Contract Coordination of Fresh Agri-Product Supply Chain

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The development of the fresh-food e-commerce has led scholars to pay more attention to research on the agricultural product supply chain. The expanded demand for fresh agricultural products is both a challenge and an opportunity. The fresh produce supply chain can be seen as a process that starts with harvesting, with suppliers or other logistics service providers involved in freshness processing, packaging, and transportation, after which the produce is sold by retailers to end consumers.

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1. Introduction

Agricultural products are necessities of life and rigid consumer goods, and they are one of the most important means of social production [1]. Fresh produce occupies an important position among agricultural products because of its own characteristics. Fresh agricultural products normally include vegetables, fruits, livestock, poultry, seafood, eggs, milk and meat [2], which are essential for improving the quality of people's diet. Fresh agricultural products have the characteristics of a high water content, a short shelf life, and a high level of perishability. With the improvement of people's living standards, consumers' requirements for the quality of fresh agricultural products have gradually increased. Therefore, it is important to study the fresh agricultural product supply chain.

The expanded demand for fresh agricultural products is both a challenge and an opportunity. One of the biggest challenges is to develop efficient supply chains for fresh produce that can meet the growing global demand for these products while managing the logistical and market complexities to meet demand at affordable prices and with as little waste as possible [3]. At present, the traditional single physical sales channel is no longer able to meet the diverse consumer needs, so online sales make up for the lack of physical sales. The emergence of online sales channels has a huge impact on physical sales. Specifically, online sales have significant advantages in terms of price and convenience, so some consumers prefer to buy the products they need online. Therefore, it is important to coordinate the interests of all members of the online and offline channels.

The application of high technology in all levels of society has promoted industrial transformation, and the logistics and supply chain, which are led by emerging high technology, continue to develop in the direction of intelligent digitalization. With the popularity of the internet, e-commerce has caused an upheaval in the traditional fresh

produce market [4]. Therefore, fresh produce is no longer limited to offline channels. In 2020, the COVID-19 epidemic affected the rapid expansion of the market; the epidemic gave rise to the rapid development of same-city delivery, direct broadcast selling, social e-commerce, and other models, which also accelerated the pace of changing the way in which consumers buy. While traditional physical channels can no longer meet this changing consumer demand [5], online channels can meet these individual consumer preferences. By integrating online platforms and offline shops, O2O becomes an innovative e-commerce model that shares online and offline information [6]. O2O differs from omnichannel which is mainly considered from the retailer's point of view, while the O2O model can be analysed both from the retailer's point of view and from the supplier's point of view. The omnichannel model mainly refers to a retailer's comprehensive sales model from online and offline brick and mortar to meet the diverse needs of consumers, with the aim of providing a unified and consistent service and experience to consumers, such as Macy's and Walmart in the US, and Suning and Gome in China [7]. The strength of the O2O model lies in the coordination of online and offline channels to provide a full range of services and enhance customer value [8]. Due to the perishable nature of fresh produce, it is important for companies to choose a suitable sales method. There are a variety of sales models in the fresh produce market, such as retail, direct sales, two-channel sales and O2O (online-to-offline) sales [4]. Dual-channel and O2O models are growing rapidly because they enable the diversification of online and offline buying and selling channels. Thus, fresh food e-commerce has risen rapidly. In recent years, the produce industry has seen a combination of direct online sales and brick-and-mortar retail stores. For example, Amazon acquired Whole Foods, a U.S. organic food chain, and Alibaba opened a grocery store called Hema Fresh Market and partnered with pop-up stores across China.

In summary, research on the fresh agricultural product supply chain under the internet environment, especially research on supply chain coordination and optimization and the supply chain model, is the focus of scholars at present. A few scholars have started to pay attention to the O2O model of fresh agricultural products, but no scholars have studied the synergistic mechanism of the O2O model of the fresh agricultural product supply chain. Based on the literature, this entry considers the characteristics of the combination of online and offline channels of the O2O supply chain and the freshness requirement of fresh agricultural products, combines the current digital development direction of the fresh agricultural supply chain, and uses the Stackelberg game model to build a dual-channel revenue-sharing contract model from the perspective of channel cooperation and profit maximization to coordinate the supply chain.

2. Fresh Products Supply Chain Coordination

The study of fresh produce is crucial due to its perishable nature and its importance to human life. Current research on fresh produce is divided into the following categories: (1) cold chain transport and path optimization of fresh produce [9][10], with research methods being mainly algorithmic [11][12]. (2) Contractual coordination of fresh produce supply chains [13][14], with game theory as the main method [15][16]. (3) Fresh produce supply chain process optimization [17][18], the main method is empirical analysis [19][20]. However, this entry focuses on the contractual coordination of fresh produce supply chains.

The fresh produce supply chain can be seen as a process that starts with harvesting, with suppliers or other logistics service providers involved in freshness processing, packaging, and transportation, after which the produce is sold by retailers to end consumers. Compared with the general supply chain, the fresh produce supply chain requires more investment in distribution, processing, transportation and storage, with a focus on product freshness, quality and safety, and loss control. As fresh produce is an essential part of human life, an increasing number of scholars are paying attention to the problems in the fresh produce supply chain.

At present, methods of contractual coordination in fresh produce supply chains fall into the following categories: revenue-sharing contracts, freshness-keeping cost sharing contracts, investment cost sharing contracts, price discount contracts and option contracts. By collating the literature, researchers can find that some scholars have considered only one method of coordination when conducting contractual coordination of fresh produce supply chains. For example, in order to maintain the freshness of fresh produce during transportation, Cai et al. [21] use price discount contracts to coordinate producers and distributors, thus ensuring more revenue for both parties. Due to the negative effect of fairness concerns on freshness and utility, Yan et al. [22] find that revenue-sharing contract can achieve Pareto improvements in supply chains. Similarly, investment cost-sharing contracts not only reduce the amount of waste in the fresh produce supply chain, but also increase the profitability of supply chain members [23]. In times of demand uncertainty, Zhou et al. [24] develop option contracts to enable supply chain coordination and information sharing. In addition, option contracts can coordinate the supply chain in the event of disruption [25].

In addition, fresh produce supply chains have also been studied using two coordination methods. Hamed et al. [26] propose that option contracts can increase the profits of supply chain members and that revenue-sharing contracts can reduce the double marginalization effect, so they combine the two coordination mechanisms to coordinate the supply chain. Zhang and Gao [27] find that the dual alignment of revenue-sharing contracts and freshness-keeping cost-sharing contracts can increase the profits of both suppliers and retailers, enabling the alignment of dual-channel supply chains. A combination of revenue-sharing and investment cost-sharing contracts based on the investment decisions of supply chain members can lead to a win-win situation for both manufacturers and retailers [28]. The decentralized supply chain can be coordinated through freshness-keeping cost-sharing and revenue-sharing contracts [29]. At the same time, the decentralized fresh produce supply chain can also be coordinated through revenue-sharing contract and price discount contracts [30].

As shown in **Table 1**, researchers summarise the existing literatures on supply chain coordination for fresh produce. Researchers can see that most studies of supply chain coordination have taken a revenue-sharing contract approach, but relatively few studies consider both online and offline collaboration. Therefore, researchers' study introduces online and offline cooperation for fresh produce supply chain coordination on the basis of existing research.

Table 1. Summary of the related literature regarding fresh produce supply chain coordination.

Literature	Types of Contracts in the Supply Chain					Involves Online and Offline Cooperation
	Revenue-Sharing Contract	Fresh-Keeping Cost-Sharing Contract	Investment Cost-Sharing Contract	Price Discount Contract	Option Contract	
Yan et al. [22]	√					
Zhang and Gao [27]	√	√				
Moon et al. [28]	√		√			
Song and He [29]	√	√				
Cai et al. [21]				√		
Yan et al. [30]	√			√		
Mohammadi et al. [23]			√			
Zhou et al. [24]					√	
Wan et al. [25]					√	
Hamed et al. [26]	√				√	
Researchers' study	√					√

With the growing integrated online and offline environment, O2O commerce has huge potential for growth [31]. Ding et al. [32] define O2O as “O2O, from online to offline, means that companies provide discounts, information and services through the Internet to attract consumers’ attention, allowing them to pay online and enjoy services offline, thus increasing consumer satisfaction and meeting personalized needs.” Many scholars have conducted research on the O2O model with different focuses.

Some studies on the O2O model have focused on price decisions, service quality and platform marketing. For example, based on the O2O model, Kong et al. [33] study the price decision problem between manufacturers and retailers in a closed-loop supply chain. Tang and Yang [34] study how different financing mechanisms affect pricing decisions in an O2O sales model when retailers are constrained by capital. Meanwhile, other scholars have studied the impact of O2O as an online platform, collaborative advertising strategies of supply chain members and online consumer reviews on the decisions of supply chain members [18][35]. In addition, to provide better service quality, Li et al. [36] investigate vehicle matching strategies in O2O freight platforms.

However, some studies have also focused on the issue of contractual coordination in the O2O model. Under O2O deterministic and stochastic demand, Govindan and Malomfalean [37] investigate how different coordination mechanisms affect the total profitability of the supply chain. Under the O2O sales model, Qiu et al. [38] find that

wholesale price, cost- sharing and two-part tariff contracts can effectively coordinate a fragmented supply chain and increase supply chain profitability. Pei et al. [39] develop a new coordination mechanism (i.e., manufacturers offer discounts to offline consumers while offering volume discounts to retailers) for mitigating competition in the O2O channel. In addition, Yang and Tang [4] study the optimal price decisions of suppliers and retailers under different sales models, and find that the O2O model can lead to higher supply chain profits under coordination. Based on the O2O platform, a new two-stage risk-sharing contract can effectively coordinate the supply chain and lead to higher supply chain profits [40].

As shown in **Table 2**, researchers summarise the main literatures on the different research foci in the O2O model. Researchers can see that there is a relatively large literature on contractual coordination, but relatively little on contractual coordination in fresh supply chains that considers both freshness and freshness-keeping. Therefore, researchers' study focuses on freshness and freshness-keeping as the main factors for contractual coordination between suppliers and retailers under decentralised decision making, which helps to bridge the gap in fresh produce supply chains.

Table 2. Summary of the related literature regarding O2O.

Literature	Research Content of O2O Model				Involves Freshness and Freshness-Keeping
	Pricing Decision	Service Quality	Platform Marketing	Contract Coordination	
Kong et al. [33]	√				
Tang and Yang [34]	√				
Li [18]			√		
Li et al. [35]			√		
Li et al. [36]		√	√		
Govindan and Malomfalean [37]				√	
Qiu et al. [38]				√	
Pei et al. [39]				√	
Yang and Tang [4]	√			√	
Yang and Peng [40]			√	√	
Researchers' study				√	√

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