreover, some possibilities exist for integrating mainstream food supply chains with local actors and incorporating localised sourcing and distribution with supermarkets' industrial infrastructure to improve food system resilience based on building public-private partnerships around shared interests and goals (Dunning *et al.*, 2015). But how long and short supply chains, traditional and AFNs, can be combined to maximise resilience in a given region-based food system is necessarily a question to be considered holistically in the context of the specific geographical endowment.

2.3.3 Consumers

The traditional 'farm-to-fork' paradigm of food systems has worked for many years but is criticised for fragmenting the connection between consumers and food producers (Marten and Atalan-Helicke, 2015). For example, consumers felt closer to restaurants than those who grew their food (DuPuis *et al.*, 2022). However, in the recent literature, we have noticed an increasing focus on how consumers' consumption behaviour and patterns generate market signals and potential feedback mechanisms on food system resilience through the food value chain (Fava *et al.*, 2022; Marten and Atalan-Helicke, 2015; Miller, 2021).

The most important part of making this feedback system work is to connect consumers to the food system. Local food markets are seen as a gateway for consumers to be educated and informed about, and connected to, agriculture, potentially leading to consumers' revaluation of local food and facilitating a rebalancing of equity within the food system via adjusting the consumer behaviours. At the same time, consumer demand is also a leverage point for partnerships between locally produced food and supermarket retailers (Campbell and McAvoy, 2020; Singh-Peterson and Lawrence, 2017). Such a supermarket food service combined with local sourcing can help to increase system redundancy and diversity, injecting resilience into national and local food networks (Dunning *et al.*, 2015). This change will provide opportunities for traditionally powerless actors, such as small-scale producers, to reformulate food chains in a way that is more closely linked to their territories, endowing them with resilience capabilities (Fava *et al.*, 2022).

During the pandemic, it was discovered that consumer behaviour at the household level had both supporting and adverse effects on the resilience of the food systems in which they are located. Improved cooking and food management skills helped increase household flexibility during the lockdown, which has reduced food waste and per capita demand for food redundancy (i.e. the need for stores of food beyond what is actually consumed), resulting in less panic buying transmitted to

upstream (Bender *et al.*, 2022). At the same time, consumers were observed to expand refrigerated food capacity and increase food stocks to cope with shortages during the lockdown (Benker, 2021), leading to larger single orders and less frequent purchases. This type of order could trigger increased demand volatility for upstream actors in the food supply chain. Consequently, the increase in consumers' household food stocks could enhance household resilience at the expense of system-wide resilience (Bender *et al.*, 2022; Benker, 2021). More importantly, consumer behaviour is very susceptible to change. Even if consumers felt the many benefits of local AFN during the lockdown, they are likely to be attracted again by the convenience of one-stop shopping, home delivery and value- added products from large retailers after the outbreak has passed (Hobbs, 2021). Even consumers with flexible budgets are less likely to prioritise buying locally-produced food over spending their time and money on other purposes (Marusak *et al.*, 2021).

The vast quantity, individual variation and changing demands of consumers make it difficult to trace how they influence food value chain actors upwards or even shape the overall resilience of the food system. We can observe some trends in the clues described above, but debating the specific impacts of particular consumer behaviours on food system resilience is necessarily case-based. In other words, the complexity of consumers makes it exceptionally important to build consensus and shape consumption trends in favour of food system resilience.

2.4 Supportive roles for food system resilience

From the literature and the previous discussion, we can see that food system resilience can be influenced not only by actors, but also relies on a number of key supportive roles that link them together. In the 105 articles that this review selects, food systems are normally dependent on the nature and agriculture, energy systems, logistics, infrastructure and governance. However, we also note that recent logistical developments and digitisation have made the food system resilience more dependent

on internet infrastructures than on physical venue infrastructures in the past. The COVID- 19 pandemic has made it impossible to ignore the role of information technology that affects so many actors in the food system, during when food storage has been highlighted even at the household level. This paper comes a couple of years after the outbreak of COVID-19 pandemic – a worldwide public crisis of socio-economic, including food systems, when this surge in learning has filtered into the literature but not yet been synthesised into a review. In this section, we thus summarise these supportive roles for food system resilience based on the 105 articles in a developing perspective, with an attempt to flag some potentially significant problems and trade-offs.

2.4.1 Nature and relevant agricultural systems

Natural systems provide the fundamental resources including climate, water, and soil for food systems (Bailey and Buck, 2016; Ruhf, 2015). Agricultural activities, such as irrigating, fertilising and feeding, use natural and environmental resources to produce food. Agriculture accounts for roughly 70% of global water withdrawals, with water needed throughout the food chain, from breeding and irrigation for food production to food waste disposal (Uhlenbrook *et al.*, 2022). Investments in water infrastructure, such as reservoirs and irrigation, can enhance the resilience of agricultural production to water-related risks (Zurek *et al.*, 2020).

Similarly, the land is a critical component of agricultural production (Skog *et al.*, 2018). A finer-grained land use pattern based on existing local land use can improve the resilience of individual farms while sustaining overall production across the agricultural landscape (Abson *et al.*, 2013). However, sustainable land use and management must carefully balance agricultural production and other uses. For example, large-scale bioenergy and carbon sequestration projects for climate change mitigation may promote land grabbing, negatively impacting smallholder livelihoods and food security (Rosenzweig *et al.*, 2020). Thus, it is crucial to prioritize stakeholder participation in land

management practices to ensure that land use does not undermine the resilience and sustainability of the food system.

Many studies have raised concerns that food systems may only operate in or near the safe operating space of the planetary boundaries by 2050 even if multiple measures are implemented immediately and simultaneously (Conijn *et al.*, 2018). Food systems account for a third of global anthropogenic greenhouse gas emissions (Crippa *et al.*, 2021). Food production has also led to 25% of the world's arable land degradation, while agricultural deforestation and intensification of agricultural landscapes are substantial contributors to biodiversity loss (Webb *et al.*, 2020). As food production expands to meet growing demand, there is a risk of further environmental degradation, damage to natural resources and animal welfare (Anthony, 2018).

Moreover, food systems are affected by their impact on natural systems and the risks posed by natural systems. For example, floods significantly risk food production, storage, and distribution (MacMahon *et al.*, 2015). Although only correlations between food system activities and natural system risks can be identified rather than judged as causal, it is essential to confront the potential conflicts and trade-offs between food systems and the nature.

2.4.2 Energy systems

Every part of the food system, from growing crops to disposing of food waste, needs direct fuel and electricity from the energy system to work. Indirect energy use for fertiliser, pesticide and machinery production has contributed to significant food production increases (Woods *et al.*, 2010). However, the globally connected food system maximises spare allocation capacity in an extremely energy-inefficient way (Rotz and Fraser, 2015), and such activities remains an important source of anthropogenic greenhouse gas emissions (Woods *et al.*, 2010). Food prices are linked to fossil energy

prices and improving food production and distribution patterns to make the food system use less energy is seen as one of the most important ways to make the food system more sustainable (Wakeland *et al.*, 2012). During the COVID-19 epidemic, many consumers have increased their food storage capacity, and refrigerators and freezers are among the most energy-intensive equipment in most homes (Bender *et al.*, 2022). Not only does the energy system directly assist the functioning of food system actors, but it also backs up the operation of the food system's supportive roles.

2.4.3 Venue infrastructure

The availability and diversity of venues is closely related to the food system resilience during crises, including retail venues such as supermarkets and farmers' markets, dining venues, distribution venues and relevant venues for charitable organisations (DuPuis *et al.*, 2022). For example, the Brisbane Food Hub became one of the few places where fresh food was available after the floods, and the venue's availability aided the resilience of the local food system (Vieira *et al.*, 2019).

However, while venues are still necessary, the development of e-commerce and delivery-to-home services has gradually shifted the key to ensuring the proper functioning of the food system from the availability of venues to ensuring the proper logistics of food in a multiplicity of consumption scenarios. This has, in part, influenced a shift in the need for venues in the food system from centralised to more decentralised, even community-based venues.

2.4.4 Logistics and food distribution networks

Logistics link the actors of the food system, including delivery from farms to processors, processors to retailers and retailers to homes or restaurants (Wakeland *et al.*, 2012). Hurricanes in the United States, protests and strikes (e.g. by truck drivers in

the United Kingdom due to a sudden rise in fuel prices), and landslides caused by heavy rains in Nepal have all caused food supply crises by disrupting the food distribution networks (Marten and Atalan-Helicke, 2015; Spies, 2018). The smooth functioning of logistics systems in times of crisis is a prerequisite for securing the livelihoods of food system actors and also meeting the needs of consumers and is therefore an essential enabler for achieving food system functions and resilience (Coopmans *et al.*, 2021; Marten and Atalan-Helicke, 2015; Paci-Green and Berardi, 2015).

However, there are some problems with the logistics system that are not necessarily caused by or could be handled within the food system. For example, traffic jams around cities make it harder to move freight efficiently and raise the costs that freight companies and shippers have to pay. The current design of the food distribution system, which relies on large retailers, has resulted in limited food availability in poorer urban areas. The pattern of consumers shopping in centralised locations and making self-last-mile delivery may further exacerbate congestion (Miller, 2021).

Regional food supply chains could adopt logistical best practices that improve efficiency, which is particularly important for regional food supply chains to remain competitive after the pandemic ends (Marusak *et al.*, 2021). At the same time, logistics remains a crucial contributor to environmental emissions throughout the food chain (Wakeland *et al.*, 2012). Therefore, actors should make ecologically sustainable choices at all stages of food distribution, such as optimising the location of supply chain nodes, improving distribution routes and reorganising supply chains to embrace more innovative approaches to distribution and transport systems (Mastronardi *et al.*, 2022; Miller, 2021).

The logistics system contributed significantly to the functioning of the food system during the pandemic, with research revealing that empty shelves were more frequently the result of initial panic buying and untimely replenishment than the food system's supply and distribution (Coopmans *et al.*, 2021). Research has also found that

providing 'last mile' home delivery helped meet consumers' food needs during the lockdown. However, home delivery has been questioned for its high capital investment costs and sustainability. Home delivery exposes drivers to poor working conditions and time pressure on perishable food, which would make home delivery socially and environmentally unsustainable. Moreover, home delivery is believed to sever the direct linkages between sellers/producers and consumers by diminishing the social role of the market's urban area, rendering producers invisible and unable to communicate sustainability issues in the food supply chain (Fava *et al.*, 2022). Therefore, how the logistics system, as the linker, can better support food system resilience still needs to be optimised in various aspects.

2.4.5 Food storage schemes at various geographical scales

Numerous interruptions in the food system have the potential to impede food shipping. As a result, setting up specific food storage schemes by governments or commercial companies at crucial points in the supply chain is considered a good buffer in case the logistics system runs into trouble (Marten and Atalan-Helicke, 2015; Paci-Green and Berardi, 2015). It is common practice for countries to establish a national food reserve system in case of emergency. For instance, China maintains extensive public inventories of food grain and frozen meat across all provinces as part of a national food stock program. By drawing on reserves during surplus and releasing them during shortages, the food reserve system has the potential to moderate price fluctuations in the food supply (Dev and Zhong, 2015).

During the COVID-19 pandemic, groceries and other upstream actors with formal inventory management strategies increased their response to shocks associated with the pandemic (Bender *et al.*, 2022). At the family level, a certain amount of household space were redefined as a resilient way to cope with shortages (Benker, 2021). Consumers increased the refrigerated food storage capacity during the pandemic by

purchasing additional fridges and freezers, and stockpiling raw materials for meal preparation (Bender *et al.*, 2022). While preparing food storage has been effective in increasing households' and supply chains' resilience during the COVID-19 pandemic, its impact on the resilience of the food system as a whole is controversial. Food storage can be wasteful if not used in a timely manner, and excessive stockpiling can pass feedback up the value chain, thereby increasing volatility at the production end and ultimately undermining the food system resilience (Bender *et al.*, 2022; Benker, 2021).

2.4.6 Digital technologies for information sharing

Information technology has improved the supply chain's visibility. For example, traceability solutions built on blockchain can send sensitive information quickly and securely. This helps supply chain actors comprehensively understand their supply chain network and get real-time information about sites, routes, suppliers, and areas where food products are at risk. Blockchain can also improve consumer communication by tracking information, and help companies build consumer trust (Collart and Canales, 2022).

The COVID-19 pandemic has acceleratively digitised various sectors of the food system. A growing number of studies report that supply chain actors increasingly use digital technologies to communicate, coordinate and transform within the supply chain (Mastronardi *et al.*, 2022; Michel-Villarreal *et al.*, 2021; Paganini *et al.*, 2020; Bassett *et al.*, 2022; Fava *et al.*, 2022). Accessible and affordable internet connections play a central role in digital communication (Paganini *et al.*, 2020). For example, in a cross-regional study, farmers could sell their crops through apps and digital agricultural marketing during the lockdown (Paganini *et al.*, 2020). This communication has helped overcome the digital gap that often prevents marginalized groups from participating equally in the food system (Paganini *et al.*, 2020). Supporting smallholders in meeting market demand

and accessing digital marketing is essential in supporting local food systems and shortening food supply chains to adapt to future shocks (Grigorescu *et al.*, 2022).

Digital technologies such as YouTube, Zoom, Google Meet, and WhatsApp have been used to exchange information between actors, enabling collaboration between customers and suppliers and extending consumer networks (Fava *et al.*, 2022; Michel-Villarreal *et al.*, 2021; Paganini *et al.*, 2020). Short food supply chain actors have been able to communicate directly with each other about stock levels, shop timetables, and consumer orders through WhatsApp, allowing for quick reconfiguration of food supplies during disruptions (Bassett *et al.*, 2022; Michel-Villarreal *et al.*, 2021). Therefore, further research and policy efforts to establish and strengthen communication networks are vital to building resilient food systems during crises (O'Connell *et al.*, 2021).

However, digitisation and e-commerce in agri-food systems as a means of promoting cooperation and rural-urban integration in supply chains are still dependent on facilitating the physical infrastructure of networks as well as storage and delivery (Berkhout *et al.*, 2023). While digitisation has the potential to compensate for some access inequalities in the current food system, it may also exacerbate such disparities, as the threshold for digitisation can make it more difficult for actors lacking digital skills to compete (Berkhout *et al.*, 2023). The potential damage that such technological thresholds may have on actor diversity deserves greater policy attention.

2.4.7 Institutional care/support

Undoubtedly, financial and resource support from the public and private sectors has long been proven to facilitate the food system and its actors to navigate crises (Folke *et al.*, 2010; Jacques, 2015). However, many studies have also pointed out that inequalities in support for actors can reinforce existing socio-economic inequalities in the food system. Existing strong retailers received much more support from public

policies after the flooding of 2011 in Queensland, while civic organisations were rarely taken into account (Smith and Lawrence, 2018). Research by Paganini et al. (2020) and Zollet et al. (2021) stated that mainstream food system actors have gained policy favour for their indispensableness in dealing with the COVID-19 pandemic, which has further crowded out the space for smaller actors to survive and operate, hence shadowing the long-term food system resilience. Because of this, the benefits of care and support need to be shared more fairly, including food aid, direct financial assistance, and public policies that support people (Dekkinga *et al.*, 2022). Receiving support and care can facilitate the adaptation of supply chain actors to the widespread disruptions of the COVID-19 and allow them to continue performing reasonable roles. Support and care are essential, but their effects can vary considerably depending on the type of help given, how well and fairly it is distributed, and the broader economic and social situation (Bassett *et al.*, 2022).

2.5 Resilience mechanisms

In this section, we seek to build on the literature and the prior review by identifying some common mechanisms by which different food system actors influence food system resilience. We note four key issues in particular, all of which are distinguished in being factors that only become apparent, and whose crucial importance becomes understandable, when adopting an actor-system perspective, since they are all specifically system-related features.

2.5.1 Actors' capability and agency for resilience

Bene (2020) highlighted the distinction between resilience and resilience capabilities, and the necessity to consider how the latter translates into the former. However, it is also crucial to acknowledge that actors' resilience capabilities and agency to pursue resilience are not always aligned. Physical elements, including finances, education, access to knowledge and infrastructure, and experience, have been

emphasised in some research as essential for food system actors' resilience (Bene, 2020). Equally essential to these objective considerations is the actor's subjective agency and the extent to which they can proactively employ buffering, coping, and adaptive capability (Dumont *et al.*, 2020). In other words, actors must be autonomous and willing to use their capabilities to strengthen the food system's resilience to disruptions (Coopmans *et al.*, 2021). This involves taking proactive steps to build resilience, such as investing in infrastructure or forming partnerships with other actors (Zurek *et al.*, 2020). However, not all actors have the agency to move towards resilience. Actors prioritising short-term gains over long- term sustainability may not be motivated to invest in resilience-building agency.

By focusing on the subjective agency of actors, we can better understand how their engagement with resilience-building agency can lead to outcomes for the food system. Actors make decisions based on their self-interest, and their engagement with shared knowledge, resources, cooperation, and collective action can be driven by their motivation for robustness, recovery, and reorientation. Therefore, agency is not wholly a subjective matter but is shaped by the 'objective' situations in which actors find themselves, rather than simply appearing alongside them. This means that even if actors have the capabilities and agency to be resilient, they may not necessarily prioritise the optimal outcome of the food system and other actors. In effect, there may be conflicting interests between actors and actors' efforts may not be conducive to food system resilience. For example, emphasising local food production during the COVID-19 pandemic may benefit local farmers but undermine the livelihoods of associated non-local producers, transporters, and retailers (DuPuis *et al.*, 2022). Actors who hold significant power may use their influence to shape the system in ways that prioritise their interests over the collective resilience of the system (Smith and Lawrence, 2018). The actor and system level interest may also be complementary, such as increasing investment in crop diversity and farmers' livelihood resilience (Bailey and Buck, 2016). Therefore, it is vital to critically assess the motivations and actions of actors in the food

system and to encourage resilience-building agency that benefits the entire system rather than just a select few.

2.5.2 Diversity of actors and functions

Diversity is widely recognised as a critical strategy for enhancing the resilience of food and even social-ecological systems while mitigating systemic vulnerabilities (James and Friel, 2015). Organisational and functional diversity of actors are vital attributes of resilience (Fletcher *et al.*, 2021; Merkle *et al.*, 2021). Organisational diversity can be achieved by including firms of various sizes, as large firms are more stable and small firms are more flexible (Merkle *et al.*, 2021). Combining firms in various sizes is critical for developing resilient systems.

Functionally, diversified farms play a crucial role in the resilience of food supply chains by increasing income from agricultural production, reducing reliance on a single product or channel, and strengthening relationships with local entrepreneurs, other farms, and consumers (Abson *et al.*, 2013; de Roest *et al.*, 2018; Dumont *et al.*, 2020; Helfenstein *et al.*, 2022; Mastronardi *et al.*, 2022; Mzyece and Ng'ombe, 2020). Supply chain flexibility can be enhanced by diversifying the network of actors through multi-source sourcing, diverse product mixes, livelihood activities, and distribution strategies. Such diversity can help actors and systems respond to market fluctuations and logistical constraints, thus increasing their ability to withstand shocks (Bassett *et al.*, 2022; Chapot *et al.*, 2021; Marten and Atalan-Helicke, 2015; Michel-Villarreal *et al.*, 2021). Conversely, highly efficient networks with greater sensitivity to shocks, low levels of functional diversity, inflexible contracts, and homogeneous processes may increase the vulnerability of supply chains (Merkle *et al.*, 2021; Voorn *et al.*, 2020).

As a critical strategy for improving food system resilience, diversity provides functional redundancy, or 'insurance', allowing some components to compensate for

the loss of others (Biggs *et al.*, 2012). The availability of redundant resources and the ability to find alternate producers quickly when needed are essential for achieving system resilience (Michel-Villarreal *et al.*, 2021). Traditional industrial agri-food systems have tended to eliminate small local farms and businesses that provided redundancy, leaving local food systems without fail-safe mechanisms (Hendrickson, 2015). The over-pursuit of efficiency, standardisation, and specialisation in the food system has reduced its functional and organisational diversity, limiting its capability to buffer disruptions and thus reducing resilience (Cabell and Oelofse, 2012). While market concentration at some levels can coexist with functional diversity, low enterprise diversity is believed to lead to system vulnerability (Merkle *et al.*, 2021). To ensure functional redundancy and resilience, it is necessary to retain a varied range of actors with different roles in the food system.

Complementarities can help to achieve the effects of diversity on the food system. Developing local and domestic supply chains that are well-connected, for instance, might lessen reliance on international markets and the accompanying risks while simultaneously enhancing the global trading system. This can make the system and its actors less vulnerable to shocks and better able to cope with or adapt to stresses (Bassett *et al.*, 2022). Snow et al. demonstrated that it might be possible to integrate businesses with high degrees of plasticity (e.g. dairy farms), which may adjust their production, processing, and distribution systems, with industries that rely on a constant flow and have little or no storage, such as pork or poultry production. Thus, one or more subsystem(s) can compensate for more vulnerable subsystems, resulting in systemic resilience (Snow *et al.*, 2021). To build resilient urban food systems, seeing different food subsystems as complementary rather than conflicting is important (James and Friel, 2015).

The literature reveals interesting debates and trade-offs between diversification/redundancy and specialisation/efficiency, identifying crucial thresholds that consider the level of development and geography (Miller, 2021). According to

Kummu et al.'s analysis, global food trade can encourage the specialisation of food production in exporting countries, while also enhance the diversity of food supply at destination and increase their reliance on external food sources (2020). This combination may leave food systems in importing and exporting countries vulnerable to several natural and social-economical disruptions (Kummu *et al.*, 2020).

However, and crucially, a single diversification or specialisation is neither inherently positive nor negative in itself; nor, therefore, definitively knowable as such in advance of the contingently and uncertainly arising shocks to the system regarding which, it subsequently turns out, it proves beneficial or harmful respectively. The systemic effect can only ever be 'confirmed/verified' post hoc, given the literally infinite – and so uncertain – potential shocks or developments it may need to cope with and prove resilient to. For instance, developing countries with low agricultural and supply chain development levels may advocate for 'sustainable intensification' to increase specialisation in agriculture. This can make farmers more efficient by acquiring specialised production skills and applying the latest production technologies (de Roest *et al.*, 2018). The question of balance, preserving and actively developing the diversity of such structures, given the particular starting point or context in each location, thus needs to be given explicit consideration. Therefore, too, governance should comprehensively consider and involve many stakeholders in determining whether the development of food systems should focus on diversification or specialisation (de Roest *et al.*, 2018; Kummu *et al.*, 2020).

2.5.3 Connectivity and connections

Food systems are characterized by various linkages and interactions between actors. Such connections mean that pursuing resilience-building activities by individual actors could positively impact others. For example, restoring degraded farmland and revegetating nearby upstream areas can increase the water available for small-scale

irrigation, improving farmers' labour productivity and households' ability to convert assets into income (Bailey and Buck, 2016). However, this widespread connectivity also makes it easy for risks to spread. The potential for rapid transmission of disturbances from one landscape scale to another, known as connectivity in ecosystems, is seen as an essential mechanism affecting food system resilience (Rotz and Fraser, 2015). Similar concepts, such as 'transmissibility' or 'ripple effects' (Bene, 2020) of the supply chain, convey the same meaning.

Many studies have argued that high levels of connectivity can make food systems vulnerable to disruptions (Sundstrom and Allen, 2019). For example, in the international food trade, the increased connectivity of different regional actors in a heterogeneous global food trade network can make local disturbances more likely to propagate throughout the system, reducing food system resilience (Karakoc and Konar, 2021; Tu *et al.*, 2019). Increased connectivity is often accompanied by reduced diversity, as a few prominent actors provide more services in the food supply chain while smaller actors are eliminated, which is detrimental to the diversity and resilience of the food system (Rotz and Fraser, 2015).

This dynamic has led to highly oligopolistic markets, such as the top three American meat processors currently controlling 80% of the US beef market. Commodity concentration in particular can leave supply chains vulnerable to contamination and outbreaks in new ways (Rotz and Fraser, 2015). One of the key criticisms of intensive meat production is the spread of zoonotic and drug-resistant pathogens (Chan and Enticott, 2019).

More importantly, actors in highly connected food systems may be disproportionately exposed to disturbances or bear a share of the costs for enhancing systemic resilience (Monastyrnaya, 2020; Zurek *et al.*, 2020). For example, in a study of the UK fresh fruit and vegetable sector, Zurek et al. (2020) found that a diversification strategy to increase supply resilience through flexibility in finding alternative suppliers

could undermine resilience at the grower level, while it is the producers who bear more of the cost of investing in agricultural infrastructure to ensure stable production.

In contrast, social connections between actors in food systems, including horizontal and vertical linkages between producers, processors, and retailers, especially across different scales, are widely recognised as contributing to the resilience of food systems (Glaros *et al.*, 2021; Leat and Revoredo-Giha, 2013). Social connections and networking between actors can facilitate better communications about shared needs and interests to cope with situations of high uncertainty and a lack of clear information, and foster trusting relationships (O'Connell *et al.*, 2021). Trust is vital in reducing bureaucracy, promoting mobility, and sometimes eliminating accreditation needs (Vieira *et al.*, 2019). Social connections and networking enable sharing of resources, collaboration, partnership formation, and collective action among food system actors.

Food system actors are encouraged to build social connections and networks with others to share infrastructure, resources, logistics, and knowledge (Merkle *et al.*, 2021). For instance, when the dairy industry experienced shocks, information sharing and collaboration throughout the supply chain helped maintain a stable milk supply by ensuring the smooth flow of products from farms to points of sale (Perrin and Martin, 2021). For underprivileged communities in Canada, the Food Community Network has become an essential social infrastructure due to its ability to speed up the establishment of community gardens, farmers' markets, and new distribution channels (Glaros *et al.*, 2021).

Social connections and networking are also crucial in regional food systems (McDaniel *et al.*, 2021). For example, connecting growers in Florida with buyers made it easier to deal with public health emergencies and natural disasters (Campbell and McAvoy, 2020). Local food councils in North Carolina increased data collection and public messaging to share concerns from various sectors, identify solutions, and build resilience in the local food system during the COVID-19 pandemic (Cruz *et al.*, 2021).

Adaptation and resilience in Australia's intricate food system require open lines of communication between the private sector, the government, and enterprises that are typically seen as rivals (Jones *et al.*, 2022).

Collective action is viewed as an opportunity to collaborate across scales, such as producer and distributor networks, and share knowledge in the Canadian Maritimes food system (Soubry *et al.*, 2020). Farmers' associations commercialise fresh produce in Nicaragua for local consumption, developing new niche markets through a network of trusted producer communities (Starobin, 2021). Collective action has knock-on effects beyond direct benefits, such as developing and maintaining market positioning, reducing farm risks and vulnerabilities, gaining official acknowledgement and legitimacy, and consolidating a body of knowledge and best practices (Soubry *et al.*, 2020).

Overall, the food system resilience depends on a complex web of connections and interactions between different actors. However, this research has found that the critical factor affecting the impact of these connections on resilience is whether they are based on diversity. Connections of actors could complement diversity by activating different components innovatively (Jones *et al.*, 2022), i.e. in novel and newly productive arrangements, combinations and relations. For example, food trade networks can increase diversity and resilience by targeting the elimination of essential large-scale exporters, thus ensuring that the system is not overly reliant on a few dominant actors (Karakoc and Konar, 2021). However, increased connectivity can lead to concentration in the food system. To ensure that connectivity contributes to resilience, it is crucial to balance it with diversity.

2.5.4 Learning and knowledge

The fourth key issue emerges from, and is manifest in and regarding, both diversity and connectivity, namely learning. Most obviously, learning is essential for

building food system resilience by enhancing the adaptability of the actors involved (Bassett *et al.*, 2022; Paloviita *et al.*, 2017; Smith and Lawrence, 2018; Walker *et al.*, 2004). This is because learning allows actors to respond accurately, or at least receptively and appropriately, to socio-ecological feedback (de Roest *et al.*, 2018). Tendall et al. stated explicitly that building food system resilience is a long-term, continual cycle of action and learning (2015).

Perrin and Martin showed that reflective and shared learning to build human capital, i.e. learning from past experiences and sharing this knowledge, is a vital strategy for building resilience on farms and that farm resilience underpins food system resilience (2021). Fletcher et al. also suggested that increasing knowledge exchange between stakeholders and actors in existing and new value chains is a crucial resilience mechanism (2021). Knowledge and learning can link food production systems and consumers, helping local or regional food systems compensate for mainstream food system deficiencies (Marten and Atalan-Helicke, 2015; Skog *et al.*, 2018). Milestad's research found that feedback between consumers and farmers provided the potential for learning, which helped to improve their adaptive capacity to each other, and thus became a driver of increased food system resilience (2010).

Such considerations clearly thus invoke issues of both diversity and connectivity. The sharing of insights and learning amongst food system actors clearly is conditional upon the connectivity amongst that food system; while the diversity of actors, and the flourishing of that diversity, also likewise manifests the extent, pace and depth of learning by actors, spotting opportunities for collaborative and/or competitive advantage and innovation, not least in their own activities and forms. But equally, diversity and connectivity are themselves key dimensions of learning here too. Flagging this explicitly, as here in this review, thus, we would hope, could contribute indirectly to alerting food system actors to otherwise neglected and untapped opportunities for learning that is productive for the resilience of both them as actors and the system as a whole.

2.6 Discussion and Conclusion

Key points arising from this review, seeking to synthesize dispersed insights regarding the interaction of system-level and actor-level perspectives regarding food system resilience, are the importance of constant learning from practical experience, shifting of focus of governance to mutual learning and enabling, and the dynamics of the ethics of actor vs system. In this process, this review is well-aware that existing research on food system resilience lacks, for a variety of reasons, the study of many important actors. For example, the review didn't seem to find very much in the way of literature engaging with the wide spectrum of retailers between large supermarkets and alternative food networks, or with intermediaries such as processors or wholesalers. More importantly, research on the mechanisms by which actors influence food system resilience is largely based on observations and empirical evidence from single crisis, with less replicable and quantifiable norms given the complexity of the food system, resulting in a degree of ambiguity about causality between what actors do and the outcomes at the system level.

This paper has seen how both large and smaller actors, long and short supply chains etc... have strengths and weaknesses, providing trade-offs, and that a diversity of all of these is thus in principle beneficial, with no perfect arrangement ex ante. Moreover, that very diversity manifests and generates a context of continual novelty and innovation, hence a dynamic background and an uncertainly moving target. As such, as already noted above, it follows that, from the perspective of appropriate intervention in food system resilience, it is in principle never definitively knowable whether a specific intervention will benefit or harm that goal in the future.

Key to all this, though, is the underlying paradigm shift this effects and the associated challenges regarding the changed expectations of scientific and governance understanding; specifically, that the above reflections strongly suggest not only that it proves to be extremely challenging to identify a clear and definitive optimal policy or

strategy for food system resilience ex ante, but that *no such optimal actually exists* (i.e. 'out there', awaiting identification).

Therefore, for future research agenda, in addition to an enhanced focus on actors that are currently under-researched, it must thus be dropped as the explicit goal of policy and policy research, for it is a cipher. And instead, a different and new approach is needed, in which the goal is explicitly reoriented towards the live and responsive ongoing experimental attempt to govern and balance the food system ever more skilfully. Of course, framed thus, this paper also sees yet more clearly why it is specifically *learning* and not 'knowledge' (let alone 'information' or 'data') that is of such central importance, viz. in terms of the still-crucial application of knowledge to improving food system resilience as explicitly a never-ending and constantly improving process, *and* at both the level of individual actors and the collective emergent level of the system as whole.

3 Navigating the Pandemic: A Study of Restaurants' Organisational Resilience of the COVID-19 and the Systemic Implications

Abstract

In early 2020, Wuhan grappled with the onset of the COVID-19 outbreak, enduring an extensive 76-day lockdown. While the urban food system managed to endure, the restaurant industry faced significant challenges. This paper employs the theoretical frameworks of organisational resilience and dynamic capabilities to examine how restaurants navigated the threats and opportunities presented by the pandemic. Focusing on their ability to sense, seize, and transform in response to COVID-19, the study reveals that rapid resource reconfiguration compensated for initial unpreparedness. The cumulative impact of dynamic capabilities on organisational resilience underscores the importance of adaptive responses throughout the pandemic. However, the analysis identifies inequalities in access to support, influencing the dynamic capabilities of various restaurants. Triangulating findings, the study unveils concerning aspects of the post-pandemic recovery and transformation of China's urban restaurant sector. Independent restaurants face deteriorating conditions, with major players gaining significant advantages in capital resources, support access, advertising, and technology. This shift towards major players, while reducing diversity, amplifies the industry's influence on consumers' dietary needs through takeaway services, raising public health concerns. This paper not only enriches resilience theories with practical managerial insights but also illuminates the impact of organisational resilience on the broader food system resilience.

3.1 Introduction

The outbreak of COVID-19 exposed the vulnerabilities as well as the unpreparedness of the food system (Blay-Palmer *et al.*, 2021), and further highlights the significance of resilience of the system and its actors against risks. Restaurants have the most intensive and unavoidable human contact in the food system and were therefore among the most impacted ones in the COVID-19 pandemic. The restaurant industry is an essential sector of the food system, catering for the dietary needs of consumers with convenient and varied food options, but it has also been frequently criticised for potentially providing insufficiently healthy dietary choices and subconsciously inducing consumer preference for unhealthy food. Restaurant businesses are commercially and economically important because of their contribution to employment and local economies (Meneguel *et al.*, 2019). Despite being often overlooked in food system research, the function of restaurants in shaping food culture and value chain (Zhang *et al.*, 2021) deserves more attention. However, research has shown that restaurants were forced to close or operate at limited capacity worldwide, resulting in significant revenue losses, job cuts and residents' inconvenience (Kim *et al.*, 2021; Yang *et al.*, 2020; Brizek *et al.*, 2021; Song *et al.*, 2021).

China's restaurant industry has made great growth, with the revenues increasing year-on-year and its contribution to GDP reaching 4.7% in 2019 (China Statistical Yearbook 2021). Meanwhile, takeaway services have revolutionized the industry by bringing more restaurant food to household tables than ever during the past decade, with their share exceeding 20% of the overall restaurant revenues in 2019 (State Information Center 2020). This has given restaurants a growing influence over what people eat and the food supply chain. Wuhan, located in the middle of China, was among the first major cities to be attacked by the COVID-19 pandemic and experienced severe lockdowns lasting for 76 days (23rd Jan to 8th April 2020). Before the pandemic, Wuhan's restaurant industry had maintained steady growth in revenue and the number of branches in chain restaurants. However, Wuhan's GDP for 2020 decreased by 3%, while

the total revenue from restaurant industry fell dramatically by 65.8%, with its contribution to GDP dropping from 4.67% to 1.66% (Wuhan Statistical Yearbook 2021).

The experience regarding SARS indicated that changing customers' negative attitudes towards restaurants after the epidemic would be challenging because of customers' self-protection (Chuo, 2014). As the COVID-19 pandemic was far worse than SARS in terms of the number of cases and the spread of infection, restaurants that survived the initial shock must contemplate managing themselves and building resilience under the long-term pressures. This paper thus applies the theories of organisational resilience, which refers to the organisation's ability to withstand disruptions in the system and adapt to new circumstances (Starr *et al.*, 2003), and dynamic capabilities, which are based on reconfiguring internal and external resources, modifying routine operations, and transforming knowledge (Cepeda and Vera, 2007), as the theoretical lenses. Through conducting interviews with restaurant operators in Wuhan, this study examines how restaurant organisations' dynamic capabilities including sensing, seizing and transforming (Teece, 2007, 2017) in response to the COVID-19 affect organisational resilience. Moreover, through survey and triangulation, this paper incorporates a food system perspective while examining restaurant changes and evolutions.

From a resilience perspective, this paper explores how restaurants' efforts to maintain themselves functioning during a short-term external shock and in the shift of this short-term shock to a longer-term stress (resilience to what and over what time period) affect their own resilience (resilience of what: the survival of organisations and functioning) as well as that of the food system to deliver desirable outcomes, i.e. providing healthy diets and economic prosperity (resilience of what) in the long run. Given that resilience at the actor-system level can be both conflictual and synergistic, this paper pioneers a restaurant industry perspective on the impact that the pursuit of organisational resilience may have on the industry and even system resilience (resilience for whom). This paper also reflects on the impact that the growing influence of the

restaurant industry, particularly on public life with the help of takeaways, may have on the diversity of the restaurant industry, the health outcomes of the food system. How to increase the industry's resilience while maintaining a degree of diversity in organisations will be a question that needs to be addressed in an integrated manner, not only by the restaurant industry but also by other sectors of the food system.

In the following sections, Section 3.2 reviews the literature on organisational resilience and food system resilience, summarises the current research landscape in the restaurant industry concerning food systems and resilience, and presents this paper's research questions and analytical perspective. Section 3.3 describes the methodology of the paper and gives the data sources. Section 3.4 concludes with interview evidence on how restaurant organisations pursue their resilience and triangulation evidence on the potential impact on the restaurant industry. Section 3.5 carries out the discussion of how organisational and industry changes will affect food system resilience. Section 3.6 offers a conclusion. Specific coding details of this paper are provided in the Appendices.

3.2 Theoretical frameworks

3.2.1 Resilience in the food system and organisations

The concept of 'resilience' was first put forth by Holling (1973), referring to the capacity of a system to accept changes while continuing to persist. Resilience of the food system has picked up steam in recent years and particularly heated during the COVID-19 outbreak, where lockdowns and travel restrictions made it difficult for people to get food worldwide.

Food systems include all actors and their interactive activities related to producing, processing, distributing, retailing, preparing and consuming food, which give rise to a wide range of socio-economic, nutrition and environmental outcomes (Zurek *et al.*, 2020). Food system resilience is defined as the ability to provide stable levels of consistent nutrition to the public despite disruptions (Tendall *et al.,* 2015; de

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Steenhuijsen Piters *et al.*, 2021). Arguably, the food system is ultimately about solving the primary challenge of people eating well appropriately; thus, the food system must continue to ensure 'people eating well' despite disruptions—and this is what food system resilience is all about. Based on the four key questions to operationalise systemic resilience including 'resilience of what, resilience to what, resilience for whom and resilience for how long' that Helfgott identified (2018), such a definition has two primary implications: (1) resilience is a capability and therefore can be enhanced (Bene, 2020), and (2) the food system must ensure that its duties to public are carried out rather than merely actors operating in challenging times (Zurek *et al.*, 2022). Concerns about the food system's functionality are focused regarding the question of 'resilience for whom' that who will benefit from increased resilience? Out of a commitment to people eating well, the public should be the ultimate beneficiaries of the food system resilience. It is worth noting, however, that the linkages between public and the food system are diverse - some groups may be involved in functioning the food system to get employment and livelihoods beyond their common consumer identities. Thus, the multiplicity of actors and complex feedback loop in the food system and the fragmentation and even possible conflict of interests raise a practical question: when these actors work individually to pursue their resilience, will this lead to desirable change at the food system level (Zurek *et al.*, 2022)? This also makes the relationship between actor- and system-level resilience a topic worthy of empirical study.

The literature review begins with what resilience actually is at the actor level in the food system. The majority of food system actors are present in the form of organisations, especially enterprises of different sizes. Staw et al. (1981) and Meyer (1982) first described resilience in organisational studies as 'rigidity' in the 1980s. Earlier views of organisational resilience focused on an organisation's capacity to absorb disruptions and remain operational at an acceptable level (Horne III, 1997). With a greater understanding of resilience across various disciplines, scholars have recognised that organisational resilience involves more than just passively or statically withstanding

disturbances (Starr *et al.*, 2003). Organisational resilience also encompasses the dynamic process of recovering from shocks by repairing and rebuilding the capital stock (Rose, 2007) and the proactive efforts to promote positive engagement and adjustment associated with changes (Burnard and Bhamra, 2011).

Research on organisational resilience can be divided into three interconnected streams that explore resilience from different angles: first – outcome, second – process, and third – capability. The view of organisational resilience as an outcome places a premium on organisational performance, notably preserving commercial organisations' economic revenue or profitability in the face of disruptions. Research typically explains the factors that contribute to organisational performance with perspectives based on views such as operational management, resources (Combs and Ketchen, 1999), capabilities (Teece, 2007), knowledge (Zack *et al.*, 2009), etc., investigating whether and how quickly organisations recover through before-and-after comparisons of organisational performance. However, prioritising outcome challenges cross-organisational evaluations of resilience given the possibility of a variety of situations, such as maintaining the status quo, returning to the status quo, or changing to achieve the original performance. Even when organisations perform similar resilience outcome, they may have significant internal discrepancies among operations and experiences.

Examining organisational resilience from a process viewpoint stresses a duration aspect that examines how organisations interact with threats in a period. Conz & Magnani introduced the temporal phases of t-1, t, and t+1 to outline the concrete process by which organisations prepare for, respond to, and transform across unexpected events occurring at time t that alter a firm's equilibria (2020). Even though many reactions of organisations are not totally chronological and possibly simultaneous, introducing a temporal aspect to observe organisations' agency helps to understand the process by which organisational resilience can be attained (Lengnick-Hall and Beck, 2005).

Understanding the components and competencies that make up organisational resilience is the focus of the capability perspective, which is somewhat a further development of the process viewpoint, suggesting that organisations are preparing for, withstanding, adapting and even transforming based on capabilities to cope with hazards. The capability-based interpretation of resilience coincides with Teece's (1997; 2007) argument for dynamic capabilities building on the awareness of the business-related external environment (Cepeda and Vera, 2007), which highlighted that firms should possess the dynamic capabilities to survive and thrive in a highly competitive and threatening market environment rather than just to 'get things done' or 'make a living' (Teece *et al.*, 1997; Teece, 2007, 2017).

Teece divided dynamic capabilities into three elements from the process perspective, including (1) sensing threats and opportunities, (2) seizing opportunities, and (3) managing threats and re-configuring resources to transform through continued renewal (Teece, 2007, 2017). Apart from a few scholars who have specifically defined organisational resilience in their research, applying the resilience concept is essentially a combination of one or more of the ideas mentioned above. For instance, Silva et al. further match dynamic capabilities to the processes by which organisations perform dynamism, proposing an integrated model of Sensing-Preparing, Seizing-Responding and Reconfiguring-Transforming (2023).

Organisational resilience inherently depends on the extensive social-ecological system in which the business operates. From a cross-level perspective, Rose (2006) proposed three interconnected levels to evaluate resilience in a business system: (1) the micro level (resilience of individual organisations), (2) the meso level (resilience of industries or groups), and (3) the macro level (overall resilience of markets and systems). A cascading effect may exist across such levels, where crises and even minor alterations that spread throughout levels might cause larger-scale failures or significant transformations (Rocha *et al.*, 2018; Rose, 2007). The adaptive cycle provides another concrete explanation of the cross-level mechanisms, outlining how organisations adapt

to new norms to maintain the functionality of a complex adaptive system (Linnenluecke and Griffiths, 2010; Williams *et al.*, 2021). Four characteristics between organisations and the system that contribute to systemic resilience across temporal and spatial scales include the ability to innovate, the flexibility of the relationship between the parts of the system and the whole, the interactive exchange between the system and its environment, and the critical role of information in evolving complexity (Linnnluecke & Griffiths, 2010; Williams et al., 2021).

Previous studies in the food system have also offered illuminating justifications that the agency of actors, and the diversity, connectivity and learning among actors all influence the resilience of food systems from various dimensions (see Paper 1). However, existing research on the relations of organisational and system-level resilience in the food system is relatively limited in terms of research objectives and occasions and may even lead to conflicting conclusions. The author's case study of pig farming in China after the outbreak of African swine fever indicated that developing self-breeding in large pig farms is beneficial in reducing the risk of epidemics being brought in by exchanges with external farms, which can improve resilience both at the farm and industry levels (see Paper 3). In contrast, a case study of the UK's vegetable and fresh fruit sector revealed that retailers' efforts to enhance supply chain resilience by introducing more producers and adopting short-term contracts may affect the producers' long-term investment strategies for mitigating water-related risks (Zurek *et al.*, 2020). These two examples show how organisational behaviours can either co-benefit other actors and the food system or cause difficulties. Consequently, regardless of the level of resilience desired in a food system, its potential impacts must be considered at higher or lower levels.

3.2.2 Resilience research in restaurants and why should restaurants be considered as food system actors

The restaurant industry used to be more frequently studied as a subsector of the hotel/tourism industries, supporting employment, generating economic income and tax

revenue for localities (Meneguel *et al.*, 2019), and growing in collaboration with local infrastructure (Xu *et al.*, 2019) and governance (Tehrani *et al.*, 2020). Most of the research regarding restaurants' organisational resilience concerns primarily from a managerial or an operational perspective (Becker, 2009; Chien and Tsai, 2021). For example, the 'why restaurants fail' series (Parsa *et al.*, 2005, 2011b, 2011a, 2015, 2021), Muller and Woods' (1991) study of restaurant failure rates in California, and Andrews and Turner's (2012) analysis of the factors influencing the decline in the number of pubs in England all use survival analysis to delve deeper into the social and economic factors that affect the success or failure of restaurants. These research identified that economic recession (Parsa *et al.*, 2011a), extreme weather (Becker, 2009), air pollution (Deng *et al.*, 2019), supply chain interruptions (Ku *et al.*, 2020) and population loss (Parsa *et al.*, 2015) can also risk the survival of the restaurant industry.

Relevant research has reached a peak since 2020 as the restaurant sector has been severely affected by the lockdown and movement limitations brought on by the COVID-19 pandemic. Numerous studies have demonstrated that closures and societal constraints have pushed many restaurants to halt operations or operate on a limited basis, resulting in sharp drops in income and the loss of jobs (Bartik *et al.*, 2020). Restaurants' capacity for adaptation and recovery has been hampered by slow reactions, a lack of just-in-time assistance, and underlying business problems. Accordingly, restaurants with property ownership, highly skilled staff, and extensive social networks would boost the company's likelihood of reviving (Song *et al.*, 2021). Restaurants have been able to effectively respond to the epidemic by making the necessary and diversified improvements to their operations (e.g. leveraging big data), recipes (e.g., streamlining menus), and business models (e.g., offering takeout services) (Perez *et al.*, 2021). Generally, the literature on how the pandemic impacts the restaurant industry shows a loose pandering to the conceptual discussion of organisational resilience, looking more at the actual experiences and reactions of the restaurants to the pandemic and making cross-organisational comparisons to summarise the causes of differences in

performance across restaurants (Song *et al.*, 2021; Brizek *et al.*, 2021; Kim *et al.*, 2021). However, restaurants have different endowments from one another, and cross-organisational comparisons that give too much weight to a restaurant's financial presentation and speed of recovery are unfair to small and medium enterprises (SMEs).

While several studies have explored the socio-economic impacts of restaurants, few have interpreted them from a food system perspective or identified restaurants as a 'food system actor'. Yet, restaurants have profound relationships with the local food system. Restaurants source fresh raw ingredients from the local food supply chain, provide local residents out-of-home venues for food consumption, and engage in perpetuating the local food culture (Ali *et al.*, 2021; Zhang *et al.*, 2021). The energy costs and food waste generated from restaurant operations are also treated locally. Despite being an essential actor in the food system, there is a mutual neglect between scholarly literature/research on restaurants and the food system. Research on restaurant has little emphasis on its role as a food system actor. Even when approached from a food system perspective, restaurants carry way fewer attentions than food retailers despite both being close to the consumption end and highly commercial (Jacobi *et al.*, 2019a).

Such mutual neglect might have been understandable in the past, as dining out in a restaurant was predominantly perceived as a leisure activity rather than an integral part of daily sustenance. However, the rise of out-of-home food consumption in recent years has called a growing number of studies investigating the potential associated environmental impacts as well as the health risks (Ali *et al.*, 2023). For example, a study conducted in Japan uncovered a significant correlation between households with elevated carbon footprints and heightened restaurant consumption (Kanemoto *et al.*, 2019). Noteworthy multinational investigations have admonished dining out, in contrast to home-cooked meals, for potentially fostering diets characterized by excessive fat, salt, and sugar (Gesteiro *et al.*, 2022).

The explosive proliferation of takeaway services offering ready-to-eat meals over the last decade has further expanded restaurants' portion on the dietary habits of households. This transformation is particularly pronounced in China, where takeaway services have accounted for over 20% of total restaurant revenues in 2019 (State Information Center 2020). On one hand, the daily diets of consumers are increasingly relied on the restaurant sector through the efficient delivery services offered (Smith *et al.*, 2009). This makes 'eating well', the core goal of the food system, become tremendously relevant to the restaurant sector. Once restaurants cannot run properly and stably, then this could lead to the public not having alternative ways to feed themselves. On the other hand, the surge in 'eating out' has led to challenges such as disposable containers and recurrent food safety concerns, all of which stand arguably in contrast to the broader environmental and public health outcomes of the food system.

The intricate web of relationships that exist between the restaurant sector and the various facets of food production, processing, delivery, wholesale, and retail activities is subject to multifaceted challenges and uncertainties. The lasting pandemic has raised concerns about the ability of food systems and their actors to ensure public food security and the fate of SMEs within the system (Nordhagen *et al.*, 2021). Since, it is not purely the case that a thriving restaurant sector is beneficial to better food system outcomes, how restaurant organisations' efforts to pursue resilience themselves across the pandemic will impact the food system lastingly becomes a debatable question.

There is currently a lack of awareness of the more integrated impacts that restaurants' resilience may have. Pesci and Brinkley's study (2021) on a Farm-to-Table restaurant is the only one that exactly looked at the cross-level resilience in restaurants. A triple win for restaurants, customers, and farmers was identified when the researcher investigated the upstream and downstream of the restaurant as well as the corresponding social and ecological changes in the local food system. The COVID-19 pandemic has compelled restaurants' operations to move beyond routine tasks and adopt 'resilience thinking' to pursue a more proactive approach, rather than viewing

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resilience solely as defensive and reactive measures (Annarelli and Nonino, 2016). In this context, it is particularly important to discuss the central question at the core of the scholarly inquiry: Does the pursuit of organisational resilience hold the potential to significantly enhance the resilience of the entire food system?

3.2.3 Research questions and analytical perspectives

The research questions of this paper will hence focus on the following:

(1) How have the restaurant organisations navigated the COVID-19 pandemic?

(2) What are the potential implications that the organisational resilience of restaurants has on industry- and system-level resilience?

This paper will first explore organisational resilience in restaurants in the context of the dynamic capability framework, as the dynamic capability perspective is a well-integrated perspective with process and outcome thinking. According to the process perspective, dynamic capabilities involve altering ordinary operations as well as aligning and realigning assets, which are the visible actions resilient organisations take in response to crises (Teece, 2007; Lengnick-Hall and Beck, 2005). From the outcome perspective, dynamic capabilities emphasise maintaining an organisation's function and evolving with the circumstances (Makkonen *et al.*, 2014), highlighting the opportunity for a firm to survive and grow (Lengnick-Hall *et al.*, 2011). With the dynamic capability-based perspective, this paper examines how restaurants exert their capabilities individually. In this way, the comparisons will be capability-based rather than performance-based. Instead of expecting to conclude which organisation and why is more resilient than others, this research focuses on whether organisations have effectively employed their respective capabilities and what drives/hinders them from pursuing organisational resilience. This paper offers real-world examples and practical advice on the crucial problem of fostering organisational resilience in the restaurant sector.

Then, this paper looks not only at the organisations' capability to absorb disruption and adapt to change but also to explore the impact that the pursuit of organisational resilience may have on the industry and even system resilience from a broader perspective. As mentioned above, current food systems research has observed that actor-system level resilience can be both conflicting and synergistic. However, studies have yet to discuss it in the context of the restaurant industry, so this paper suggests including a system view while examining the change and development of the restaurants. Such an exploration is particularly significant in the research site China, where restaurants are being incorporated into increasing food consumption scenarios due to the boom in takeaway services, with the restaurant industry gaining unprecedented importance in fulfilling Chinese population.

3.3 Methods: research design and data collection

In line with the research questions, this paper applied a two-step method: firstly, primary self-reported data was generated through interviews to investigate how individual restaurants navigate the COVID-19 pandemic; secondly, secondary data was collected in a triangulation analysis to explore the impact of organisational actions on food system resilience.

The exploratory nature of the research led us to adopt a multi-case study strategy for the first step, which allows for in-depth analyses of the phenomenon of interest (Voss *et al.*, 2002; Hendry *et al.*, 2019). Based on the theoretical groundwork from Section 3.2, this paper used a dynamic capability-based perspective that examines how organisations exert each of their different capabilities. Three fundamental categories of questions were developed for all the interviewees. The first set of inquiries focused on the foundational elements, regular operations, and relationships with the supply chain of restaurants. Such information allowed us to examine the organisations' resources and connections to the restaurant industry and the food system. The second group of questions focused on restaurants' experiences during the lockdown to learn how the

organisations utilised their dynamic capacities. The responses revealed the driving forces for their behaviour and performances (Valtakoski and Witell, 2018). In the third set of questions, interview participants were questioned about their changes due to the pandemic during and after the lockdown.

The interviews took place from May to September 2021, one year after Wuhan's lockdown was lifted. As the first city in the world to experience an unprecedented severe lockdown, this paper expects that analysing the reactions and changes in Wuhan's restaurants will provide reference for other cities. This paper has restricted interviewees to those located in the Dongxihu District of Wuhan to control as many variables as possible, including the length of the lockdown, supportive policies, and the commercial recovery of the area. The differences in experiences of restaurants of various types have been considered when choosing research participants (Yang *et al.*, 2020; Perez *et al.*, 2021).

This paper had some difficulty in finding restaurants willing and ready to participate in in-depth, face-to-face interviews because the data collection phase for this paper took place when China still had strict Zero COVID-19 measures that masks and health QR codes were must-haves indoors and outdoors. Finally, this paper narrowed down nine restaurants with various features in terms of affiliation, scale & size, years in operation, and location through recommendations, internet searches, and snowballing. Table 3.1 provides essential details about the restaurants interviewed, along with the mnemonics used to refer to the data for each of the nine interviewees in the following text.

Before the interviews, this paper conducted appropriate background research by compiling relevant news articles and government policies. During the interviews, this paper cross-validated several crucial pieces of information with interviewees, such as the supportive measures they had received. The interviews were semi-structured, allowing the interviewees to express themselves freely and provide additional information as

appropriate. The length of each interview ranges from 50 to 90 minutes. All the interviews were recorded, fully transcribed, and sent to the interviewees for confirmation to ensure the reliability and internal validity of the research. Data coding was undertaken in Nvivo 12, using open coding and constructs from the literature. The native Chinese-speaking authors individually accomplished the coding process. By comparing and summarising the coding records, this paper found a clear picture of the dynamic capabilities that played out over the process of the restaurants' experiences (Figure 3.1).

Categories of questions

Basic information	Supply chain management	Collaborations
Takeaway business	Experiences about Covid-19	Performance after lockdown

Coding nodes

Resources	Operations (before and after the lockdown)	Dynamic capabilities
Customer group	Procurement	Sense-threats
Affiliation and scale	Storage and inventory	Sense-opportunities
Site selection	Independent or central kitchen	Seize-absorb the threats
Staff and competence	Operational management	Seize-adapt to the lockdown
Duration of operation	Design and decoration	New threats after the lockdown
Supplier resources	Marketing	Manage threats and transform
Supportive policies	Collaborations with counterparts	
Government relations	Takeaway business	
Experiences about disruptions		

Figure 3.1 The coding nodes

Mnemonics	R1	R2	R3	R4	R5	R6	R7	R8	R9
Cuisine style	Grill & barbecue in local flavours	Canteen serving group meal	Chinese Cuisines	Halal food	Chinese Cuisines	Chinese Cuisines	Chinese fast food (mutton)	Banquet (wedding & business)	Business and private dinner
Years operated	3	2	17	25	2	14	3	15	3
Affiliation and number of employees	150+ (in 11 chain branches)	100+ (in two branches)	22	0+ (in 2 branches)	20	40-50 per branch (4)	10	100+ per branch (2)	48 per branch (27 chains in four levels)
Price per person (RMB)	60	15	70	80	55	160	50	80	100+
Ownership and management	Managed jointly by the founders and professionals	Managed jointly by the owner and professionals	Self-employed and managed	Self-employed and managed	Managed by professionals hired by the owner	Managed by the shareholder	Self-employed and managed	Managed by professionals hired by the owner	Managed by professionals hired by the owner
Role of the interviewee (years of working experience)	Founder, shareholder and manager (7)	Owner (20)	Owner (17)	Owner (25)	Owner (2)	Shareholder and manager (14)	Owner (5)	Manager (30+)	Manager (20+)

Table 3.1 The basic information of the interviewees

For a firm to be sustainable and competitive, it must use dynamic capabilities to adapt to changing conditions (Teece *et al.*, 1997). In light of the COVID-19 lockdown, this paper contends that a firm's capability to withstand losses is a precondition for taking advantage of opportunities. Therefore, this paper introduces sub-dynamic capabilities (Winter, 2003; Ambrosini *et al.*, 2009; Inigo and Albareda, 2019) such as *absorbing* and *adapting* to further explain 'seizing opportunities' in the coding process to describe the dynamics of the restaurants during the lockdown. After the lockdown was lifted, 'transforming' combines 'managing new threats' with 'renewing businesses' (Figure 3.2). Several studies have applied the lens of organisational resilience or dynamic capabilities to restaurants (Neise *et al.*, 2021; Chien and Tsai, 2021; de Freitas and Stedefeldt, 2020; Otengei *et al.*, 2017), but no empirical study has yet looked at how restaurants' dynamic capabilities affect their organisational resilience from a process lens. This paper will fill this critical gap with the specific results shown in section 3.4.
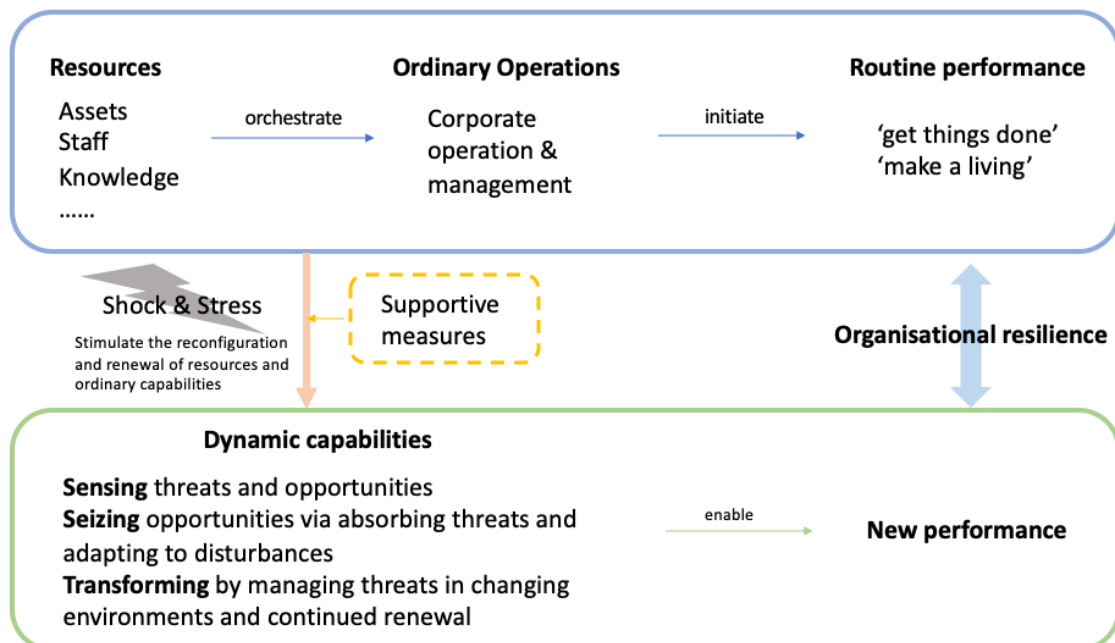
Figure 3.2 Theoretical framework linking organisational resilience and dynamic capabilities

Then, this paper triangulated pertinent information from multi-case interview manuscripts and secondary data to examine how resilience at the organisational level can affect the restaurant industry. The secondary data consists of three major categories: (1) annual reports on the development of the restaurant industry published by restaurant industry associations and other institutions; (2) policy documents and statistics about the restaurant industry made public by official channels; and (3) consumer survey from renowned international investigation institution (Table 3.2). Analysing organisational actions and industrial trends will allow us to explore and anticipate the potential impact on the food system's resilience. The specific results regarding the industrial trend are shown in 3.4.2, and the anticipation of food system resilience will be displayed in the Discussion.

Type	Title	Publisher and issue time	Mnemonics
Policy documents	Policy Measures to Promote Economic and Social Development in Hubei Province	Hubei Provincial Government, March 2020	HBES 2020
	Policy Measures to Support the Business Development of Small and Medium-sized Enterprises in Response to the COVID-19 Lockdown in Wuhan	Wuhan Municipal Government, May 2020	WHBD 2020
	Policy Measures to Encourage Owners of Various Types of Business Venues to Reduce or Waive Rent in Wuhan	Wuhan Municipal Government, May 2020	WHRR 2020
Industrial reports	Annual Report on China's Catering Industry-2021	China Hospitality Association, Sep 2021	CHA 2021
	Annual Report on China's Catering Industry-2022	China Hospitality Association, Oct 2022	CHA 2022
	Development Report on Group Meals in China -2022	China Hospitality Association, Nov 2022	CHAGM 2022
	China Chain Restaurant Industry Report-2021	China Chain-Store & Franchise Association, Feb 2022	CCFA 2021
	China Chain Restaurant Industry Report-2022	China Chain-Store & Franchise Association, Aug 2022	CCFA 2022
Consumer Survey	A Global Analysis of Cooking Around the World-2020	Gallup and Cookpad, 2021	Gallup and Cookpad, 2021

Table 3.2 Triangulate materials and mnemonics for reference

3.4 Results

3.4.1 Organisational level observations

3.4.1.1 General findings

Sensing
around the outbreak of Covid-19

- Threats
  - Unguaranteed supply chain during Chinese New Year (R1, R2, R4, R6, R8)
  - An infectious disease (R7, R8)
- Opportunities
  - Serving group catering (R4, R5, R6, R8, R9)

Seizing
during the lockdown

- Absorbing the threats
  - Bearing losses on rent (R1, R2, R3, R4, R5, R6, R7, R8, R9)
  - Affording the payment of staff wages when not operating normally (R1, R3, R4, R5, R6, R7, R8, R9)
- Adapting to the lockdown
  - Utilising food inventories for group catering and other channels (R1, R2, R4, R7, R8, R9)
  - Taking the lockdown period for internal enhancements (R1, R8, R9)

Transforming
after the lockdown

- Extending products and services to where the customers are
  - Offering group catering (R2, R3, R9)
  - Selling products via contactless ways (R1, R9)
  - Providing delivery services (R9)
- Managing labour redundancies and recruitment difficulties (R3, R7, R8)
- Dealing with rising operational costs (R3, R5, R7, R8)

Figure 3.3 Summary of the key points of the coding process, with original coding evidence presented in the Appendices.

For the city of Wuhan, the pandemic breakout before the Chinese New Year and the following lockdown came suddenly since January 23rd. While this was happening, restaurants that planned to remain open throughout the Chinese New Year had stockpiled ingredients due to the potential delays of the supply chain and probable price increases during this period. In the first few weeks of 2020, just R7 and R8 realised the possibility of sickness spreading and provided their workers with masks. During the pandemonium of the lockdown's early days, some restaurants (R4, R5, R6, R8, R9) saw an opportunity to supply people who were still working, such as medical workers and police officers.

During the lockdown, most of our interviewees experienced some loss of rent (R1, R2, R3, R4, R5, R6, R7, R8, R9) and employee salaries to varying degrees (R1, R3, R4, R5, R6, R7, R8, R9), which was a heavy burden for those unable to conduct business. Some, but not all, of the restaurants that had sensed the opportunity beforehand were

fortunate enough to be given a chance to provide group box-meals and efficiently use previously prepared food stockpiles while the area was under lockdown (R1, R2, R4, R7, R8, R9). Some proficient restaurant operators, especially those who experienced the SARS pandemic in 2003, have also exploited the downtime to train their workers internally and upgrade their skills (R1, R8, R9).

The lockdown in Wuhan was lifted on April 8th, 2020. Wuhan's business environment, however, was considered to have witnessed a noticeable shift after the lockdown. The majority of restaurants resumed operations within a month of April 8th, but customers became fearful and reluctant to dine in public and needed a safer alternative. Besides fewer customers (R1, R3, R4, R6, R7, R8), the restaurants were still threatened by labour concerns (R1, R2, R4, R5, R9), increasing raw material prices (R2, R4, and R6), and rising operational costs (R3, R4, R6). As COVID-19 changed into a state of long-term stress, the restaurants did not just return to their previous routines; rather, they were continually adapting to challenges and transforming. Some of our interviewees attempted to bring their products, such as fast food, formal dinners, and ready-to-eat meal boxes, to the consumers instead of waiting for them to dine in (R1, R2, R3, R9). Restaurants also took the agency to control labour (R3, R7, R8) and operational costs (R3, R5, R7, R8) to weather the storm.

However, many were incapable of adjusting their business models because they were still battling to recover from the losses they incurred during the lockdown and the subsequent increase in operational costs. One year after reopening, when interviews, there was a more significant disparity in the organisational performances of the restaurants based on their perceptions of when their business began to recover. Not everyone experienced the anticipated post-epidemic consumption boom until October 2020, usual busiest month for the Chinese restaurant industry. Restaurants providing formal and banquet-style meals with more diners per table (R3, R6, R8 and R9) rebounded more slowly than those restaurants providing fewer diners per table (R1, R4 and R5).

In general, all of our interviewees survived and are therefore resilient on a fundamental level, but the degree to which they are resilient depends on how these organisations utilised their dynamic capabilities. In the following sections, this paper will continue investigating, through cross-organisational research, the aspects that may influence restaurants' dynamic capabilities and resilience.

3.4.1.2 The effects of supportive measures

The interviewees received assistance from various sources throughout the outbreak and lockdown. First and foremost was the collaboration of the supply chain with stakeholders and non-stakeholders, as well as the government, which ensured the arrival of emergency food supplies and donations from outside Wuhan so that restaurants that remained open during this period had access to supplement ingredients. Mutual care amongst restaurants was also crucial. For example, the restaurant (R2) with extra disposable food containers shared them with other restaurants to provide group box-meals when such containers were in short supply. In addition, the local administration of Wuhan introduced many rent, tax, and low-interest loan incentives for the service sector (HBES 2020). After the end of the lockdown, the authorities issued consumer vouchers to the citizens of Wuhan to boost dining consumption (WHBD 2020). Notably, such assistance also enabled the recipients to become support-providers and deliverers of food system functions by offering group box-meals for others in need of food, such as medical staff and public servants, who continued to work for the city during the lockdown.

Despite getting the same support, restaurants did not have equal opportunities to benefit from the assistance. The most common difficulty arises from Wuhan's municipal government's policy of waiving three months' rent during the lockdown and lowering the additional 50% rent for six months after the lockdown for service enterprises (WHRR 2020). Although many of our interviewees attributed their survival

to this rent reduction, this paper discovered that their landlord could determine whether or not they were eligible for rent assistance. They were approved for the whole rent savings specified in the scheme if they rented publicly owned sites. However, if they leased private property, their chance of obtaining a rent decrease depended on their negotiations with the landlord. And frequently, the smaller the business, the more likely the landlord was to be an individual, making it more challenging to get a rent cut. This shows that the assistance provided by the government through the public funds of the entire society was not universal and that only a subset of organisations was eligible to receive it. A portion of the projected support was actually intended to come from private rather than public sources, which also raises ethical difficulties. Private landlords might be subject to financial pressure if they agreed to provide such assistance and may face moral condemnation if they rejected to do so.

3.4.1.3 Prompt response throughout the lockdown

Given that the average cost of raw material purchase for Chinese restaurant enterprises in 2019 was 41.87% of restaurant revenue (CCFA 2021), the food inventory losses of the interviewees represented a significant hardship in addition to rent and labour losses. Surprisingly, such losses depended not entirely on restaurants' chilling and preservation facilities but also on their capability to react promptly.

The procurement cycle for perishable foods with a short shelf life, such as meat, fish, and fresh vegetables, varies by restaurant. Some restaurants put 'buy today, use today' on their menus as a sign of superior quality (R3, R6), based on the assumption that the food supply chain would run reliably and efficiently. Unfortunately, the abrupt lockdown messed up the supply chain, and only restaurants with food stocks could compete for the most crucial opportunity during this time, which was serving group box-meals. Buy-today-use-today restaurants that lacked buffer food storage were thus ineligible for this business, which, on the plus side, protected them from the loss of food stock. Chain and larger restaurants were better equipped with on-site facilities or even

relied on distribution from central kitchens, allowing them to pre-stock according to varying needs and fluctuating prices.

R2, R8, and R9 seized the opportunity to provide group box-meals to utilise their food stocks and remain operational during challenging circumstances. R8 and R9 quickly got used to their new roles as box-meal providers. R9's procurement team even endeavoured to expand food sourcing by collaborating with local farmers to assist them in marketing their goods. R1 also avoided losing some food stocks because its owners delivered online orders by themselves during the lockdown.

However, the boundary between resource buffers and waste was not set in stone since food stockpiles could become a problem if the restaurant failed to use these buffer resources. R6 lost nearly all its food stocks because it missed the above opportunities. Even worse, as R6 was oversaturated with the business prior to the outbreak, they were unprepared for the probable transition. After the lockdown, their primary business (banquets) shrunk drastically, affecting their entire operational conditions significantly.

Even after experiencing the lockdown, the majority of interviewees remained convinced that proactive preparation for extreme risks was unnecessary as they lacked the capacity to do so. In contrast, they highlighted the ability to react rapidly, which, according to interviews, could possibly compensate for their unpreparedness. Responding quickly is part of a restaurant's agency, which explains why R6 with the resources has sensed the threats and opportunities but still failed to perform competently. However, this paper found a restaurant's implementation of dynamic capabilities in reality had been plagued by delays in response and action at nearly every stage. Worse yet, poor performance in the early stages can later damage their capability for transformation.

3.4.1.4 Transforming as a cumulative privilege

In addition to restoring operational processes and workers, the restaurants' service recovery following the lockdown also created the potential to recruit more consumers. Several tendencies in the transformation of restaurants to suit the post-pandemic business environment and consumers' perceptions have been stated. In the first place, restaurants gravitated toward ventures that could produce a steadier income stream. R5 attempted to simplify the menu by developing a fish-themed restaurant centred on its distinctive dishes. R2,8 and 9 continued and expanded their group box-meal offerings as a growing number of corporations began to consider the safety of their employees' dining environments in the post-epidemic age. In addition to earning consistent revenue, the group box-meal company assisted restaurants in efficiently coordinating their food stockpiles by modifying the portfolio of dishes in the meal boxes. During this continuous renewal phase, many of the interim adjustments that restaurants made during the lockdown became permanent.

Restaurants also probed contactless and novel strategies for marketing their products to customers. Takeaway food orders contributed to revenue but were not very profitable, according to nearly all of the restaurants this paper interviewed that offer takeout services. Unsurprisingly, they all admitted that the importance of takeaway services has increased since the lockdown. After reopening, R1 decided to start offering takeaway services, despite concerns that the delivery time could influence the taste of its grilled cuisine and harm its reputation. In recent years, restaurant chains have established central kitchens to save labour costs through integrated procurement, production, and distribution and maintain product quality throughout chain branches (R1). R8 even had ambitions to upgrade its central kitchen into a semi-finished food factory, extending the market for its goods beyond regular consumers to other restaurants and communities (R9).

The dine-in business was more important to mid-to-high-end restaurants (R6, R8, R9), and as a result, they were adversely affected by the pandemic. R9 thus explored delivering not only prepared meals but also services that could only be enjoyed on-site at the restaurant to the customer's location by charging an additional service fee. Dedicated to premium business dining, R9 created the one-stop home service to accommodate customers' concerns about gathering outside during the epidemic, providing chefs, food and waitpersons so that clients can enjoy a customised and live-cooked dinner at home. However, this service necessitated close communication and professional teamwork between the restaurant's many departments, which, as other transformations would also appear, are no longer techniques that small restaurants can manage or implement.

Aside from changes in business strategies, several restaurants were embracing an austerity model owing to continuing financial pressures, including firing redundant personnel (R3), transitioning to a buffet model requiring fewer workers (R7), reducing backup workers (R8), and switching from monthly to daily wages (R7). This paper identified that how the interviewees withstood the disruption—whether they could generate revenue or suffer significant financial losses during the lockdown—cumulatively affected their capability to transform or reorient themselves once they were back in business. Smaller, self-employed restaurants were more about struggling to survive and recover, with limited aspiration and capabilities to transform. Their bigger competitors, who ran businesses more professionally, were better prepared and more able to change their strategies to meet new demands in the post-COVID era.

3.4.2 Triangulation analysis at the industry level

In the previous sections, this paper identified the interviewees' transformations in developing central kitchens, offering semi-finished products, streamlining menus, and delivering one-stop services with first-hand field data. After delving deeper into the

reasoning behind such transformations, this paper uncovered three mutually linked trends: (1) the standardisation of manufacturing procedures for dishes, (2) the increasing advantages of chain and branding restaurants, and (3) the diversification of consumption and service delivery scenarios (Table 3.3). Due to the multi-case study's relatively limited sample size, this paper conducted an additional inter-level analysis using secondary data. This paper triangulated whether the organisational-level restaurant transformations indicated an industry-wide trend and influenced broader resilience. The findings verified the field data and revealed that these trends are affecting each other at the industry level.

Trends behind the organisational transformations	Evidence on industrial-level transformations
The standardisation of manufacturing procedures for dishes (Central kitchen, semi-finished products, streamlining menus)	Hotpot chains are currently the fastest-growing restaurant type in China (CCFA 2021). Grill catering grows significantly in scale (CHA 2021). Pre-prepared dishes can help standardise the supply chain and improve the cold chain logistics infrastructure. Take Meituan takeaway as an example; the net profit of a takeaway has increased from RMB 0.5 to RMB 3 after using pre-made dishes, while the waiting time has decreased from 40 minutes to 28 minutes (CCFA 2022). Among large and medium-sized catering enterprises, those with breeding bases accounted for about 27.8%, an increase of 6.2% year-on-year (CHA 2022). More than 74% of domestic restaurant chains have built their central kitchens to delivering pre-made dishes to their branches. The proportion of prepared dishes used by leading restaurant chains has reached over 80%, particularly in well-known companies such as Zhen Kung Fu, Yoshinoya, Xibei and Xiao Nan Guo (CCFA 2022).
The increasing advantages of chain and branding restaurants (Central kitchen, semi-finished product, one-stop service)	China's restaurant chain rate rises from 12.8% to 15% from 2018 to 2020 (CCFA 2021). The proportion of income earned by chain and above-designated-size restaurants in Wuhan's catering industry had increased to 2.5 times its pre-pandemic levels by 2020 (Wuhan Statistical Yearbook 2021). The overall rate of brand expansion for restaurants has increased compared to last year (CCFA 2021).

The diversification of consumption and service delivery scenarios (semi-finished products, one-stop service)	Catering enterprises are increasingly constructing supply chains, central kitchens, centralized lean kitchens and other supporting elements (CCFA 2021).
	Group meals favoured by capitals (CHAGM 2022)
	In the catering industry, the real value of a restaurant is not to provide food but to process food and provide offline services (CHA 2021).
	The future restaurant industry is more integrated than traditionally providing food but is more likely to be a platform industry with the primary function of food service, thematic culture and consumer experience (CHA 2022).
	The demand for new jobs related to e-commerce marketing, such as business operations, platform maintenance, marketing planning and graphic design, has also increased significantly (CHA 2021 &2022).
	The workforce of frontline staff has shrunk slightly, while the workforce of administrative staff has expanded (CHA 2021&2022).
	Chinese people's number of meals cooked at home decreased by 32% in 2020 compared to the previous year (Gallup and Cookpad, 2021).

Table 3.3 Triangulation evidence on industrial-level transformations

With the chain rate (i.e. rate of total restaurants that are chain restaurants) rising from 12.8% to 15% from 2018 to 2020 (CCFA 2021), China's restaurant industry has been transitioning from fragmented to more centralised operations. Chains, in some ways, represent professionalism, meaning standardised operations and management, uniform food flavours and services across branches. Central kitchens that could provide standardised ingredients for different branches through integrated sourcing and pre-processing have increasingly been adopted for chain restaurants. Accordingly, the more standardised the preparation procedure of ingredients can be, the easier the model for restaurants to expand.

For example, the most standardised hotpot chains are currently the fastest-growing restaurant type in China. The takeaway services provided greater opportunities for many smaller, independent restaurants. However, the profit margins of restaurants offering takeaway services have been shrinking due to rising costs and intense competition. Fast and simple processing of ingredients has grown in importance given tight preparation time in food takeout services. Prepared dishes, which merely need heating or simple handling to be ready for service, are thus gaining popularity with many takeaway restaurants. Numerous strong restaurant companies are also eyeing the prepared dish market and have been developing techniques to pre-prepare their own cuisine using their gathered technologies.

The takeaway boom and influential corporations are driving the maturation of the supply chain for semi-finished meals, particularly the cold chain, which has enlarged the market for pre-prepared dishes, allowing them to bypass restaurants and reach consumers directly. To some extent, the restaurant industry has expanded and shifted toward food processing factories. The ambivalence of our interviewees towards pre-prepared dishes somehow reflected the complexity and struggle of restaurants. While they all disagreed with the idea of 'using pre-prepared dishes in my restaurant' and believed that 'cooking on the spot is a sign of quality' (R1, R2, R3, R4, R5, R6, R7, R8, R9), they did not mind selling pre-prepared or half-done products to other restaurants and the public (R1, R8, R9).
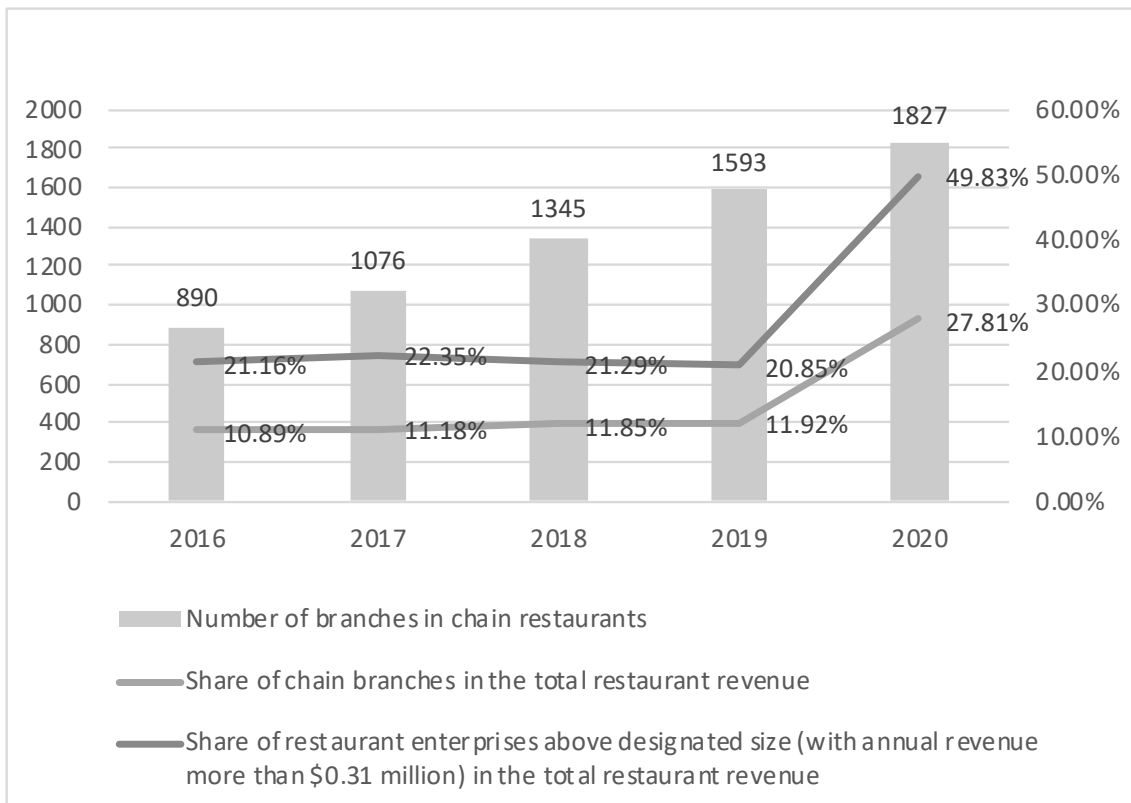
Figure 3.4 The development of the restaurant industry in Wuhan (Wuhan Statistical Yearbook 2017-2021)

Combined with the one-stop service mentioned in 3.4.1.4, this paper discovered that the epidemic has transformed how restaurants interact with their patrons. The restaurant sector is saving itself by broadening its business by offering finished, semi-finished items and even services at home. These shifts further highlight the benefits branded restaurant chains enjoy in acquiring technology accumulation, financial assistance, and advertising over their independent counterparts, who have found the climate to be increasingly hostile to newcomers.

Wuhan's industrial statistics bear witness to this discrepancy as well. Even while the proportion of income earned by chain and above-designated-size restaurants in Wuhan's restaurant industry had been relatively consistent prior to the epidemic, it increased to 2.5 times its pre-pandemic levels by 2020. Amidst the wave of restaurant closures, the expansion of chain restaurants has shown a counter-trend growth. The epidemic has severely impacted the restaurant business in Wuhan, with large corporations and chains enjoying an unparalleled edge over their smaller, independent competitors.

While digitalisation, infrastructure/venue, and takeaway services indicate the democratisation of technology, it is not arguably that there is any more democratic influence over its production. Apparently, the pursuit of cost-effective and standardised products have resulted in the withdrawal of smaller producers that are less competitive in terms of efficiency and quality from the market. The increased connectivity in sharing more standardised products of the restaurant industry has raised the potential for risks to spread internally while enjoying the convenience of efficiency. The rise in the chain rate of the restaurant industry has also been accompanied by increasing modularity of the sector as restaurant chains are sharing more resources internally. Although the products and services offered by the restaurant sector still retain numerous customised features that are far from being fully standardised, the room for diverse types of SMEs in the restaurant industry has inevitably been limited. Restaurants in many areas are carriers of the local food culture with strong ties to the community and customer bases. Whereas the restaurant industry's ability to source from afar has been bolstered by the current trend toward 'chainisation' of operations and product standardisation, this could eventually result in a decline of the industry's linkages to the local food system and thus severe the industry's connection with local consumers. Promoting standardisation may lose the varied localised details therein, thus harming the diversity of food culture, which highlights the necessity of maintaining restaurant niches. Given the current trend of exporting semi-finished products, the big players in the restaurant sector can affect the autonomy of small organisations more deeply. Such technological colonisation of prominent players may further stifle small businesses' creativity and knowledge accumulation.

3.5 Discussion

China's rigorous preventative regulations against COVID-19 and the resulting restrictions on social distancing have promoted diversifying the roles that restaurant industry played in the food system. It has evolved into more than just a 'provider of prepared meals and food services to consumers', while also absorbing partial functions of food processors to offer both finished and semi-finished items. Similar trends have been identified in studies in Southeast Asia (Maifiah *et al.*, 2020). Arguably, the food system is ultimately about solving the primary challenge of people eating well appropriately; thus, it must continue to ensure that despite disruptions—and this is what food system resilience is all about. In this case, the

restaurant industry contributed to safeguard the dietary requirements of people as it took on a wider variety of intermediary roles between consumers and the food system. Co-benefits at both the organisational and system levels were evidenced by the restaurants' participation in delivering the urban food system's functions for feeding residents in the city during the lockdowns.

Consequently but not surprisingly, Chinese people's number of meals cooked at home decreased by 32% in 2020 compared to the previous year while the rising popularity of ordering takeways, running counter to the growth in home cooking observed in other major countries during the pandemic (Gallup and Cookpad, 2021). However, a great number of news and reports praised the continuing operation of restaurants and takeaway services helped urban residents of China get through the lockdowns, while there have been far fewer attentions on how many disposable food boxes were thus consumed and wasted, and relevant environmental footprints and dietary health problems. Although the restaurant industry's overall resilience has benefited the functions of the food system (i.e. providing adequate meals to public) during lockdowns, an excessive attention to it may risk ignoring the hidden costs (i.e. waste of food and containers), especially considering the far-reaching effects that changes in consumer behaviour may sustain, even when the emergency situation that required the highest priority to ensure the food supply of the population no longer exists.

The cumulative effects of dynamic capabilities on organisational resilience underline the significance of keeping up-if organisations fail to sense challenges, they may be less likely to seize the opportunities, and poor performance in the early stages can subsequently undermine their capability to transform. This explains why self-employed restaurants absorbed and maintained, and professionally-run ones transformed as the latter apparently have better finance, resources and preparedness. Although the capabilities and agency of different types of restaurants vary, they're worryingly transforming in a similar less diverse direction. Although including more large companies with solid risk-tolerant capacities could make the industry more robust, the diversity of actors is largely considered necessary to socio-economic and food system resilience (Gret-Regamey *et al.*, 2019; Zurek *et al.*, 2020). Similar dangers have been spotlighted in the food production sector. Species diversity and long-term system resilience could have been compromised due to the societal expectations placed on the food production sector to consistently deliver standardised products and the resulting

streamlining of the agricultural production sector (Rotz and Fraser, 2015). Therefore, the proactive pursuit of resilience by restaurant organisations and the industry may, in turn, force itself into the 'reinforcing spiral of productivity paradigms and efficiency maximisation' observed in European organic farming (Brzezina *et al.*, 2016), but that's maybe detracting from the system resilience in terms of enabling people to eat well and healthfully, although it may be contributing to system resilience in terms of being able to develop just sufficient quantities of food in a very difficult outcome.

On the other hand, identifying the problem doesn't necessarily mean there's a solution. This is not a defence, but we should also consider the reason which has driven the change of restaurants is the demand for quick and convenient meals. Unlike fast-food outlets which have been criticised for emphasising calorie quantity over quality and nutrition, the standardised takeaway food offered by Chinese restaurants is not simply HFSS food, but rather a more everyday type of meal. In fact, many Chinese takeaway meals contain a good mix of meat, vegetables and nutrients to meet the needs of a balanced diet. The main purpose of eating out or ordering takeaway meals in China may simply be to save time that would otherwise be spent on cooking and other related activities, which is both an active and unavoidable choice in a fast-paced society and has become an important part of the Chinese lifestyle. In this situation, the continued growth and seeming trajectory of ever-increasing efficiency of takeaway meals may provide a way to achieve better food system outcomes, such as sustainability and resilience. In general, more and more countries have entered a new phase of modernisation, primarily conditioned by digitalisation. This paper raises the question of how the restaurant, fast food and delivery system industries can then be part of making the food system better in this process, rather than just an ever-worsening sore on its face.

3.6 Conclusion

This paper asked retrospectively and collected data from prior to the pandemic to examine how the COVID-19 epidemic has affected organisational performance. As the first multi-case study of organisational resilience in the restaurant industry around the epidemic, this paper applies the theoretical lens of dynamic capabilities to understand how organisations sensed opportunities and threats in the early stages, absorbed threats and

seized opportunities to adapt during the lockdown, and further manage threats and transform afterwards.

Although restaurants received plenty of support from various sources, they have not benefited equally. From the resilience perspective, food inventories can also serve as buffer resources that allow the organisation to remain operational under challenging times. However, delays in response and action can occur at almost every phase of a restaurant's application of dynamic capabilities, emphasising the significance of reacting rapidly as a part of an organisation's agency. The boundary between resource buffers and waste is variable. Once an organisation fails to seize the opportunity to utilise buffer resources, those food inventories may become a burden. Generally, self-employed restaurants tend to absorb the change and maintain business as usual, while those operated and managed professionally are more willing and able to seize opportunities and transform their business models and products.

The COVID-19 pandemic's threats to the food system and its actors differ from other natural disasters and have shifted from an imminent shock to long-term stress. By outlining the particularities of the restaurant industry in the COVID-19 context, this paper contributes to connecting actor-level and system-level resilience theories. This paper identifies several operations challenges around the recovery and transformation of the restaurant sector via triangulation. The environment for independent restaurants has generally deteriorated, with branded shops gaining overwhelming advantages over independent competitors in terms of capital resources, access to finance supports, and advertising ability. By exporting semi-finished products, the big players in the restaurant sector can affect the autonomy of small organisations more deeply. Such technological colonisation of prominent players may further stifle small businesses' creativity and knowledge accumulation. Given the cost advantage and convenience of the production process, the abuse of semi-finished products may further domesticate consumers, thus imperils the diversity of food culture and leaving traditional dining in a challenging future.

Paper 3

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4 How can governance influence food system resilience? Evidence from

China's pork system

Abstract

Enhancing resilience is increasingly emphasised as a way for the food system to maintain function under disruptions, but it is unclear how food policies may influence resilience. In this paper we conduct an observational analysis of China's pork system, which had experienced two significant pressures from 2014 to 2020—the Environmental Protection Campaign (EPC) and African Swine Fever (ASF) with the Driver-Pressure-State-Impact-Response (DPSIR) model. We innovatively extend the term 'environmental problems' in the DPSIR framework beyond the ecological sense to the holistic environment, and look beyond the traditional application of this framework to study one pressure but to examine multiple, sequential disruptions. The results demonstrate that the pork-related policy priorities have experienced a swing between environmental sustainability and resilience. From the resilience perspective, pursuing the reorientation of the pork system during the EPC resulted in less robust system due to withdrawing small-scale producers, while dedicated policies on recovery in response to ASF have further compromised the original goals of systemic reorientation. By formulating a lens that examines the complex system dynamics, we look at the process by which China's pork system has handled crises, with a particular focus on how governance has affected the resilience of the pork system. This paper reveals the complex trade-offs between sustainability, resilience and various dimensions of resilience (e.g. robustness, recovery and reorientation), offering more promising grounds for enhancing food system via appropriate forms of governance.

Keywords: governance; resilience; sustainability; pork system; African Swine Fever; China

4.1 Introduction

As one of the critical subsystems contributing to the overall environmental impacts of the food system, the livestock system provides the vast majority of meat for human consumption whilst also being severely threatened by troubles such as climate change, land degradation, animal diseases, supply chain breakdown, feed crisis and poor management on site (Meuwissen *et al.*, 2001; McKendree *et al.*, 2021). These dangers may affect the availability and affordability of livestock products, thereby risking the food (livestock) system's function - to provide stable levels of consistent nutrition to the public (Tendall *et al.*, 2015). The prediction of the continuing growth of meat consumption has raised critical concerns about livestock production's sustainability and resilience against disruptions (Henchion *et al.*, 2017).

Compared to the enormous literature on sustainability, research on resilience in food system-related issues has begun to take off in recent years given the deteriorating global food security. This in part reflects growing recognition that, while undeniably interconnected, and possibly inseparable in the longer-term, system resilience is not in itself adequately addressed by a focus purely on sustainability, and is a sui generis consideration that itself needs concerted attention, particularly in governance (Turner Ii, 2010; Rajesh, 2018). However, the impacts of governance (at various scales, with the national as pre-eminent) are not confined to its geographical boundaries (Lenschow *et al.*, 2016; Häyhä *et al.*, 2016). Livestock policies therefore should involve not only a context-specific approach across spatial and temporal circumstances (Duru and Therond, 2015), but also a holistic strategy at the system level.

As both the top pork producer and consumer of the world (MOA 2017), the impacts of China's livestock system are unquestionably of global significance. With a population of 1.4 billion and pork making up more than 60% of China's total meat production (China Statistical Yearbook 2016), the reliability of pork supply is vital for the country's food security. The prominent environmental impacts of pig production forced the central government to launch an Environmental Protection Campaign (EPC) in 2014, aiming to optimise the regional layout and the producers' structure and competence to produce more sustainably. However, such efforts have been interrupted and challenged by the unexpected African Swine Fever (ASF) attack in 2018, with domestic pork yield falling sharply in 2019 and pork prices soaring consequently.

China's colossal pork demand can hardly be met by simply increasing imports, thus making the resilience of domestic pork production particularly important for ensuring food security. Past studies have focused on the sustainability of China's pork production, for example, the environmental (Bai *et al.*, 2019; Liu *et al.*, 2021), economic (Mason-D'Croz *et al.*, 2020; Ma *et al.*, 2021), and social (Xu *et al.*, 2022; Ji *et al.*, 2019) impacts of EPC and ASF respectively, but few studies combined EPC and ASF from an integrative perspective. There has also been a particular lack of attention to the resilience of China's pork production, with only a handful of farm-level studies (Ni *et al.*, 2020; Zhuo *et al.*, 2021) and little systematic insight into resilience and its trade-offs with sustainability. Neither have we seen a complete system-level policy review of EPC and ASF for this very policy-influenced sector.

This paper thus examines government-led transformation towards sustainability (EPC) and the unexpected disruption that occurred midway (ASF) in hope of providing references for building resilience in the pork and other livestock/food systems. From a resilience perspective, this paper explores how the Chinese government's attempts to promote a more stable and environmentally sustainable transformation of pork production in the past decade (resilience of what, for whom, and over what time period) have been affected by successive shock and stress (resilience to what: EPC and ASF), and how actors' livelihoods and performances in the pork system in this process were shaped jointly by disruptions and governance (resilience for whom).

We apply the Driver-Pressure-State-Impact-Response (DPSIR) framework to look at the complex system dynamics with the hope of presenting this profuse and prolonged story, which involves policymakers and multiple stakeholders, as logically and explicitly as possible. We thus collected policy documents and the economic and agricultural statistics for the period 2014 - 2020 regarding China's pig production from publicly available sources. The results illustrate the crucial role of governance in China's pork system - as a pressure source for EPC by proactively facilitating systemic transformation, or as partners with the pork industry to fight with ASF shocks. The EPC aimed to reorient China's pork production towards a more sustainable future, while such aggressive efforts may have inevitably compromised the system's robustness over time, leaving the system overstretched by ASF. Furthermore, some of the policies designed to recover the pork production capacity quickly were likely to undermine the original reorientation objectives.

We also see the trade-offs between sustainability and resilience from central policymakers, in which the alignment and allocation of interests among various actors within local governments and the pork industry are entangled. Our paper thus reveals important policy implications for governance in China's and global livestock industries, namely that although inseparable over the longer-term, sustainability and resilience did not necessarily cohere seamlessly in the inescapable short- and medium term of policy and intervention. Drawing on the existing theoretical framework of resilience, we induce the competing concepts of the past literature and deduce a grounded 'Robustness, adaptation, Recovery, Re-orientation' ('adaptation' deliberately not capitalized – see 4.4.4) based on our retrospective exploration of the pork case in China. Given the irreducible complex system dynamics, this paper suggests a more successful strategy in governance: to organise and regulate the system in a way that prioritises a clear and steady trajectory of reorientation over the medium- and long-term.

We contribute to the literature in four important ways. Instead of treating ASF as a singular incident, we integrate it with the prior EPC to paint the first comprehensive picture of the governance, sustainable transformations, and effects of China's pork system over the past decade, filling a gap in the pig policy literature and also being of considerable practical value. We employ the DPSIR model to track how stresses, shocks and associated responses affect resilience in such complex circumstances, in which we innovatively extend the 'environmental problems' beyond the ecological sense to the holistic environment and look beyond one pressure to examine multiple, sequential disruptions, showing significant implications in the context of global environmental changes where disturbances tend to diversify and overlap. This case study, while specific to China's pork system, offers substantive insights that governance must take into account when focused on issues of sustainability and resilience and, especially, an analytical framework to initiate and facilitate building resilience of the food system.

The rest of this paper proceeds as follows. Section 4.2 provides a theoretical background of food system resilience. Section 4.3 first describes the case background and how governance operates in China's pork system, and then explains the methods and data we adopt. Section 4.4 illustrates our findings with the DPSIR framework and induces our grounded exploration on the resilience process. Section 4.5 goes with the discussion and

policy implications, with Section 6 summarising the study and discussing future research potentials.

4.2. Theoretical background: food system resilience

Originating from ecology (Holling, 1973), the concept of resilience has evolved into a social-ecological concept (Walker *et al.*, 2004) applicable to the food system and its subsystems. The definition of food system resilience has been explored for a few years, and the view that food system resilience refers to the capacity of food systems to deliver desired functions/outcomes despite shocks and stresses has recently become the consensus of some scholars (Tendall *et al.*, 2015; Ingram, 2017). However, explorations on the connotations of food system resilience present competing emphases.

Recovery from perturbations has been the most accepted connotation of resilience (Ingram, 2017; Oliver *et al.*, 2018). Robustness, the capacity to withstand the disruptions and to continue to deliver desired outcomes, is seen as a component of resilience in the broader sense (Tendall *et al.*, 2015; Ingram, 2017; Meyer, 2020), though in earlier studies it was considered to be a parallel concept related to resilience (Anderies *et al.*, 2013; Mumby *et al.*, 2014). Food system resilience has also been interpreted with adaptation and concretized by the adaptive capacity to deal with uncertainty in all means (Tendall *et al.*, 2015; Meyer, 2020). Beyond adapting to disturbances to support the robustness or recovery of the food system, food system resilience is further considered more of a transformation or reorientation that the food system actively pursues, despite crises, to maintain function in the longer-term (Ingram, 2017; Meyer, 2020). In recent years, a more integrated understanding of resilience as a collection of components sharing common but differentiated emphases including robustness, recovery and reorientation across these various definitions and dimensions, has become increasingly representative (Tendall *et al.*, 2015; Ingram, 2017; Meyer, 2020).

Such interpretations of food system resilience suggest actionable insights on capacity-building for resilience, but the relationship between actual causal mechanisms and/or specific interventions and effects demands clarification (Young, 2010; Vogel *et al.*, 2012). Situated within complex, dynamic systems, the efforts of pursuing resilience may only work at a specific level of the system for a certain length of time, and some may even be counterproductive over more extended periods for the actors involved (Nyström *et al.*, 2019). Moreover, the

possibility that enhancing food system resilience may lead to trade-offs between different features of resilience (van Wassenaer *et al.*, 2021) and affect other important system goals, such as sustainability (Tendall *et al.*, 2015), appeals for more comprehensive and sophisticated governance. Building food system resilience involves the active participation of public authorities and food system actors at multiple levels; the complicated interactions within and between them likely make the process of competent, effective governance of resilience even more challenging (Bremmers *et al.*, 2007; Sambell *et al.*, 2019).

In times of global environmental changes and uncertainty, another outstanding question here remains 'resilience to what and for what time period'. In terms of duration and intensity, a disruption may manifest as numerous combinations of these two dimensions. Regarding duration, a simplified approach divides disruption into primarily shock and stress (Zurek *et al.*, 2022), then building resilience may also range from immediate to long-term normalised responses. More importantly, disruptions may not come in ones and the boundary between (what may be defined as) shock and stress is dynamic, with the possibility of a shock converting to stress and a new shock emerging in stress. Reflecting such narrow temporal binaries, current research regarding food system resilience mainstreams pre-event planning for capacity development and/or post-event assessment of outcomes. But it lacks the analysis of process that how stresses, shocks and associated responses actually affect resilience, even as it is this approach and temporality that is arguably most promising and most in need of concerted development given the increasing complexity of food system (Fazey *et al.*, 2018). For pre-event (and often, therefore, top-down) approaches to be adequate, there must be adequate certainty regarding (and stability in) the interrelations and identities of key factors. Yet this is precisely what is often the challenge that requires a focus on 'resilience' specifically in the first place; or else simple stability and continuation would be adequate policy targets. Conversely, post-event approaches may be both too focused on results and too late regarding practical intervention, as effectively pre-event learning for the 'next time', simply another instance of the challenges already mentioned. There may well be little ground to support the presumption that learning about the 'last' crisis, however insightful and well-informed, will be particularly helpful in pre-empting or tackling the 'next' one (Bateson, 1972, Kaiser, 2018).

But how can such track of disruptions, responses and impacts best be supported? Here we suggest that a Driver-Pressure-State-Impact-Response (DPSIR, further explained in 4.3.3)

approach can be highly informative, illustrating this with (an admittedly post-event) analysis of the recent trajectory of two major disruptions in China's pork system. This not only illustrates the utility of this form of analysis, but also highlights crucial substantive insights regarding the nature of governance for resilience by offering more realistic expectations about what can and cannot be achieved by such policy, and particular orientation to such governance challenges that may be more promising than those currently dominant.

4.3 Case background, data and methods

4.3.1 Background and drivers of transformation in China's pork system

Pork takes the leading role in China's livestock production in terms of economic, social and environmental impacts. Regarding the regional layout, China's pig production was concentrated in key producing areas, as the top 13 provinces accounted for over 78.7% of the total yield in 2015 (China Statistical Yearbook 2016). However, such a regional distribution of pig production has two notable aspects that could raise the administrative challenges of the pork system and increase its vulnerability to risks. First, many traditional pork-producing provinces have a relatively fragile environmental capacity and are geographically far from the main producing areas of maize – one of the significant feed crops (Zhuo *et al.*, 2019). Second, China's most economically developed and densely populated regions and megacities, such as the Yangtze River Delta, the Pearl River Delta and Beijing, cannot produce enough pork to meet their demand and thus rely heavily on importing pork from other provinces and countries (Figure 4.1).

Figure 4.1 Pork and corn producing areas of China in 2015 (China Statistical Yearbook 2016)

At the local level, the distribution of pig farms has long been relatively decentralised, with numerous small-scale producers (annual pig slaughter fewer than 500) providing 58% of the total yield in 2014 (MOA, 2017). Such a composition of yield has allowed for the repeated occurrence of the 'pig cycle' in China's pork system, in which small-scale producers could be prone to swarm into or out of the market due to fluctuations in pork prices, resulting in cyclical variations in pork yield and prices. The numerous small-scale producers also posed higher risks of contaminating the water, air and land at their sites as they are often less financially and technically equipped, and therefore lack necessary waste treatment facilities for manure disposal (Liu *et al.*, 2021).

With climate change intensifying globally, mitigating greenhouse gas emissions and environmental pollution from livestock production have become increasingly critical. Pig farms would preferably remain distant from residential areas due to the terrible odours and potential pollution, but the rapid urbanisation of east-central China has diminished available land. China's pork system faced long-term pressure on sustainability from the great contradictions between production and environment, while repeated 'pig cycle' and occasional shocks from animal diseases have caused dramatic fluctuations in pork yields and

prices. Moreover, given that pork is the most significant single component of the CPI basket, the dramatic fluctuations of pork price could threaten national inflation at the whole economy level (Funke *et al.*, 2015). All these constitute the drivers for the transformation of China's pork system towards a more sustainable and resilient orientation.

Since 2014, there has been strong political will behind environmental protection in China. The oversupply of pork in the first half of 2014, which led to low pork prices and severe losses in the pig industry, also presented an opportunity to restructure China's pig production. The EPC in the pork system thus began, aiming at optimising the regional layout and the producers' structure and competence. However, such efforts have been interrupted and challenged by the unexpected ASF attack in 2018. This paper takes an observational analysis of China's pork system that experienced two significant disturbances (EPC and ASF) and examines how the pressures and responses from 2014 to 2020 have shaped the pork system.

4.3.2 Governance in China's pork system

Policymakers play a crucial role in China's pork system, as they are also market monitors and in-depth participants. At the central level, the State Council dominates the formation of common political will, while the Ministry of Agriculture and Rural Affairs (MOA) is directly responsible for national pork production. The Ministry of Ecology and Environment (MEE, previously Ministry of Environmental Protection, MEP) and the Ministry of Natural Resources (MNR) may also provide regulatory or guiding policies based on the requirements of the State Council and the concerns of their departments.

In this multi-jurisdictional system, the voice of one sector may outweigh the others over some time due to the common political will, thus influencing strategic direction and resource allocation. The governance from the central authorities is enforced on a provincial basis. However, the interests at the central level do not necessarily coincide with those of the provinces, hence the sharing and gaming of interests between them may affect the implementation and effectiveness of policies. As a result, (livestock) food system governance is fragmented both 'vertically' (regarding central vs. provincial/local levels) and 'horizontally' (i.e. between different ministries or departments at the same level).

The transmission of stress and shocks within the system necessitates policymakers to consider multi-jurisdictional and multi-level interests when developing operating rules for the

pork system. Although China has not explicitly referred to 'resilience' in the pork-related policies, the associated connotations such as 'stability' (*WenDing*), 'recovery' (*HuiFu*) and 'transformation' (*ZhuanXing*) have been repeatedly mentioned as objectives for developing China's pig production. It is thus worth looking at how governance has affected the resilience of the pork system and the trade-offs between resilience and sustainability, long-term and short-term interests, as well as the sharing of risks and benefits among multi-jurisdictional and multi-level policymakers.

4.3.3 Methods and data: observational and empirical analysis

Developed by the European Environment Agency in the late 1990s, the Driver-Pressure-State-Impact-Response (DPSIR) framework has been widely utilised to explore the causal links between particular environmental problems and appropriate responses (EEA, 1999). In this framework, Drivers (D) in social and economic activities impose Pressures (P) on the environment and lead to changes in environmental State (S), which then generate Impacts (I) on human society and trigger institutional Responses (R) to address changes in state (Carr *et al.*, 2007; Qu *et al.*, 2020). Natural processes have a similar effect on the environment but drivers may not necessarily result in pressures (Carr *et al.*, 2007). Häyhä et al. (2016) further argued that the framework could be considered a form of the adaptive cycle, as responses may include adaptation to impacts, remediation of environmental damage, or mitigation against social drivers. We apply the DPSIR framework to look at the pressures on China's pork system and the processes of how governance has engaged with and responded to such pressures (Figure 4.2).
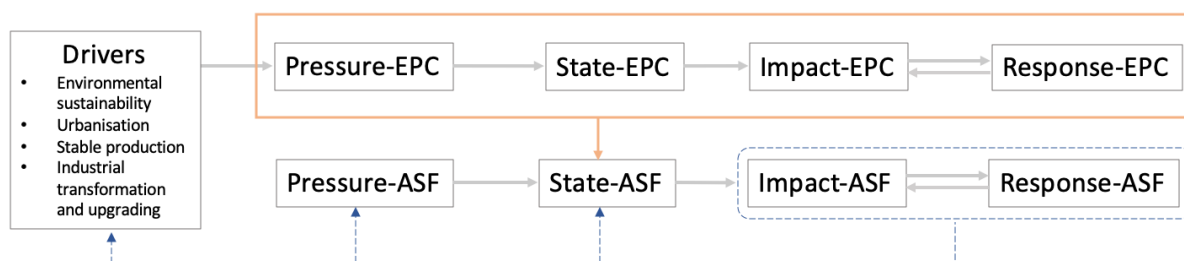
Figure 4.2 Applying the DPSIR model in China's pork system, adjusted from Carr et al. (2007)

The DPSIR model allows us to get into the complex system dynamics, and the corresponding clarifications of the application of the model are as follows:

(1) Drivers have already been summarised in 4.3.1;

(2) China's pork system has experienced two successive pressures, where the EPC was driven and proactively undertaken, while the ASF was not triggered (at least directly or by readily-attributable causation, rather than within the complex system as a whole) but broke out 'naturally' within the EPC process;

(3) State indicates changes in the pork system such as yield distribution, producer structure, etc.;

(4) The outbreak of ASF occurred when the EPC had not yet completed, and thus the State-ASF was based on the overall states of the ongoing EPC; and

(5) Given both the State of the pork system and the institutional Responses contributing to the Impacts on human society, this study characterises these complex interactions by data on pork prices, imports, and per capita pork consumption, etc.

This paper employs both qualitative and quantitative data. The qualitative component consists of the central-level policy documents (regulations, action plans, and guiding opinions) regarding pig production from 2014 to 2019 that constitute the Pressure and Response. Here, a part of the policies deals with the overall governance of the livestock and poultry sectors. Given the critical position of pig production in China's livestock farming, we consider it appropriate to review such policies in this paper. The other parts of the policies focus on pigs or pork specifically, with the words 'pig' or 'pork' included in the policy titles. To avoid possible duplication and ambiguity in the policy emphasis that might result from the responsive documents of lower-level authorities, we have selected only relevant policies issued by central ministries and above in the administrative hierarchy of the Chinese government, i.e. the State Council, MEE, MOA, MNR, etc.

The quantitative data contains the publicly available agricultural and economic statistics regarding pig and pork production and consumption that reflect the State and Impact. We make every effort to maintain the consistency of metrics. However, we had to compromise

on State-ASF owing to data availability, as the data related to pig farms of different scales has not been made public since 2018. Table 4.1 displays the data selection and sources in detail.

	EPC	ASF
Pressure	Formally issued policy documents from central government regarding livestock and pig production between 2014 and March 2018 (listed in Figure 3).	—
State	1. National average net profit per pig in different scales of pig farms from 2016 to 2018 (MOA); 2. The number of pig farms in different scales from 2015 to 2017 (China Veterinary Animal Husbandry Yearbook 2018); 3. Provincial-level pork yield from 2014 to 2018 (China Statistical Yearbook, CSY 2015-2019).	1. Provincial-level pork yield and pigs stock from 2018 to 2020 (CSY 2019-2021); 2. National rate of scale pig breeding (MOA).
Impact	1. National pork import from 2014 to 2018 (MOA); 2. National average price of lean pork strip from 2014 t0 2018 (MOA) 3. National average pork consumption per capita per year (CSY 2015-2019)	1. National pork import from 2019 to 2021 (MOA); 2. National average price of lean pork strip from 2019 to 2021 (MOA). 3. National average pork consumption per capita per year (CSY 2020)
Response	Actions at the representative provinces (4.1 Response-EPC): 1. Guangdong; 2. Jiangsu; 3. Sichuan.	Formally issued policy documents from central government regarding livestock and pig production between September 2018 and December 2019 (listed in Figure 10).

Table 4.1 Data selection and sources

We adopt an integrated research approach for data analysis. For the qualitative data, we would like to state at the outset that this paper does not intend to concentrate on particular provisions of the corresponding policy documents, but rather attempts to sort out a comprehensive governance lineage from the ground up with the DPSIR model. Therefore, two authors, both native Chinese speakers, have carefully reviewed each policy document,

analysing the content and distilling the key points. To ensure the accuracy of the summaries, the two native speakers have cross-checked their notes and discussed a limited number of variations and specific translations to reach an agreement, as shown in Figures 4.3, 4.4, 4.10 and Table 4.2 in the following text. For the quantitative data, we conduct descriptive and analytical statistics of quantitative publicly sourced data, as displayed in Figure 4.1, 4.5, 4.6, 4.7, 4.8, 4.9 and 4.11 in the following text.

4.4 Results

Section 4.4.1 describes the EPC-related DPSIR process. As the ASF was more an unexpected 'natural' shock', Section 4.4.2 presents the PSIR process associated with the ASF. Section 4.4.3 then describes how Response-ASF has changed the state of the pork system afterwards and the impacts on human society, and analyses the transformation that the pork system has undergone. Section 4.4.4 places the stress (EPC) and the shock (ASF) encountered in the pork system and interprets the corresponding DPSIR processes in the resilience framework.

4.4.1 Driver-Pressure-State-Impact-Response regarding the EPC

The multi-factors analysed in 4.3.1 motivated the EPC that began in 2014 and manifested as Pressure-EPC on the pork system through policies from the central government. The State-EPC reflects what changes the Pressure-EPC brought to the holistic environment of the pork system, while Impact-EPC demonstrates how these changes in the pork system have affected society. The Response-EPC involves the institutional efforts to address changes in state.

Pressure-EPC

The State Council identified two priorities for EPC in the pork system: pollution prevention & control; and the resourceful use of waste. Led by the MOA and supported by the MEP, the proposed roadmap was 1) to improve environmental performance at the farm level and 2) to relocate pork production capacity at local and national levels (Figure 4.3).

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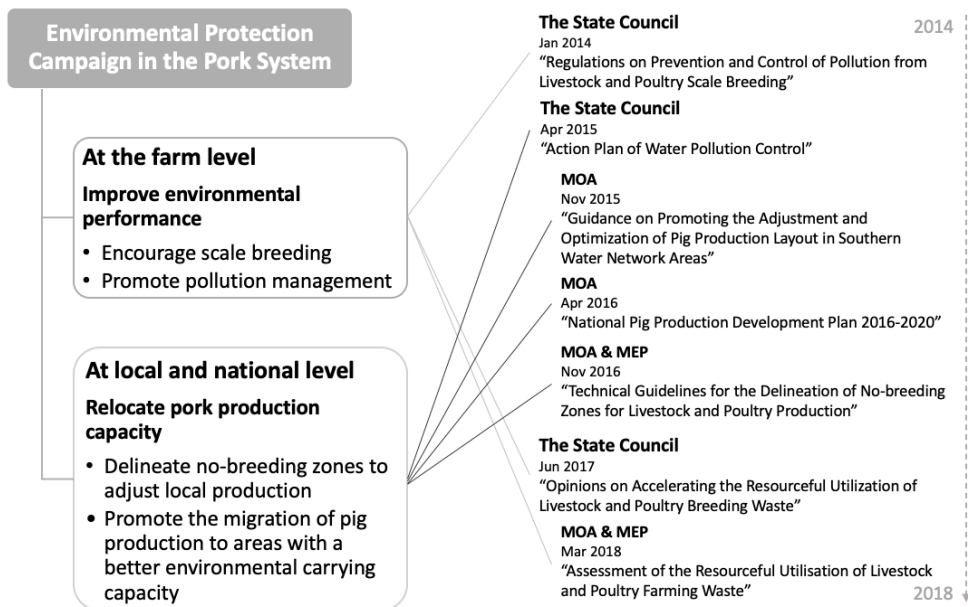
Figure 4.3 The formulation of Pressure-EPC via policymaking

At the farm level, promoting pollution management and encouraging scale breeding were the main objectives of the central government. The 'Regulations on Prevention and Control of Pollution from Livestock and Poultry Scale Breeding' came into force in 2014, setting out specific requirements for preventing and comprehensively treating pollution and waste. The regulations also identified incentives ranging from the input of land, electricity and facilities to the financial support for the resourceful utilization of waste and scale breeding. The 'Opinions on Accelerating the Resourceful Utilization of Livestock and Poultry Breeding Waste' further indicated quantifiable targets for pollution management.

Figure 4.4 Regional Layout of the National Pig Production Development Plan (Plan PD)

Regarding the relocation of pig production, the central government set a two-phase goal: (1) completing the delineation of no-breeding zones to adjust local production by the end of 2017; and (2) promoting the migration of pig production to areas with a better environmental carrying capacity between 2016 and 2020. At the local level, the Water Plan further required that the withdrawal of pig production in no-breeding zones should be accomplished one year ahead of schedule in Beijing, Tianjin, Hebei, Yangtze River Delta, and Pearl River Delta regions. The technical guidelines published in November 2016 provided related instructions on no-breeding zones.

At the regional level, pig breeding in the dense water networked southern regions has attracted particular policy attention to relocating pig production capacity. The National Pig Production Development Plan (Plan PD) issued in 2016 further divided the country into four categories of regions for pig breeding (Figure 4.4), with the water networked southern regions generally becoming the constrained area and the main maize-producing provinces becoming the key and potential areas. Plan PD has set different development goals for each area in order

to ensure a stable and slight increase in pork yield, maintain basic self-sufficiency in pork supply at the national level and enhance the scale producing and slaughtering of the pork industry.

State-EPC

At the farm level, the requirement for existing pig farms to establish qualified pollution treatment facilities increased their operational costs and reduced the overall profits. However, pig breeding had apparent scale effects, with the costs diluting as the scale grows and the net profit of one pig subsequently increasing. The threshold imposed on newly built farms for environmental assessment further limited the entry of small-scale producers. Such policies intended to phase out scattered farms unable to meet environmental requirements or sustain losses, and encouraged farms that remained financially and technically capable of transforming further or introduced more scale breeding.

Consequently, the total number of pig farms in China fell by more than 8.8 million from 2015 to 2017, 94.6% of which were scattered farms with an annual pig slaughter of fewer than 50 (CVAHY, 2018). In general, the number of pig farms producing fewer than 50,000 pigs per year declined during this period, with the reduction rate gradually narrowing as the annual slaughter exceeded 1,000. In contrast, there was a 55.9% increase in pig farms, with more than 50,000 pigs slaughtered per year (Figure 4.5).
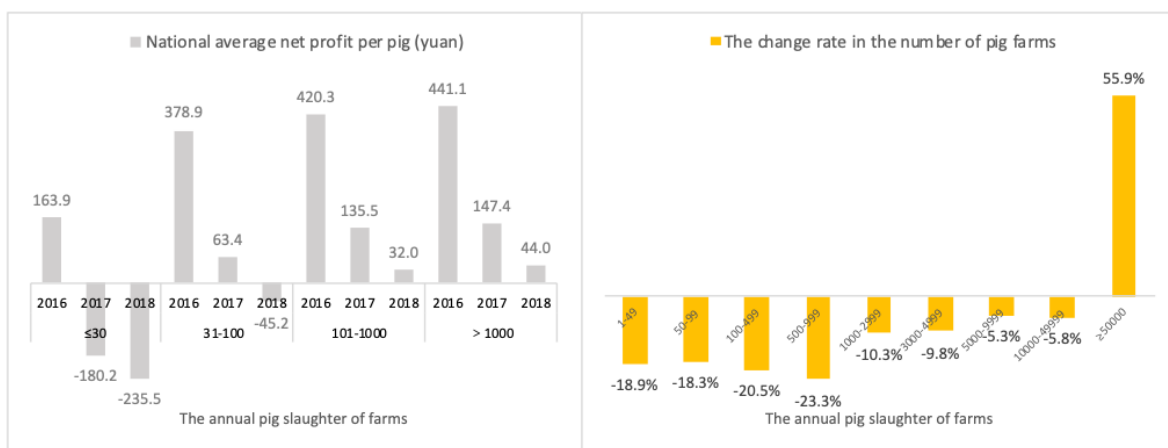
Figure 4.5 National average net profit per pig from 2016 to 2018 and the change rate in the number of pig farms from 2015 to 2017

In the first phase of relocating pig production, the withdrawal of local production capacity in the no-breeding zones had entailed a continuous decline in pork yield between 2014 and 2016. As local-level actions came to an end, the second phase of adjusting regional production capacity started with the ambitious Plan PD in 2016, aiming at maintaining a dynamic balance between pork production and demand by expanding production in the potential areas to compensate for the reduction in constrained areas. The yield in the four areas after 2016 showed that the Plan PD was progressing reasonably (Figure 4.6), with the national pork yield recovering since the low point in 2016. However, the time required to build new pig farms may have made capacity growth in potential areas insufficient to meet expectations.
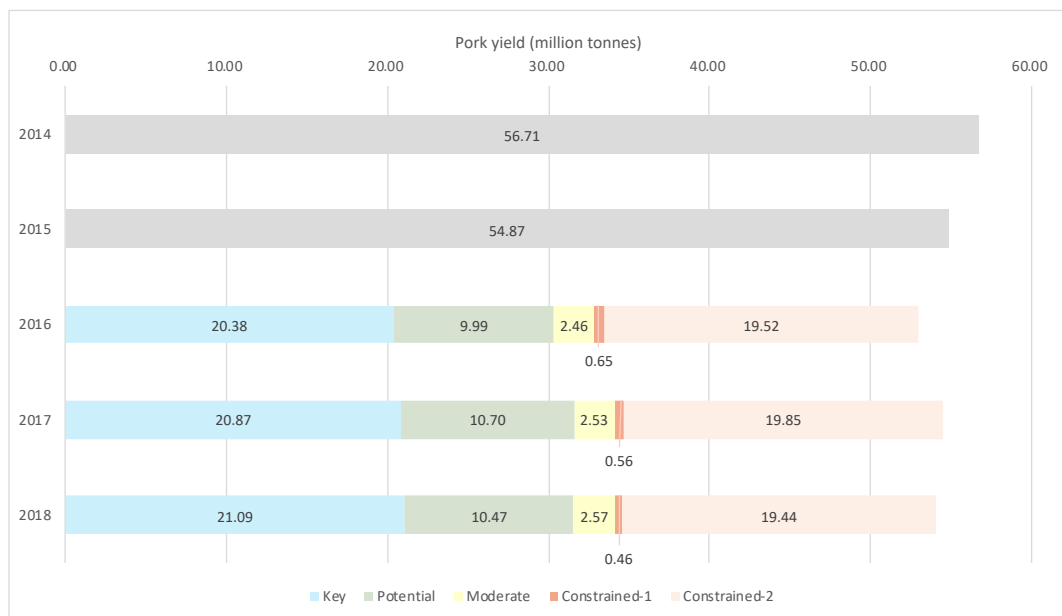
Figure 4.6 Changes of pork yield in the Key, Potential, Moderate and Constrained areas from 2014 to 2018

Impact-EPC

In spite of the shrinkage of national pork yield under Pressure-EPC, the shortfall was compensated by the growth in imported pork and therefore did not cause significant impacts on society. The annual per capita consumption of pork experienced a modest increase during this period, while pork prices fluctuated moderately and remained relatively stable (Figure 4.7).
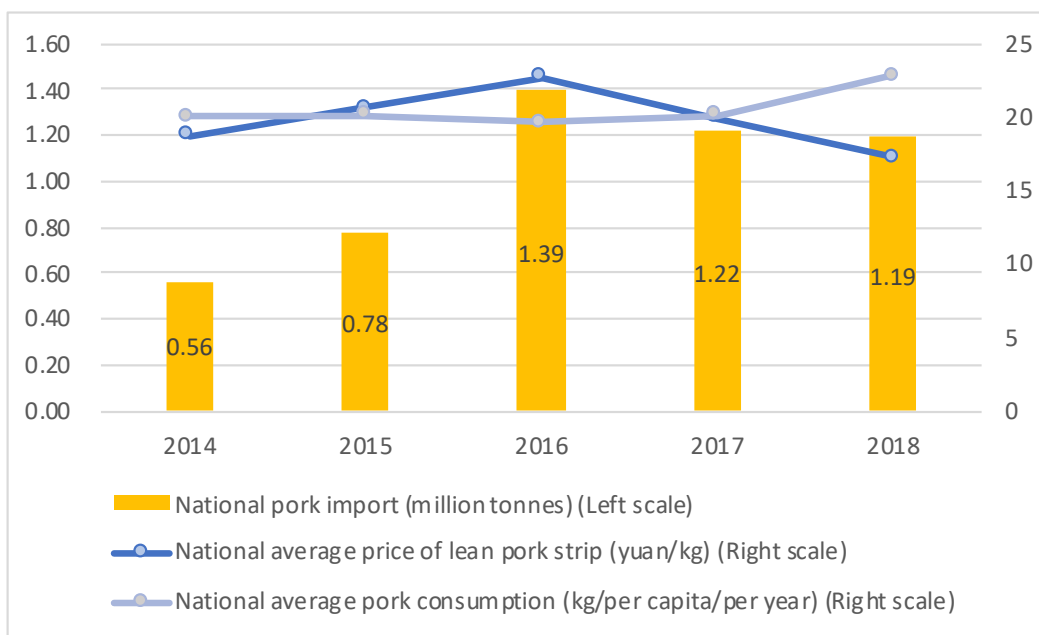
Figure 4.7 The impacts of the EPC on pork import, price and consumption

Response-EPC

Despite many pains of transformation during the EPC, the pork system had reached its milestones step-by-step by 2017/18 and was progressing in the intended direction. The institutional efforts at multi-jurisdictional and multi-level authorities were thus mainly on implementing and strengthening the effects of the EPC.

The EPC has put different pressures on each province, with Plan PD further defining the priorities of four areas, thereby limiting the trade-offs that each province could make among local economic, employment, industrial interests and environmental benefits. For instance, Guangdong and Jiangsu, China's top two economically developed provinces, have been highly active in the EPC. They have been redirected to constrained areas and were the only two provinces that have published specific provincial plans in response to the Plan PD. Contrastingly, Sichuan, the largest producer of pigs in China, was criticised for being too slow in progress during the central inspection on delineating no-breeding zones in 2017. To some extent, this reflected the reluctance of the top producer to shut down its pig farms.

4.4.2 Pressure-State-Impact-Response regarding the ASF

Pressure ASF

The outbreak of African Swine Fever (ASF) first occurred in August 2018, when the withdrawal of local production capacity in the no-breeding zones had been completed, and the relocation of regional capacity was ongoing according to Plan PD. The MOA first restricted the inter-provincial transport of live pigs in August-September to stem the spread of the disease. However, the 'Notice on Environmental Impact Assessment of Livestock and Poultry Farms' issued by MEE in October indicated that EPC remained an essential matter at this time. It suggested that China's pork system was under the joint pressures of the EPC and ASF in the early months of the ASF epidemic. Subsequently, the ASF outbreak was extinguished and resurfaced several times, eventually sweeping through most major pig producing provinces, thus making ASF the overwhelming pressure on the pork system (Ma *et al.*, 2021; Xiong *et al.*, 2021).

State-ASF

As mentioned in 4.1, China's pork production had started to recover after 2016, but the process was interrupted by the severe strikes of the ASF. Consequently, China's pork yield fell sharply by 21.3% in 2019 compared to 2018 (China Statistical Yearbook 2020), with no provinces spared. The key and constrained-2 areas with strong capacity also experienced the most severe shrinkage in pork yield regarding regional production (Figure 4.8).
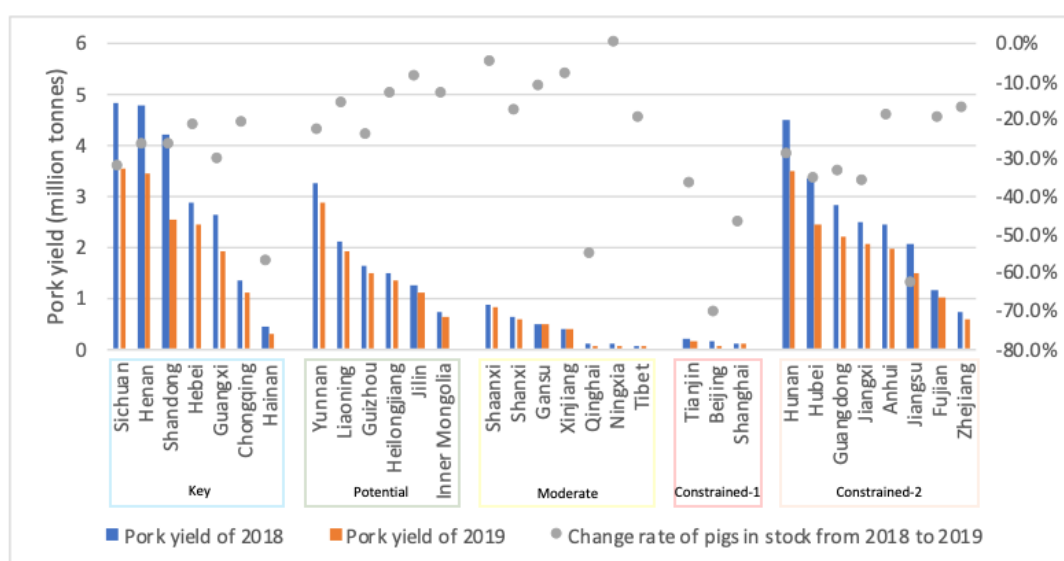
Figure 4.8 The shrinkage of pork yield and pigs stock from 2018 to 2019

The restrictions on transporting live pigs across provinces affected the sale of pigs, while the repeated outbreaks of ASF further undermined the ability and willingness of pig producers to replenish piglets. The national year-end pigs stock of 2019 declined by 27.5% compared to 2018 (China Statistical Yearbook 2020). Each province suffered differentiated reductions, some even exceeding 50%, further influencing pork yield in the following year. The control and prevention of ASF placed higher demands on the biosecurity protection and feed sources of pig farms, which pushed up the cost of breeding and made small-scale producers yet more challenging to sustain.

Impact-ASF
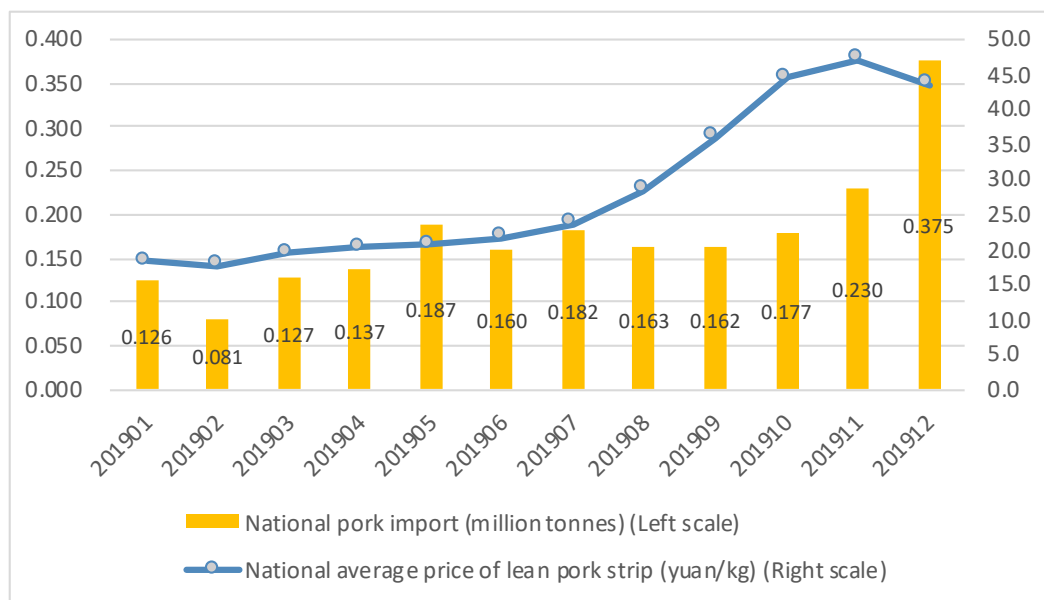
Figure 4.9 The impact of the ASF on pork import and price

The impact of the ASF on society began to appear about half a year after the initial outbreak (Figure 4.9). The significant decline in the domestic pork yield caused the pork prices to double in the second half of 2019, with the national per capita pork consumption at 20.3 kg in 2019 being 2.5 kg lower than in 2018 (China Statistical Yearbook 2020). Pork imports surged in 2019, particularly in the second half of the year, to relieve pressure on the domestic pork supply, increasing by 75% for the year compared to 2018 (China Statistical Yearbook 2020).

Response-ASF

To address the outbreak of ASF, the central government began to introduce policies to stabilise pork production from March 2019 (Figure 4.10). The responses escalated abruptly in September 2019 as the epidemic worsened and caused a dramatic reduction in domestic pork production and pig stocks. The State Council and its subordinate central departments launched a series of policies to adjust actions under the EPC, ensure domestic pork supply and restore pig production.

MOA issued opinions on stabilising pig production in March, which for the first time proposed 'not to expand the scope of no-breeding zones arbitrarily'. The State Council then required each province to conduct an in-depth self-examination and make immediate adjustments (i.e. reductions) to the delineated areas of no-breeding zones that exceed the limits of laws, which in effect proved that there were some overreaches of policy implementation during EPC. Besides, the MEE and MOA also relaxed the requirements for environmental assessment for pig farms to a certain extent, thus encouraging the building of new farms. The 'Three-Year Action Plan to Accelerate the Recovery and Development of Pig Production' (Plan RD) proposed to 'curb the decline in pig stock as soon as possible, ensure that pork production capacity returns to near-normal levels by the end of 2020 and recovers to normal in 2021'. These policies illustrated that the recovery of production capacity and securing supply, rather than improving the environmental sustainability, became the priority for the pork system under the attack of ASF.
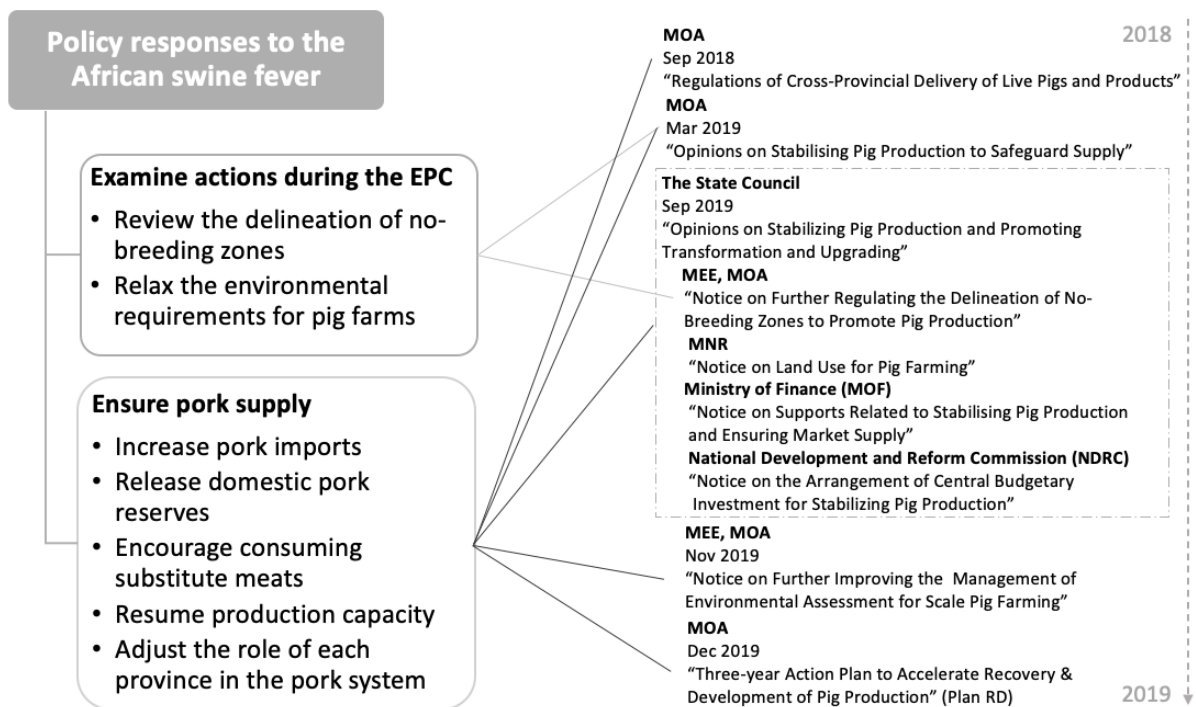
Figure 4.10 Policy responses to the ASF

To alleviate the surge in pork prices resulting from the pork supply gap, the central government increased pork imports while releasing many domestic pork reserves into the market to curb prices. At the same time, the central government also encouraged the consumption of substitute meats other than pork to relieve the pressure on the pork supply.

Tackling the long-term pressure on pork supply relied more on the recovery of production capacity. The central government thus introduced a series of policy concessions in terms of land use, electricity, financial support and taxation that benefit more actors in the production, slaughter, delivery and marketing segments of the pork industry. The government further expanded the types of subsidies available to pig farmers, including equipment and insurance for live pigs, to reduce the risk of financial losses due to ASF. It is noteworthy that these policies also proposed supportive measures in breeding and pollution prevention to small-scale pig farmers. This suggests that the attitude of policymakers towards the more polluting producers had shifted from withdrawing them from the system to enabling them to continue operating. Such policies have also created more opportunities for expanding large-scale breeding. For instance, the construction of pig farms within Class III and IV protected

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forest have been allowed, with the 15 mu (1 hectare) cap on land use for ancillary facilities being removed.

As the ASF broke out halfway through Plan PD, the surplus capacity in key and potential areas was insufficient to supplement the pork demand in the constrained areas. Coupled with the restrictions on inter-provincial delivery of live pigs, the role of each province in the pork system was adjusted accordingly to their production capacity and consumption (Table 4.2), rather than based on the environmental carrying capacity in the Plan PD. Guangdong, Jiangsu, Fujian, Zhejiang and Tianjin retained their roles as 'consumers'; Hunan, Hubei, Jiangxi, and Anhui were adjusted from 'constrained areas' to suppliers because of their surplus production capacity. Sichuan, Chongqing and Hainan, which used to be 'key areas', were classified as 'balance areas' as their fast decline in production capacity could hardly provide pork to other areas. The forced adjustment of provincial roles reminded policymakers of the importance of matching slaughter capacity with the regional breeding layout in transforming the pork system.

Province	Plan PD (2016-2020)	Plan RD (2019-2021)	
	Area	Role	Targets
Henan, Guangxi, Hebei, Shandong	Key	Supplier	Redeploying some production capacity to supply other regions
Hunan, Hubei, Jiangxi, Anhui	Constrained		
Jilin, Heilongjiang, Liaoning	Potential		
Sichuan, Hainan, Chongqing	Key	Balancer	Ensuring self-sufficiency
Yunnan, Guizhou, Inner Mongolia	Potential		
Shanxi, Gansu, Shaanxi, Xinjiang, Qinghai, Ningxia, Tibet	Moderate		

Jiangsu, Guangdong, Fujian, Zhejiang, Tianjin		Consumer	Maintaining the self-sufficiency of pork at 70%
Beijing, Shanghai	Constrained	Mega-city consumer	Ensuring 70% of pork demand through cross-regional cooperation on breeding bases, etc.

Table 4.2 The role of provinces in Plan PD and Plan RD

4.4.3 How Response-ASF has affected the pork system

Driven by a plunge in pigs stock by more than a quarter in 2019, China's pork yield hit a record low-end in 2020, with national average pork prices rising from 29.63yuan/kg in 2019 to an unprecedented 42.58yuan/kg in 2020 (Figure 4.11), and annual pork consumption per capita continuing to shrink from 20.3kg in 2019 to 18.2kg in 2020. As the effects of policy responses unfolded, pigs stock surged by 31% at the end of 2020. Pork yield consequently rebounded strongly in 2021, rising by 28.8% over the previous year to 52.96 million tonnes, a recovery of 98% of the 2018 level, which fulfilled the policy target highlighted in Plan RD. With adequate pork supply, pork prices fell responsively in 2021 to an average of 25.35yuan/kg, returning essentially to pre-2019 levels.
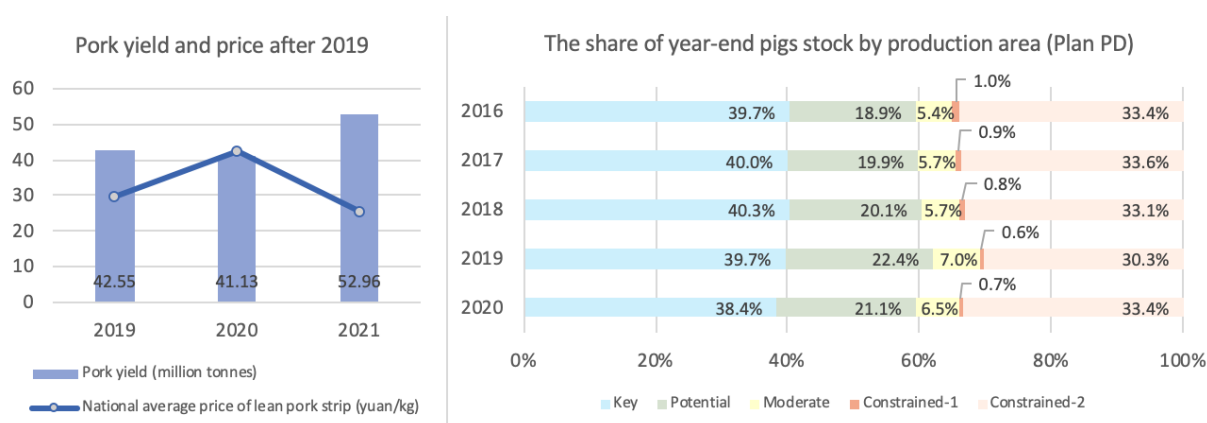
Figure 4.11 How Response-ASF affected the pork system in terms of pork yield, price and the distribution of year-end pigs stock

In terms of the transformation and upgrading of China's pork system, the targets of Plan PD (2016-2020) were partially achieved despite the dramatic impacts of the ASF, which caused the self-sufficiency rate of pork to fall from 97.5% in 2016 to 90.4% in 2020. The rate of scale breeding had reached 53% by 2020 (MOA, 2021), fulfilling the 52% target set by plan PD, and the 'potential' area has played a growing role. However, many of the provinces in the constrained-2 area were assigned the supplier status in Plan RD. Consequently, this area's share of the national pigs stock at the end of 2020 increased the fastest compared to other areas, and remained unchanged in 2020 vs. 2016 (Figure 4.11). Although detailed data on pork yield by province in 2021 are not yet available, it is conceivable that the provinces in constrained-2 may have made efforts that were consistent with Plan RD's expectations but contrary to Plan PD's objectives during the nationwide rapid recovery of pork production capacity in 2021, potentially leaving these 'constrained' (i.e. environmentally constrained) regions carrying even greater burden for pork production than in 2016.

4.4.4 Coupling the DPSIR analysis with the food system resilience theory

Following the explanations above, we can now refer back to Figure 2 and populate further explanations of the boxes in Figure 4.12, which, in turn, allows us to relate to the questions of resilience. We found a multi-level and progressive resilience (Figure 4.13), including reorientation, robustness and recovery as explained by Ingram (2017).
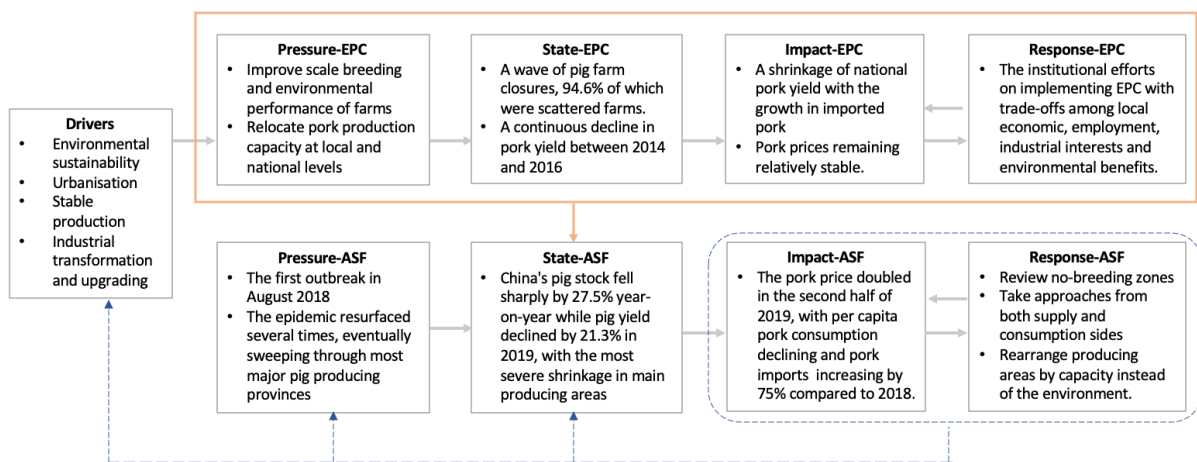
Figure 4.11 The deduction of the pork story in the DPSIR framework, based on 4.4.1, 4.4.2 and 4.4.3

The central government introduced the Plan PD during EPC, targeting the transformation and upgrading of pig production towards an optimal functionality of the pork system – maintaining a basic level of self-sufficiency of pork at a relatively moderate environmental cost. From a resilience perspective, these policies aimed to achieve reorientation or sustainability in a resilient manner in China's pork system by putting pressure on vulnerable actors (small-scale producers, production capacity in environmentally vulnerable provinces) in the system to exit or improve their environmental sustainability. However, this reorientation process reduced the robustness of China's pork system over time as the system turned out less agile to adjust yield due to a lack of small-scale producers and allowed the ASF to hit deeper., resulting in a significant decline in domestic pork yield and accelerating the withdrawal of vulnerable actors.
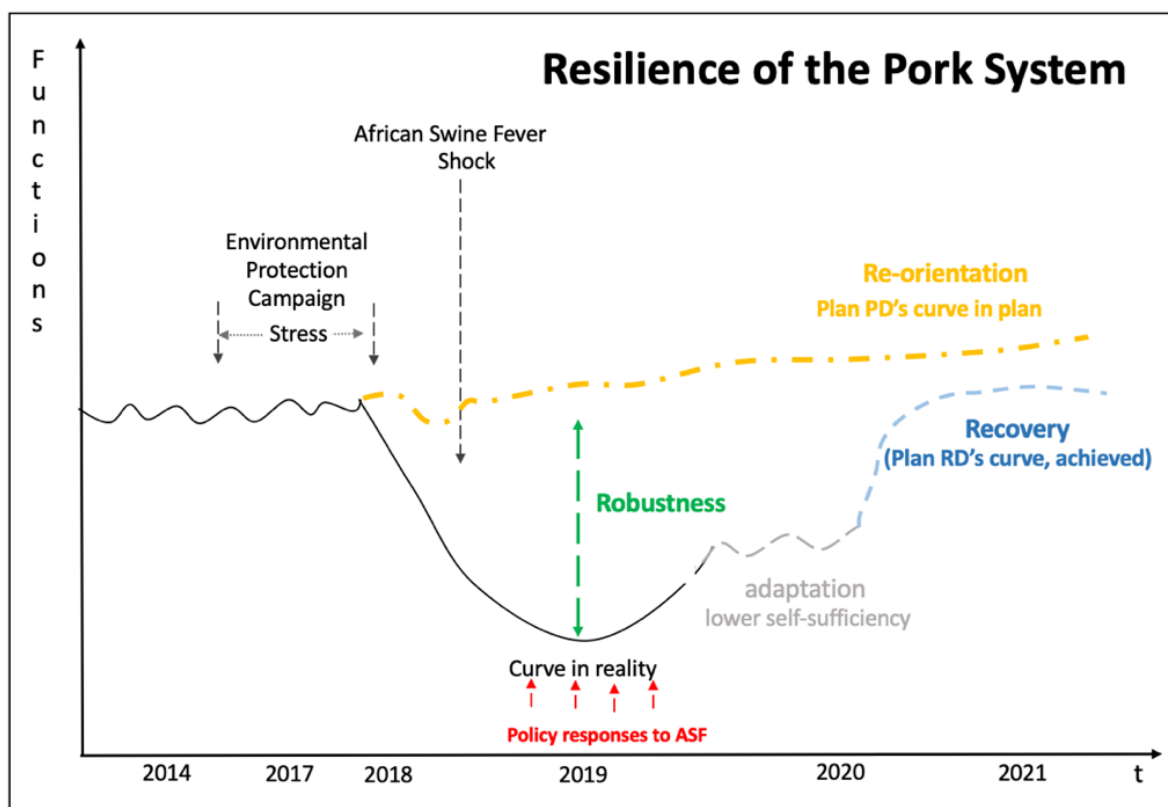
Figure 4.12 Interpreting resilience in China's Pork System with the 'RaRR' framework

Consequently, the pork supply shortage emerged rapidly, but it took a long time to recover the pork production. In order to make up for the short-term lack of pork supply, the

central government put in pork reserve, increased pork imports and encouraged consumption of substitute meat. Given that these adaptive policies changed the previous optimal expectations of the pork system, we argue that such adaptations were not a core connotation of resilience capacity for government in this case but more a matter of a temporary expedient. We therefore add a lowercase 'a' in the 3R (Robustness, Recovery, Reorientation) framework proposed by Ingram (2017) and make it 'RaRR', not to downgrade the adaptation but as an accurate description of what these policies meant for the functions of the pork system. For longer-term capacity recovery, the central government proposed a range of policies along with Plan RD. However, some of these policy objectives aiming at recovery were not entirely consistent with those previously introduced to achieve reorientation, with certain compromises in environmental sustainability.

4.5 Discussion

4.5.1 The dynamics between resilience and sustainability in the pork system's governance

Governance has played a diversified role in China's pork system as both pressures in EPC and responses to ASF, with policy objectives experiencing swings not only within different elements of resilience (i.e. in terms of differentiated prioritizing of robustness, recovery and reorientation at various times and places) but also between sustainability and resilience at different stages. Based on the actual rapid shift in the priorities of policy responses by the Chinese government, this section thus looks at whether policy responses in the pork system to EPC and ASF can contribute to delivering sustainability as a food system goal in more (or less) resilient way. We present a matrix of the related policies in the following manner in Figure 4.14, where: (1) 'Sustainable and Resilient' means that these policies drove the system towards optimal reorientation, with better outcomes in terms of both sustainability and resilience; (2) 'Sustainable but less Resilient' implies that these policies, while still conducive to sustainability, may be detrimental to the system's robustness and recovery in the face of disruptions; (3) 'Resilient but less Sustainable' means that these policies may be beneficial to the system's recovery from the disruption, but not be favourable to achieving a sustainable future; (4) 'Neither Sustainable nor Resilient' suggests that these policies may only be supportive of short term recovery, but in the long term were neither contributory to the reorientation nor to the sustainability of the system.

Sustainable but less resilient

-Delineating no-breeding zones and withdrawing production capacity there (2014-2017)

-Suspending pig breeding of farms with substandard environmental facilities (2014-2018)

2

Sustainable and Resilient

-Concessions on facilities and insurance (during EPC, same below)
-Farm-level environmental assessment
-Improving epidemic prevention
-Increasing the scale and match of production and slaughter capacity
-Combining pig breeding and crop farming zones

1

Neither sustainable nor resilient

-Revisiting no-breeding zones and adjusting over-enforcement (2019)

-Turning some provinces in constrained areas to 'Supplier' in response to ASF (2019)

4

Resilient but less sustainable

-Supporting small and medium-sized pig farms again (after ASF, same below)

-Preferential policies on land-use, electricity price for pig farms

-Incentives for main pig production towns

-Adjusting the demand on farm-level environmental assessment

3

Figure 4.13 Policy implications in the Resilient-Sustainable matrix

From such categorisation, we identified:

Policies that combine sustainability and resilience, particularly in terms of re-orientation, were generally carried forward as pressures of EPC, while some of these measures were then weakened by the policy response to ASF. For example, the environmental assessment requirement for newly built pig farms during EPC were relaxed during ASF, suggesting that the pressures encountered could largely influence the institutional policy priorities.

The policy objectives of EPC were mainly sustainability-related but did not necessarily favour, or thereby seriously consider, resilience. The efforts of designating no-breeding zones

and suspending the production capacity of farms without qualified environmental facilities might undermine the ability to recover after disruptions.

Many of the policy responses to ASF were biased towards resilience, especially in terms of rapid recovery (compensating for the weakened robustness effected by the EPC), but were probably not contributing to environmental sustainability.

The excessive recovery of production capacity in areas not suitable for pig breeding could lead to the worst scenario of Neither Sustainable nor Resilient, despite the succession of concerted policy efforts over 5+ years tackling both of these issues in turn. 'Jumping on the bandwagon' of lax enforcement for no-breeding zones in the name of recovery and re-absorbing small- and medium-scale farmers into pig production may have similar effects.

4.5.2 Policy implications

In China's pork system, the system-level governance would be practised on actors, where provincial governments and the production, slaughter, transportation and retail sectors in the pork industry are all actors susceptible to changing policies from central government. Both the withdrawal of backward actors and the transformation of qualified actors towards large-scale breeding and better regional layouts in the pork system work through regional and industrial governance coordination. The system-level pursuit of sustainability and resilience has complex implications for actors at different levels.

The EPC began with the designation of no-breeding zones and the elimination of backward production capacity, indicating that the systematic adjustment towards the optimal outcome came at the cost of vulnerable producers, who were treated as expendable. The restructuring of producers was supposed to be a bout of reorienting the pork system. However, the severe impacts of the ASF suggested that the previous attitude toward small-scale producers reduced the flexible buffer space available to the system, thereby making the system less agile due to a lack of small-scale producers.

More importantly, with changing policy priorities, we observed the process from 'self-reinforcing' to 'self-undermining' in such policies regulating small-scale producers. During EPC, the government kept pushing localities to designate no-breeding zones by setting policy targets and issuing technical guidelines. However, while facing ASF, the central government

proposed to review the delineation of no-breeding zones. Similarly, the government's attitude towards small-scale producers has shifted from shutting them down during EPC to retaining (and even reopening) them in a specific capacity during ASF. Such policy iterations have not been conducive to consolidating the political support base (Jacobs and Weaver, 2015) for further transforming the pork system, hence potentially significant costs for future policy initiatives to address the crucial challenges of sustainability and resilience.

Promoting large-scale production and adjusting the regional layout of production capacity are mutually complementary objectives of system-level governance, requiring the joint participation of actors across different regions and sectors. However, actors in the pork industry may react differently, and the gaming of interests within and between provinces have made the development of actors in various sectors, regions and levels not always well coordinated in pace (Zhuo *et al.*, 2021), which could affect the functions of the pork system and the outcome of governance. For a typical example, consider why the policy responses to ASF emphasised strengthening the matching of breeding and slaughter capacity. Due to a cultural preference for unrefrigerated meat, live pigs used to be transported closer to the market before being slaughtered. The outbreak of ASF restricted the interregional delivery of live pigs, affecting the conventional cross-regional coordination between production and slaughter actors, thereby interfering with the timely supply of pork and, in turn, farmers' income and willingness to replenish piglets (Xu *et al.*, 2022).

Scaled breeding is superior to small-scale breeding in management, productivity, reliance on labour, waste treatment, and environmental impacts (Liu et al., 2021). Therefore, increasing the scale of pig production has been the focus of the pork system's reorientation. Despite the expectation of the positive impacts of the scale effect, scale-up is not without pitfalls. Expanding scale capacity would take a certain period, so that the recovery of pork yield inevitably lags and is less flexible than small-scale producers. For example, China's pork yield hit bottom in 2020, despite policy incentives from 2019. However, once the scale effect started, it tended to be strong, such as the surge in China's pork yield in 2021, which almost halved the pork price. Moreover, this wave of scale effects has not ended, driving pork prices to a continued decline in the first half of 2022.

The great ups and downs in the production capacity and pork prices are not consistent with the pork system's expectation, suggesting room for further adjustment. In other words,

it seems that the potential sustainability benefits of a more concentrated pork sector can come at the cost of various crucial dimensions of system resilience, including robustness (at least to certain shocks, such as disease), recovery or flexibility and reorientation.

4.6 Conclusion

The governance of China's pork system is dominated by the central government, and the implementation of policies rely on multi-sectoral and multi-level collaboration across regions and the pork industry. By applying the DPSIR framework, we witnessed the crucial role of governance in China's pork system - as a pressure source for EPC by proactively facilitating systemic transformation, or as partners with the pork industry to fight with ASF shocks. The EPC aimed to reorient China's pork system towards a more sustainable future. However, such aggressive efforts may have inevitably compromised the system's robustness over time, leaving the system overstretched by the shock of ASF. Furthermore, some of the policies designed to recover the pork production capacity quickly were likely to undermine the original reorientation objectives. In the pork related policies from 2014 to 2020, we saw the trade-offs between sustainability and resilience from central policymakers, in which the alignment and allocation of interests among various actors within local governments and the pork industry entangled.

Given the tight and complex interconnections of environmental impacts of the food system, on the one hand, and environmental factors as potentially major and unpredictable challenges to system functioning, on the other, it would seem that food system sustainability and resilience are inseparable over the longer-term. But in the inescapable short- and medium term of policy and intervention, sustainability and resilience do not necessarily cohere seamlessly. As such, an important aspect of governing them well might mean abandoning the goal of managing the system 'perfectly' at any one time; paradoxically, the demand for a 'whole system' approach does not seem to lend itself easily to an approach aiming for comprehensive system oversight. Instead, a more successful strategy, reflecting the irreducible complexity, dynamism and uncertainty of such systems, may be to organize and regulate the system in a way that prioritises a clear and steady trajectory of reorientation over the medium- and long-term.

As such, sustainability and resilience are also made much more compatible as policy imperatives where the focus on the latter is interpreted in terms of reorientation primarily, rather than robustness and/or recovery, as is conventionally the case. Such an approach must also reckon with the need to reorient the system as a whole, including, and with the inescapable participation of, the complex social relations and actions of important stakeholders, including possibly government itself and its default modes of policymaking and implementation.

With the case study and trade-offs outlined in this paper, while specific to China's pork system, we hope to offer substantive insights and, especially, an analytical framework to initiate and facilitate building both resilience itself for other, diverse aspects of the food system globally and the associated appropriate forms of governance. The development of such parallel concerns is thus a question still to be explored in multiple further case studies.

Discussion Chapter

5 How to enhance food system resilience? Challenges and prospects via an actor-based lens

5.1 Introduction: Insights and reflections from previous papers

For this final paper, we turn to the key issue motivating the thesis as a whole, of how to enhance food system resilience given the insights regarding the nature of food systems and resilience thereof in the preceding papers. Accordingly, our starting point here is a quick recapitulation of the major findings of those prior papers.

Paper 1, as the literature review, synthesizes dispersed insights regarding the interaction of system-level and actor-level perspectives regarding food system resilience. Every food system actor influences the resilience of the food system to varying degrees in their own way, and the multitude of supportive roles that tie together the various elements of the food system demonstrates the complexity of the linkages between the system and the actors, as well as the importance of a tetrad of specifically system issues of actors' agency, diversity, connectivity and learning. This paper has explored and illuminated how both large and smaller actors, long and short supply chains etc... have strengths and weaknesses, providing trade-offs, and that a diversity of all of these is thus in principle beneficial, with no perfect arrangement ex ante. Moreover, that very diversity manifests and generates a context of continual novelty and innovation, hence providing a dynamic background and an uncertainly moving target. As such, it follows that, from the perspective of appropriate intervention in food system resilience, it is in principle never definitively knowable whether a specific intervention will benefit or harm that goal in the future (and/or to what extent).

Paper 2, from the perspective of an under-researched food system actor, shows that restaurants have significant agency to sustain livelihoods, recover from crises, and transform to remain competitive after major disruptions. Small but diverse actors can serve as an essential buffer during crises for the food system (Gret-Regamey *et al.*, 2019), while their

efforts at organisational level are not necessarily positive to support industrial and food system resilience as they are worryingly transforming in an opposite way. Prominent restaurants with more resources can better withstand disruptions, react and transform than smaller competitors. In the post-pandemic era, restaurants have begun introducing more standardised, pre-prepared products under the leadership of prominent actors. Concentration of industries is a familiar phenomenon under capitalism, and this tendency seems to be affecting the restaurant sector at present. The lack of power and financial resources has prevented the more minor actors from resisting this trend. The forced involvement consequently has resulted in a double de-diversification of the entire restaurant sector regarding types and products, trapped into "a reinforcing spiral of productivity paradigms and efficiency maximisation" (Brzezina *et al.*, 2016). However, the evidence in this paper suggests that in China restaurants are catering to the Chinese consumer's demand for convenient access to meals, which may arguably provide a pathway to better food system outcomes, despite that pathway not being entirely positive.

This case illustrates that it is extremely difficult to foresee the specific impact of what actors do on the overall outcome of the food system as individual impact can accumulate as more actors are involved, with varying feedback loops and uncertainties. Similarly, there may be conflicting interests between different food system actors, e.g. in work identified by other scholars. A scenario analysis of drought and free trade in the Swiss food system suggests that governing one activity towards more resilience could deteriorate others (Monastyrnaya, 2020). In the UK's fresh fruit and vegetable sector, a diversification strategy to increase supply resilience through flexibility in finding alternative suppliers could undermine resilience at the grower level (Zurek *et al.*, 2020). Therefore, good livelihoods or organisational resilience should aim to ensure continuity and improvement (Quandt and Paderes, 2022) for both themselves and the systems they are in, and to balance these twin concerns where they are not obviously and completely aligned. While the individual actors' agency to adapt to critical challenges is necessary (Quandt and Paderes, 2022), it would be meaningful to have a more holistic perspective to probe how families, communities, organisations and industries can appropriately play (or not play) their respective capabilities in dynamics in order to have better systemic outcomes (van Bers *et al.*, 2019).

Paper 3 explores the impact of the pursuit of resilience at the system level on actors from an opposite perspective to Paper 2 by looking at a particular subsystem, e.g. that related to a specific food type. In China's pork system, top-down governance for resilience involves the changing priorities and compromise in multiple goals and levels. On the one hand, reorienting the pork producers' structure and geographical distribution to promote environmental sustainability came at the cost of eliminating vulnerable small-scale pig farmers. On the other hand, the public and political pressure for rapid recovery of pork production amidst the African swine fever had effectively hindered governance efforts to transform the pork system towards a more sustainable and resilient future.

Learning from other studies, the pursuit of food system resilience involves actors with different goals, power, and priorities, resulting in potential conflicts between the goals of the food system and those of individual actors (Paloviita *et al.*, 2017), such as protecting resources and the environment versus increasing production and income for farmers (Uhlenbrook *et al.*, 2022). Starobin (2021) observed similar dilemmas in the practice of food certification institution. Certifications as a management strategy can help ensure food safety and credibility. However, in some cases, they create barriers for small food producers to enter the sector, particularly in emerging agricultural transitions such as agroecology, sustainable agriculture, and organic farming. For example, in the European transition to organic farming, the certification cost has made it challenging for small producers to participate in the market, leading to consolidation and a loss of diversity in the organic food system (Brzezina *et al.*, 2016). Such a reputational dilemma exacerbates the challenges already faced by smallholder farmers, including livelihood insecurity, political instability, and environmental degradation (Starobin, 2021).

Based on the three papers and preceding debates raised from research, this discussion chapter tries to return us to the overarching concern of this thesis, regarding the relation and balance between resilience (or flourishing) at system and actor levels. While both levels are thus crucial, and so, in principle, the relationship between them may be studied from a perspective in which either one is prioritized, or with an attempt at 'balance' between them, there are good reasons to opt for an analysis that prioritizes the actor level, as in this paper.

First and foremost amongst these reasons are ethical considerations. The challenge of balancing system and actor levels is effectively an ethical challenge, because the 'actor-level'

is simply a euphemism for the effects on actual living human (and non-human) beings, which is the crux of any ethics worthy of consideration. Moreover, questions of ethics really matter here, because they are so challenging: the balance between the two perspectives is again one that *in principle* cannot be resolved in the abstract and 'beforehand', but only ever in the present instant and by involving the ethical reflection of actual persons affected by the issues.

For instance, despite the possibility that elimination of vulnerable actors from the food system may contribute to system resilience, individuals and households should not be trapped in food insecurity due to the loss of their livelihoods. But, of course, the resilience of food systems, i.e. at systems level, also profoundly affects such ethical subjects, making it too an ethical issue, albeit less directly. The conjunction of, and potential tension between, the unconflatable actor- and system-level concerns of food system resilience thus pose one set of ethical imperatives against another set, with neither one ever clearly nor definitely primary. Yet it is in privileging the actor perspective that this tension emerges most clearly, while focusing on a system-level primarily lends itself too easily to a functionalist and/or dehumanized analysis.

As well as these ethical considerations, though, there are also important issues of strategy and effective action that point towards the priority of an actor-level perspective. The temptation from existing default ways of proceeding is often to focus on learning ever more, in ever greater detail, about the specific mechanisms, strengths and weaknesses of specific actors and structures with a view to building up an asymptotically 'perfect' picture of the system in all its complexity. In other words, the standard approach to learning about food system resilience focuses on the 3rd-person, objective actuality of that system. Yet this enterprise quickly runs into inescapable limits of definitive knowledge about food system resilience. While initially illuminating and edifying, gesticulating to system complexity in this way can quickly lead not to further illumination but to paralysis and overload, at least from the perspective of attempts to govern the system well (governing that is, of course, to be done by actors).

By contrast, an approach that prioritizes the first-person, actor perspective does not make the strategic – and epistemic – mistake of presuming that 'more perfect knowledge' always and necessarily equals 'more perfect system government' (and/or vice versa); or even the mistake of presuming that there actually *is* a 'right' way of governing the system 'if only

we had all the data'. Instead, by prioritizing the first-person actor perspective, the question of food system resilience can become a self-consciously practical and experimental enterprise in which *how* the strategic agents are themselves oriented to the challenge of system resilience (i.e. resilience of the systems in which they are themselves situated) in part shapes the systems-level outcome of their attempted interventions, and with that knowledge never perfectible, in principle. What is needed in the future, in short, is an approach focused on optimal sharing of strategic insights, strategic learning and the practical enabling both of these.

Building on the insights from earlier chapters, therefore, this one aims to bring together specifically system-attuned reflections on food system resilience, the tetrad of agency, diversity, connectivity and learning, and the irreducibly multi-level complexities foregrounded by these concerns; concerns of both ethics and of strategy (i.e. where strategy is a matter of both government and understanding). This agenda, though, points towards a quite fundamental reorientation in prevailing 'common-sense' approaches to food system resilience in ways that resonate strongly with parallel arguments about the need to rebase science and policy in such complex system spheres towards the prioritization of phronesis (or situated *strategic-ethical* wisdom) (Tyfield, 2020; Yuille *et al.*, 2021).

What then are the prevailing and common consensus-based practices and the challenges the practices confront? How could governance of food system resilience, at *both* system *and actor* levels, advance amidst difficulties and uncertainties? This chapter will continue to explore the above questions based on field research and relevant literature in the next sections.

5.2 The challenges of resilience governance in the food system

Systems are not governed for the sake of resilience in and of itself, but about delivering a particular outcome in a resilient manner. It is increasingly recognised that it is imperative to improve the food system and its actors' capability to function amid crises. However, scholars also suggest that governing food system resilience may have unintended negative externalities. This section summarises several typical challenges of resilience governance in the food system.

5.2.1 Overemphasis on robustness and recovery

According to Ingram (2017), the food system's resilience can be interpreted into a joint framework of the three Rs with differentiated focuses, namely Robustness, Recovery, and Reorientation. While each element is crucial, governing food system resilience must pay attention to the challenge that an overemphasis on robustness and recovery may expose imbalances and distortions in resilience (Meuwissen *et al.*, 2021), as shown in the following.

Highly robust systems may lack the ability to change fundamentally (Doherty *et al.*, 2019), while the continued emphasis on robustness amidst contemporary rising visibility and urgency of disruptions, may only temporarily shift vulnerability elsewhere at the expense of the food system's long-term adaptability (Meuwissen *et al.*, 2021). Smith and Lawrence (2018) pointed out that having food retailers limit their sourcing to local farmers during the COVID-19 pandemic to assist in the robustness of food supply could reduce their vulnerability to global trade collapse but might also increase their exposure to local supply shocks, which are not necessarily more resilient in the long run. However, it is undeniable that there are outcomes of the food system that do require high robustness if they are to be guaranteed. For example, if it's about food security, then we cannot allow people to starve in the interim of shifting to a fundamentally new system.

Similarly, recovery means bouncing back to past levels, regardless of whether the past is optimal. Smith and Lawrence identified a cyclical focus on disasters in policy-making out of a commitment to political elections may exacerbate the mismatch between recovery in short term and long-term resilience goals (2018), as may broader issues of political cycles and legitimacy, regardless of elections. Consequently, technical solutions to immediate crises may be prioritised over long-term social considerations (Zollet *et al.*, 2021) but opportunities for reorganisation and transformation born out of chaos may thus be missed due to the emphasis on rapid recovery. For example, Paper 3 on China's pork system indicates that the rapid recovery of pork production amidst the African swine fever had effectively hindered governance efforts to transform the pork system towards a more sustainable and resilient future.

5.2.2 Disruptive and unsustainable transformations

It is essential to emphasise, though, that criticisms of governance prioritising food system robustness and rapid recovery should not induce a conclusion that reorienting the food system is necessarily a route to resilience. Achieving resilience in agri-food systems requires striking a balance between socio-economic and ecological considerations, and is thus a complex task in need of trade-offs (Manyise and Dentoni, 2021). Therefore, transformational strategies may be only sometimes conducive to achieving such a balance with potentially conflicting environmental and social goals.

In transforming to industrialised food production, artificial inputs to ensure yields, such as pesticides, fertilisers and irrigation, can reduce production fluctuations, but these practices come with environmental externalities that may ultimately lead to negative feedback on production and decreased productivity (Macfadyen et al., 2015; Spies, 2018). Through observation of grape production, Pedreño et al. (2015) noted that the transition from smallholder to highly profitable and intensive production models, despite being well-adapted to the global supply chain, could never be considered environmentally and socially sustainable. Not only are natural resources overexploited in the transformation, but more importantly, smallholders' livelihoods have been deprived due to their inability to invest in necessary technological infrastructure, while the seasonal work patterns offered to smallholders as an alternative could lead to job insecurity for farmers (Pedreno et al., 2015). During the COVID-19 pandemic, food delivery to household has improved consumers' food access during the lockdown and it has continued to play an increasingly important role in a well-developed food distribution system in the post-pandemic era. However, such a transformation has also increased carbon emissions from delivering food and disconnected consumers from producers and urban spaces (Fava et al., 2022).

More importantly, deliberate attempts at transformational reorientation also risk falling back into traditional paradigms anyway, but with all the added disruption of the 'transformation', as observed in the transition to introduce organic food production into the European food system (Brzezina et al., 2016). Organic food producers may be incentivised to comply with minimum standards as they are not rewarded for continuous improvement. This can trap organic food producers back into a reinforcing spiral of involvement in maximising productivity and efficiency. The certification institution also creates barriers for small organic

food producers to enter the market, trapping the organic food system in the exact mainstream-driven mechanisms as the conventional food system and increasingly losing its diversity (Brzezina *et al.*, 2017).

5.2.3 Potential trade-offs between resilience and efficiency

Resilience and efficiency, two key considerations frequently mentioned in the governance of the food system, are often viewed as conflicting as well. Efficiency, which implies minimal slack or redundancy, suggests that resources are fully utilised, leaving little room to absorb disruptions (Garnett, 2014). However, resilience requires some degree of flexibility to mitigate the impact of shocks (Merkle *et al.*, 2021). Some scholars have even directly criticised the focus on efficiency, standardisation, and specialisation for reducing the size and organisational diversity of the food system as a whole (Eidt *et al.*, 2020). The interplay of efficiency and resilience is present across almost all food system actors and subsystems, regardless of their geography or scale within the food system.

The geographical scale of food systems has a significant impact on their resilience and efficiency. While increased connectivity in global food trade has improved efficiency, and potentially mitigates exposure to highly localized shocks, e.g. floodings and plant diseases, it has also increased the vulnerability of these systems to transmitted risks (Karakoc and Konar, 2021), especially where that greater geographical scale is achieved precisely through supply chains that are prioritizing efficiency gains. The dependence of local food systems on food imports can negatively impact their diversity of crops (Sellberg *et al.*, 2020) and their resilience to natural disasters (Spies, 2018). In contrast, locally diversified and interconnected actors with a high degree of self-sufficiency may enhance the resilience of regional food systems but not necessarily align with environmental goals related to resource efficiency and carbon emission reduction (Sellberg *et al.*, 2020).

Efficient food supply chains often minimise inventory and capacity buffers, which makes them vulnerable to sudden and widespread demand increases or supply shortages (Hobbs, 2021). Based on such remote supply chains, supermarkets can improve cost efficiency but lack flexibility to deal with supply disruptions (Marusak *et al.*, 2021). Diversifying the supply chain can increase resilience by minimising risks (Matthews, 2020), but this strategy

will inevitably raise the multifaceted costs of the chain (Arabsheybani and Arshadi Khasmeh, 2021). For instance, a dispersed food processing sector consisting of diverse small-scale actors is less prone to extensive breakdowns, but higher costs, more staff requirements overall and lower processing efficiency compared to food factories may increase food prices for consumers (Hobbs, 2021), which is also seen as an insurance premium (Merkle *et al.*, 2021) for resilience at the expense of sectoral efficiency.

Although an efficient food system is more sensitive to shocks due to inner connectivity and thus exhibits greater vulnerability (Voorn *et al.*, 2020), this trade-off is not a universal rule in every food system activity (Kahiluoto, 2020). For instance, there is no evidence of compromise between farm efficiency and resilience in resource use efficiency versus land use diversity (Kahiluoto and Kaseva, 2016). Moreover, some argue that system intensification did not prevent inter-individual diversity as a driver of resource use efficiency and farm resilience (Dumont *et al.*, 2020). The trade-off between resilience and efficiency may also change depending on various factors, such as agent interactions and shocks. The ability of agents to reorganise trading partners is also an important aspect of resilience (Voorn *et al.*, 2020).

Notably, although there are many cases where efficiency and resilience are hardly compatible in governance, we should avoid portraying things as dichotomous, when there are often more than two opposing variables. Food system resilience and efficiency can be effectively synergistic if pursued appropriately – i.e., at the very least, with an eye deliberately on *both* considerations. For instance, applying breeding technologies and varietal mixing can enhance production resilience and efficiency through diversification strategies (Dwivedi *et al.*, 2017).

5.2.4 Potential conflicts in pursuing food system sustainability and resilience

Driven by climate change, the global attention on food system sustainability emphasises the simultaneous need to improve food security, reduce environmental footprints, ensure socio-ecological resilience, and consider equity, highlighting the economic, environmental, and social aspects of sustainability. Resilience is a critical element of sustainable food systems (Jacobi *et al.*, 2019; Brandão *et al.*, 2020), as they must be able to adapt to future fluctuations and long-term threats, such as those arising from climate change

(Eakin *et al.*, 2018). Therefore, resilience and sustainability are increasingly considered a dual imperative for the global food system (Ruhf, 2015) and attract governmental or non-governmental international organisations, such as the United Nations, to coordinate between countries to address multiple challenges jointly.

Numerous observations indicate that sustainable strategies for food system governance can synergize resilience strategies. Taking the critical resource of water as an example, sustainable management of water resources can improve food system resilience and security via ensuring actors' access to it (Uhlenbrook *et al.*, 2022). Local governments can contribute to food system sustainability by supporting the reduction of food miles, e.g. through sourcing from local and regional agriculture. These activities can also create jobs and stimulate the local economy, promoting the long-term resilience of local food systems (Hecht *et al.*, 2019). Moreover, in building resilient urban food systems, developing multiple sustainable food subsystems is considered a strategic mechanism for enhancing resilience by incorporating diversity and flexibility to reduce system vulnerability (James and Friel, 2015).

Although we may assume that efforts to enhance the sustainability of food systems ideally align with resilience, empirical evidence suggests that there is also a trade-off between the two goals. Strategies promoting resilience may not prioritise sustainability while sustainability-focused governance approaches may not necessarily lead to greater resilience. According to Kuokkanen et al. (2016), selective destructions may be necessary to achieve a sustainable transition by balancing socio-economic and ecological trade-offs. However, such a transformation may withdraw some of the most vulnerable actors, particularly small farmers who lack the physical and financial capability to adapt, and diminish the diversity of actors as a result (Manyise and Dentoni, 2021; Pedreno *et al.*, 2015).

In Paper 3, reorienting the pork producers' structure and geographical distribution to promote environmental sustainability came at the cost of eliminating vulnerable small pig farmers. Such a radical reorientation has simultaneously changed the multifaceted configuration of the entire pork sector, leaving China's pork production particularly vulnerable to the shock of African swine fever. Sustainable transitions in other systems may also affect the food system, such as bioenergy and carbon sequestration projects that may encourage land grabbing and negatively affect small farmers' livelihoods and food security (Hasegawa *et al.*, 2018).

5.2.5 Possibilities of exacerbating existing inequalities

The current food system governance of resilience may not benefit actors equally, which could reinforce the dominant structure of mainstream actors over the food system and exacerbate existing power imbalance among actors. For example, Smith and Lawrence (2018) found that small businesses, farmers, and producer/industry groups were left out of formal public policies and processes after the 2011 floods in Queensland, Australia. Similar issues have been observed in cross-regional cases during the global pandemic. Smallholder farmers in the informal economy could only produce in limited quantities because of strict lockdowns. When farmers' markets and restaurants closed, it took away a source of income for small producers (Paganini *et al.*, 2020; Zollet *et al.*, 2021).

In contrast, mainstream food system actors, such as supermarkets, benefited from higher social capital and adaptive capacity during the pandemic as being identified as 'essential' and thus received more public support (Paganini *et al.*, 2020; Zollet *et al.*, 2021). Such a virtual bias favouring mainstream food retailers reflects the government's widespread distrust and even active antipathy toward small-scale and especially informal commerce. While seemingly logical from the point of view that prominent actors may be more capable of dealing with disasters, this bias might obscure the contribution of excluded citizen groups to food security and consolidate the power of large retailers to influence decision-making in their favour (Smith and Lawrence, 2018).

Paper 2 discovers that Wuhan's public policy on rent reductions for food outlets during the COVID lockdown might only benefit some restaurants with public landlords. Such an invisible threshold led to an unequal distribution of support and risked propelling private landlords who failed or refused to give the same rent cuts as public landlords into moral criticism. Moreover, de facto inequalities in access to restaurant support could cumulatively affect their subsequent capability to transform. Overall, the lack of support from the government for smaller or alternative food system actors may reduce the likelihood of formally enrolling smaller or alternative actors in the food system (Smith and Lawrence, 2018). Privileging mainstream food system actors with limited considerations of vulnerable actors in the policy arena is ultimately a significant barrier to transforming food systems (Chhetri, 2021; Jones *et al.*, 2022).

5.2.6 Reliance on external support

Several studies from different political, cultural and geographical contexts have reminded that governance strategies prioritising actors' welfare may not always lead to systemic resilience, as they can create actors' reliance and limit their capacity to adapt to complex political and market dynamics. In the Karakoram mountains, government subsidies for growing wheat saved poor farmers from starvation despite rising food prices, but this has also resulted in farmers' solid dependence on agricultural subsidies (Spies, 2018). The Swiss food system heavily relies on state support with the value chain lacking the capability to maintain current levels of self-sufficiency under free trade scenarios (Monastyrnaya, 2020). European organic producers' higher profits than conventional farmers are mainly due to price premiums and public subsidies, which can make them increasingly dependent on external input and vulnerable to political changes (Brzezina *et al.*, 2016). In the fishing industry, an overemphasis on improving access for the poor can overlook the potential for wealth creation and rural development from fisheries resources and also risks ecological constraints that could undermine resource productivity (Jacques, 2015). While public food procurement schemes can create a stable income and market for farmers, they may also lead to a dependence on institutional markets organized by the government (Brandão *et al.*, 2020).

5.2.7 Inadequate coordination among multi-level authorities and actors

More generally, the food system governance for resilience is hindered by a lack of coordination among cross-level agencies and by challenges in distributing responsibilities. On the one hand, many foods are produced in the global ecosystem and traded using worldwide networks, but the associated governance is not carried out globally. Using global fisheries as an example, the majority of the global fish market is caught (or farmed) in the Global South but consumed in the Global North. The exploitation and commercialization of fisheries thus occur globally, yet conventional dispersed governance is incapable of managing such a scale (Jacques, 2015). In another case study, China needed to import large amounts of feed to stabilise domestic pork production. A large proportion of feed imports shifted to Brazil following trade tensions between the US and China, which may have encouraged deforestation in rainforest areas.

On the other hand, responsibility for food system decision-making is assigned to the national or regional level, while food system outcomes are delivered at the local level by actors outside of government. However, almost all countries, regardless of their stage of development, do not have a ministry that focuses on food system governance, let alone specific food categories. Responsibility for different aspects of the food system rests with multiple departments, including environment, household livelihoods, social security, land and others (James and Friel, 2015). In many cases, locally independent and uncoordinated institutions made decisions that affect the food-energy-water nexus, limiting the potential for collective action for mutual resilience in multi-sectors (Sukhwani *et al.*, 2019). While many food system actors and AFNs have responded to food shortages by supplying food innovatively, only a few have engaged in collaborative problem-solving with the government (Smith and Lawrence, 2018).

For instance, the barriers to transforming the nutrition cycle in the Finnish food system came from institutional failures at the policy-governance and business-market interface. This two-way problem involved an insufficient directional push from the downward guidance at the policy-governance level and an inadequate expression of demand at the business-market level (Kuokkanen *et al.*, 2016). The case of South Africa also highlighted the tension between ambitious goals for food system governance and institutional constraints that impede transformation (Termeer *et al.*, 2018). The paradox of 'bottom-up' action but 'top-down' decision-making reflects the lack of linkages and participation at different scales of governance in the food system.

According to the evidence presented in this section, it appears that the food system governance for resilience has been stuck in a loop of criticism, wherein one method may not be adequate while going the opposite way may not improve outcomes either. Many of the examples used rely on an oversimplification of food system dynamics and create a dichotomous situation, when in reality dynamics are complex and not dichotomous, and this complexity needs to be better acknowledged and engaged. This paralysis in a 'loop of criticism' also demonstrate/bring to light some pretty fundamental lack of understanding of how the food system works/what food system resilience actually is in practice. And a lack of

understanding is tightly connected to a lack of a deliberate practice of *developing* it, which is precisely what phronesis (i.e. practical *wisdom*) is.

Ultimately, underpinning these criticisms and praises is the fact that the food system is inherently a complex multi-actor system with multiple systemic goals, such as sustainability and justice. Moreover, the intertwining of resilience among the various actors, the conventional capitalist paradigm and other critical goals makes the governance for resilience in the food system a tremendously challenging matter. Whilst resilience is important, it shouldn't be the only priority because actors at all tiers of the food system are impacted by the trade-offs between the system's many competing interests. More importantly, governance for resilience is not for the sake of resilience in and of itself. It is about delivering food system outcomes in a resilient manner, i.e. ultimately for *actors* within that food system. Thus, food system governance for resilience is also considered a 'window of opportunity' (Folke *et al.*, 2010) to allow for positive institutional and policy change. The focus on minimising negative exposures and vulnerabilities may divert attention from maximising profit opportunities. As Jacques argued, such a "window of opportunity" can assist actors in the food system to achieve a desirable balance between wealth, rights, and resilience (2015).

But, crucially, food system resilience is not just a matter of the characterisation of food systems in this way. Governance must grapple with all these complexities what is also *missing* is an adequate paradigm and/or process for practical *understanding and working with* such a system. This is crucial, because without this qualification to the argument, 'a complex multi-actor system with multiple system goals' may be (mis)understood as simply inherently and inescapably *un*governable. Yet such a conclusion is both a cry of defeat, and a speculation to boot. At worst, we don't know if such systems are governable or not; at best, we do have growing evidence that they *are*, so long as we change *ourselves* and *how* we approach the challenge of governing them – i.e. again privileging the first-person and actor-level perspective. The following, and final, section will thus explore how to promote governance for food system resilience.

5.3 How to promote governance for resilience in the food system?

Since there is neither an optimal strategy nor one-size-fits-all solution, this section does not seek to come up with any concrete recommendations for improving food system resilience. Instead, we offer insights that should be taken into account to make the food system more resilient in a more integrated and inclusive manner. Beginning with the concept of system governance, several essential factors are then discussed in this section, including the appropriate temporal and geographical scale for resilience governance, actors' activism, and the possibility of paradigm shifts. In all these regards, we illustrate and flesh out processes and practices that manifest the broader shift to the actor, first-person perspective advocated throughout words to this effect.

5.3.1 System governance approach

Scholars have highlighted the importance of system governance in food systems for several reasons. First, the economic, institutional, and social linkages among food system actors render them extremely interdependent and susceptible to one another (Bene, 2020). Secondly, food systems have multiple objectives with potential trade-offs that include improving environmental sustainability, livelihoods, equity of access to food, population health outcomes, and resilience to change (James and Friel, 2015). Thirdly, food systems are complex socio-ecological systems that span multiple geographical scales and transcend the jurisdiction of traditional governance structures (van Bers *et al.*, 2019). Despite existing governance practices, most approaches to resilience that address food-related issues have been criticised for failing to address food system vulnerability holistically and inclusively. An integrated framework is required to address connected concerns, drivers, and feedback loops to develop a more resilient food system (Termeer *et al.*, 2018). This framework should break down entrenched sectoral categories and existing adaptation and mitigation silos (Monastyrnaya, 2020).

Many conflicts among food system actors may stem from neglecting interrelated stakeholder drivers and feedback loops in governance. Paper 2 and the study of organic farming in Europe (Brzezina *et al.*, 2016) revealed that a capitalist system's food sector could be driven by an efficiency quest that may eliminate less efficient but diverse competitors.

Maximising economies of scale for efficiency can undermine diversification structures and transformation attempts, thereby affecting the system's resilience. Food system governance for resilience must identify this potential contradiction between systemic resilience and spontaneous regime-driven efficiency-seeking among organisations and industries, taking into account actors' heterogeneity and their different risk frameworks and resilience-building mechanisms.

The key to balancing these complex trade-offs lies in identifying interconnected actors' relations and feedback loops in the food system (Rasul, 2021) and balancing them with a systemic perspective and more integrated, inclusive strategies for natural and human systems governance (Uhlenbrook *et al.*, 2022) [that enables actor-level 'advocates' for the diversity of concerns]. For instance, soil and water management techniques can promote crop diversification better, and such an approach to improve technical efficiency can help offset or reduce crop diversification's negative effects on technical efficiency (Mzyece and Ng'ombe, 2020). Crop management practices such as increasing soil organic matter can both enhance crop yields and their resilience while reducing greenhouse gas emissions (Rosenzweig *et al.*, 2020).

The complex relationships among food system actors, as well as their potential conflicting interests, highlight resilient governance of food systems is potentially implicitly destructive. However, responsible resilience governance should neither be at the expense of livelihoods, particularly those of small-scale producers, nor should it exacerbate existing inequalities or create new vulnerabilities. In addition, actors who work in the food system are also consumers, and loss of livelihoods can result in difficulties in achieving basic household needs, such as food security. Therefore, food system governance for resilience must be aware of its potential impacts on all stakeholders, particularly the most vulnerable, and prioritize their needs to avoid unintended consequences (Jones *et al.*, 2022; Bailey and Buck, 2016; Paloviita *et al.*, 2017), including but not limited to providing employment, and learning opportunities.

Governments have been the main policy-making body for carrying out governance related to the food system. However, there is often no single (quasi-public) body tasked with oversight of food systems, and even if there were, it alone cannot be expected to govern such a complex system well as top-down 'sovereign', i.e. without appropriate relations to and input

from the diversity of other system actors. While system integrity may be theoretically feasible for food systems which are so open, how governments intervene in reality is bound to be complicated. The emphasis on the system approach is thus more motivated by the spread of risks and behavioural impacts among actors rather than by the need for all of them to act in a coordinated manner, which is obviously not possible. Therefore, the complexity and interdependence of food system actors require more innovative and collaborative approaches that involve all stakeholders to consider their interests, including governments, the private sector, civil society, and individuals. A landscape approach, which involves multiple scales and emphasizes ecosystem processes and conflict management, has been suggested as one potential approach (Bailey and Buck, 2016). The polycentric perspective is another way to govern food systems. It recognizes that food systems comprise multiple independent decision-making units and need patterns for the public and private sectors to work together, compete, and explore conflict resolution mechanisms (van Bers *et al.*, 2019).

Effective food system governance requires decision-making centres at different levels and jurisdictions, allowing for adaptive management and information transfer between levels (van Bers *et al.*, 2019). Modelling the impacts of disruptions on the food supply chain can help develop tailored recovery plans based on multi-criteria optimisation objectives (Tsiamas and Rahimifard, 2021). Participatory, multi-stakeholder dialogue is also a promising approach beyond traditional public governance (Ratner and Allison, 2012). This approach involves coordination and collaboration between actors to ensure the proper functioning of the food system in times of crisis. It also includes the role of actors in the decision-making process, which could increase the possibility of creating inclusive solutions (Vieira *et al.*, 2019).

Participatory dialogue takes complete account of the interests of the actors and is informed by their views, leading to improved transparency, feedback, and learning across sectors and scales (Ratner and Allison, 2012; Kahiluoto, 2020). Anticipatory governance with a participatory process is an innovative strategy for effective food system governance. In Sweden, for example, a dialogue on a vision for a better food system revealed tensions and conflicting views among actors regarding the goal of self-sufficiency, plant-based protein, and higher-value food. Participatory dialogue can help uncover potential barriers to change and facilitate advanced thinking about mitigation measures and the alignment of goals (Sellberg *et al.*, 2020).

The institutional arrangements and coordination mechanisms of food system governance, thus, can certainly be significantly improved with appropriate effort and reorganization. Yet it is also crucial to acknowledge that the very complexity and dynamism of the issues and interests involved still cannot be 'perfected' simply by shifting the emphasis from perfection of the knowledge and oversight of the system to perfection of the governance framework. Rather, optimization of the governance framework, and thence of the functioning of the food system itself, still depends upon a broad-based acceptance of, and orientation towards, a pragmatic 'muddling through' of continual learning and the cultivation of strategic-ethical wisdom. For any residual expectation, no matter how tacit or buried, from system actors that stable and definitive oversight of the food system is possible (and so legitimately expected of those tasked with system governance) is itself a profoundly significant and problematic factor in the realization of that very goal. While participatory and more inclusive governance is thus crucial, it is also crucial *how* and what on grounds of expectation such measures are convened. Without foregrounding these issues the great risk is that participation alone may even makes system governance *worse* where, due to mistaken understanding of the nature of challenge, it simply converts unworkable complexity of the issues into unworkable complexity of the governance; as now increasingly observable in the growing impatience with experiments in participatory governance [refs].

5.3.2 Governing food system resilience for how long?

One of the classic four questions in resilience research is 'resilience for how long?' (Helfgott, 2018). This question is especially relevant in governance for food system resilience, which, as a frequently disrupted system, requires a focus on robustness, recovery, and reorientation in different circumstances. There might be a standard answer to the 'how long' question: good food system resilience governance should balance long- and short-term concerns (i.e. *at least both* of these temporalities, if not also 'medium-term' others too), addressing immediate emergencies while considering transformations (Magar *et al.*, 2021; Paganini *et al.*, 2020). Planning for a reasonable focus length of resilience governance can have a positive impact, such as setting reasonable expectations for the supply chain and household consumers, providing ongoing and long-term education for society, and fostering

innovation and technology adoption (Rodriguez and Gonzalez, 2018). Achieving these goals requires aligning multiple aspects of the food system, including infrastructure, innovation policies, legal instruments, and institutional arrangements (Magar *et al.*, 2021). However, based on field research and literature studies, this paper argues that three priorities need particular attention in pragmatic answering of the 'resilience for how long' question.

When planning for long-term transformation in the food system, it is essential to consider that it takes time to restructure complex production relationships and build new infrastructure. Paper 3 on China's pork system demonstrated that shutting down plants in no-breeding zones could be easy but constructing new capacities would take engineering time. The neglect of the timeframe could result in an exceptionally fragile period of transition for the pork system, where the old farms have gone but the new ones are still underbuilding and adapting.

Additionally, long-term transformation should not be contingent on eliminating vulnerable actors. Therefore, adaptation possibilities and costs for small actors should be a primary concern. It's necessary to distinguish whether actors lack sufficient capacity or are unwilling to transform, as Bene has repeatedly emphasized (2020). Implementing environmentally and socially beneficial activities may lead to long-term benefits, such as improved performance or better product quality. However, the initial costs involved, such as additional labour or expensive resources, may be insurmountable for companies with small margins, discouraging them from transforming (Fletcher *et al.*, 2021). Therefore, it's equally important to help vulnerable actors build transformational capacities and provide more assistance to them to enable transformations.

While designing measures for coping with shocks, it is crucial to be cautious about anticipating a speedy recovery of the food system. Policymakers could be misled into giving more weight to powerful and established actors while overlooking the demands of more vulnerable ones. This pressure to deliver outcomes within a limited time frame may come from public expectations or be encouraged by the current widespread tenure systems for policymakers. However, in either case, this may pose trade-offs for the food system that could have been avoided. The author's research on China's pork system showed that too much focus on yield recovery after an African swine fever outbreak could undermine long-term system transformation. Similarly, during the pandemic, the government's decision to prioritise

supermarkets over local food suppliers might have intensified existing disparities and further damaged equity (Smith and Lawrence, 2018). Therefore, future policies should prioritise building stronger and more resilient food systems rather than relying on short-term fixes that may not address underlying issues. By doing so, we can ensure that the food system is better prepared to withstand shocks and promote long-term sustainability (Matthews, 2020; Glaros *et al.*, 2021).

5.3.3 Geographical scale of food system governance for resilience

Governing food system resilience faces a fundamental challenge: reconciling the global production, trade, and consumption of food with regional and industrial compartmentalization of governance (Jacques, 2015). As food is traded globally, exploitation of human and environmental resources takes place at a global level. Differential effects of climate change, varying degrees of political and economic development among countries, and a rapidly expanding global population all contribute to a challenging setting for constructing resilient food systems.

Policymakers must take action to promote resilience, yet most food categories have no global governance structure. Consequently, if poorly designed, national actions could conflict with one another and create unexpected crises for socio-economic systems in other countries. Moreover, lacking a collective decision-making mechanism could potentially lead to a tragedy of the commons (Macfadyen *et al.*, 2015). Coordination at the global level is desirable, but the current state of global climate governance suggests that expecting such coordination at the governmental level might be unrealistic. Instead, large businesses and retailers have taken on a governance role in such an anarchic situation, having set standards on food safety, quality, and environmental sustainability that have global impacts on different actors across countries (Macfadyen *et al.*, 2015).

Many countries that are significant producers of a particular food strive to guide public governance by providing an integrated agenda at the national level. Unfortunately, governance is often compartmentalized between regions and sectors, even for the same food product. However, the rules and institutional procedures, stakeholders, and ecosystem

dynamics of governance agents at all scales and sectors could contribute to many pressures for the food system across regions (Jacques, 2015).

In China's pork production, for instance, the Ministry of Agriculture and Rural Affairs, the Ministry of Ecology and Environment, and the Ministry of Natural Resources have all introduced policies related to the governance of pork production with different focuses. Meanwhile, the status quo of the regional output has evolved geographically and historically, and the interests across regions are not aligned. Imposing regulations at a higher level through administrative rather than market forces tended to create more de facto inequalities and unexpected distortions. The so-called macro-regulation, therefore, is hardly truly macro without taking into account measures that will affect other relevant regions and sectors. As a result, not only did the breeding regions and farmers in China lose their autonomy, but the balance in the country's pork production was disrupted. Thus, effective governance of food systems requires explicit attention to issues of coordination and collaboration at multiple levels to address the complex and interrelated challenges of sustainability and resilience.

In contrast, local food networks have demonstrated their potential to safeguard food system functions during the pandemic due to the advantages of smaller-scale food systems in terms of their diversity of organisational forms, decentralisation of production spaces, and reconnection of production to site-specific consumption. Such features can provide redundancy of roles and functions in many parts of the food system and contribute to the (re-)territorialisation of food supply chains and the delegation of power in food system governance (Glaros et al., 2021; Jones et al., 2022). The local government could promote a shift in actors' roles to respond positively to the COVID-19 pandemic, for example by making locally produced food an integral part of their tourism product (Kaufmane et al., 2021). Some studies even highlighted the benefits of community food system approaches as additional safeguards in times of crisis, emphasising the flexibility that can be achieved at the community level in balancing power between various interest groups and stakeholders.

However, the possible failure of macro-regulation does not necessarily justify placing power at the grassroots level. While these approaches have their merits, we note also tentative reservations about the potential of smaller governance units. While smaller-scale food systems can be an essential piece of the puzzle, it is crucial to balance this with effective

governance at higher levels to ensure the resilience and sustainability of the whole food system.

As Bailey and Buck (2016) suggested, local-level strategies of food systems could be compromised or even disrupted if the more significant socio-ecological drivers of the crisis are not addressed. In addition, the coordination provided at the local level may be insufficient (Berkhout *et al.*, 2023), both in terms of delivering regulated alternatives and ensuring food security by guaranteeing sufficient food categories and coordinating with other scales and regions (Hendrickson, 2015; Marten and Atalan-Helicke, 2015). While large-scale actors such as supermarkets have been criticised, global food supply networks have played an important role in enriching tables worldwide over the last few decades (Dunning *et al.*, 2015; Matthews, 2020). In contrast, the ability of local farmers to provide adequate and abundant food locally is highly dependent on local climatic, geographical, economic, and other agriculture-related conditions (Ruhf, 2015). For instance, local food self-sufficiency should not be overemphasised in mountain regions, and the risks of such exposure to local environmental conditions is likely to become relevant to increasingly diverse geographies as the extreme weather events of a warming planet continue to intensify. Although programs to improve food self-sufficiency can contribute to resilience building, their effectiveness can be limited if they do not address other food system elements (Spies, 2018). Fava et al.'s study also found evidence of a return to traditional retailing by consumers after the pandemic, which suggests that locally-based food production may limit the choices and thus struggle to sustain consumer appeal (2022).

Achieving resilience in food system governance requires balancing broad and local coordination. Regional governance may offer a suitable compromise in terms of geographical scope. Benefits of regional food systems that local communities cannot match include a larger pool of actors and greater product diversity (Marten and Atalan-Helicke, 2015; Ruhf, 2015). Also, compared to food systems that acquire ingredients from across the country or the world, regional food systems are more flexible and can encourage regional connections, trust, and relationships (Ruhf, 2015). Region-based combinations of long-short food supply chains offer opportunities to both assess multiple vulnerabilities to reduce the likelihood of risks and increase the ability of the system to respond to unforeseen adverse events (Fletcher *et al.*, 2021).

To make regional food systems more resilient through governance, it is most important to set up a vision based on regional realities with the participation of all stakeholders. The study in Stockholm provides a vivid example of stakeholder participatory visioning of a well-formulated regional food system (Sellberg *et al.*, 2020). A powerful and regionally appropriate food resilience strategy is essential to address food demand, storage, and distribution while rebalancing dependence on food imports and complex domestic supply chains (Paci-Green and Berardi, 2015; Marten and Atalan-Helicke, 2015). However, it is worth noting that regional food systems are not necessarily healthier or more equitable. For this reason, building resilient regional food systems should require the participation of relevant stakeholders and integrated social governance across the region, which considers factors like inflation and poverty that affect food security at the regional level (Nuryartono *et al.*, 2021).

5.3.4 Bottom-up governance by encouraging actors' participation

Bene noted a distinction between actors' capability for resilience and their actual application of that capability (2020). Partnering with multi-stakeholder groups involved in the value chain/network across the food system (van Bers *et al.*, 2019; Glaros *et al.*, 2021; Skog *et al.*, 2018) is essential to encourage actors' agency and address complex trade-offs for achieving long-term resilience (Manyise and Dentoni, 2021). Beyond partnerships, collective action in cooperatives, collaborative marketing, and shared customers can create and sustain market niches. Networks, peer support, and regional agricultural organizations can contribute to building shared knowledge and helping collectives respond and adapt to the risks they face (Starobin, 2021; Soubry *et al.*, 2020). Achieving resilience requires institutional and technical changes and a mix of actors at different levels and sectors who can leverage each other's strengths and resources (Glaros *et al.*, 2021).

More importantly, partnerships and collective action can challenge the conventional top-down approach to food system governance decision-making. By forming solidarity coalitions, the actions and voices of local producers can become more visible and better reflect their importance in sustaining rural communities and household livelihoods (Campbell *et al.*, 2018; Glaros *et al.*, 2021). Coalitions can also empower stakeholders currently excluded from governance mechanisms (Berkhout *et al.*, 2023), enhancing the political and social

capital of the local food sector and its ability to participate in existing governance systems (Jones *et al.*, 2022).

It's important to note, however, that the association of local food system actors should go beyond the defensive localism of self-sufficiency. Local associations can mobilize localism on many issues, such as climate change, biodiversity, and well-being (Jones *et al.*, 2022). However, this should not lead to irrational political preferences for local food through protectionist measures, which could hurt the health of local diets and weaken rather than strengthen food security (Matthews, 2020). As discussed in the subsection on the regional scope of governance, resilient governance in one place should not come at the cost of additional vulnerability to other sites.

A platform with reputation, trust, and reciprocity is needed for participatory governance to create a shared identity and responsibility among actors (Skog *et al.*, 2018), and allow coordination for partnerships and collective action (Soubry *et al.*, 2020). The most vulnerable actors in the food system can benefit from resilience-building strategies discussed and created via these channels, including training and funding for new infrastructure and resources. To prevent unintended outcomes that could undermine the overall supply or the resilience of any particular actor, it is crucial to ensure that the risks and advantages of these tactics are adequately considered and addressed among actors (Zurek *et al.*, 2020).

5.3.5 Reverse paradigm for a fork-driven transformation

Sustainable Development Goal (SDG) 12 underscores the significance of responsible consumption and production in balancing adaptation, mitigation, and other SDGs. Research increasingly examines how consumers influence food system resilience through their choices and behaviours (Campbell *et al.*, 2018). However, the current production-driven food regime shapes food availability on store shelves. Consequently, we might ask whether it would help to transform the food system if consumers could, in turn, have greater decision-making power over what appears on the shelves. One noteworthy trend is that consumers are becoming more aware of the link between food consumption and climate change, prompting them to modify their dietary habits by embracing a more environmentally friendly, vegetarian diet. These shifts in diet are, in turn, encouraging supermarkets to offer a broader range of

vegetarian products, both in terms of content and form, and more restaurants to introduce vegetarian menus.

Consumers can also promote a more equitable power distribution in the food supply chain. By fostering consumer connections with locally produced food and promoting preferences for local food, local food systems can collaborate with supermarket retailers to bring about changes (Dunning *et al.*, 2015). This shift offers opportunities for traditionally disadvantaged actors, such as small-scale producers, to steer the local food supply towards locally produced food more connected to the territory (Singh-Peterson and Lawrence, 2017; Fava *et al.*, 2022). While such changes must be rooted in sociocultural foundations, it is clear that consumer empowerment has significant potential to effect change.

Educating consumers about the need for change in the food system, the trade-offs involved, and their ability to participate in this change is the precondition for such transformations (Stave and Kopainsky, 2017; Zurek *et al.*, 2018). Several studies have shown that consumers are willing to pay more for food produced by farmers affected by risks (Monastyrnaya, 2020). As previously mentioned, a participatory or anticipatory governance approach that includes consumer perspectives may be viable. However, empirical research on how consumers can influence food system trade-offs in a reverse paradigm and how other value chain members will respond still needs to be explored in more empirical studies, and any definitive conclusions will depend on more field experiments and research.

5.4 Conclusion

The impossibility of delineating the 'perfect' food system arrangement vis-à-vis our target here of optimal resilience has been signalled at numerous points above, but essentially there are three key (and overlapping or converging) aspects to it.

First, there is no ideal strategy for resilient governance of food systems or, more simply, no ideal resilience. Any strategy for bolstering food system resilience will necessitate sophisticated cooperation and compromise among many actors and between those actors and the system as a whole due to the pervasive nature of trade-offs amongst numerous food system objectives. The period, geography, politics, economy, culture, and risk of a food system

must all be considered when designing food system governance for resilience. Hence, there is a need for a more phronetic approach, with a shift from seeking an (let alone 'the') optimal solution to a more strategic learning based on more participatory approaches. Such reflections, in other words, suggest that significant, concerted and ongoing attention, into the future, is required on what is now here posed as a key, but never definitely answerable, question of 'how can relations and balance between food system resilience at system- and (specific) actor-levels be practically improved?', where that is always to be read with the qualifications of a specific, indexical 'here' and 'now'.

Second, another key challenge that this paper would like to highlight is the inequality of power distribution between actors. The key challenge, though, is that their actions are not always directly and solely complementary and can often involve competitive and even mutually antagonistic elements. A key question, often neglected, not least because there is often no single (quasi-public) body tasked with oversight of food systems, is thus the balance between different actors, keeping their respective contributions complementary. Indeed, absent such explicit institutional (concern for) balancing, the larger actors' greater concentration, and hence visibility and power, will tend to their further accumulation of power and influence, to the increasing neglect of the smaller ones. The predictable result of such a tendency over time, though, is the breakdown of the mutually dependent complementarity of these large and smaller actors in the imbalance towards the former: a situation that seems to be to the former's zero-sum advantage in the short-term but over longer duration is at their cost too, through the indirect route of undermining the resilience and integration of the food system as a whole.

Third, it is thus for these reasons that, from the perspective of both actors and system alike, this further emphasises the need for proactive intervention in food system governance and responsible action by actors, in all their diversity. If left unchecked, emerging practices in every food system sector, perhaps under the current food regime, would be repeatedly caught in a productivity-maximising spiral. One potential strategy is to shift the traditional production-led paradigm towards empowering consumers to help the food system make the many trade-offs previously discussed and drive the transformation of the food system through consumer demand. However, this paradigm shift may lead to some fundamentally unknown changes in the food system, the effects of which may need to be corroborated by more

exploration; and, as argued above, it may also end up changing comparatively little insofar as the *way* in which those empowered consumers engage with the food system is itself still expressive of relatively unchanged understanding of the challenge and nature of food system governance. As such, while significant progress regarding food system resilience, and balance between system- and actor-level concerns, may be made by reorganizing the governance framework, this remains only a necessary, not sufficient, condition; and explicit attention to transforming the practical understanding of that system, and to a prioritized focus on the mechanisms for instituting that collective learning on an ongoing basis, remains inescapable and paramount.

6. Conclusions and outlook

6.1 Conclusions

Through theoretical and empirical studies, this thesis explores the relationship between food system resilience and food system actors. The thesis focuses on a bi-directional issue: 1) what impact actors have on food system resilience, and 2) how efforts to improve food system resilience affect actors.

For the first question, this thesis conducted a cross-actor literature review on the food system revealing the challenges of drawing definitive conclusions about how actors influence food system resilience since the case background shapes such impacts. This thesis has seen how both large and smaller actors, long and short supply chains, have strengths and weaknesses, providing trade-offs. Instead, the thesis identifies key factors at the actor level that impact food system resilience, including actors' capability and initiative, diversity, connectivity, connections, and learning across sectors.

Building on the literature review findings, this thesis explores the resilience of restaurants as a food system actor during the COVID-19 pandemic, which has rarely been studied before. Actors' resilience can be decomposed into two aspects: the actor's livelihood resilience and the continued function of the actor's role in the food system. The findings prove that actor capability and initiative are crucial in determining their resilience, while the effects on the food system resilience are ambiguous, with both positive and negative feedback. Some restaurants that remained in operation helped the food system to partially fulfil its function of keeping the public in demand for food. However, in the restaurant sector's transformation, the environment for independent restaurants has generally deteriorated, with prominent players gaining overwhelming advantages over small competitors regarding capital resources, access to financial support, advertising ability and technology accumulation. Consequently, the otherwise reasonably diverse industry has become increasingly concentrated and undiversified. As evidenced by the concentration and homogenization of the restaurant industry, actors' pursuit of their resilience can have unexpected outcomes for the food system resilience. Despite the importance of actors' initiative, it does not mean a tidy causal relationship exists between actor-level and food system resilience.

Regarding the second question, food system resilience goals are inherently diverse, requiring trade-offs between inner objectives such as robustness, recovery, and reorientation. The complexity of actors in the food system and the multi-level governance make these trade-offs even more complex. In the case study of pork production in China, this thesis found that pursuing systemic resilience involves a process of adjusting the previous balance, followed by a return to equilibrium, where actors and interests restructure. This process is inherently disruptive, and vulnerable actors will most likely bear the adverse outcomes. Therefore, there is no such thing as perfect, unharmed resilience. However, the resilience of actors' livelihoods is still an ethical issue. Although food system actors may be eliminated for falling behind, no individual within them should be impoverished or become a burden on society because of their withdrawal. Acknowledging this allows for mitigation and compensation for possible disruptions, such as the destruction of vulnerable livelihoods and the transfer of vulnerability between actors, which can make food system governance for resilience more feasible in practice.

It is noticeable that practices to move the food system and its sectors towards resilience, whether spontaneous (e.g. in restaurants) or deliberate/policy-driven (e.g. in pig farming), tend to address non-resilience by excluding vulnerable actors rather than figuring out institutional solutions. This may cause these sectors, if not already, to fall into a trap of (obsession with or even fetishizing of) maximising productivity. In the experience of the food production sector, the impact of intensive production on biodiversity, soil, and water resilience has been demonstrated in numerous studies. Pursuing resilience in this way may only be effective in the short term and self-defeating in the long run (thereby questioning whether it counts as 'resilience' at all), especially if other, less industrialised food system sectors continue to run forward to such known dilemmas.

The powerful inertia of the capitalist paradigm under the existing food regime underlines the need for governance to intervene to ensure that the food system retains more resilient characteristics. However, there is often no single quasi-public institution responsible for overseeing the food system or maintaining the balance between large and small actors that keeps their contributions complementary. Current food system governance still places greater value on already powerful mainstream actors, which may exacerbate inequalities between food system actors. While this choice is understandable from the government's

perspective – it is less risky and less stressful to support mainstream actors because the government needs to meet its political commitments on food security etc. within a fixed period of time – it may reinforce the concentration of power towards mainstream actors over time, depriving the diversity of the food system and thus undermining its resilient future.

Therefore, in order to enhance food system resilience, this study argues that public governance alone may not be sufficient even if it aims for the (i.e. what appears at the time to be the) optimal outcome. The diversity and complexity of actors in food systems create an environment of constant innovation, making it a dynamic and uncertain context. Defining a clear and definitive optimal policy or strategy for food system resilience in advance is extremely challenging, and there is neither perfect mastery of knowledge nor definitive 'best practice' policy that can be implemented in practice. Food system governance is thus a continuous process of improvement at the individual actor level and the collective emergence of the system as a whole.

Instead of focusing on detailed refinement and mastery of food system metrics and models, there needs to be a shift in approach that prioritises restructuring how best to share strategic insights and learning and make it work in practice. For instance, the pork study suggests organising and managing the food system to prioritise a clear and stable consensus trajectory for medium to long-term reorientation and enhance the ability to respond quickly and reasonably in the event of disruptions.

Building such consensus on medium to long-term goals requires more participatory engagement, especially from bottom-up food system actors. However, this thesis does not propose complete decentralisation of power to smaller local actors, as it is impossible to solve the overall power imbalance in the food system with only local optimisation alone. Furthermore, this thesis is conservative about whether a more locally based food system can meet the population's food needs. Therefore, this thesis does not support totalized critique of the power imbalance between different actors, some of which is set by the laws of economics. But instead, it considers how governance for food system resilience can be made as good as possible based on accepting some degree of power imbalance as an inevitable fact.

From an improvement perspective, this thesis suggests that food system actors can fight for a greater voice through joint and collective action. In addition, the production-driven

food system currently determines what food is available on the shelves for consumption. Suppose consumers become more involved in decision-making process of governing food system resilience. In that case, it may help make the current insoluble trade-offs about which goals and actors should be prioritised, which presents an opportunity for fundamental changes. By exploring theoretical and empirical evidence of the relationship between actor and food system level resilience, this thesis hopes to contribute to food system research, particularly on how to build more inclusive resilience that takes actors into account.

6.2 Research Limitations and outlook

This thesis has several limitations regarding the study area, subjects, and methods. The research on pork production in China had been planned with field study from the beginning as this typical case inspired the PhD theme. However, the original plan to conduct field research on pig farms was disrupted by the occasional cases of African swine fever and the outbreak of the COVID-19 pandemic. Pig farms have largely restricted visitors due to safety concerns, rendering field research unfeasible.

The second case study had planned to select food system actors in the UK or Europe to allow for a comparison of the impact of the different political decision-making processes on food system governance for resilience. Due to the pandemic and the resulting difficulty of travelling, the study had to be relocated to China for practical reasons. While Wuhan, the site of the pandemic outbreak, is representative, it was challenging to find restaurants willing to participate in the study due to the enormous pressure of the city's reputation for the pandemic outbreak. Given the constraints on the sample size, the study employed a multi-case method to compare restaurants' performance before and after the pandemic. This approach avoided unreasonable comparisons between interviewees of different sizes and operations. If more interviewees had been available, this paper would have allowed for a comparison between actors.

Despite compromising on the research site, studying the restaurant sector in China is highly essential, given the significant changes to its business model over the past decade resulting from the growth of the gig and platform economies. Future research could

investigate the resilience of restaurant organisations in other regions or countries with diverse cultural and institutional backgrounds to provide valuable insights into how local contexts shape resilience. Additionally, the authors suggest conducting international comparative studies of innovative food system practices related to food system resilience. For example, in China, where urbanisation is still ongoing with limited households or community gardens and open spaces, innovative practices to enhance the sustainability and health of food systems may differ from those in the UK, Europe, and other areas. However, the Internet economy and the spread of food distribution services have led to many innovative food system practices in China, like community group buying. Through separate ongoing research on food system transformation and innovation, the author has identified some counter-paradigm elements in these innovative practices, where consumers order first, and retailers make on-demand procurement. More observations are needed on whether a reverse paradigm of fork-to-farm, in which consumer demand drives food production, can improve food system resilience by shifting from supply by production to production by demand. The author will explore and address research gaps in different country contexts in future postdoctoral research.

This thesis highlights the challenges and trade-offs inherent in building food system resilience. While Paper 3 addresses trade-offs through descriptive analysis based on available statistical data, a notable gap exists in quantitative studies on this subject. Most current studies with a similar focus, including those cited in this thesis, remain qualitative. Future research could delve deeper into these trade-offs, employing quantitative methods to assess influencing indicators to provide policymakers and stakeholders with more nuanced insights for informed decision-making on balancing competing objectives.

While current research predominantly focuses on the social and institutional factors that contribute to food system resilience, a promising avenue for future exploration involves examining the impact of technological change on the food system. Recent studies during the pandemic highlight the positive influence of Internet access on actors' performances. Hence, investigating the effects of more advanced technological innovations, such as urban agriculture, blockchain, and artificial intelligence, on food system resilience holds significant potential – as long as, of course, such research continues to explore these technological novelties as themselves still inescapably socio-technical developments, unintelligible from a purely technological lens.

Last but not least, the thesis argues for investigating the potential impact of reorganising the governance framework on food system resilience, taking into account system and actor level concerns. Future research should rigorously evaluate the effectiveness of such changes in achieving desired outcomes. By emphasising the paramount importance of explicit attention to collective learning, researchers can explore how prioritising this aspect positively influences food system adaptation and evolution over time. The practical integration of research findings into governance structures and day-to-day operations is crucial and requires the exploration of strategies to bridge the gap between theoretical understanding and practical implementation (often concentrated amongst very different groups with different skills, capacities and interests) for a more resilient food system.

Appendices

3.3 Semi-structured interview in Wuhan

Interview instructions

The interviews will be conducted with restaurants, companies, and start-ups doing catering in Wuhan. In the interview guide, we have used the concept [organisation] to describe all earlier mentioned actors.

In our experience, the interviews will take between 30-45min. Please ask the interviewee for their consent to record the interview and use the interview data for an anonymous scientific evaluation within the SIRIUS research project.

Please start the interview by briefly introducing the research project context and your person!

Basic Information

Can you introduce the founding time and founders of your organisation?

Can you briefly summarise your role/position in your organisation?

At what scale does the organisation operate? (e.g. local, regional, national, global; chain store or not)

E.g. structure of staff, e.g. waiter/kitchen/manager ratio

Who are the targeted consumers of your organisation?

E.g. in what gender & age group? Any unique design for them?

Have you ever participated in the process of selecting the location of your organisation? If so, what is your consideration for the selection?

In what way is the organisation doing something differently/ innovative than others?

e.g. in products, in organisation models……

How does your organisation dispose of kitchen waste? Is waste sorted?

Collaboration and supply chain

What are your organisation's leading suppliers?

In what way and how often does the organisation get ingredients, e.g. food with long shelf life, fresh fruits and vegetables, beverages…

Are such suppliers wholesalers, market retailers or farmers?

How does the organisation store ingredients?

Does your organisation stock up on food inventory? What kind?

What local government departments do you have to deal with in your everyday business? How is the experience?

How does your organisation have marketing in some online & offline channels?

How important is the collaboration between your organisation and other food system actors?

How did the COVID-19 pandemic and lockdown shape your organisation?

For an organisation who are alive

During the lockdown,

Could your organisation stay open? If so, how about the business condition? If not, how many days has your organisation been closed? What measures were taken to mitigate losses when the organisation was not open?

Did the organisation have stock in reserve? If so, how did your organisation deal with them? If not, why?

Has the cooperation with suppliers been affected?

What were the operation costs of employees and rent?

After the restrictions were lifted,

Why can your organisation survive the COVID outbreak?

E.g. finance, employment, stock, consumer confidence…

How has the traffic of your organisation changed after that?

How about the supply of meat & storable ingredients & vegetables & fruits & alcoholic beverages?

Cold chain logistics may also spread viruses; how has this affected your organisation?

Would you adjust your strategies for stocking up on food ingredients?

What are other difficulties for your organisation after the lockdown? Have you anticipated these difficulties before?

Does the government have some supportive policies for your organisation's recovery?

E.g. reduction of rent, tax and salary subsidy for employees…

Are there any practices that changed (because of COVID) that have improved your organisation?

Is your organisation likely to continue these new practices when you are in a post-COVID situation?

Or does your organisation expect to go back to business as usual?

For organisations that have failed during the epidemic

What are the reasons for suspending your organisation?

E.g. unwilling to continue, hard to recover…

Will you consider continuing your organisation in the future?

If so, how can the experience from the outbreak provide you with some lessons for enhancement? Will you change/remain with your previous business model?

Particular focus on restaurants with a takeaway business

When did your restaurant start cooperating with platforms?

Does your restaurant operate on both Meituan and Ele. me? What is the percentage of the contribution from each?

What is the share of total turnover for takeaway and dine-in, respectively? Has this ratio changed after the epidemic?

Are there any differences between dine-in and takeaway, for instance, in the menu, price of dishes or per-customer transaction?

For what reasons are takeaway discounts offered on certain items, e.g. inventory management?

How long does it usually take to deliver one takeaway order? Do the platforms have any requirements for delivery time? Is there any overtime penalty?

How much does the packaging cost per takeaway order?

The resilience of the organisation

What other risks (stress & shock) have your organisation experienced?

How does your organisation ensure the stability of your practices?

E.g. through specific collaborations or alliances or by securing a long-term investment into the organisation, etc.

What risks/potential shocks do you foresee for your organisation? Does your organisation plan to deal with these risks in case they occur?

Will you undertake such strategies actively, or must you wait and react?

Does your organisation have any plans for transformation/innovation? If so, how do you prepare for it?

Based on this interview, any questions from the interviewee?

3.4.1 The coding evidence for organisational-level observations

Evidence of sensing threats/opportunities around the outbreak of Covid-19	
Threats/risks	**Sample quotes from the evidence**
The unguaranteed supply chain during Chinese New Year	"We were planning to operate during Chinese New Year, so we stocked up on [….] ingredients in advance for fear of rising prices and untimely supply around the festival" R1, R2, R4, R6, R8 "My freezer warehouse is full of semi-finished meat" R1 "We prepared some beef and lamb in stock that need to be sourced elsewhere" R4, R8 "We had orders for the new year dinner, so we prepared many fresh ingredients in the large refrigerator on-site as we did not rent a freezer warehouse. We normally buy-today use-today because we value the freshness of ingredients" R6
An infectious disease	"I felt the danger and thus closed my restaurant a day before the lockdown" R7 "This infectious disease reminded me of the SARS. As we always host banquets with a large number of people around Chinese New Year, so I asked our staff to wear masks to protect themselves and our customers" R8
Opportunities	**Sample quotes from the evidence**
Serving group catering	"We heard that the medical workers from the north to support Wuhan were not used to eating rice, so we would like to provide noodles and Muslim meals for them" R4 "I asked the municipal officials if they need meals" R5 "Hospitals would need group catering services" R6, R8, R9

Table 3.4.1-1 Evidence of sensing threats/opportunities around the outbreak of COVID-19

Evidence of absorbing the threats during the lockdown	
Absorbing the threats	**Sample quotes from the evidence**
Bearing losses on rent	"I received the standard rent waiver for 3 to 6 months according to the policies as my landlord is the public sector" R2, R5, R7 "We negotiated with different landlords for rent reductions about half a million RMB. We felt thankful because our business would be greatly impacted if the rent had to be paid normally" R1 "Our private landlord gave us one-month exemption from rent" R3, R4, R8 "We were granted a percentage reduction in rent" R6, R7, R9 "We would not continue our business if we did not go rent-free" R5
The payment of staff wages when not operating normally	"We had to stop paying salaries during the lockdown as we were not operating" R5, R7 "I paid my employees a minimum living allowance during the lockdown" R1, R3 "The staff salaries were cut in half during the lockdown" R4 "We ensured regular social insurance for their staff" R6, R9 "We offered full pay for all staff as we could not just look at the immediate benefits of cost savings. We have been in business for a long time and are better financed with a good sense of crisis and long-term vision" R8

Table 3.4.1-2 Evidence of absorbing the threats during the lockdown

Evidence of adapting to the lockdown via seizing the opportunities	
Adapting to the lockdown	**Sample quotes from the evidence**

Utilisation of food inventories during the lockdown (threats and opportunities)	Group catering	"As a banquet-type restaurant with a standardised production process of meals, we made over 1,000 group meals per day with 20 local staff during the lockdown to serve the hospitals and other public servants" R8 "We offered extra meal boxes at the original price for other group catering providers" R2 "Initially we were volunteering to donate the meals, and the financial allocation came in afterwards" R4, R8 "Our original supply chain could not function properly during the lockdown, so our Group organised teams to source fresh vegetables in the surrounding countryside. In this way, we also contributed to the rural economy during the epidemic" R9 "We got special procurement permits and driving licenses from the municipal government for delivering group catering" R2, R4, R8, R9
	Other actions	"We had semi-finished meat ingredients in stock, so we advertised that we could provide barbecue ingredients in WeChat groups and delivered the orders by ourselves" R1 "We set up WeChat VIP groups for one-to-one service and tried to deliver ingredients and meals to these VIP customers when possible" R8 "An employee stranded in Wuhan during the lockdown, so I asked him to live in my restaurant and to feed himself with the durable food inventories over two months. He lived there alone for over two months" R7
	No action	"We prepared stocks for Chinese New Year and sensed the opportunity for group catering, but we hesitated and lost the chance eventually. We thus had huge losses from our stock spoilage" R6
The lockdown period for internal enhancements		"We did internal training to prepare for operation after the lockdown" R1 "We organised staff training to improve the quality of service while renovating the products by bridging skills between different cuisine categories during the lockdown" R8 "We refined our techniques on producing and preserving semi-finished ingredients" R9

Table 3.4.1-3 Evidence of adapting to the lockdown via seizing the opportunities

Interviewee	Re-opening time	Early recovery after re-opening	Threats for recovery	Interview time	The performance at the interview time
		Restaurants' performances and threats after the lockdown			
R1	May 2020	"We felt a retaliatory increase in turnover from June to October"	"There were far fewer consumers than before and this is the hardest aspect"	May 2021	"Our business has not returned to the level prior to the outbreak, but we have three new branches"
R2	Kept operating during lockdown	"Our business has been very stable"	-	July 2021	"We have established a second branch"
R3	April 2020	"The business got a bit better after October, but it was very vulnerable to disturbances"	"It felt like people were afraid to consume, and fewer customers reduced our turnover"	July 2021	"My business now were not as good as in 2020"
R4	April 2020	"Business started to pick up by June with a boom in the summer"	"It took time for customers' confidence to return. Recruiting waiters has become increasingly difficult with higher labour costs. The price of raw materials has gone up so much this year that we had to raise the prices of our menus"	July 2021	"Now the business was not as good as in 2020"
R5	May 2020	"Our business was good for June and July"	"It was difficult to recruit staff and sometimes we had to hire temporary workers to ease this pressure"	July 2021	"My business now were not as good as in 2020.

					It's not a good year for business"
R6	June 2020	"The business in 2021 was only good in October, for the rest of the year it has not returned to its previous level"	Fewer banquet customers due to restrictions, higher labour costs, soaring prices for raw materials, especially seafood	July 2021	"We have not returned to the level prior to the outbreak"
R7	May 2020	"Our business improved a bit in October, but overall we lost money in 2020"	"There were far fewer consumers than before and this is the hardest aspect"	July 2021	"We have returned to the level of previous years"
R8	March 2020	"Our business did not resume until July and August, but it was still worse than previous years"	"The main difficulty was still the reduced customers. Once we have customers and some financial support, we can handle everything"	September 2021	"We have not returned to the level prior to the outbreak but business in 2021 is hard to predict [...]"
R9	August 2020	"Our customers were mainly business people, so we had to wait for the recovery of commercial activities in Wuhan. Our business started to recover in October, with an increase in the price per order and returned to normal later on"	"It's hard to recruit proper staff. Originally recruitment was difficult in the service industry, especially for us as a high-end restaurant since we have demands on the age and appearance of our waiters"	September 2021	"We have returned to the level of previous years"

Table 3.4.1-4 Restaurants' performances and threats after the lockdown

		Evidence of managing threats and transforming after the lockdown
Managing threats and transforming		**Sample quotes from the evidence**
Managing fewer consumers: extending products and services to where the customers are	Offering group catering	"Before COVID, we occasionally served group catering when we got orders. After reopening I realised group catering business is more important than before because it can bring my restaurant stable income. I thus strengthened my connections with several Danwei and they order their lunch from me" R3 "Our experience regarding serving group catering during the lockdown let us know the advantages of this business. It could bring us a stable income and help us to reconcile the inventory effectively. After reopening, we set up a team dedicated to the group catering business to expand corporate customers" R9 "We had transformed to serve group catering before the epidemic. I opened the second canteen for group catering and introduced smaller bowls of dishes in the canteen to give consumers the feel of having a buffet" R2
	Selling products via contactless ways:	"We had concerns on takeaway business as we were worrying that the timing of delivery might affect the flavour of the grilled food and therefore damage our reputation. However, we decided to offer takeaway service after reopening in order to expand the market. We are building a central kitchen now. With this central kitchen, we can ensure a consistent taste of our semi-finished products across all our branches" R1 "We are preparing our central kitchen as we want to serve not only semi-finished or finished food, but also our techniques to other restaurants and customers. Now we are designing and elaborating seasoning kits to be used with central kitchen products" R8 "Our central kitchen was helpful during the lockdown. After reopening, we decided to expand our business on producing semi-finished food in our central kitchen for sale in the community and to our VIP customers" R9

Delivering services	"Our new business offers a one-stop service, providing chefs, ingredients and waiters to serve the designated dinner at your home. We have professional teams to communicate with customers to decide the details of cuisines. Our chefs and waiters will collaborate to fulfil our customers' demands. Of course, we can earn additional service fees via this business" R9
Managing labour issues and transforming	"I employed more than 20 people before the epidemic, but now I only hire 15. I'm now taking on some of the work myself that my employees had previously undertaken" R3 "I used to have 10 employees, now there are only 7-8. They are currently all paid on a daily basis, because there are so many departures now" R7 "We would recruit 25 people as a back-up if there was a shortfall of 20 before the COVID, but now we will only recruit 20 without a back-up because we are not operating at full capacity. The loss of jobs has given the remaining staff a sense of insecurity and made them more manageable" R8
Managing other operational cost and transforming	"The containers for our takeaway orders are smaller than before, but the price has not changed" R3 "My restaurant is under redecoration and will transform from a traditional Chinese restaurant to a fish restaurant. We paid for online promotion on Dianping before the epidemic, but now it's stopped" R5 "We now buy many of our raw materials directly from their origins via the e-commerce, which is cheaper than local products" R7 "We rely on combining ingredients to balance the price and profit margin of our dishes, and we can abandon some dishes if the ingredients are too expensive for customers to afford" R8

Table 3.4.1-5 Evidence of managing threats and transforming after the lockdown

Abbreviations

Alternative food network (AFN)

Short food supply chains (SFSC)

Small and medium enterprises (SMEs)

Driver-Pressure-State-Impact-Response (DPSIR)

Environmental Protection Campaign (EPC)

African swine fever (ASF)

Sustainable Development Goals (SDG)

National Pig Production Development Plan (Plan PD)

Three-Year Action Plan to Accelerate the Recovery and Development of Pig Production (Plan RD)

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