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How COVID-19 Affects Agricultural Food Sales: Based on the Perspective of China's Agricultural Listed Companies' Financial Statements

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Abstract: Agricultural food is generally regarded as the basis of "national security" by most countries. Through marketing strategies, promoting the sales of agri-food products in the context of a pandemic is of great significance to national food security and economic growth. The purpose of our study is to understand how the COVID-19 crisis affects the sales of agri-food products as well as the organizational and management changes it brings. By understanding those points above, we can address the problem and policy challenges to better promote the recovery of the agri-food sector from the effects caused by COVID-19. The demand is today overwhelmingly urgent. Based on the data of China's agricultural-listed companies from 2015 to 2020, this study adopted the perspective of financial statements and conducted empirical analysis through the translog revenue function, and the results showed that the COVID-19 pandemic has reduced the sales of agri-food products, and the sales of agri-food products by large agricultural companies have fallen more than those of small- and medium-sized ones. Based on the results of the study, the government can consider the policy of providing financial support and temporary subsidies to agri-food enterprises during the pandemic, while agri-food enterprises actively practice digital marketing to reduce the adverse impact of COVID-19 on agri-food sales.

Keywords: agricultural food sales; COVID-19; coronavirus; marketing; financial statements

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1. Introduction

The pandemic often led to uncertainty in supply, which affects agri-food prices and agri-food consumption. The rapid spread of COVID-19 has slowed the growth of the global economy [1–3] and has had a significant impact on agricultural food sales. With the closure of restaurants, hotels and schools, some agricultural producers have lost more than half of their buyers [4]. Although the sales of agri-food products sold on online shopping platforms have been increasing as the pandemic has progressed, this increase may not be enough to offset the number of agri-food products previously grown for schools, restaurants and other businesses. The progress of the pandemic also affects national security. National security involves politics, economy, culture, ecology, and resources. Agricultural security is related to food security, and food security is an essential part of national security. The country needs to ensure that all citizens can eat rich and nutritious food at all times. The government and agricultural enterprises must ensure agricultural security, sustainable resource security, and ecological security to provide agricultural food security. Therefore, agriculture is often regarded by countries as a priority for "national security" [5,6].

The processing of agri-food products, the storage of agricultural food products and the consumer demand for agricultural food products all have strong particularities. Agricultural production has a strong dependence on land and seasons. In particular, the production of fruits and vegetables has high seasonal requirements [7,8]; if producers cannot find buyers for their crops, they may choose to abandon planting to minimize costs; most of the agricultural products that have been produced require special storage conditions. If these agricultural products are not sold in a timely manner, it means that agricultural food products may be discarded to reduce storage costs or because of spoilage. In addition, Chenardes et al. [9] pointed out that COVID-19 has disrupted the global supply chain. Compared with before the pandemic, many agricultural exporting countries have drastically reduced agricultural exports (e.g., Russia and Vietnam) [10], which has exacerbated the difficulties faced by agricultural food sales [11].

Many countries in the world have announced several relief plans to reduce the impact of the pandemic on agri-food enterprises [12,13]. However, many government relief policies are not enough to completely make up for the loss of agri-food product sales caused by the COVID-19 pandemic [14]. Understanding the specific impact of the pandemic on agri-food product sales and the revenue of agri-food enterprises, and how to minimize the impact has become a top priority. Figure 1 shows the output value, import value and export value of China's agri-food products from 2015 to 2020. Taking 2020 as an example, the National Bureau of Statistics of China [15] reported that the output value of China's agri-food products in 2020 was USD 1082.18 billion. According to statistics from the Department of International Cooperation of the Ministry of Agriculture [16], the total export value of agri-food products was USD 76.03 billion, and the total import value of agri-food products was USD 178.0 billion. It can be seen from Figure 1 that in recent years, the Chinese population's consumption of agricultural products has shown an increasing trend year by year, from USD 881.41 billion in 2015 to USD 1176.95 billion in 2020, an increase of 33.53% in six years. Given the importance of agri-food products, we use the translog model to study how the pandemic affects agri-food product sales from the perspective of corporate financial statements. Furthermore, we propose policy options to assist the recovery of agricultural food sales from the effects caused by COVID-19. The demand is today overwhelmingly urgent. Our research found that the COVID-19 pandemic has reduced the sales of agri-food products, and moreover that the sales of agri-food products by large agricultural companies have fallen more than those of small and medium-sized ones.

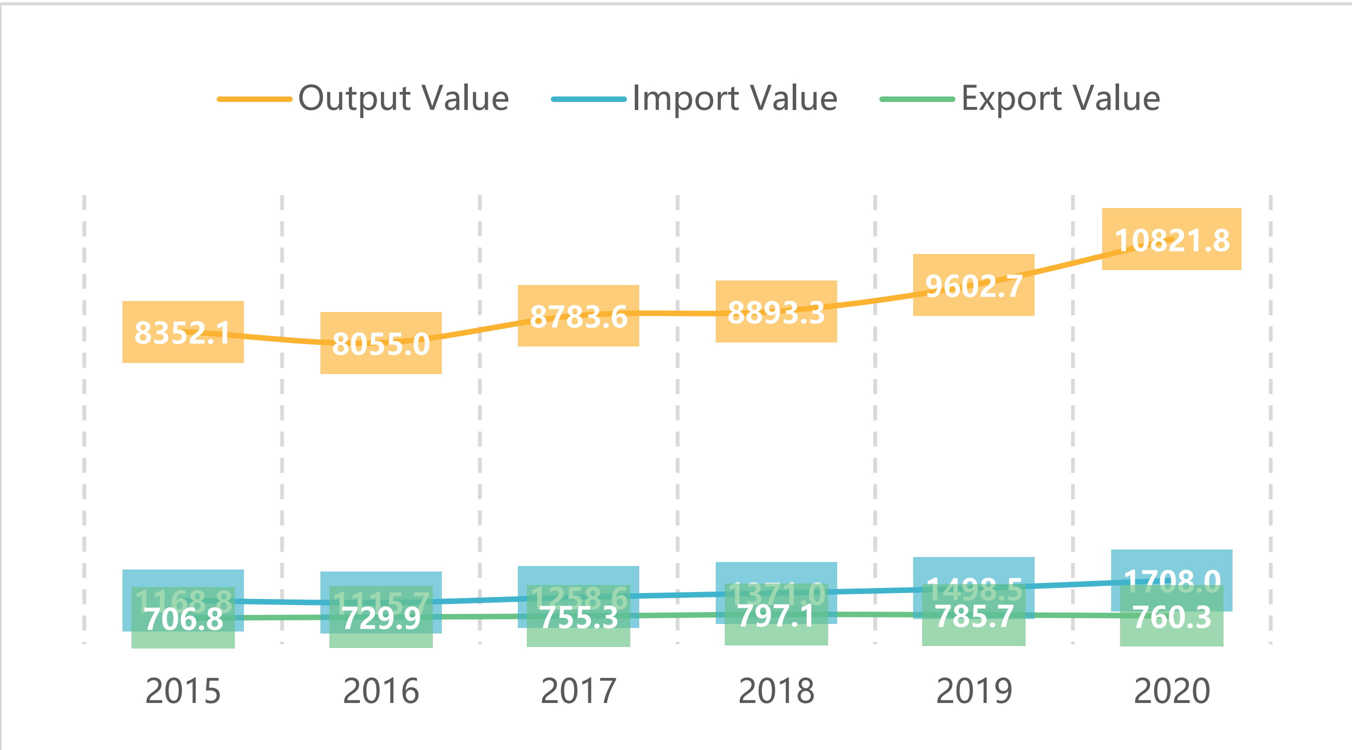

Figure 1. Output value, import, and export value of China's agri-food products from 2015 to 2020 (Unit: USD 100 million).

The contributions of this research are as follow. First, we are trying to understand the specific impact of COVID-19 on agricultural food sales in order to find a way for agricultural enterprises and authorities to cope with this dilemma. At present, the quantitative research on the impact of the COVID-19 pandemic on the sales of agri-food products and the revenue of agri-food enterprises is relatively limited, mainly focusing on some non-quantitative studies [17–20]. This study is based on the 2015–2020 data of listed Chinese agri-food companies, quantitatively estimates the impact of the pandemic through industrial econometrics and fills the gaps in the literature. Second, as the largest developing country, China's agricultural production feeds 1.4 billion people. Studying the sales of agri-food products in China may provide positive suggestions for the consumption and nutritional intake of agri-food products for 1.4 billion people. Third, based on the findings of this study, we have proposed agri-food products marketing strategies and policies for consideration by the competent authorities and agri-food enterprises to effectively reduce the negative impact of COVID-19 on China's agricultural food sales, which is important for ensuring a reasonable diet structure for the Chinese population and to maintain food security and well-being. Fourth, although the pandemic has affected the world's trade pattern, most countries are still conducting foreign trade frequently, and the business of agri-food products is indispensable in foreign trade. The Ministry of Agriculture and Rural Affairs of China reported that China's agri-food trade volume is enormous. It has become the most significant agri-food product importer and the second-largest agri-food product trader [21]. In recent years, China's purchases of soybeans, sugar, cotton, and other agricultural products rank first in the world. China's agri-food product trade policy under the pandemic will profoundly impact the global agri-food product market. This study can provide references for the agri-food trade policies of countries with close agri-food trade with China (e.g., the United States, Brazil, the European Union, and Australia). The remaining part is as follows: Section 2 provides the literature review. In Section 3, we introduce the research methods and models. Sections 4 and 5 are the results and conclusions, respectively.

2. Literature Review

Early studies have an in-depth analysis of the adverse effects of epidemics, such as SARS [22,23], H1N1 [24], and COVID-19 [25]. These studies indicate that pandemics may change the input [26,27] and productivity [22,23] and cause GDP losses [24,25]. There is no doubt that since 2020, agri-food enterprises have also been significantly affected by the pandemic, and sales of agri-food products have become difficult due to road closures. Consumers have also reduced the frequency of going to the market to buy agri-food products due to safety concerns. The pandemic has slowed world economic and social development [28].

Issues related to COVID-19 have attracted worldwide attention due to its impact on global health and the economy [29]. Recently, some scholars have investigated the obstacles of COVID-19 to specific agricultural sectors [30–37] and national and regional case studies related to COVID-19 [38–44]. The World Bank [17] reported that many African countries have agricultural product safety risks: reduced income and rising retail prices mean low-income families will reduce agri-food product consumption and nutritional intake. The World Bank observed that agri-food prices in the poorest countries rose sharply in September 2021, reaching the highest level since the outbreak of COVID-19. FAO [18] reported these negative impacts of COVID-19 on agri-food products: (1) in many African countries, due to restrictions on cross-border transportation, the transportation routes of bulk agri-food products have been disrupted; (2) the government's advice to stay at home and travel restrictions have caused agricultural product traders to face logistics difficulties, leading to supply delays and losses of agri-food products; (3) agri-food trade is also affected by border controls; (4) labor shortages have affected the production and processing of agri-food products due to the stay-at-home policy; (5) many cities' markets have been closed to avoid virus infection, which disrupted the agricultural supply system;

(6) due to the reduced consumer demand for agri-food products and the interruption of agri-food product market access and logistics difficulties, the livelihoods of many agri-food product operators have been negatively affected [45]. The Organisation for Economic Co-operation and Development [19] reported that the governments of more than 50 countries have adopted hundreds of measures to alleviate transaction interruptions, alleviate the contradiction between supply and demand, provide relief to affected producers and consumers, or support the restoration of affected production activities. In the countries above, at least USD 157 billion is earmarked for the agricultural sector, of which a large part is used for agricultural food assistance. However, these studies did not examine the relationship between COVID-19 and agri-food sales in China from the perspective of financial statements and econometrics.

At present, food market disruptions caused by COVID-19 [43]. From a micro point of view, panic buying may cause agricultural food prices to fluctuate [46]. After the short-term panic buying of agricultural food products, consumers usually avoided markets as a way to reduce the risk of infection. Therefore, in the long run, the sales of agricultural food may actually decline. In addition, COVID-19 not only affects the sales of agricultural food products that are more perishable or more difficult to transport, but may also cause nutritional imbalances in the population [47–50]. From a macro perspective, according to the FAO report, at present, about 800 million people in the world are still living without enough food, and even more than 100 million people are unable to meet the basic needs of survival. This part of the poorest people still relies on the assistance of other countries and organizations to make a living [51]. After the outbreak of COVID-19, the share of food exports in many countries has been significantly reduced (e.g., Russia and Vietnam), which has a significant impact on people in urgent need of food to live. Therefore, we need to determine the impact of COVID-19 on the sales of agri-food products, and understanding the specific consequences of this impact will promote the recovery of the agricultural sector as soon as possible in this pandemic.

3. Method

3.1. Theoretical Model

High-quality employees are one of the prerequisites for the stable operation of enterprises [52–57]. We use the following equation to represent the agricultural production function (The definitions of y_{it}^{a}, x_{it}^{m}, x_{it}^{o}, x_{it}^{r}, x_{it}^{f}, x_{it}^{d} and x_{it}^{g} are shown in Table 1).

$$y_{it}^{a} = f\left(x_{it}^{m}, x_{it}^{o}, x_{it}^{r}, x_{it}^{f}, x_{it}^{d}, x_{it}^{g}\right) \tag{1}$$

Table 1. Variable definitions.

Variable			**Definition**
Theoretical Variable	**Proxy Variable**		
r	*REVENUE*	*DREVENUE*	Total revenue of enterprises
x_{it}^{m}	*MSTAFF*	*DMSTAFF*	Total number of management personnel
x_{it}^{o}	*RSTAFF*	*DRSTAFF*	Total number of research and development personnel
x_{it}^{r}	*OSTAFF*	*DOSTAFF*	Total number of ordinary personnel
	EMPLOYEE	*DEMPLOYEE*	Total number of employees
x_{it}^{f}	*FIXED*	*DFIXED*	Net fixed assets
x_{it}^{d}	*DEVELOP*	*DDEVELOP*	R&D investment
x_{it}^{g}	*INTANG*	*DBIOLOGY*	Net intangible assets/Net productive biological assets
	BIG	*DBIG*	A dummy variable that equals one if the agricultural/dairy enterprise is one of China's top three agricultural/dairy enterprises, and 0 otherwise
	COVID	*DCOVID*	A dummy variable. In 2020, *COVID* is 1; in 2015–2019, *COVID* is 0. Considering the particularity of dairy products, *DCOVID* will begin in the second quarter of 2020.

In Equation (1), y_{it}^{a} is the sales, the revenue function of agri-food enterprises is as follows:

$$\begin{gathered} r\left(p_{it}^{a}; x_{it}^{m}, x_{it}^{o}, x_{it}^{r}, x_{it}^{f},\ x_{it}^{d},\ x_{it}^{g}\right) = max\ p_{it}^{a} y_{it}^{a} \\ \textbf{\textit{subjectto}}\, y_{it}^{a} = f\left(x_{it}^{m}, x_{it}^{o}, x_{it}^{r}, x_{it}^{f},\ x_{it}^{d},\ x_{it}^{g}\right) \end{gathered} \tag{2}$$

r is revenue, p_{it}^{a} represents the prices of agri-foods. The revenue function of agri-food enterprises is converted into the following equation:

$$ln\ r = \alpha_0 + \delta\ ln\ p_{it}^{a} + \sum_{i=1}^{3} \alpha_i\ ln\ x_{it}^{e} + \beta_1\ ln\ x_{it}^{f} + \delta_1\ ln\ x_{it}^{d} + \epsilon_1\ ln\ x_{it}^{g} \tag{3}$$

This study normalized by setting p_{it}^{a} = 1 [58]. we can further simplify Equation (3) as follows:

$$ln\ r = \alpha_0 + \sum_{i=1}^{3} \alpha_i\ ln\ x_{it}^{e} + \beta_1\ ln\ x_{it}^{f} + \delta_1\ ln\ x_{it}^{d} + \epsilon_1\ ln\ x_{it}^{g} \tag{4}$$

Scholars have studied the use of translog revenue function in many industries [59]. The translog revenue function in this study is as follows:

$$\begin{aligned} ln\ r = \ & \alpha_0 + \sum_{i=1}^{3} \alpha_i\ ln\ x_{it}^{e} + \beta_1\ ln\ x_{it}^{f} + \delta_1\ ln\ x_{it}^{d} + \epsilon_1\ ln\ x_{it}^{g} + \frac{1}{2}\sum_{i=1}^{3}\sum_{l=1}^{3} \alpha_{il}\ ln\ x_{it}^{e}\ ln\ x_{it}^{l} + \frac{1}{2}\beta_{11}\left(ln\ x_{it}^{f}\right)^2 \\ & + \frac{1}{2}\delta_{11}\left(ln\ x_{it}^{d}\right)^2 + \frac{1}{2}\epsilon_{11}\left(ln\ x_{it}^{g}\right)^2 + \sum_{i=1}^{3} \gamma_{i1}\ ln\ x_{it}^{e}\ ln\ x_{it}^{f} + \sum_{i=1}^{3} \varepsilon_{i1}\ ln\ x_{it}^{e}\ ln\ x_{it}^{d} + \sum_{i=1}^{3} \mu_{i1}\ ln\ x_{it}^{e}\ ln\ x_{it}^{g} \\ & + \theta_{11}\ ln\ x_{it}^{f}\ ln\ x_{it}^{d} + \rho_{11}\ ln\ x_{it}^{f}\ ln\ x_{it}^{g} + \sigma_{11}\ ln\ x_{it}^{d}\ ln\ x_{it}^{g} \end{aligned} \tag{5}$$

To assess the relative impact of the pandemic on agriculture, this study uses the same model for the Chinese dairy industry. This study mainly discusses the sale of agri-food products, and the empirical analysis on the sale of dairy products is only for comparative discussion.

3.2. Data and Variables

3.2.1. Data Source and Sample Period

We obtained the data for this study from the quarterly financial statements data provided by the CSMAR database, including agricultural data from 2015 to 2020 and dairy industry data from 2016 to 2020. We have excluded unreasonable observations, such as the number of employees or when the net fixed assets are zero. Finally, the agriculture and dairy industry obtained 320 and 148 valid observations, respectively. This study mainly focuses on agricultural enterprises. Meanwhile, the data in this study also includes the dairy industry to facilitate comparison between agriculture and other sectors.

In terms of listed companies in agri-food products, this study selects data from China's agri-food listed companies from 2015 to 2020. COVID-19 began to spread widely in 2020. In order to study the difference between the sales of Chinese agri-food products during the pandemic and before the pandemic, the study data needs to include 2020 and the years before 2020. Based on the data of 2015–2020, with 2020 as the boundary point, we use the Chow Test to analyze the difference between sales of Chinese agri-food products before 2020 and during 2020. *RSTAFF* is an essential variable in this study. However, the CSMAR began to disclose *RSTAFF* in 2015 uniformly. At the same time, we need to maximize the number of samples to obtain the most accurate results. Therefore, we can only extract agricultural data from 2015 to 2020.

3.2.2. Variable Definitions

In the agriculture of this study, COVID-19 (*COVID*) and top three agri-food companies (*BIG*) are the dummy variables of the agricultural income model of this study. This study uses revenue to define large agri-food companies. From 2015 to 2020, the revenue of China's top three large agri-food products enterprises accounted for 59.32% of the entire industry's revenue. *BIG*'s agri-food product marketing network covers a wide range, which usually means relatively high operation and maintenance costs and inventory costs. We expect large agri-food enterprises to be more affected by the pandemic. Therefore, this study takes the top three agri-food companies (*BIG*) as one of the dummy variables of the model. Under the pandemic, this study can use *BIG* to explore the impact of *COVID* on the different sales of large and non-large agri-food companies. In addition, we have defined the same/similar variables in the dairy industry. We bring together the definitions of the above variables and other variables in Table 1.

4. Results

4.1. Descriptive Statistics

Table 2 shows the descriptive statistics. It can be seen that during the study period, the medians of agricultural revenue, various types of human resources, net fixed assets, R&D investment, and net intangible assets are all less than the average. From the perspective of the average annual agricultural revenue, the average yearly revenue growth rate of agri-food products from 2015 to 2019 was 15.91%, but in 2020, this proportion plummeted to 5.92%. In addition, from 2015 to 2018, the overall research and development investment (*DEVELOP*) of agricultural enterprises showed an upward trend, and development investment increased by 66.54%. However, from 2019 to 2020, the overall research and development investment of agricultural enterprises has shown a downward trend, and *DEVELOP* has dropped by 6.25%. Table 2 also found that in 2020, agricultural companies generally reduced their investment in human resources. This also shows that considering the adverse effects of the COVID-19 on agri-food product sales, Chinese agricultural enterprises have generally reduced labor costs in response to the negative impact of the COVID-19 crisis.

Table 2. Descriptive statistics.

Panel A:			**2015 (n = 46)**					**2016 (n = 54)**		
Variables	**Mean**	**Median**	**Max**	**Min**	**Std. Dev.**	**Mean**	**Median**	**Max**	**Min**	**Std. Dev.**
REVENUE	$128.81	$72.73	$580.89	$13.78	$141.45	$172.21	$94.93	$1285.09	$10.05	$230.10
MSTAFF	15.13	14	23	11	3.51	16	14	29	11	4.81
RSTAFF	141.87	88	316	17	114.3	136.37	99	322	11	103.41
OSTAFF	4506.09	1188	31960	228	8798.28	7219.82	1560	43,350	208	13,120.2
EMPLOYEE	4663.09	1513	32289	265	8856.26	7372.19	1911	43,435	259	13,137.18
FIXED	$136.21	$97.53	$631.74	$23.57	$158.71	$138.21	$105.21	$551.37	$19.83	$128.08
DEVELOP	$5.11	$2.31	$25.42	$0.28	$6.73	$5.43	$2.40	$32.42	$0.26	$8.12
INTANG	$54.08	$30.05	$318.95	$3.63	$84.13	$58.03	$29.23	$429.81	$2.44	$98.99
Panel B:			**2017 (n = 56)**					**2018 (n = 52)**		
Variables	**Mean**	**Median**	**Max**	**Min**	**Std. Dev.**	**Mean**	**Median**	**Max**	**Min**	**Std. Dev.**
REVENUE	$196.67	$116.19	$1,633.89	$10.29	$293.49	$159.19	$94.79	$976.85	$9.54	$188.13
MSTAFF	15.07	14	28	6	5.11	15.31	15	27	7	5.08
RSTAFF	146.43	116	409	13	117.54	131.15	68	453	12	127.61
OSTAFF	6384.14	1736	33,932	203	11,254.42	5843.46	1646	35,128	148	10,264.59
EMPLOYEE	6545.64	1770	34,261	237	11,280.99	5989.92	1668	35,428	194	10,311.49
FIXED	$145.54	$112.56	$493.19	$18.61	$121.48	$157.74	$100.43	$463.10	$15.63	$127.50
DEVELOP	$6.50	$2.30	$48.87	$0.16	$12.16	$8.51	$2.51	$64.98	$0.33	$16.79
INTANG	$62.03	$30.56	$437.22	$2.29	$107.26	$63.82	$33.86	$408.10	$1.77	$104.20
Panel C:			**2019 (n = 56)**					**2020 (n = 56)**		
Variables	**Mean**	**Median**	**Max**	**Min**	**Std. Dev.**	**Mean**	**Median**	**Max**	**Min**	**Std. Dev.**
REVENUE	$210.76	$91.28	$2005.81	$4.24	$340.12	$223.23	$94.42	$2368.02	$3.21	$384.62
MSTAFF	15.57	15	27	7	4.54	14.29	13.5	23	6	3.92
RSTAFF	118.07	63.5	510	8	133.54	134.57	72	456	15	132.38
OSTAFF	5105.79	1299	34,629	77	9390.78	5023.71	856.5	34,100	131	9257.77
EMPLOYEE	5239.43	1353.5	34921	101	9441.48	5172.57	999	34412	183	9309.66
FIXED	$155.52	$92.88	$463.66	$14.08	$129.94	$165.91	$90.20	$493.21	$13.65	$144.04
DEVELOP	$7.68	$2.15	$59.88	$0.15	$14.97	$7.20	$2.29	$52.19	$0.07	$13.05
INTANG	$63.08	$31.40	$399.71	$1.56	$100.15	$66.06	$32.73	$402.71	$1.32	$101.96

Note: All variables' definitions are the same as Table 1.

4.2. The Pandemic and Agricultural Food Sales

This research analyzes the impact of COVID-19 on sales of agri-food products. Taking the time of COVID-19 occurrence in 2020 as the boundary, the Chow Test is used to explore the relationship between the pandemic and the sales of agricultural enterprises, the F statistics were 1.98. The rejection of the null hypothesis indicates that the COVID-19 would impact sales of agri-food products. Meanwhile, this study puts *BIG* as a dummy variable into the model.

4.3. Estimation Results

4.3.1. The Revenue Function

Table 3 shows the estimated results of Chinese agricultural and dairy enterprises' revenue functions. This study uses the more flexible translog format instead of using the simple Cobb-Douglas format (Log-linear). We needed to check whether the translog format can provide a correct representation of Chinese agricultural and dairy enterprises' revenue function. Therefore, this study tests whether these conditions in Equations (7) and (8) are met:

$$\alpha_{il} = \beta_{11} = \delta_{11} = \epsilon_{11} = \gamma_{i1} = \varepsilon_{i1} = \mu_{i1} = \theta_{11} = \rho_{11} = \sigma_{11} = 0 \text{ for all } i = 1, 2, 3. \tag{6}$$

Table 3. Translog estimates (agriculture and dairy industry).

Agri. Variables/Dair. Variables	**Coefficient** ***t*-Statistic**	**Agri. Variables/Dair. Variables**	**Coefficient** ***t*-Statistic**
Intercept/DIntercept	−18.698/607.287 (−0.249)/(3.052)	(ln*MSTAFF*)(ln*DEVELOP*)/ (ln*DMSTAFF*)(ln*DDEVELOP*)	−1.808 ***/−1.290 (−3.120)/(−1.110)
ln*MSTAFF*/ln*DMSTAFF*	49.212 ***/−23.652 (3.288)/(−0.730)	(ln*MSTAFF*)(ln*INTANG*)/ (ln*DMSTAFF*)(ln*DBIOLOGY*)	−0.533/−0.865 (−0.929)/(−1.208)
ln*RSTAFF*/ln*DRSTAFF*	−2.727/16.555* (−0.480)/(1.914)	(ln*RSTAFF*)(ln*OSTAFF*)/ (ln*DRSTAFF*)(ln*DOSTAFF*)	−0.059/0.892 *** (−0.424)/(2.678)
ln*OSTAFF*/ln*DOSTAFF*	−0.577/36.784 *** (−0.107)/(2.918)	(ln*RSTAFF*)(ln*FIXED*)/ (ln*DRSTAFF*)(ln*DFIXED*)	0.088/−1.423 *** (0.388)/(−3.036)
ln*FIXED*/ln*DFIXED*	3.358/−80.831 *** (0.358)/(−3.972)	(ln*RSTAFF*)(ln*DEVELOP*)/ (ln*DRSTAFF*)(ln*DDEVELOP*)	0.067/0.534 (0.374)/(1.600)
ln*DEVELOP*/ln*DDEVELOP*	0.336/13.456 (0.089)/(1.372)	(ln*RSTAFF*)(ln*INTANG*)/ (ln*DRSTAFF*)(ln*DBIOLOGY*)	−0.003/−0.078 (−0.025)/(−0.288)
ln*INTANG*/ln*DBIOLOGY*	−6.808/1.678 (−1.090)/(0.375)	(ln*OSTAFF*)(ln*FIXED*)/ (ln*DOSTAFF*)(ln*DFIXED*)	−0.083/−2.465 *** (−0.257)/(−4.037)
$(\ln MSTAFF)^2/(\ln DMSTAFF)^2$	2.025/1.439 (1.628)/(0.624)	(ln*OSTAFF*)(ln*DEVELOP*)/ (ln*DOSTAFF*)(ln*DDEVELOP*)	0.246 **/−0.005 (2.073)/(−0.013)
$(\ln RSTAFF)^2/(\ln DRSTAFF)^2$	−0.115/−0.242 (−0.699)/(−1.041)	(ln*OSTAFF*)(ln*INTANG*)/ (ln*DOSTAFF*)(ln*DBIOLOGY*)	−0.203/0.285 (−1.004)/(1.333)
$(\ln OSTAFF)^2/(\ln DOSTAFF)^2$	0.021/0.645 ** (0.231)/(2.149)	(ln*FIXED*)(ln*DEVELOP*)/ (ln*DFIXED*)(ln*DDEVELOP*)	−0.191/−0.250 (−0.842)/(−0.617)
$(\ln FIXED)^2/(\ln DFIXED)^2$	−0.007/2.653 *** (−0.021)/(4.686)	(ln*FIXED*)(ln*INTANG*)/ (ln*DFIXED*)(ln*DBIOLOGY*)	0.231/−0.563 * (0.627)/(−1.669)
$(\ln DEVELOP)^2/(\ln DDEVELOP)^2$	0.163**/−0.162 (2.556)/(−1.025)	(ln*DEVELOP*)(ln*INTANG*)/ (ln*DDEVELOP*)(ln*DBIOLOGY*)	0.072/−0.071 (0.648)/(−0.396)
$(\ln INTANG)^2/$ $(\ln DBIOLOGY)^2$	0.101/0.326 *** (1.052)/(3.130)	*BIG/DBIG*	0.600 ***/1.177 (2.775)/(1.074)
(ln*MSTAFF*)(ln*RSTAFF*)/ (ln*DMSTAFF*)(ln*DRSTAFF*)	0.448/0.571 (0.640)/(0.551)	*COVID/DCOVID*	−0.253 ***/0.419 ** (−2.815)/(2.211)
(ln*MSTAFF*)(ln*OSTAFF*)/ (ln*DMSTAFF*)(ln*DOSTAFF*)	0.893/−0.841 (1.317)/(−0.442)	*BIGCOVID/DBIGDCOVID*	−0.335/1.045 * (−1.429)/(1.752)
(ln*MSTAFF*)(ln*FIXED*)/ (ln*DMSTAFF*)(ln*DFIXED*)	−1.401/2.640 (−1.488)/(1.538)		
Adjusted R–squared		0.661/0.820	
System degrees of freedom		320/148	
*Testof*loglinear*specification* $(\alpha_{il} = \beta_{11} = \delta_{11} = \epsilon_{11} = \gamma_{i1} = \varepsilon_{i1} = \mu_{i1} = \theta_{11} = \rho_{11} = \sigma_{11} = 0)$			
F–statistic		2.87/2.61	
Significance level		0.000/0.000	

Note: ***, **, * Denotes significantly difference from zero at the 1%, 5%, and 10% levels, respectively.

Table 3 shows the result of the F statistical value is 2.87 and 2.61, respectively, which significantly rejects the null hypothesis of the log-linear specification, indicating that the translog format is suitable for analyzing Chinese agricultural and dairy enterprises' revenue functions. The following is the estimation model (agriculture and dairy industry):

$$\begin{aligned} ln\ REVENUE_a = {} & \alpha_0 + \alpha_1\ ln\ MSTAFF + \alpha_2\ ln\ RSTAFF + \alpha_3\ ln\ OSTAFF + \beta_1\ ln\ FIXED + \delta_1\ ln\ DEVELOP \\ & + \epsilon_1\ ln\ INTANG + \tfrac{1}{2}\,\alpha_{11}\ (ln\ MSTAFF)^2 + \tfrac{1}{2}\,\alpha_{22}\ (ln\ RSTAFF)^2 + \tfrac{1}{2}\,\alpha_{33}\ (ln\ OSTAFF)^2 \\ & + \tfrac{1}{2}\,\beta_{11}\ (ln\ FIXED)^2 + \tfrac{1}{2}\,\delta_{11}\ (ln\ DEVELOP)^2 + \tfrac{1}{2}\,\epsilon_{11}\ (ln\ INTANG)^2 \\ & + \alpha_{12}\ ln\ MSTAFF\ ln\ RSTAFF + \alpha_{13}\ ln\ MSTAFF\ ln\ OSTAFF + \alpha_{23}\ ln\ RSTAFF\ ln\ OSTAFF \\ & + \gamma_{11}\ ln\ MSTAFF\ ln\ FIXED + \gamma_{21}\ ln\ RSTAFF\ ln\ FIXED + \gamma_{31}\ ln\ OSTAFF\ ln\ FIXED \\ & + \varepsilon_{11}\ ln\ MSTAFF\ ln\ DEVELOP + \varepsilon_{21}\ ln\ RSTAFF\ ln\ DEVELOP + \varepsilon_{31}\ ln\ OSTAFF\ ln\ DEVELOP \\ & + \mu_{11}\ ln\ MSTAFF\ ln\ INTANG + \mu_{21}\ ln\ RSTAFF\ ln\ INTANG + \mu_{31}\ ln\ OSTAFF\ ln\ INTANG \\ & + \theta_{11}\ ln\ FIXED\ ln\ DEVELOP + \rho_{11}\ ln\ FIXED\ ln\ INTANG + \sigma_{11}\ ln\ DEVELOP\ ln\ INTANG \\ & + \varphi_1\ BIG + \varphi_2\ COVID + \varphi_3\ BIG\ COVID \end{aligned} \tag{7}$$

$$\begin{aligned} ln\ REVENUE_d = {} & \alpha_0 + \alpha_1\ ln\ DMSTAFF + \alpha_2\ ln\ DRSTAFF + \alpha_3\ ln\ DOSTAFF + \beta_1\ ln\ DFIXED \\ & + \delta_1\ ln\ DDEVELOP + \epsilon_1\ ln\ DBIOLOGY + \tfrac{1}{2}\,\alpha_{11}\ (ln\ DMSTAFF)^2 + \tfrac{1}{2}\,\alpha_{22}\ (ln\ DRSTAFF)^2 \\ & + \tfrac{1}{2}\,\alpha_{33}\ (ln\ DOSTAFF)^2 + \tfrac{1}{2}\,\beta_{11}\ (ln\ DFIXED)^2 + \tfrac{1}{2}\,\delta_{11}\ (ln\ DDEVELOP)^2 \\ & + \tfrac{1}{2}\,\epsilon_{11}\ (ln\ DBIOLOGY)^2 + \alpha_{12}\ ln\ DMSTAFF\ ln\ DRSTAFF + \alpha_{13}\ ln\ DMSTAFF\ ln\ DOSTAFF \\ & + \alpha_{23}\ ln\ DRSTAFF\ ln\ DOSTAFF + \gamma_{11}\ ln\ DMSTAFF\ ln\ DFIXED \\ & + \gamma_{21}\ ln\ DRSTAFF\ ln\ DFIXED + \gamma_{31}\ ln\ DOSTAFF\ ln\ DFIXED \\ & + \varepsilon_{11}\ ln\ DMSTAFF\ ln\ DDEVELOP + \varepsilon_{21}\ ln\ DRSTAFF\ ln\ DDEVELOP \\ & + \varepsilon_{31}\ ln\ DOSTAFF\ ln\ DDEVELOP + \mu_{11}\ ln\ DMSTAFF\ ln\ DBIOLOGY \\ & + \mu_{21}\ ln\ DRSTAFF\ ln\ DBIOLOGY + \mu_{31}\ ln\ DOSTAFF\ ln\ DBIOLOGY \\ & + \theta_{11}\ ln\ DFIXED\ ln\ DDEVELOP + \rho_{11}\ ln\ DFIXED\ ln\ DBIOLOGY \\ & + \sigma_{11}\ ln\ DDEVELOP\ ln\ DBIOLOGY + \varphi_1\ DBIG + \varphi_2\ DCOVID + \varphi_3\ DBIG\ DCOVID \end{aligned} \tag{8}$$

4.3.2. Agri-Food Sales

Table 4 shows the average partial effect (APE) (see Appendix A for the estimation method of APE). The APE of *COVID* to the $REVENUE_a$ of Chinese agricultural enterprises is negative and significant. Meanwhile, Table 3 shows that the estimated value of the *COVID* coefficient is significantly negative in the revenue function equation of Chinese agricultural enterprises. These results showed that the coefficient of *COVID* in the agricultural translog model is significantly negative. These figures show that the COVID-19 pandemic has reduced overall sales of agri-food products. However, as shown in Table 4, the APE of *DCOVID* on the $REVENUE_d$ is positive and significant. Table 3 shows that the estimated value of the *DCOVID* coefficient is significantly positive in the revenue function equation of Chinese dairy enterprises. These figures show that the COVID-19 pandemic has increased dairy sales in China.

The different impacts of COVID-19 on the overall sales of agri-food products and dairy products indicate that COVID-19 does not have a negative effect on all food products. Although the pandemic has reduced the overall sales of agri-food products, some food types have increased sales. The possible reason is that most agri-food products have a short shelf life and are difficult to store and transport for a long time. However, in China, most dairy products can be stored for a long time.

The APE of *COVID* on *BIG* and non-*BIG* are −0.588 and −0.253, respectively. These results indicate that although the sales of agri-food products by companies of different sizes have declined during the pandemic, large enterprises' sales of agri-food products have fallen even more. The possible reason is that, unlike small and medium-sized agricultural enterprises, large agricultural enterprises usually have a nationwide sales network, and their overall operating costs and storage costs are relatively high. Under the impact of the pandemic, large agricultural enterprises still need to maintain various high costs, which causes great pressure on corporate finances. However, small- and medium-sized agricultural enterprises generally market regionally. Under the pandemic, they can do a better job in regional sales through more flexible marketing and operation methods; thus, the sales of small- and medium-sized agricultural enterprises have a lower decline in sales.

Table 4. APE of variables on $REVENUE_a/REVENUE_d$ (agriculture and dairy industry).

APE	Agri. Value/Dair. Value	Agri. Signi./Dair. Signi. Test
APE_MSTAFF/DMSTAFF	0.017/−0.936	$H_0: \alpha_1 = \alpha_{11} = \alpha_{12} = \alpha_{13} = \gamma_{11} = \varepsilon_{11} = \mu_{11} = 0$ F-statistic = 3.82/1.91 Significance level = 0.00/0.07
APE_RSTAFF/DRSTAFF	−0.095/0.069	$H_0: \alpha_2 = \alpha_{22} = \alpha_{12} = \alpha_{23} = \gamma_{21} = \varepsilon_{21} = \mu_{21} = 0$ F-statistic = 0.43/4.76 Significance level = 0.88/0.00
APE_OSTAFF/DOSTAFF	0.503/0.674	$H_0: \alpha_3 = \alpha_{33} = \alpha_{13} = \alpha_{23} = \gamma_{31} = \varepsilon_{31} = \mu_{31} = 0$ F-statistic = 4.63/4.67 Significance level = 0.00/0.00
APE_FIXED/DFIXED	0.207/0.258	$H_0: \beta_1 = \beta_{11} = \gamma_{11} = \gamma_{21} = \gamma_{31} = \theta_{11} = \rho_{11} = 0$ F-statistic = 0.75/4.09 Significance level = 0.63/0.00
APE_DEVELOP/DDEVELOP	0.465/0.044	$H_0: \delta_1 = \delta_{11} = \varepsilon_{11} = \varepsilon_{21} = \varepsilon_{31} = \theta_{11} = \sigma_{11} = 0$ F-statistic = 6.11/1.08 Significance level = 0.00/0.09
APE_INTANG/DBIOLOGY	−0.020/0.070	$H_0: \epsilon_1 = \epsilon_{11} = \mu_{11} = \mu_{21} = \mu_{31} = \rho_{11} = \sigma_{11} = 0$ F-statistic = 0.38/2.03 Significance level = 0.91/0.05
APE_BIG/DBIG		$H_0: \varphi_1 = \varphi_3 = 0$
When *COVID/DCOVID* = 0	0.600/1.177	F-statistic = 4.01/1.54
When *COVID/DCOVID* = 1	0.265/2.222	Significance level = 0.02/0.22
APE_COVID/DCOVID		$H_0: \varphi_2 = \varphi_3 = 0$
When *BIG/DBIG* = 0	−0.253/0.419	F-statistic = 7.90/3.20
When *BIG/DBIG* = 1	−0.588/1.464	Significance level = 0.00/0.04

5. Conclusions

5.1. Discussions

Sustainable development is inseparable from economic efficiency [60]; the development of agriculture is closely related to a country's socio-economic sustainability [61,62]. COVID-19 has caused changes in the price of agricultural foods of different magnitudes in different countries, and the price changes of agricultural foods are closely related to energy [63] and population welfare [64]. Currently, almost every country's food system suffers from the adverse effects of the pandemic. China's efforts to ensure the sale of agri-food products can maintain the development of the country's agriculture and ensure the nutritional level of the population and provide a valuable reference for the restoration of agricultural development in other countries. Considering the difficulties that agri-food products companies may encounter during the COVID-19, we must analyze the current sales of agri-food products. Thus, this paper discusses the specific impact of the pandemic on agricultural food sales based on the data from the company's financial statements and makes policy recommendations. The empirical results show that the COVID-19 pandemic has reduced the sales of agri-food products, and the sales of agri-food products by large agricultural companies have fallen more than those of small and medium-sized ones.

Our quantitative study results are similar to earlier qualitative study results on COVID-19. In some early studies, Štreimikienė et al. [20] found that the pandemic hindered the development of agriculture. Due to the decline in purchasing power and the restrictions on people going out by the epidemic prevention policy, people's food safety and security have been significantly weakened. The poorest groups are most threatened under the impact of the pandemic. Bisoffi et al. [65] observed the weakness of the global governance mechanism under the pandemic, Ecological agriculture and food processing industries may be affected by the economic recession caused by the pandemic. Taken together, the pandemic affects agriculture and food in many ways, including but not limited to the following [65]:

(1) COVID-19 has affected the prices of many types of food and has increased the inequality of access to food among the populations of different countries.
(2) In almost all countries, the population in urgent need of food assistance has increased significantly.

(3) Under COVID-19, the role of international multilateralism has been significantly weakened, and its role in the recovery of agriculture and food has been lower than expected.
(4) Blockade measures, travel cessation, and social distancing have plunged the food service industry into a deep crisis.
(5) The food consumption behavior of the population has undergone significant changes during the pandemic.

Almost all currently known studies on COVID-19 in the agricultural and food sector discuss the adverse effects of COVID-19. However, some scholars have also reported a significant increase in online sales channels of agri-food under COVID-19 [65,66]. We believe that expanding online sales may minimize the impact of COVID-19.

5.2. Suggestions

(1) The government may consider reducing or exempting relevant expenses for agricultural credit guarantees. For some agri-food enterprises in China, financing costs account for a relatively high proportion of production and operation costs. During the pandemic, many agri-food enterprises are facing operational crises. Agricultural guarantee companies may consider further reducing or exempting the re-guarantee fees charged by agri-food business entities, which will significantly help reduce the financing costs of agri-food business entities.
(2) Assist agri-food enterprises by actively allocating disaster relief funds for agri-food production. Under the pandemic, allocating funds for disaster relief in agri-food production will be essential to promote agri-food production and strong support for preventing and controlling rice, wheat, and vegetable pests and diseases.
(3) Further improve the ability of agriculture to resist risks by increasing support for refrigerated and fresh-keeping of agri-food products.
(4) Another aspect of reducing the operating burden of agricultural enterprises is to help them reduce unit production costs. In addition, when an epidemic strikes, the competent authorities and agricultural enterprises should put more emphasis on the use of machinery. The advantages of machinery over traditional labor are more obvious.
(5) Agri-food enterprises may consider exploring the sales model of "e-commerce platform + enterprise direct supply + contactless distribution". Under the pandemic, it is more difficult for agri-food products to reach the dinner table. Agri-food enterprises can actively use e-commerce platforms to carry out live broadcasts to promote agri-food products effectively. In addition, through the sales model of "e-commerce platform + enterprise direct supply + contactless distribution", agri-food products can be sent directly from enterprises, reducing the staleness of agri-food products due to multiple transfers during the pandemic.

5.3. Limitations and Future Studies

The focus of this study is the comprehensive impact of COVID-19 on the sales changes of Chinese agri-food companies. However, there are many possible reasons for this comprehensive impact, such as recovery rates, travel restrictions, and COVID-19 death numbers. This study focuses on the comprehensive impact of COVID-19 on the changes in agri-food product sales without analyzing the above possible causes one by one. In the future, scholars can consider gathering quarterly or monthly data of time-varying factors, such as the number of COVID-19 deaths or COVID-19 stringency index and Nikkei COVD-19 recovery index for further study, and may evaluate the impact of COVID-19 on Chinese agri-food enterprises from the perspective of specific factors related to COVID-19.

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Appendix A

The agricultural estimation model of this study is as follows:

$$\begin{aligned} ln\ REVENUE_a &= \alpha_0 + \alpha_1\ ln\ MSTAFF + \alpha_2\ ln\ RSTAFF + \alpha_3\ ln\ OSTAFF + \beta_1\ ln\ FIXED + \delta_1\ ln\ DEVELOP \\ &+ \epsilon_1 ln\ INTANG + \tfrac{1}{2}\alpha_{11}\ (ln\ MSTAFF)^2 + \tfrac{1}{2}\alpha_{22}\ (ln\ RSTAFF)^2 + \tfrac{1}{2}\alpha_{33}\ (ln\ OSTAFF)^2 \\ &+ \tfrac{1}{2}\beta_{11}\ (ln\ FIXED)^2 + \tfrac{1}{2}\delta_{11}\ (ln\ DEVELOP)^2 + \tfrac{1}{2}\epsilon_{11}\ (ln\ INTANG)^2 \\ &+ \alpha_{12}\ ln\ MSTAFF\ ln\ RSTAFF + \alpha_{13}\ ln\ MSTAFF\ ln\ OSTAFF + \alpha_{23}\ ln\ RSTAFF\ ln\ OSTAFF \\ &+ \gamma_{11}\ ln\ MSTAFF\ ln\ FIXED + \gamma_{21}\ ln\ RSTAFF\ ln\ FIXED + \gamma_{31}\ ln\ OSTAFF\ ln\ FIXED \\ &+ \varepsilon_{11}\ ln\ MSTAFF\ ln\ DEVELOP + \varepsilon_{21}\ ln\ RSTAFF\ ln\ DEVELOP + \varepsilon_{31}\ ln\ OSTAFF\ ln\ DEVELOP \\ &+ \mu_{11}\ ln\ MSTAFF\ ln\ INTANG + \mu_{21}\ ln\ RSTAFF\ ln\ INTANG + \mu_{31}\ ln\ OSTAFF\ ln\ INTANG \\ &+ \theta_{11}\ ln\ FIXED\ ln\ DEVELOP + \rho_{11}\ ln\ FIXED\ ln\ INTANG + \sigma_{11}\ ln\ DEVELOP\ ln\ INTANG \\ &+ \varphi_1\ BIG + \varphi_2\ COVID + \varphi_3\ BIG\ COVID \end{aligned} \tag{A1}$$

The following is the APE derivation process of variables:

The APE of *MSTAFF* on *REVENUE*:

$$\begin{aligned} \partial\ ln\ R\hat{E}VENUE\ /\partial\ ln\ MSTAFF \\ = \hat{\alpha}_1 + \hat{\alpha}_{11}\ \overline{ln\ MSTAFF} + \hat{\alpha}_{12}\ \overline{ln\ RSTAFF} + \hat{\alpha}_{13}\ \overline{ln\ OSTAFF} \\ + \hat{\gamma}_{11}\ \overline{ln\ FIXED} + \hat{\varepsilon}_{11}\ \overline{ln\ DEVELOP} + \hat{\mu}_{11}\ \overline{ln\ INTANG} \end{aligned} \tag{A2}$$

The APE of *RSTAFF* on *REVENUE*:

$$\begin{aligned} \partial\ ln\ R\hat{E}VENUE\ /\partial\ ln\ RSTAFF \\ = \hat{\alpha}_2 + \hat{\alpha}_{22}\ \overline{ln\ RSTAFF} + \hat{\alpha}_{12}\ \overline{ln\ MSTAFF} + \hat{\alpha}_{23}\ \overline{lnOSTAFF} \\ + \hat{\gamma}_{21}\ \overline{ln\ FIXED} + \hat{\varepsilon}_{21}\ \overline{ln\ DEVELOP} + \hat{\mu}_{21}\ \overline{ln\ INTANG} \end{aligned} \tag{A3}$$

The APE of *OSTAFF* on *REVENUE*:

$$\begin{aligned} \partial\ ln\ R\hat{E}VENUE\ /\partial\ ln\ OSTAFF \\ = \hat{\alpha}_3 + \hat{\alpha}_{33}\ \overline{ln\ OSTAFF} + \hat{\alpha}_{13}\ \overline{ln\ MSTAFF} + \hat{\alpha}_{23}\ \overline{ln\ RSTAFF} \\ + \hat{\gamma}_{31}\ \overline{ln\ FIXED} + \hat{\varepsilon}_{31}\ \overline{ln\ DEVELOP} + \hat{\mu}_{31}\ \overline{ln\ INTANG} \end{aligned} \tag{A4}$$

The APE of *FIXED* on *REVENUE:*

$$\begin{aligned} \partial\ ln\ R\hat{E}VENUE\ /\partial\ ln\ FIXED \\ = \hat{\beta}_1 + \hat{\beta}_{11}\ \overline{ln\ FIXED} + \hat{\gamma}_{11}\ \overline{ln\ MSTAFF} + \hat{\gamma}_{21}\ \overline{ln\ RSTAFF} \\ + \hat{\gamma}_{31}\ \overline{ln\ OSTAFF} + \hat{\theta}_{11}\ \overline{ln\ DEVELOP} + \hat{\rho}_{11}\ \overline{ln\ INTANG} \end{aligned} \tag{A5}$$

The APE of *DEVELOP* on *REVENUE*:

$$\begin{aligned} \partial\ ln\ R\hat{E}VENUE\ /\partial\ ln\ DEVELOP \\ = \hat{\delta}_1 + \hat{\delta}_{11}\ \overline{ln\ DEVELOP} + \hat{\varepsilon}_{11}\ \overline{ln\ MSTAFF} \\ + \hat{\varepsilon}_{21}\ \overline{ln\ RSTAFF} + \hat{\varepsilon}_{31}\ \overline{ln\ OSTAFF} + \hat{\theta}_{11}\ \overline{ln\ FIXED} \\ + \hat{\sigma}_{11}\ \overline{ln\ INTANG} \end{aligned} \tag{A6}$$

The APE of *INTANG* on *REVENUE*:

$$\begin{aligned} \partial\ ln\ R\hat{E}VENUE\ /\partial\ ln\ INTANG \\ = \hat{\epsilon}_1 + \hat{\epsilon}_{11}\ \overline{ln\ INTANG} + \hat{\mu}_{11}\ \overline{ln\ MSTAFF} + \hat{\mu}_{21}\ \overline{ln\ RSTAFF} \\ + \hat{\mu}_{31}\ \overline{ln\ OSTAFF} + \hat{\rho}_{11}\ \overline{ln\ FIXED} + \hat{\sigma}_{11}\ \overline{ln\ DEVELOP} \end{aligned} \tag{A7}$$

The APE of *BIG* on *REVENUE*:

$$\partial\ ln\ R\hat{E}VENUE/\partial\ BIG = \varphi_1 + \varphi_3\ COVID \tag{A8}$$

The APE of *COVID* on *REVENUE*:

$$\partial\ ln\ R\hat{E}VENUE/\partial\ COVID = \varphi_2 + \varphi_3\ BIG \tag{A9}$$

References

1. Mofijur, M.; Fattah, I.R.; Alam, M.A.; Islam, A.S.; Ong, H.C.; Rahman, S.A.; Mahlia, T.M.I. Impact of COVID-19 on the social, economic, environmental and energy domains: Lessons learnt from a global pandemic. *Sustain. Prod. Consum.* **2021**, *26*, 343–359. [CrossRef] [PubMed]
2. Verikios, G. The dynamic effects of infectious disease outbreaks: The case of pandemic influenza and human coronavirus. *Socio-Econ. Plan. Sci.* **2020**, *71*, 100898. [CrossRef] [PubMed]
3. Wu, Y.; Kwakkenbos, L.; Henry, R.S.; Tao, L.; Harb, S.; Bourgeault, A.; Welling, J. Validation of the COVID-19 fears questionnaires for chronic medical conditions: A scleroderma patient-centered intervention network COVID-19 cohort study. *J. Psychosom. Res.* **2020**, *139*, 110271. [CrossRef] [PubMed]

4. People's Food Sovereignty. The Supermarket Was Robbed Empty VS Agricultural Products Unsalable: Epidemic under the Irradiation of Industrial Food System. Available online: https://www.163.com/dy/article/FC2OUU520514C63D.html (accessed on 1 December 2021). (In Chinese).
5. Kuznetsova, I.G.; Voronkova, O.Y.; Nimatulaev, M.M.; Ruiga, I.R.; Zhuruli, G.N.; Levichev, V.E. Ensuring the national security of agriculture in the digital era through the formation of human capital. *Int. J. Econ. Bus. Adm.* **2019**, *7*, 558–569. [CrossRef]
6. Adenew, B. The food security role of agriculture in Ethiopia. *J. Agric. Dev. Econ.* **2004**, *1*, 138–153. [CrossRef]
7. Charlton, D.; Castillo, M. Potential impacts of a pandemic on the US farm labor market. *Appl. Econ. Perspect. Policy* **2020**, *43*, 39–57. [CrossRef]
8. Luckstead, J.; Nayga, R.M., Jr.; Snell, H.A. Labor issues in the food supply chain amid the COVID-19 pandemic. *Appl. Econ. Perspect. Policy* **2020**, *43*, 382–400. [CrossRef]
9. Chenarides, L.; Manfredo, M.; Richards, T.J. COVID-19 and food supply chains. *Appl. Econ. Perspect. Policy* **2020**, *43*, 270–279. [CrossRef]
10. Time Finance. "Land Owner" also Have No Surplus Grain? COVID-19 Exacerbates the Global Food Crisis. Available online: https://finance.ifeng.com/c/7vC0RyPVISq (accessed on 13 August 2021). (In Chinese).
11. Casey, C.; Cimino-Isaacs, C. Export Restrictions in Response to the COVID-19 Pandemic. Available online: https://crsreports.congress.gov/product/pdf/IF/IF11551 (accessed on 13 August 2021).
12. Varshney, D.; Kumar, A.; Mishra, A.K.; Rashid, S.; Joshi, P.K. India's COVID-19 social assistance package and its impact on the agriculture sector. *Agric. Syst.* **2021**, *189*, 103049. [CrossRef]
13. Snow, V.; Rodriguez, D.; Dynes, R.; Kaye-Blake, W.; Mallawaarachchi, T.; Zydenbos, S.; Stevens, D. Resilience achieved via multiple compensating subsystems: The immediate impacts of COVID-19 control measures on the agri-food systems of Australia and New Zealand. *Agric. Syst.* **2021**, *187*, 103025. [CrossRef]
14. Nayak, J.; Mishra, M.; Naik, B.; Swapnarekha, H.; Cengiz, K.; Shanmuganathan, V. An impact study of COVID-19 on six different industries: Automobile, energy and power, agriculture, education, travel and tourism and consumer electronics. *Expert Syst.* **2021**. [CrossRef]
15. China Economic Information. 2020 Analysis of the Current Situation of China's Agricultural Products Processing Industry, New Consumption Mode to Stimulate New Growth Points. Available online: https://business.sohu.com/a/501925012_120113054 (accessed on 2 December 2021). (In Chinese)
16. Industry Information Network. 2020 China Agricultural Products Industry Development Review and Industry Development Trend Analysis. Available online: https://www.chyxx.com/industry/202102/933607.html (accessed on 2 December 2021). (In Chinese)
17. The World Bank. Food Security and COVID-19. Available online: https://www.worldbank.org/en/topic/agriculture/brief/food-security-and-covid-19 (accessed on 1 December 2021).
18. FAO. Impact of COVID-19 on Agriculture, Food Systems and Rural Livelihoods in Eastern Africa: Policy and Programmatic Options. Available online: https://www.fao.org/3/cb0552en/CB0552EN.pdf (accessed on 1 December 2021).
19. The Organisation for Economic Co-Operation and Development (OECD). Keep Calm and Carry on Feeding: Agriculture and Food Policy Responses to the COVID-19 Crisis. Available online: https://www.oecd.org/coronavirus/policy-responses/keep-calm-and-carry-on-feeding-agriculture-and-food-policy-responses-to-the-covid-19-crisis-db1bf302/ (accessed on 1 December 2021).
20. Štreimikienė, D.; Baležentis, T.; Volkov, A.; Ribašauskienė, E.; Morkūnas, M.; Žičkienė, A. Negative effects of covid-19 pandemic on agriculture: Systematic literature review in the frameworks of vulnerability, resilience and risks involved. *Econ. Res.-Ekon. Istraz.* **2021**, 1–17. [CrossRef]
21. Ministry of Rural Agriculture. China's Agriculture Have the Confidence to Cope with Economic Risks. Available online: https://m.sohu.com/a/256550787_114731/ (accessed on 1 December 2021). (In Chinese)
22. Matthee, M.; Rankin, N.; Webb, T.; Bezuidenhout, C. Understanding manufactured exporters at the firm-level: New insights from using SARS administrative data. *S. Afr. J. Econ.* **2017**, *86*, 96–119. [CrossRef]
23. Agusto, F.B. Optimal isolation control strategies and cost-effectiveness analysis of a two-strain avian influenza model. *Biosystems* **2013**, *113*, 155–164. [CrossRef]
24. Keogh-Brown, M.R.; Smith, R.D.; Edmunds, J.W.; Beutels, P. The macroeconomic impact of pandemic influenza: Estimates from models of the United Kingdom, France, Belgium and The Netherlands. *Eur. J. Health Econ.* **2010**, *11*, 543–554. [CrossRef]
25. Duan, H.; Wang, S.; Yang, C. Coronavirus: Limit short-term economic damage. *Nature* **2020**, *578*, 515–516. [CrossRef]
26. Smith, R.D.; Keogh-Brown, M.R.; Barnett, T.; Tait, J. The economy-wide impact of pandemic influenza on the UK: A computable general equilibrium modelling experiment. *BMJ* **2009**, *339*, b4571. [CrossRef]
27. Bonet-Morón, J.; Ricciulli-Marín, D.; Pérez-Valbuena, G.J.; Galvis-Aponte, L.A.; Haddad, E.A.; Araújo, I.F.; Perobelli, F.S. Regional economic impact of COVID-19 in Colombia: An input–output approach. *Reg. Sci. Policy Pract.* **2020**, *12*, 1123–1150. [CrossRef]
28. Ahmed, Q.A.; Memish, Z.A. The cancellation of mass gatherings (MGs)? Decision making in the time of COVID-19. *Travel Med. Infect. Dis.* **2020**, *34*, 101631. [CrossRef]
29. Arshad Ali, S.; Baloch, M.; Ahmed, N.; Arshad Ali, A.; Iqbal, A. The outbreak of coronavirus disease 2019 (COVID-19)—An emerging global health threat. *J. Infect. Public Health* **2020**, *13*, 644–646. [CrossRef] [PubMed]
30. Çakır, M.; Li, Q.; Yang, X. COVID-19 and fresh produce markets in the United States and China. *Appl. Econ. Perspect. Policy* **2020**, *43*, 341–354. [CrossRef]

31. Khanna, M. COVID-19: A cloud with a silver lining for renewable energy? *Appl. Econ. Perspect. Policy* **2020**, *43*, 73–85. [CrossRef] [PubMed]
32. Lusk, J.L.; Tonsor, G.T.; Schulz, L.L. Beef and pork marketing margins and price spreads during COVID-19. *Appl. Econ. Perspect. Policy* **2020**, *43*, 4–23. [CrossRef] [PubMed]
33. Mallory, M.L. Impact of COVID-19 on medium-term export prospects for soybeans, corn, beef, pork, and poultry. *Appl. Econ. Perspect. Policy* **2020**, *43*, 292–303. [CrossRef]
34. Maples, J.G.; Thompson, J.M.; Anderson, J.D.; Anderson, D.P. Estimating COVID-19 impacts on the broiler industry. *Appl. Econ. Perspect. Policy* **2020**, *43*, 315–328. [CrossRef]
35. Martinez, C.C.; Maples, J.G.; Benavidez, J. Beef cattle markets and COVID-19. *Appl. Econ. Perspect. Policy* **2020**, *43*, 304–314. [CrossRef]
36. Ridley, W.; Devadoss, S. The effects of COVID-19 on fruit and vegetable production. *Appl. Econ. Perspect. Policy* **2020**, *43*, 329–340. [CrossRef]
37. Weersink, A.; von Massow, M.; Bannon, N.; Ifft, J.; Maples, J.; McEwan, K.; Wood, K. COVID-19 and the agri-food system in the United States and Canada. *Agric. Syst.* **2021**, *188*, 103039. [CrossRef]
38. Chang, H.; Meyerhoefer, C.D. COVID-19 and the demand for online food shopping services: Empirical evidence from Taiwan. *Am. J. Agric. Econ.* **2020**, *103*, 448–465. [CrossRef]
39. Gupta, A.; Zhu, H.; Doan, M.K.; Michuda, A.; Majumder, B. Economic impacts of the COVID−19 lockdown in a remittance-dependent region. *Am. J. Agric. Econ.* **2020**, *103*, 466–485. [CrossRef]
40. Liverpool-Tasie, L.S.; Reardon, T.; Belton, B. Essential non-essentials: COVID-19 policy missteps in Nigeria rooted in persistent myths about African food supply chains. *Appl. Econ. Perspect. Policy* **2020**, *43*, 205–224. [CrossRef]
41. Fei, S.; Ni, J.; Santini, G. Local food systems and COVID-19: An insight from China. *Resour. Conserv. Recycl.* **2020**, *162*, 105022. [CrossRef] [PubMed]
42. Schnitkey, G.D.; Paulson, N.D.; Irwin, S.H.; Coppess, J.; Sherrick, B.J.; Swanson, K.J.; Zulauf, C.R.; Hubbs, T. Coronavirus impacts on Midwestern row-crop agriculture. *Appl. Econ. Perspect. Policy* **2020**, *43*, 280–291. [CrossRef]
43. Mahajan, K.; Tomar, S. COVID-19 and supply chain disruption: Evidence from food markets in India. *Am. J. Agric. Econ.* **2021**, *103*, 35–52. [CrossRef] [PubMed]
44. Varshney, D.; Kumar, A.; Mishra, A.K.; Rashid, S.; Joshi, P.K. COVID-19, government transfer payments, and investment decisions in farming business: Evidence from Northern India. *Appl. Econ. Perspect. Policy* **2021**, *43*, 248–269. [CrossRef]
45. FAO. Mitigating the Impacts of COVID-19 on the Livestock Sector. Available online: http://www.fao.org/3/ca8799en/CA8799EN.pdf (accessed on 2 December 2021).
46. FAO. *Impact of the Ebola Virus Disease Outbreak on Market Chains and Trade of Agricultural Products in West Africa*; FAO REOWA: Dakar, Senegal, 2016; ISBN 978-9251092231.
47. Katona, P.; Katona-Apte, J. The interaction between nutrition and infection. *Clin. Infect. Dis.* **2008**, *46*, 1582–1588. [CrossRef] [PubMed]
48. Aberman, N.L.; Rawat, R.; Drimie, S.; Claros, J.M.; Kadiyala, S. Food security and nutrition interventions in response to the AIDS epidemic: Assessing global action and evidence. *AIDS Behav.* **2014**, *5*, 554–565. [CrossRef]
49. Kodish, S.R.; Bio, F.; Oemcke, R.; Conteh, J.; Beauliere, J.M.; Pyne-Bailey, S.; Rohner, F.; Ngnie-Teta, I.; Jalloh, M.B.; Wirth, J.P. A qualitative study to understand how Ebola virus disease affected nutrition in Sierra Leone-A food value-chain framework for improving future response strategies. *PLoS Negl. Trop. Dis.* **2019**, *13*, e0007645. [CrossRef]
50. Kodish, S.R.; Simen-Kapeu, A.; Beauliere, J.M.; Ngnie-Teta, I.; Jalloh, M.B.; Pyne-Bailey, S.; Schwartz, H.; Wirth, J.P. Consensus building around nutrition lessons from the 2014-16 Ebola virus disease outbreak in Guinea and Sierra Leone. *Health Policy Plan.* **2019**, *34*, 83–91. [CrossRef]
51. FSIN. 2019 Global Report on Food Crises. Available online: https://www.fsinplatform.org/report/global-report-food-crisis-2019/ (accessed on 17 October 2021).
52. Chen, J.; Yang, C.C. The impact of the COVID-19 pandemic on consumers' preferences for wood furniture: An accounting perspective. *Forests* **2021**, *12*, 1637. [CrossRef]
53. Tien, N.H.; Anh, D.B.H. High quality human resource development approach of Vietnamese enterprise. *Int. Multidiscip. Res. J.* **2019**, *6*, 84–88.
54. Yang, C.C.; Chen, J.X.; Yang, W.C. The Impact of the Amendment of Taiwan's Certified Public Accountant Act in 2007 on Large Accounting Firms. *Sustainability* **2020**, *13*, 1229. [CrossRef]
55. Chen, J.; Yang, C.C. Competitive Revenue Strategies in the Medical Consumables Industry: Evidence from Human Resources, Research and Development Expenses and Industry Life Cycle. *Int. J. Environ. Res. Public Health* **2021**, *18*, 3180. [CrossRef] [PubMed]
56. Yang, C.; Tsai, T.; Fu, C. Human Capital and Knowledge Spillover Effect: Evidence from Taiwan's CPA Firms. *Sun Yat-Sen Manag. Rev.* **2010**, *18*, 251–279.
57. Chen, J.; Yang, C.C. The impact of the National Nutrition Program 2017–2030 on people's food purchases: A revenue-based perspective. *Nutrients* **2021**, *13*, 3030. [CrossRef]
58. Banker, R.D.; Chang, H.; Cufnningham, R. The Public Accounting Industry Production Function. *J. Acc. Econ.* **2003**, *35*, 255–281. [CrossRef]

59. Christensen, L.R.; Greene, W.H. Economies of scale in U.S. electric power generation. *J. Polit. Econ.* **1976**, *84*, 655–676. [CrossRef]
60. He, L.J.; Chen, J. Does Mandatory Audit Partner Rotation Influence Auditor Selection Strategies? *Sustainability* **2021**, *13*, 2058. [CrossRef]
61. Thirtle, C.; Lin, L.; Piesse, J. The impact of research-led agricultural productivity growth on poverty reduction in Africa, Asia and Latin America. *World Dev.* **2003**, *31*, 1959–1975. [CrossRef]
62. World Bank. *World Development Report 2008: Agriculture and Development*; World Bank: Washington, DC, USA, 2007. [CrossRef]
63. Taghizadeh-Hesary, F.; Rasoulinezhad, E.; Yoshino, N. Energy and food security: Linkages through price volatility. *Energy Policy* **2019**, *128*, 796–806. [CrossRef]
64. International Food Policy Research Institute. Biofuels, International Food Prices, and the Poor Joachim von Braun. Available online: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.140.9858&rep=rep1&type=pdf (accessed on 3 December 2021).
65. Bisoffi, S.; Ahrné, L.; Aschemann-Witzel, J.; Báldi, A.; Cuhls, K.; DeClerck, F.; Brunori, G. COVID-19 and sustainable food systems: What should we learn before the next emergency. *Front. Sustain. Food Syst.* **2021**, *5*, 53. [CrossRef]
66. Barcaccia, G.; D'Agostino, V.; Zotti, A.; Cozzi, B. Impact of the SARS-CoV-2 on the Italian agri-food sector: An analysis of the quarter of pandemic lockdown and clues for a socio-economic and territorial restart. *Sustainability* **2020**, *12*, 5651. [CrossRef]