



Article

# The Contribution of Chicken Products' Export to Economic Growth: Evidence from China, the United States, and Brazil

Xiaowei Wen <sup>1</sup>, Lin Li <sup>2,\*</sup>, Sangluo Sun <sup>1</sup>, Qinying He <sup>1</sup>  and Fu-Sheng Tsai <sup>3,4,5</sup> 

<sup>1</sup> College of Economics and Management, South China Agricultural University, Guangzhou 510642, China; wxwcn@scau.edu.cn (X.W.); sunsangluo@stu.scau.edu.cn (S.S.); heqy83@scau.edu.cn (Q.H.)

<sup>2</sup> Youth Volunteers' Guidance Center of Guangzhou, Guangzhou 510642, China

<sup>3</sup> Department of Business Administration, Cheng Shiu University, Kaohsiung 83347, Taiwan; tsaiifs@gcloud.csu.edu.tw

<sup>4</sup> Center for Environmental Toxin and Emerging-Contaminant Research, Cheng Shiu University, Kaohsiung 83347, Taiwan

<sup>5</sup> Super Micro Mass Research and Technology Center, Cheng Shiu University, Kaohsiung 83347, Taiwan

\* Correspondence: 20182038004@stu.scau.edu.cn

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**Abstract:** As a core industry of the national economy, there is no doubt that the agricultural sector has to adapt to the new economic development. In the literature, many researchers have agreed that agricultural export is an important factor affecting economic growth. This paper explores the contribution of chicken products' export to economic growth and the causal relationship between them. Based on the data from the Food and Agriculture Organization of the United Nations (FAO) and World Bank between 1980 and 2016, this paper describes and compares the characteristics of chicken products' export trade of China, the United States, and Brazil. By applying the co-integration analysis, we find that there is no significant long-term equilibrium relationship between chicken products' export and economic growth rate in China, the United States, or Brazil. However, the growth rate of chicken products' export significantly promotes the economic growth rate for the United States. Besides, for both China and the United States, the direct pull degree (an estimator quantifying the degree of agricultural products' exports in stimulating economic growth) of chicken products' export is relatively small and less volatile. Yet, the direct pull degree of China is 14 times that of the United States, and the contribution to the economic growth rate of the United States is 8 times that of China. Both the direct pull degree and economic growth contribution of chicken products' export of Brazil fluctuates more often, and its direct pull degree is 0.25 times that of China, and the economic contributions to the growth rate is 1.65 times that of China.

**Keywords:** chicken products; export trade; economic growth; co-integration; ADF test

## 1. Introduction

The issue of openness and sustainability has been noticed since decades ago [1]. In most international organizations, including the United Nations (UN) and the World Trade Organization (WTO), conventional wisdom is that international trade supports sustainable development. Trade growth enhances a country's income-generating capacity, which is one of the essential prerequisites for achieving sustainable development. Over the past few decades, we've seen the significant role of global trade in reducing poverty, creating jobs, and promoting growth. Agricultural products are also related to environment protection, which is another pillar of sustainable development. In addition, agriculture is one of the core industries in many nations. As the main component of the agricultural

economy and an important factor affecting economic growth, the export trade of agricultural products is obviously worth investigating. It is of great practical significance for the realization of agricultural modernization and sustainable development.

With the rapid development of the economy and improvement of people's income levels, people's consumption concept and structure have changed. With its nutritional advantages of low fat and high protein, chicken products have received increasingly more attention, and demands for chicken products have increased globally. The United States is the world's largest chicken producer, accounting for 20.42% of chicken production in 2016 globally and its per-capita consumption of chicken accounted for 45.99% of total meat consumption for retail in 2016 (calculated from the United States Department of Agriculture website: [http://www.ers.usda.gov/data-products/food-availability-\(per-capita\)-data-system.aspx](http://www.ers.usda.gov/data-products/food-availability-(per-capita)-data-system.aspx)). Brazil and China are the second and third largest chicken production countries in the world. The international competition of chicken products has increasingly become fierce with the development of globalization so chicken products of China have encountered the United States and Brazil, which are two strong opponents. Chicken products can be a major source of economic growth stimulation by diversifying exports, creating employment, increasing foreign exchange earnings, and improving food security for some other developing or less developed countries, which are conducive to sustainable development.

As we know, China's chicken products are labor-intensive, and chicken breeding is basically small-scale raising, which is the mainstream development mode. In 2012, there were 24,387,555 broiler farms (or households), whose annual slaughter number were under 2000, accounting for 98% of the total farms (or households). However, there were 180,262 broiler farms (or households), whose slaughter number was more than 10,000, which only accounted for 7.25% of the total farms (or households). In addition, in the production process, many owners of the broiler farms (or households) tend to ignore the problem of sewage, mortality, and drug treatment, resulting in environmental pollution and disease spread [2,3]. The United States has developed its poultry industry rapidly, of which the broiler industry is mainly led by large-scale slaughter and processing enterprises or circulation enterprises, with advantages of intensive and large-scale production, a high degree of industrial concentration, the profound depth of processing, and so on. Additionally, as the world's leading country of agricultural products' exportation, Brazil has not only achieved self-sufficiency but also exported various kinds of agricultural products. Due to the favorable climate conditions and abundant labor, its chicken production price is relatively low, which may be one of the reasons why Brazil is the top exporter of chicken products [4].

The objective of this study is to evaluate the export of chicken products and their importance in the ground of a nation's economy. In this case, a comparative analysis is applied to three countries with different economic growth: Two emerging countries China and Brazil, and a developed country with a strong economy, the United States. To accurately describe how trade can support the economic pillar of sustainable development, this paper conducted an empirical analysis to describe the characteristics and role of chicken products in economic growth and to compare China with the world's two major chicken production countries. Note that although we set out to understand the chicken export's influence on economic growth, we remained cautious on such growth's potential risky effect on the sustainable development of the poultry sector and even the larger environment of China.

The remainder of the article is organized as follows: Section 2 provides the empirical literature review derived from the export-led growth hypothesis (ELG). Section 3 focuses on describing and comparing chicken products of China, the United States, and Brazil. Section 4 includes data, the methodology, and the empirical findings. Finally, Section 5 concludes and highlights some policy implications.

## 2. Literature Review

Numerous works have investigated the relationship between foreign trade and economic growth. In the 1970s, this topic has raised serious concerns [5–7]. The ELG states the causal

relationship that export is an important determinant of economic growth. ELG is often identified with manufacturing. The export growth represents both domestic and foreign demand growth [8–11]. Moreover, the expansion of exports might result in the specialization of production, so that the domestic resources would gain efficient allocation. In contemporary times, the increase in exports may help release the restrictions on foreign exchange and increase imports, which meets the needs of the domestic, and would thus be more conducive to the expansion of output. Although there are many reasons within trade theory to support the ELG proposition, debates still exist over whether exports could truly increase economic growth [12,13]. One aspect of the concerns on the hypothetical nature of the methods is that the results of ELG based on standard causality techniques are not typically robust to specification or method [14,15].

Recent empirical literatures have explored the relationship between foreign trade and economic growth from newer and more specific perspectives, such as energy consumption and utilization [16–19] and agriculture. In addition, the available empirical literature focuses more on developing countries, such as China, Kenya, and Mongolia, aiming to investigate how export products' structure, export strength, and other factors promote economic growth [20,21]. Furthermore, new models and methods are used. The panel data methods were used to test the ELG hypothesis in 18 least-developed countries [22]. Nonparametric co-integration test and nonlinear causality test were utilized to examine potential nonlinear long-run and short-run relationships between trade and economic growth in five founders of the Association of Southeast Asian Nations (ASEAN-5, i.e., Indonesia, Malaysia, Philippines, Singapore, and Thailand) countries [23].

We have observed that most literature has focused on the total exports as the only source of growth, but agriculture's share of total exports is generally substantial in developing economies. Over the past few decades, exports of agricultural products have played a pivotal role in the economic growth of many developing countries. Several studies emphasize on the exports of agricultural products to economic growth [24]. Kwa and Bassoume examined the linkage between agricultural exports and sustainable development. The study provided case studies of different countries that were involved in agricultural exports [25].

On the impact of the agriculture sector and its foreign trade on economic growth, much controversy and confusion still exists among development economists. Previous investigations emphasized the potential influences of the relationships between agricultural and economic growth [26]. Some experts assert that growth in the overall economy depends on the development of the agricultural sector [27]. They examined data for a set of 62 countries and pointed out that the relationship is positive between the growth in a country's agricultural productivity and the movement of labor out of agriculture. This finding implies that countries experiencing increases in agricultural productivity are able to release labor from agriculture into other sectors of the economy. This is particularly crucial to poor countries. While agriculture could be an engine of economic growth, scholars suggest that the impact varies across countries. Through revisiting the debate on the role of agriculture in promoting economic growth and conducting an empirical analysis on a selection of nine developing countries, some provided evidence indicating that some of the countries show that agriculture stimulates aggregate economic growth [28]. In addition, the empirical evidence also indicates that the reverse causality also exists for some countries in that a vibrant economy could be a catalyst for expansion in the agricultural sector. Results also show that a long-term relationship exists between economic growth and agriculture. In contrast to the stated literature that outlines a strong relationship between the agriculture sector and economic growth, further investigations prove that the agricultural sector lacks a sufficiently innovative structure to support export growth [29,30].

Some experts have concluded that the expansion of agricultural exports is significantly beneficial to increasing income and stimulating the economy [31]. Scholars tend to focus on comparing the agricultural sector with the nonagricultural sector. Some examine the effect on the GDP of exports of both manufactured and primary goods (primary goods includes agricultural commodities) [32]. Results show that GDP growth can be increased by manufacturing export growth, but not by expanding primary

commodity exports. Therefore, export promotion should focus on manufacturing output. Dawson (2005) studied the contribution of agricultural exports to economic growth in less-developed countries. Fixed and random effects were estimated in each model using a panel data of 62 less-developed countries for the period 1974–1995. The study provided evidence from less-developed countries that supported the theory of export-led growth. The results of the study highlighted the role of agricultural exports in economic growth [33]. Sanjuan-Lopez and Dawson (2010) estimated the contribution of agricultural exports to economic growth in developing countries. They estimated the relationship between gross domestic product and agrarian and non-agrarian exports. The panel co-integration technique was used in analyzing the data set of 42 underdeveloped countries. The results of the study indicated that a long run relationship existed, and the agriculture export elasticity of GDP was 0.07. The non-agriculture export elasticity of GDP was 0.13. Based on the empirical results, the study suggested that poor countries should adopt balanced export promotion policies, but rich countries might attain high economic growth from non-agricultural exports [34]. Some experts note that fishing has great potential for a number of LDCs (least developed countries), because as demands for fish continue to grow strongly, it has become the most highly traded food commodity globally, and some developing countries have a comparative advantage due to a combination of low-cost labor and waters rich in highly prized varieties of fish. Fishing has been a major source of protein to stimulate economic growth by diversifying exports, creating employment, increasing foreign exchange earnings, and improving food security [35]. Some authors analyze exports by dividing them into three subcategories: Non-agricultural exports, agricultural exports (excluding rice exports), and rice exports in major rice exporting countries, and found that in the main rice export countries, like Thailand, Vietnam, India, and Pakistan, rice exports play a very significant role in economic growth [36].

To date, despite the increasing demands and attention of chicken products, to our knowledge, comprehensive research literature has mainly concentrated on the overall exports of agricultural products to economic growth, but less on the relationship between the export of a specific agricultural product and economic growth. Additionally, few scholars have compared China two globally leading chicken production and export countries. With this paper, we aimed to contribute to extending the literature on such an aspect by investigating the production and export levels among these countries.

### 3. Comparison of Chicken Products Exports

China, the United States, and Brazil are famous for producing and exporting chicken products. They are different from each other in quantity, variety, and destination regions of exports of chicken products, which may induce the difference in the relationship between export and economic growth among the three countries.

In 2016, China's chicken production export quantity was 0.70 million tons, accounting for 5.35% of the world total; the United States was 3.11 million tons, accounting for 23.76% of the world total; and Brazil's chicken production capacity was 3.96 million tons, accounting for 30.25% of the world total. In 2016, the export value of Chinese chicken products was 1.21 million tons, accounting for 6.25% of the world total; the United States was 2.86 million tons, accounting for 14.77% of the world; and as the world's largest chicken product exporting country, Brazil was 5.95 million tons, accounting for 30.72% of the world. In terms of production capacity, the gap between China and Brazil is not that huge, but with the United States, it is evident (as shown in Figure 1). While referring to the export quantity and export value, the United States and Brazil both have the obvious advantages. As shown in Figure 2, China was not that backward compared with Brazil and the United States before 1988 while the gap between China and the other two countries gradually expanded after 1988. Especially, since 1994, the export growth rate of chicken products in the United States and Brazil has continued to accelerate and their export quantity has increased. It should be noted that the chicken exports increased during the global financial crises of 2007 to 2009, especially for Brazil, indicating that chicken export may play an important role in alleviating downturn economic contraction. As shown in Figure 3,

the export value of chicken products in both the United States and Brazil continues to rise, and the gap between China and them is widening.

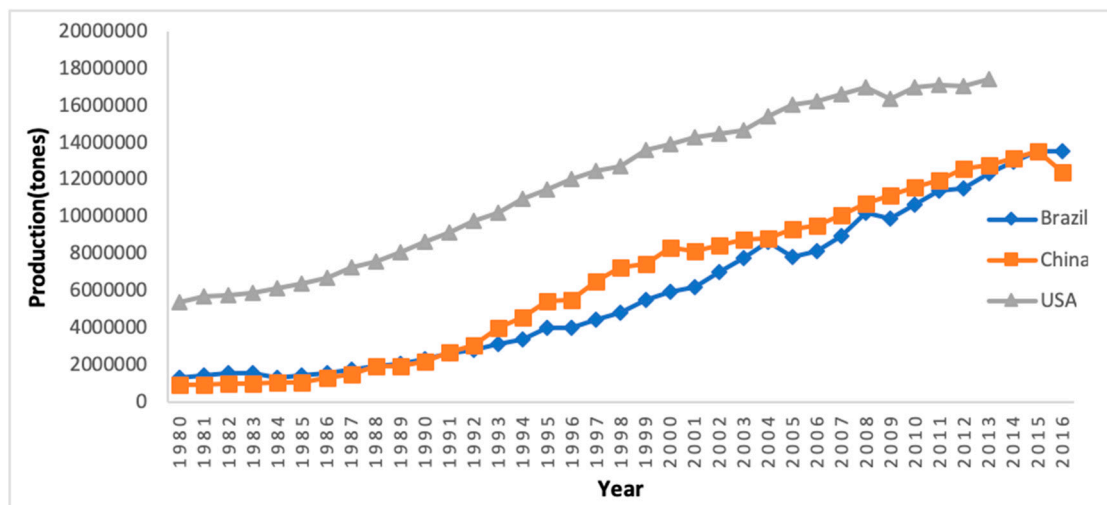


Figure 1. Productions of chicken products of China, the United States, and Brazil 1980–2016.

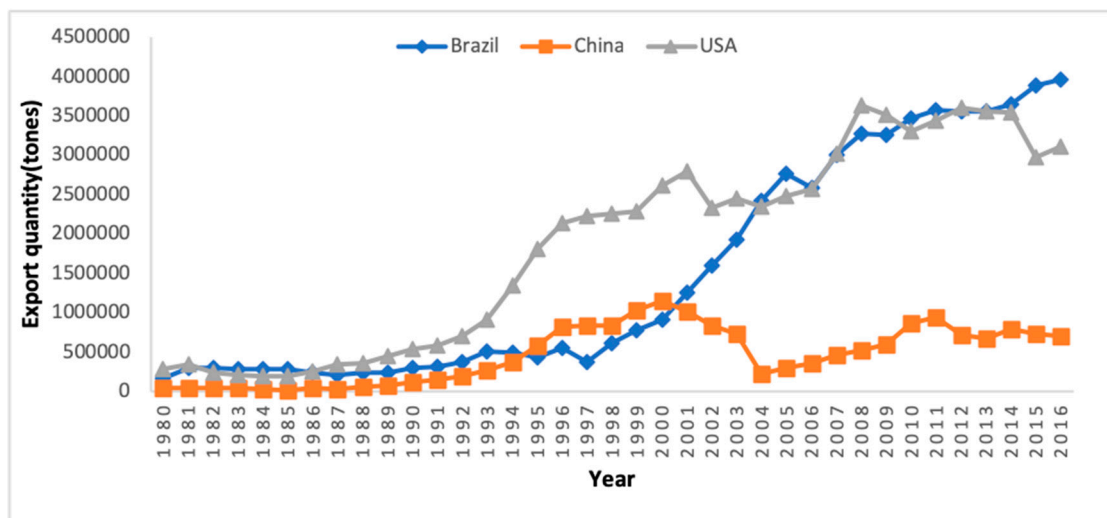


Figure 2. Export quantities of chicken products of China, the United States and Brazil: 1980–2016.

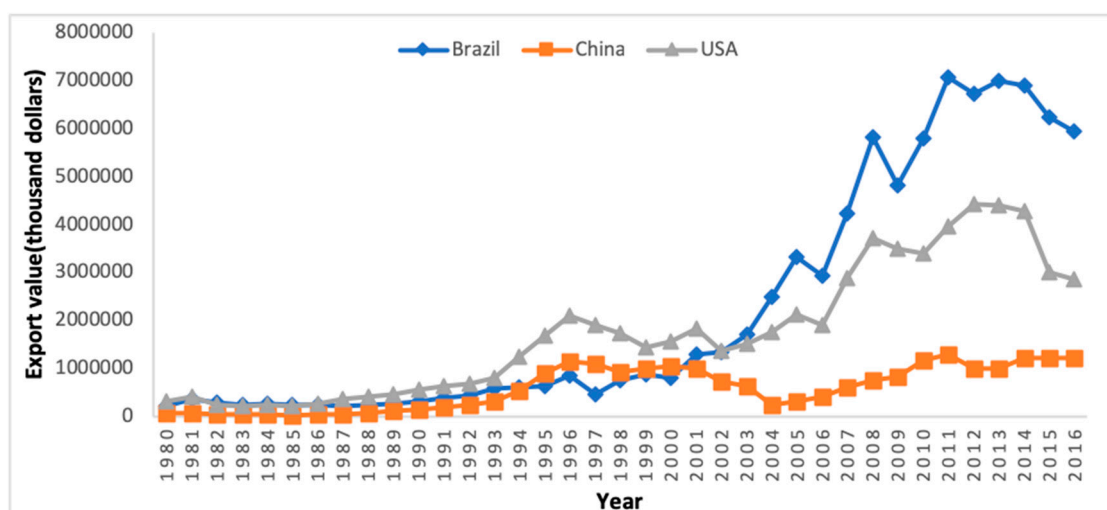


Figure 3. Export value of chicken products of China, the United States, and Brazil: 1980–2016.

China's exported varieties of chicken products are relatively single, including cooked chicken and conditioning products out of chicken mainly, with frozen chicken and iced fresh chicken as supplements. Chicken legs and breasts account for larger proportions in raw chicken meat exports ('Chinese chicken exports 52 countries and regions, this year is expected to have 45 million tons', [http://news.china.com.cn/2014-07/28/content\\_33073886.htm](http://news.china.com.cn/2014-07/28/content_33073886.htm), 28 July). The United States' exports of chicken products include broiler chicken, turkey, fresh eggs, and so on. Among them, chicken claws are mainly exported to China (Excerpted from surging News Network: [http://www.thepaper.cn/newsDetail\\_forward\\_1293848](http://www.thepaper.cn/newsDetail_forward_1293848)). According to the statistics of the United States, from November 2014 to January 2015, poultry product exports from the United States to China reached \$272 million. Additionally, during January to November in 2014, the number of chicken product exports from the United States to China reached 240 million pounds (1 pound is about 0.45 kg)). Over the same period, China has also imported 5.592 million pounds of turkey from the United States (excerpted from the monthly statistical report: <http://www.ers.usda.gov/data-products/livestock-meat-international-trade-data.aspx>. USDA. From May 2014 to January 2015, the number of China importing turkey from the United States reached 47,252,000 pounds (1 pound is about 0.45 kilograms)). Additionally, Brazil's exports of chicken products are diverse, including whole chicken, deep processing products out of chicken, bacon, and sausages (international animal husbandry network. <http://www.guojixumu.com/newsall.aspx?id=3543>, 12 January 2015).

China's chicken products are mostly exported to East Asian countries and regions. The foreign trade department of the Ministry of Commerce of China's chicken products and export monthly statistical report shows that in 2014, according to the ranking, China mainly exported chicken products to Japanese, Hong Kong, and Malaysia (pick from 'China Export Monthly Statistical Report: Chicken and Its Products' from the foreign trade department of China, December 2014). Meanwhile, the United States' and Brazil's exports are relatively different. The United States mainly exports chicken products to Mexico, Canada, China, Russia, Angola, and other countries and regions (appeared in the United States Department of agriculture <http://www.ers.usda.gov/data-products/livestock-meat-international-trade-data.aspx>). In 2014, excluding export markets containing sausages, Brazil exported 1370 thousand tons of chicken products to the Middle East, as well as Asian, African, European, and American regions (excerpted from International Network of Animal Husbandry, <http://www.guojixumu.com/newsall.aspx?id=3543>, 12 January 2015). To sum up, although the amount of China's chicken products is large, there is still a certain gap between China and these two major chicken exporting countries in the export quantity, export value, export varieties, and export countries and regions.

## 4. Empirical Research

### 4.1. Co-Integration Analysis

In this part, we conducted a co-integration analysis [37] to check whether chicken products' export and economic growth have a long-term equilibrium relationship by using the statistical software Stata 15. The method was also used to investigate the contribution of agricultural exports to economic growth in Cameroon and the relationship between agricultural GDP and the output of major crops in [38,39].

#### 4.1.1. Description of Data Source

This paper employed an annual time series data from 1980 to 2016 of China, the United States, and Brazil on both chicken products' export value and the GDP, in order to verify the relationship between chicken product exports to economic growth. Data on the export value of chicken products are from the FAO website (<http://www.fao.org/faostat/zh/#data/TP>), and GDP data are from the World Bank World Development Indicators statistics website (<https://data.worldbank.org/country>). The export value of chicken products is the independent variable, denoted by  $X$ , and the GDP is the dependent variable, denoted by  $Y$ . In order to study the characteristics of the time series without changing those,

the natural logarithm of  $Y$  and  $X$  were respectively recorded. The descriptive statistics of the two variables are given in Table 1. The mean chicken product export values and GDP of China are about 0.58 billion USD and 2.7 trillion USD, respectively. Brazil achieves the largest mean chicken export values at 2.2 billion USD.

**Table 1.** Descriptive statistics of the chicken product export values in thousand USD and GDP in trillion USD.

Variables	China		The United States		Brazil	
	Export	GDP	Export	GDP	Export	GDP
Mean	583,002.9	2.70	1,738,380	9.77	2,237,626	0.938
Std. Dev.	454,417	3.47	1,350,150	4.86	2,507,505	0.755
Min	18,933	0.191	201,646	2.86	206,790	0.203
Max	1,294,104	11.1	4,429,607	18.7	7,063,214	0.262

#### 4.1.2. Testing for Unit Roots

In the data analysis, it is necessary to firstly investigate whether the variable is a stationary, trend-stationary or unit-root process. To weaken the influences of different variances and make the data closer to the normal distribution, we used the augmented Dickey–Fuller (ADF) test method, which tests whether a variable follows a unit-root process. The null hypothesis is that the variable contains a unit root, and the alternative is that the variable was generated by a stationary process. The theoretical introduction of ADF tests are given in some econometric textbooks [40].

Table 2 displays the test statistic, interpolated estimates (from the Dickey and Fuller calculations) of 5% critical values, and the corresponding MacKinnon approximate  $p$ -values. If the test statistic was larger algebraically than the displayed critical values, we accepted the null hypothesis of a unit root. If the augmented Dickey–Fuller statistic used in the ADF test was a negative number, and the more negative it was, the stronger the rejection of the hypothesis that there is a unit root. The estimated results of the ADF test presented in Table 1 show that none of variables of the attained stationarity at their level form, while all of the variables became stationary after taking the first difference, as indicated by the values of the ADF statistics test being greater than the critical values at the 5% significance level. With a large MacKinnon approximate  $p$ -value, both the logarithm of the export value of chicken products and the logarithm of the GDP in China, the US, and Brazil are unit root processes. We selected time trend terms in the tests of logarithm series, while we did not include trend terms in first-order differenced sequences, which were tested as a stationary process with a  $p$ -value close to zero. Thus, the co-integration equation was as follows:

$$\ln Y = a + b * \ln X + u. \quad (1)$$

**Table 2.** Results of the ADF method of China, the United States, and Brazil.

Variables	China		The United States		Brazil		5% Critical Value
	Statistic	$p$ -Value	Statistic	$p$ -Value	Statistic	$p$ -Value	
$\ln X$	−2.036	0.8761	−1.355	0.8736	−2.192	0.4943	−3.556
$\ln Y$	−1.346	0.5814	−1.735	0.7350	−1.966	0.6201	−3.556
$\Delta \ln X$	−5.177	0.0000	−4.748	0.0001	−7.886	0.0000	−2.972
$\Delta \ln Y$	−3.451	0.0000	−4.167	0.0007	−4.878	0.0000	−2.972

#### 4.1.3. OLS Regression and Co-Integration Analysis

By following the EG-ADF test proposed in Engel and Granger (1987) [37], Ordinary least squares (OLS) regression of variable  $\ln Y$  on  $\ln X$  were run. The regression results are given in Table 3. The Durbin Watson (DW) statistics are much smaller than the lower limits of the critical values,

indicating an autocorrelation in the regression residuals. We further used the ADF test to check whether they were unit root processes to see whether there was a long-run equilibrium between  $LnY$  and  $LnX$ .

**Table 3.** OLS regression results of the logarithm economic growth on logarithm chicken products' export value of China, the United States, and Brazil.

Variables	China			The United States			Brazil		
	Coefficient	Std.	<i>p</i> -Value	Coefficient	Std.	<i>p</i> -Value	Coefficient	Std.	<i>p</i> -Value
Constant	17.6251	1.3149	0.0000	22.3657	0.4228	0.0000	19.3098	0.5437	0.0000
$LnX$	0.8006	0.1031	0.0001	0.5300	0.0302	0.0000	0.5730	0.0390	0.0000
AIC		2.5109			−0.5341			0.4925	
DW Statistics		0.1199			0.3687			0.4786	
<i>F</i> -Statistics		60.2917 ***			308.3431 ***			215.6487 ***	

Note: \*\*\* indicates significance at the 1% level, \*\* significance at the 5% level, \* significance at the 10% level (the same below).

The second step of the EG-ADF test was to check whether the regression residuals were unit root processes. If the residual was a unit root process, then  $LnY$  and  $LnX$  did not have a long-term equilibrium. The ADF test results of the regression residuals are given in Table 4. The residual unit root test shows that under the condition of a 1% significant level, both regression residuals of the United States, China, and Brazil have unit roots, which are non-stationary processes. Therefore, there is no significant long-term equilibrium relationship between chicken product exports and economic growth in China, the United States, or Brazil. Since the first differenced log series are stationary from Table 2, here, we used regressions of the first differenced log series to describe the relationship between chicken product exports and economic growth rate. Table 5 shows that the growth rate of chicken product exports is significant with the economic growth rate for the United States; specifically, the economic growth rate increases 0.0861% if the growth rate of chicken product exports increases 1%. The impact of the growth rate of chicken product exports on the economic growth rate for Brazil (0.2064) is the largest among these three countries, but the significance level (0.1117) is a little bit greater than 0.1 and 0.05 (the usual significance levels we used). The magnitude of the impact in China is between the United States and Brazil.

**Table 4.** ADF test of residual errors of China, the United States, and Brazil.

ADF Test Statistic and <i>p</i> -Value	China		The United States		Brazil	
	Statistic	<i>p</i> -Value	Statistic	<i>p</i> -Value	Statistic	<i>p</i> -Value
ADF test statistic and <i>p</i> -Value	−0.608	0.8691	−2.271	0.1815	−2.181	0.2134
Critical value of the test	1% Significant level	−3.675	−3.675		−3.675	
	5% Significant level	−2.969	−2.969		−2.969	
	10% Significant level	−2.617	−2.617		−2.617	

**Table 5.** OLS regression results of the first differenced log series of China, the United States, and Brazil regression results of China and Brazil.

Variables	China			The United States			Brazil		
	Coefficient	Std.	<i>p</i> -Value	Coefficient	Std.	<i>p</i> -Value	Coefficient	Std.	<i>p</i> -Value
$\Delta LnX$	0.0967	0.0636	0.1372	0.0861	0.0435	0.0554	0.2064	0.1265	0.1117
AIC		−1.1400			−2.9386			−0.4846	
DW Statistics		0.4574			0.2055			1.6810	



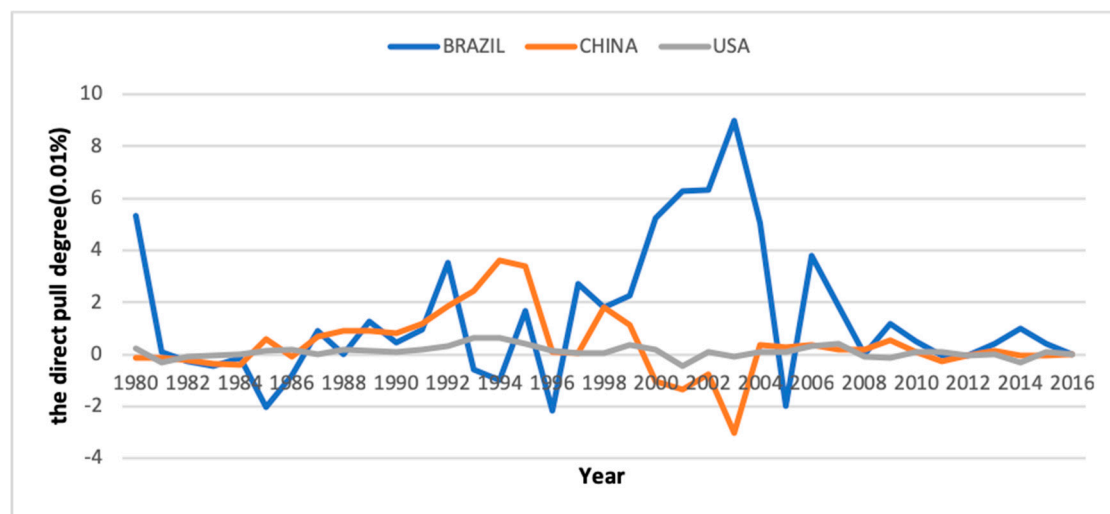
#### 4.2. Testing the Direct Pull Degree and Economic Growth Contribution Rate

The empirical analyses mentioned above consider whether chicken product exports could affect China, the United States, and Brazil in both the long and short term. The results indicate that the impact varies across countries. In this part, we used two estimators to quantify how strongly these agricultural product exports stimulate economic growth. According to the national income identity  $Y = C + I + G + (X - M)$  (of which  $Y$  indicates the national income,  $C$  means consumption,  $I$  indicates investment,  $G$  represents government budget,  $X$  is considered as exports, and  $M$  means imports), exports affect economic growth in two ways, both directly and indirectly. Export growth will directly lead to the growth of the national income. The direct impact is measured by the direct pull degree of exports on the national income. In accordance with the above ideas, we measured the impact of chicken product exports on GDP using: The direct pull degree of chicken products and incremental quantity of chicken products to economic growth = last year's GDP.

Due to the increase in exports, consumption, investments, and imports will be stimulated, which leads to an increase in national income. The economic growth contribution rate of exports can be defined as the contribution share of the direct pull degree in the economic growth rate. To quantify the contribution share of chicken product exports to economic growth, the formulae was designed as follows: Economic growth contribution rate of the direct pull degree of chicken product exports = growth speed of GDP.

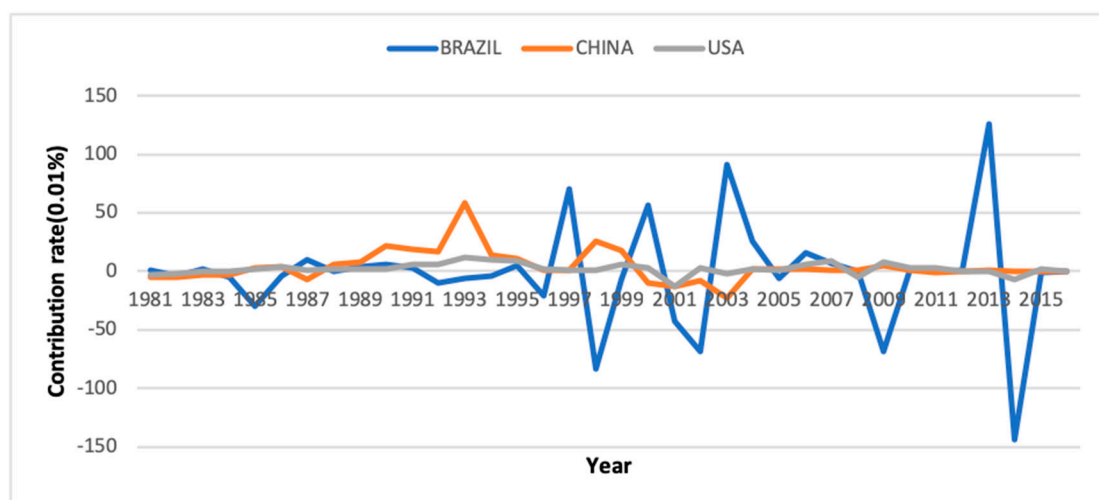
The calculation results are shown as follows.

Figure 4 shows that, first, for both China and the United States, the direct pull degree and economic growth contribution rate of chicken product exports are very small, and less volatile. Second, Brazil chicken product exports to economic growth of the direct pull degree fluctuates, and after 2002, the fluctuation is particularly evident.



**Figure 4.** The direct pull degree of chicken products to economic growth in China, the United States, and Brazil: 1980–2016.

Figure 5 indicates that first, the contribution rate of chicken products to economic growth is close to 0 and less volatile. Second, Brazil chicken product exports to economic growth has contributed to economic growth.



**Figure 5.** Contribution rates of chicken products to economic growth in China, the United States, and Brazil: 1980–2016.

Based on the above calculations, we found that China is 14 times the direct pull degree of the United States; however, its contribution to the economic growth rate is 8 times that of China. The direct pull degree and economic growth contribution of chicken product exports of Brazil fluctuates more often, and its direct pull degree is 0.25 times that of China, and the economic contributions to the growth of the rate are 1.65 times that of China.

## 5. Discussions

Several studies have found a significant contribution of agricultural exports, such as rice and fishing, to economic growth in some developing countries [35,36]. Results from the empirical analysis indicate that although China plays an important role in producing chicken products, it is far away from the United States and Brazil, which are two major global chicken product exporting countries, on the aspects of export quantity, export value, export varieties, or export countries and regions. The possible reasons are as follows: (1) China's domestic consumption of chicken increases fiercely with the enhanced purchasing power and counts for a large share of the world population. Therefore, chicken products must first serve the important and immediate domestic demands, which may diminish the number of chicken products for export; (2) the quality of China's chicken products is relatively backward. Due to the frequent outbreaks of avian influenza disease in recent years, concerns over food safety have generally increased. Global consumers are worried about being infected by the widespread and deadly disease, which may decrease the number of China's chicken products for export. Meanwhile, China's drug residue problem in chicken products has seriously affected the reputation of its exports. For a long time, due to the epidemic control and drug residues, the development of chicken products in China suffered setbacks. Exports of chicken products from China to the European Union, Japan, Malaysia, and so on were detected strictly and results confirmed that excessive drug residues existed. Because of that, China's chicken products were restricted and sealed off; (3) last but not least, with the expansion of the scope of foreign trade, many importing countries use technical barriers to limit trades on Chinese exports of chicken products to protect their own industries.

Results from co-integration analysis indicate that although the export of chicken products in these three largest chicken exporting countries has no long-term equilibrium relationship with national economic growth, the growth rate of chicken product exports positively affects the economic growth rate, but only significantly for the United States. The possible reasons are as follows: (1) The United States' chicken production is well known for its larger-scale and labor-intensive advantages, which differs from China's and Brazil's chicken-producing mode; (2) further development of export trade has a great

relationship with a country's ability to adjust to the industrial structure according to the comparative advantage of its own economy.

In this paper, we considered chicken product exports in relation to national income to estimate its impact on economic growth. To do this, we utilized the direct pull degree and economic growth contribution rate to estimate and compare China, the United States, and Brazil. By calculating the direct pull degree and contribution rate to the economic growth of China, the United States, and Brazil, we found that both indicators of the United States are very stable with small volatility while those of Brazil are positive and fluctuate a lot. China's direct pull degree and the contribution rate of the economic growth of chicken products are not high, which may be because the added value of the products is too low. Due to the high-density breeding mode, poor business management, and serious pollution, export of chicken products will be processed at the low end of the value chain. Science and technology are less used in chicken products and the output value of chicken production enterprises is not high. There are loads of small and medium enterprises and broiler farms, where production modes are rather raw and management levels are low, resulting in a low value of output per unit of labor.

Our findings are useful for business management and policymakers. In summary, we believe that in order to improve the quality of Chinese chicken products, more efforts should be made to change and upgrade the whole supply chain. To be more specific, first, policymakers should place greater emphasis on optimizing the mode of the breed, high efficiency, and less pollution. Therefore, strict control of high stocking density and small-scale farms and households is crucial. Second, education and sanitary conditions are often neglected. Joint efforts should be put into the promotion of education on properly using drugs, keeping production sites clean, and so on. Third, investments should be utilized to foster the new industry support and improve participation in large-scale and international chicken products enterprises. Fourth, it is urgent that a number of well-known chicken products brands are supported and established. In China, the construction of agricultural product brands is relatively weak. Although the risk of the implementation of agricultural product brands is high, both local and central governments should encourage and give certain preference to chicken production enterprises. Fifth, production for exports should be carefully inspected and examined by carrying out scientific and technological innovation in order to protect our reputation. Last but not least, we should protect our legitimate rights and interests and take some measures to deal with discriminatory quarantine measures applied on us by some importing countries.

## 6. Conclusions

By using the data ranging from 1980 to 2016 and describing the characteristics of chicken products, this paper examined whether such a kind of specific agricultural product could improve economic growth, exploring the nature of the causal relationship between agriculture exports and the economic growth of China, the United States, and Brazil. In recent decades, whether agricultural product exports could stimulate economic growth has been debated. While some contend that agricultural export development has contributed to stimulating the economy, others are strongly against this view and argue for a different path. Despite much debate and qualitative analyses of this topic, few empirical investigations on this issue exist.

Overall, because the real economic system is complex and nonlinear, the choice of the model and the estimation method may have a significant impact on the results. Thus, more econometric methods should be used to determine the impact of exports on economic growth. In this aspect, the model setting and estimation methods of this paper may not be ideal, so need to be further improved. Moreover, due to the mixed nature of current empirical results, the findings from this paper should not be generalized to all chicken producing and exporting countries. Our results suggest that caution should be taken before massive exports in agriculture. Future research on this issue could expand the methodological approach advocated in this study to a larger cross-section of countries, including Thailand, Japan, and so on. The limitations of this paper are twofold. One is that the data period is not

long enough. Another one is that we did not consider any other main variables that affect both chicken export and economic growth in our analysis. These are possible directions for further study.

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