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Research article

# Importance and share of agribusiness in the Chinese economy (2000–2014)

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A B S T R A C T

This paper analyzes the importance and share of agribusiness and its aggregates in the Chinese national economy in the context of economic growth observed in 2000–2014. Based on National Input-Output Tables (NIOT) data, the share of agribusiness in Gross Domestic Product (GDP), employment, and global output was found to have declined due to a decrease in the share of agriculture itself. Hence, the increase in agribusiness GDP was primarily driven by the supply-related aggregate. In turn, the food industry provided the greatest momentum for growth in global output of agribusiness. This research also found that the GDP of the agriculture-based aggregate had a large share in its global output. This means that compared to other sectors, agricultural production demonstrated low levels of direct material intensity, which is important from the perspective of material efficiency and sustainable development.

## 1. Introduction

The rapid development of emerging economies, especially China's, has triggered a shift in the global balance of power in international trade and in investment flows. The growing internationalization of the Chinese economy, driven by factors such as the implementation of the Go Out Policy in 1999 and joining the World Trade Organization in 2001, resulted in the Middle Kingdom becoming one of the world's leading economies (Guilhoto, 2004; Liu et al., 2016). The strengthening of China's economic position brings new challenges to developed countries who revise their international economic policies in an attempt to maintain their positions in the global market (Pawlak et al., 2016).

Agricultural development was of crucial importance to the development of the entire Chinese economy (Zhao and Tang, 2018). Since the launch of the Chinese economic reform in 1978, the popular communist system has been replaced by the household responsibility system. Agricultural production witnessed rapid growth, with a tenfold increase in rural per-capita incomes over a 20-year period (Quan and Liu, 2002). In the early 2000s, China entered a new stage of urban and rural development. As part of the reform for the national economy and farmers, the 2000 reform of rural taxes and fees was intended to reduce and simplify the burden on farmers. For instance, diverse types of fees and taxes were replaced with a single agricultural tax (Chen, 2009).

According to numerous researchers (e.g. Huang et al., 2013; Wang and Shen, 2014; Huang and Yang, 2017), the reform was intended to improve the quality of the agricultural sector and rural areas, and to increase the wealth of the farming population by introducing production payments while significantly alleviating the fiscal burden, and it has been delivering the expected results since the early 2000s. The proposed support systems improved access to sophisticated farming practices and contributed to restructuring the mix of inputs. As shown by a series of studies (e.g. Chen and Song, 2008; Yang et al., 2013; Pang et al., 2016; Zhao et al., 2017; Shen et al., 2018), the Chinese agricultural sector—especially in less developed regions—continues to enjoy considerable opportunities for development, particularly in increasing labor productivity and efficiency. Meanwhile, the share of the agricultural sector in the Chinese economy follows a downward trend (Zhao and Tang, 2018). However, insufficient analyses take account of agriculture in a broader context of agribusiness. According to Leones et al. (1994), the importance of agriculture to the national economy should be determined based on the role of agribusiness rather than on that of the agricultural production sector alone. This is explained in research findings that suggest that as countries develop, value adding economic activities at the pre- and post-farmgate levels are increasing, while decreasing at the farm production level (Cook and Chaddad, 2000).

As mentioned above, the economic development of China was and continues to be researched, including the role agriculture plays in it. However, there is a gap in research on the transformations in agribusiness. The analysis carried out by the authors is intended to bridge that gap. The purpose of this study is to determine the importance and share

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of agribusiness in the Chinese national economy in the context of economic growth observed in 2000–2014. This study examined the size and structure of the GDP, global output, and labor resources of agribusiness. The share of agribusiness in these figures was calculated at the national economy level.

Following this introduction, Section 2 reviews the relevant literature on agribusiness research and discusses the emerging problems. Section 3 presents the sources of data and the research methodology used; the topics discussed include the author's own method for calculating agribusiness GDP. Findings are presented and discussed in Section 4. Section 5 is a summary of the key conclusions from this study.

## 2. Literature review

### 2.1. A concept of agribusiness

The term "agribusiness" was first used by J.H. Davis in October 1955 at a conference held in Boston. In January 1956, he published a paper titled "From Agriculture to Agribusiness" (Davis, 1956). Ultimately, the concept of agribusiness was characterized and explained in detail one year later, in *A Concept of Agribusiness* (Davis and Goldberg, 1957). The authors emphasized the relationships between agriculture and other industries are more complex than anywhere else in the economy, which makes it difficult to track and quantify them accurately. To do this, Davis and Goldberg (1957) used the input–output model (I/O model) and cooperated with Wassily Leontief, its originator and author. His input–output tables (I/O tables) for the US economy allowed the authors to trace the relationships taking place in agribusiness. The analysis of inputs and outputs continues to be the sole accurate method for measuring the importance of agribusiness in the national economy, as it allows one trace the most complicated flows between the sectors (Miller and Blair, 2009).

According to the classical concept by Davis and Goldberg, agribusiness is "the total of all operations involved in the manufacture and distribution of farm supplies; production operations on the farm; and the storage, processing, and distribution of farm commodities and items made from them" (Davis and Goldberg, 1957). However, the authors themselves noted the problem of how to delimit appropriate aggregates that help analyze the interdependencies. Both farms and companies comprising the agribusiness can be grouped in various ways. In the initial concept, agribusiness was divided into three aggregates: farm supplies, agriculture, and processing and distribution of agricultural produce. Davis and Goldberg carried out an in-depth analysis of interdependencies and redefined the three aggregates to use as a reference for research findings, namely: agriculture, food processing, and fiber plants processing (at that time, these were believed to be the most important elements of agribusiness). They concluded that interdependencies in the agribusiness could be analyzed from different standpoints. Therefore, the appropriate selection of aggregates plays a crucial role in analyses based on the I/O model. Whether certain flows between production sectors are classed as components of agribusiness is also important. Obviously, this gives rise to doubts because no official statistics exist for that subsystem of the economy. Therefore, particular areas of agribusiness are interpreted in different ways by authors dealing with this topic.

### 2.2. Different measurement methods for and approaches to agribusiness

The relevant literature provides two main methods for estimating the size of agribusiness. The first one, proposed by Davis and Goldberg (1957) and detailed in a paper by Schluter et al. (1986), estimates the Gross National Product (GNP) of agribusiness by computing the influence coefficient for food and fiber sectors for the period not covered by the I/O tables published. However, this method assumes that the industrial linkage structures are fixed, even when the structure of agribusiness is changing, which is unrealistic (Yan et al., 2011). The second method, proposed by Furtuoso et al. (1998), allows one estimate the GDP of agribusiness directly based on I/O tables and relaxes the assumption of the first method. Furtuoso et al. (1998), proposed a division of agribusiness into four aggregates: a) inputs to agriculture: this includes the part of all sectors that supply products to agriculture; b) agriculture; c) agriculture-based industries: these include industries the most related to agriculture in terms of demand for its products; and d) final distribution, which estimates the share of agribusiness products in value added of Transportation, Commerce and Service sectors. That classification is also applicable to the structure of the food supply chain and was used to measure the size of agribusiness by several authors (Guilhoto, 2004; Xianhui and Yingheng, 2010; Yan et al., 2011; Moreira et al., 2016).

However, certain difficulties in using this classification emerge in the context of international benchmarking. This is especially true for the extraction of sectors comprising aggregate III (agriculture-based industries). Although, the demand for agricultural products in each sector varies from one country to another (and changes in function of development levels), the agribusiness measurement method considers the total value added of sectors classed as agriculture-based industries. Therefore, if the assessment considers all major sectors (the same in each country), it may result in revaluations. Conversely, if different sectors are identified in each country, this could result in understatements in relation to countries with a larger number of sectors (if a sector is not classed as an agriculture-based industry, it does not necessarily mean it does not require any agricultural produce at all; instead, it only means it requires agricultural produce in smaller quantities compared to its demand for products of other sectors). Similar problems might occur in the analysis of dynamics in a single country. That risk is probably smaller because the differences in interdependencies are greater between countries than between periods within one country. However, if a country experiences rapid economic development and the study period is relatively long, changes in links between sub-sectors of the economy may become important. In such cases, the problem of how to extract the sectors classed as agriculture-based industry is equally important as international comparisons are.

Wilkinson and Rocha (2009) state the food industry is the key sector related to agriculture, and its role becomes increasingly important as the population's incomes grow. Moreover, the food industry is inextricably linked to agriculture as its main supplier. Together, agriculture and the food industry are responsible for the entire production and processing of food. The conclusion from the above is that—considering the ability to make correct comparisons—the food industry should be extracted as a separate agribusiness aggregate. This is reflected in the concept of food economy, which has been developed since the late 1960s in socialist European countries (e.g. Strużek, 1969; Siwek, 1971; Zegar, 1973). In that concept, the key role to be played by agriculture, in broad terms, is to ensure enough food for the population. Hence, the most important sector—in addition to agriculture itself—is the food industry, whose role is strictly related to food. Woś (1979) also developed the concept of a food economy, and proposed that material and service inputs to the food sector be considered a component of agribusiness to emphasize that the food sector and agriculture are inseparable. In his concept, agribusiness was divided into three aggregates: a) supply of goods and services to the agriculture and food industry; b) agriculture; and c) food industry (for a detailed theoretical description of that agribusiness concept, see Poczta and Mrówczyńska-Kamińska, 2004). This became the basis for many other papers (e.g. Czyżewski & Mrówczyńska-Kamińska, 2021; Mrówczyńska-Kamińska and Poczta, 2013).

Other less commonly used methods for the identification and classification of agribusiness include van Leeuwen's (2000) estimate of the share of agribusiness in selected European economies, and Trejos et al., (2004) estimate of the share of agribusiness in North and South American economies. However, no studies address Chinese agribusiness from that perspective. Xianhui and Yingheng (2010) attempted to estimate the share of agribusiness in China's economy compared to the US's and Japan's economies. Yan et al. (2011) conducted interesting research based on Chinese regional I/O tables to explore the share of particular agribusiness aggregates in the economy. However, there are no papers which, instead of being limited to the share of agribusiness in the Chinese national economy, consider other factors such as employment, global output, or the relationships between them.

A concept similar to agribusiness is bioeconomy, it focuses in particular on the use of biomaterials. Also, the literature provides several different methods for measuring it (e.g. Vandermeulen et al., 2011). In a recent paper, Heijman (2016) proposed using input–output tables to divide the bioeconomy into 2 parts: part 1 of primary bio-based production consisting of agriculture, forestry, fishery, aquaculture and veterinary services; and part 2 of secondary bio-production, i.e. bio-business. Bio-business consists of the parts of all other sectors that use inputs from sectors of primary bio-based production. That approach is therefore similar to the concept of agribusiness. The main difference is that bioeconomy is a broader term because it takes into account more production sectors. Agribusiness focuses mainly on food products whereas bioeconomy addresses both food and non-food uses of biomaterials. On the methodological side, it encounters similar problems as it relies on the assumption that fixed relationships exist between sectors.

## 3. Methodology and data

All calculations were based on I/O tables retrieved from the World Input–Output Database (WIOD), Release 2016. Moreover, the labor data was retrieved from WIOD Socio-Economic Accounts which are satellite accounts to WIOD I/O tables. The advantage of WIOD is that, it publishes methodologically unified tables for each year of the 2000–2014 period. The tables are derived from the Supply and Use tables. Input–output tables for reference years, as published by the National Bureau of Statistics, are also used in the case of China (Timmer et al., 2016). When preparing the tables, emphasis is placed on data quality. Therefore, data values are consistent with official government statistics. In WIOD Release 2016, data for 56 sectors was classified as per the International Standard Industrial Classification revision 4 (ISIC Rev. 4). The tables adhere to the 2008 version of the System of National Accounts (SNA).

Labor data for China in WIOD Socio-Economic Accounts are estimated figures. The data construction follows a procedure by Wu and Yue (2010) in principle, and is based on detailed industry employment time series retrieved from various releases of the China Industrial Economic Statistics Yearbook by the Department of Industrial and Transportation Statistics, which is part of the National Bureau of Statistics (NBS). The estimation technique used largely solves the known problem of overestimation of agricultural employment in China's statistical accounts.

Slight differences emerge when comparing WIOD data on agricultural employment with estimates by Kwan et al. (2018) who tried to eliminate the problem of over-reported agricultural labor statistics. WIOD data for the period 2001–2013 is nearly 10% higher. On the other hand, NBS data is more than 45% higher. More information on the structure of the WIOD database can be found in publications by Erumban et al. (2012), Dietzenbacher et al. (2013), Timmer et al. (2015), and Timmer et al. (2016).

In accordance with Woś's (1979) proposal, three aggregates of agribusiness were identified: I: supply (product and service inputs from all sectors to agriculture and the food industry); II: agriculture-based aggregate; III: food-industry-based aggregate. As provided for in ISIC Rev. 4, agriculture is defined as sector A01: Crop and animal production, hunting and related service activities. In turn, the food industry is sectors C10–C12: Manufacture of food products, beverages, and tobacco products.

The GDP of agribusiness was calculated using a proprietary method, by modifying the one described by Furtuoso et al. (1998). The values for particular aggregates need to be summed up to calculate the GDP for the entire agribusiness:

$$GDP_{Agribusiness} = GDP_I + GDP_{II} + GDP_{III} \tag{1}$$

where:

$GDP_{Agribusiness}$ = Gross Domestic Product of agribusiness
$GDP_I$ = Gross Domestic Product of aggregate I
$GDP_{II}$ = Gross Domestic Product of aggregate II
$GDP_{III}$ = Gross Domestic Product of aggregate III

The first step in calculating GDP consists of determining the value added at producer prices in the I/O table. In accordance with SNA 2008, value added at producer prices is the total value added at basic prices plus net taxes on products, i.e.:

$$VA_{PP} = VA_{BP} + NT_{OP} \tag{2}$$

where:

$VA_{PP}$ = value added at producer prices
$VA_{BP}$ = value added at basic prices
$NT_{OP}$ = taxes less subsidies on products

To determine the GDP of aggregate I, the proportion of GDP of the different sectors that contribute to it needs to be calculated. To do this, the coefficients of value-added flows from different sectors ($CVA_i$) were determined and multiplied by the value of products and services (inputs) supplied by the corresponding sectors to agriculture ($z_{ia}$) and to the food industry ($z_{if}$), as retrieved from the I/O table. The flow of value added (which results from self-supply in the agriculture and food industry) was deducted from the amount calculated above in order to avoid double counting.

The coefficients of value-added flows for each sector were calculated by dividing value added at producer prices in the sector concerned by the corresponding output, i.e.:

$$CVA_i = VA_{PPi}/X_i \tag{3}$$

where:

$CVA_i$ = value added coefficient of sector $i$
$VA_{PPi}$ = value added at producer prices of sector $i$
$X_i$ = output of sector $i$

In accordance with what was described above, GDP for aggregate I was calculated as follows:

$$GDP_I = \sum_{i=1}^{n}(z_{ia} * CVA_i) + \sum_{i=1}^{n}(z_{if} * CVA_i) - (z_{aa} * CVA_a) - (z_{ff} * CVA_f) \tag{4}$$

$i$ = 1, 2, ..., n are the economic sectors.
where:

$z_{ia}$ = total input value of sector $i$ to the agriculture sector $a$
$z_{if}$ = total input value of sector $i$ to the food industry sector $f$
$z_{aa}$ = total input value of the agriculture sector $a$ to itself
$CVA_a$ = value added coefficient of the agriculture sector $a$
$z_{ff}$ = total input value of the food industry sector $f$ to itself
$CVA_f$ = value added coefficient of the food industry sector $f$

and other variables as previously defined.

The calculation of GDP for aggregate II boils down to determining agricultural value added at producer prices. Following this, to avoid double counting, agricultural value added delivered to the food industry (classed under the GDP of aggregate I) was deducted:

$$GDP_{II} = VA_{PPa} - z_{af} * CVA_a \tag{5}$$

where:

$VA_{PPa}$ = value added at producer prices of the agriculture sector $a$
$z_{af}$ = total input value of the agriculture sector $a$ to the food industry sector $f$

$CVA_a$ = value added coefficient of the agriculture sector $a$

and other variables as previously defined.

The GDP for aggregate III was calculated in a similar manner, as value added of the food industry at producer prices less value added delivered from the food industry to the agriculture (classed under the GDP of aggregate I):

$$GDP_{III} = VA_{PPf} - z_{fa} * CVA_f \quad (6)$$

where:

$VA_{PPf}$ = value added at producer prices of the food industry sector $f$
$z_{fa}$ = total input value of the food industry sector $f$ to the agriculture sector $a$
$CVA_f$ = value added coefficient of the food industry sector $f$

and other variables as previously defined.

A similar procedure was used to calculate agribusiness employment figures. For each sector, the number of persons engaged was assumed to be the labor force. Labor data was retrieved from WIOD Socio-Economic Accounts. First, the labor flow coefficients were determined for each sector:

$$CL_i = L_i / X_i \quad (7)$$

where:

$CL_i$ = labor coefficient of sector $i$
$L_i$ = number of persons engaged in sector $i$
$X_i$ = output of sector $i$

The next step was to calculate employment in aggregate I as the total of the labor flow coefficients multiplied by the corresponding product and service inputs to agriculture and the food industry. As was the case for GDP calculations, in order to avoid double counting, labor flows from agriculture to agriculture and from the food industry to the food industry were deducted because they are classed as employment in aggregate II and in aggregate III:

$$E_I = \sum_{i=1}^{n} (z_{ia} * CL_i) + \sum_{i=1}^{n} (z_{if} * CL_i) - (z_{aa} * CL_a) - (z_{ff} * CL_f) \quad (8)$$

$i$ = 1, 2, ..., n are the economic sectors.

where:

$E_I$ = employment of aggregate I
$CL_a$ = labor coefficient of the agriculture sector $a$
$CL_f$ = labor coefficient of the food industry sector $f$

and other variables as previously defined.

Employment in aggregate II was calculated as follows:

$$E_{II} = L_a - z_{af} * CL_a \quad (9)$$

where:

$E_{II}$ = employment of aggregate II
$L_a$ = number of persons engaged in the agriculture sector $a$

and other variables as previously defined.

In turn, employment in aggregate III was calculated as:

$$E_{III} = L_f - z_{fa} * CL_f \quad (10)$$

where:

$E_{III}$ = employment of aggregate III
$L_f$ = number of persons engaged in the food industry sector $f$

and other variables as previously defined.

Employment in agribusiness is calculated as the total employment in each of its aggregates:

$$E_{Agribusiness} = E_I + E_{II} + E_{III} \quad (11)$$

where:

$E_{Agribusiness}$ = employment of agribusiness

and other variables as previously defined.

Similar to GDP and employment, global output of agribusiness was also calculated as the total global output of each of its aggregates:

$$X_{Agribusiness} = X_I + X_{II} + X_{III} \quad (12)$$

where:

$X_{Agribusiness}$ = output of agribusiness
$X_I$ = output of aggregate I
$X_{II}$ = output of aggregate II
$X_{III}$ = output of aggregate III

Global output of aggregate I was calculated as the total intermediate consumption in agriculture and the food industry. The value of self-supply was deducted from the total in order to avoid double counting:

$$X_I = IC_a + IC_f - z_{aa} - z_{ff} \quad (13)$$

where:

$IC_a$ = intermediate consumption of the agriculture sector $a$
$IC_f$ = intermediate consumption of the food industry sector $f$

and other variables as previously defined.

In turn, global output of aggregate II is the global output of agriculture less the value of inputs from agriculture to the food industry (classed as global output of aggregate I):

$$X_{II} = X_a - z_{af} \quad (14)$$

where:

$X_a$ = output of the agriculture sector $a$

and other variables as previously defined.

Similarly, global output of aggregate III is the difference between the global output of the food industry and the input from the food industry to agriculture (classed as global output of aggregate I):

$$X_{III} = X_f - z_{fa} \quad (15)$$

where:

$X_f$ = output of the food industry sector $f$

and other variables as previously defined.

## 4. Results and discussion

### 4.1. Agribusiness GDP

The economic growth experienced in China in 2000–2014 resulted in a more than 8.5 times increase in GDP in current prices (from less than USD 1.2 trillion to over USD 10 trillion) (Table 1). The GDP of the entire

**Table 1**
Agribusiness GDP (current prices, USD million) and share in the Chinese national economy in 2000, 2005, 2010, and 2014.

| Aggregates | 2000 | | |
|---|---|---|---|
| | Value | Aggregate share (%) in agribusiness GDP | Aggregate share (%) in Chinese GDP |
| Aggregate I (supply) | 63,374 | 28.0 | 5.3 |
| Aggregate II (agriculture-based) | 121,049 | 53.4 | 10.1 |
| Aggregate III (food-industry-based) | 42,204 | 18.6 | 3.5 |
| Agribusiness | 226,627 | 100.0 | 18.9 |
| GDP | 1,198,452 | | 100.0 |
| **Aggregates** | **2005** | | |
| | Value | Aggregate share (%) in agribusiness GDP | Aggregate share (%) in Chinese GDP |
| Aggregate I (supply) | 119,089 | 32.7 | 5.3 |
| Aggregate II (agriculture-based) | 170,117 | 46.6 | 7.5 |
| Aggregate III (food-industry-based) | 75,488 | 20.7 | 3.3 |
| Agribusiness | 364,694 | 100.0 | 16.2 |
| GDP | 2,257,161 | | 100.0 |
| **Aggregates** | **2010** | | |
| | Value | Aggregate share (%) in agribusiness GDP | Aggregate share (%) in Chinese GDP |
| Aggregate I (supply) | 336,617 | 38.8 | 5.7 |
| Aggregate II (agriculture-based) | 325,304 | 37.5 | 5.5 |
| Aggregate III (food-industry-based) | 205,779 | 23.7 | 3.5 |
| Agribusiness | 867,700 | 100.0 | 14.6 |
| GDP | 5,931,147 | | 100.0 |
| **Aggregates** | **2014** | | |
| | Value | Aggregate share (%) in agribusiness GDP | Aggregate share (%) in Chinese GDP |
| Aggregate I (supply) | 612,155 | 41.1 | 6.0 |
| Aggregate II (agriculture-based) | 499,143 | 33.5 | 4.9 |
| Aggregate III (food-industry-based) | 377,320 | 25.3 | 3.7 |
| Agribusiness | 1,488,618 | 100.0 | 14.5 |
| GDP | 10,283,983 | | 100.0 |

Source: Authors' calculation based on the World Input–Output Database

agribusiness rose more than 6.5 times in the same period, which is equally impressive. Between 2000 and 2014, GDP increased nearly 9.5 times in aggregate I (supply) and nearly 9 times in aggregate III (food-industry-based aggregate), from over USD 200 billion to almost USD 1.5 trillion; all this contributed to the growth rates mentioned above. The slowest growth across the entire agribusiness was recorded in aggregate II (agriculture-based aggregate) with GDP moving from over USD 120 trillion in 2000 to nearly USD 500 billion in 2014.

Due to uneven growth in its different aggregates, Chinese agribusiness underwent a transformation of its internal structure. Between 2000 and 2005, there was already a clear decline in the contribution of agriculture to agribusiness with a simultaneous increase in the share of aggregates III and I. That trend continued in both 2010 and 2014. These changes are consistent with patterns observed in other countries around the world (Cook and Chaddad, 2000; Mrówczyńska-Kamińska and Poczta, 2013). Also, in 2000–2014, there was a clear decline in the contribution of aggregate II to the total GDP of the Chinese economy (from over 10% to less than 5%). This also translated into a decreasing share of the entire agribusiness in total GDP (from nearly 19% in 2000 to 14.5% in 2014).

Based on these findings, it may be concluded that the share of agribusiness in the economy behaves similarly to the share of agriculture in the economy, which means it decreases as the economy grows. Note, however, that the share of agribusiness in the Chinese GDP follows a downward trend only because of the declining share of agriculture itself. This can be concluded from the fact that the GDP of aggregates I and III had a stable share in total GDP of the Chinese economy throughout the study period. When comparing the figures between 2000 and 2014, a clear increase can be seen in the share of GDP of these aggregates in the national economy. Though relatively constant between 2000 and 2005, their share increased in 2010 and 2014. The share of GDP of aggregate I rose from 5.3% in 2005 to 6% in 2014; the corresponding figures for aggregate III are 3.3% and 3.7%.

The decline in the share of the GDP of aggregate II and the simultaneous increase in the share of the GDP of aggregates I and III were the reasons for the share of the GDP of the entire Chinese agribusiness in 2014 remaining at a level similar to that recorded in 2010. These findings are consistent with a pattern well known in economic theory: as the economy grows, the share of agriculture in the national economy declines. Production moves from agriculture to other sectors, i.e. industry and services (Kuznets, 1973).

The constant share of the GDP of aggregate III in total GDP is related to changes that took place over the years in Chinese food consumption trends. The first important observation is the increase in the consumption of processed products (Reardon et al., 2012; Zhou et al., 2015), which require greater involvement of the food industry in the production process.

Of importance too, is the increase in the consumption of food away from home (FAFH) with a simultaneous decline in the consumption of food at home (FAH) (Ma et al., 2006; Bai et al., 2016). This trend is forecast to continue in the years to come (Zheng et al., 2018). This is likely to result in a constant (if not increasing) share of the GDP of aggregate III in the economy.

The main reason behind changes in food consumption is believed to be the increase in the Chinese population's incomes. Changes in incomes have resulted in a smaller share of cereal products and vegetables and an increasing share of animal products in the population's diet.

Another general conclusion is that product consumption is becoming more diversified (Yuan et al., 2019). The above changes correspond to what is known in the literature as Bennet's law, which suggests that as their income grows, consumers shift from low-quality food (especially starchy food) to higher-value food products. These developments have been taking place in Asia since the late 1990s and early 2000s (Fuglie, 2004). The shift takes place primarily in cities and is much slower among the rural population. This is because, especially in cities, there is a growing number of wealthy middle-class consumers. They are largely the ones who might be willing to change their diet to make it similar to what is commonplace in rich Western countries (where many more processed products are consumed) (Pingali, 2007; Bai et al., 2014).

The trends presented above suggest that the share of the food industry in the Chinese national economy will not drop in the coming years; therefore, neither will the share of the GDP of aggregate III of agribusiness in the total GDP.

When considering the entire study period (2000–2014) (Fig. 1), the conclusion is that, the share of aggregate I in the Chinese economy follows an upward trend. This reflects the growing importance of industries and services directly related to agriculture and the food industry for the entire agribusiness. The share of aggregate II in the economy followed a clear downward trend, which is the consequence of development patterns discussed earlier. In turn, the share of aggregate III in the economy showed neither an upward nor downward trend and may therefore be concluded to have remained at a near-constant level throughout the

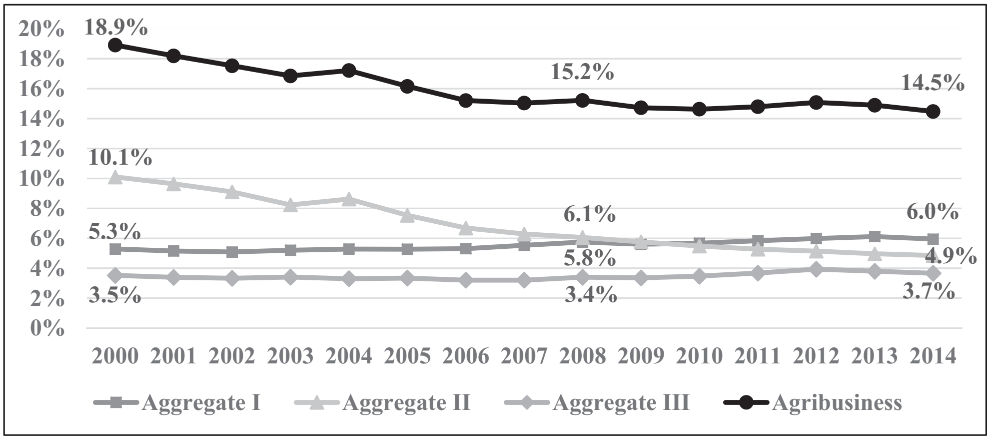


**Fig. 1.** Share of GDP of agribusiness and its aggregates in Chinese GDP in 2000–2014. Source: Authors' calculation based on the World Input–Output Database.

study period (from 3.2% to 3.9%).

As mentioned before, the share of the GDP of the entire agribusiness in the Chinese GDP followed a trend like that of the share of aggregate II. However, the analysis of the entire study period reveals that the correlation between them weakened over time. For instance, in 2008, the share of aggregate II in the total GDP was observed to go down, whereas the share of the entire agribusiness moved up due to an increase in the share of aggregates I and III. The situation was similar in 2011 and 2012. Obviously, this is a perfectly reasonable consequence of the slowdown in the decline of the share of aggregate II in the total GDP and, mostly, of the decreasing share of aggregate II in the agribusiness GDP (Table 1). Note, however, that this is why in the future, the transformation in aggregates I and III will become of greater importance for the share of agribusiness in the total Chinese GDP than it is now. Thus, Chinese agribusiness evolved from a mostly agricultural subsystem to one where the food industry, and other sub-sectors only indirectly related to agriculture and food processing, play an important role.

### *4.2. Agribusiness employment*

Similar changes, though faster than in the case of GDP, can be observed in agribusiness employment. In 2000, the share of agribusiness employment was over 40% of total employment in the economy. In 2014, it was already below 25% (Table 2). Such a rapid decrease was caused by the decline in employment in aggregate II: from nearly 220 million working in aggregate II in 2000 declining to slightly over 100 million in 2014, representing 30.4% and 12.1% of total employment in the economy, respectively.

The release of a large part of labor force employed in agriculture is a necessary condition for economic growth in developing countries (Démurger and Xu, 2015). Hence, considering that the Chinese economy grew rapidly over the study period, the sharp decline in employment in aggregate II comes as no surprise.

Some researchers emphasize that the transfer alone of labor force from agriculture, which exhibits relatively low levels of productivity, to a more productive industry is a driver of development. In the literature, this is usually referred to as the structural bonus (Timmer and Szirmai, 2000; Temple and Woessmann, 2006; Szirmai, 2012).

Even though employment in aggregate II goes down rapidly, it continues to be the largest of all the agribusiness aggregates. However, there is a reduction in the difference in employment between aggregate II and aggregate I. Over the study period, employment in aggregate I fluctuated, with the shares in total employment reaching higher levels in 2005 and 2010 than in 2000 and 2014. When it comes to aggregate III, a considerable increase in employment can be observed between 2005 and 2014. In that period, employment figures grew by over 5.5 million (a growth rate of ca. 58%). Consequently, the share of aggregate III employment in total agribusiness employment rose significantly from 3.6% to over 7%. This was accompanied by a growth in the share of aggregate III employment in total employment in the Chinese economy.

The summary of GDP and employment figures (Tables 1 and 2) shows that of all agribusiness aggregates, aggregate III certainly exhibits the highest labor productivity, defined as the GDP/employment ratio. This is related to high labor productivity in the food industry. As the Chinese economy grew, so did labor productivity in other aggregates of agribusiness. However, it remains clearly below the level recorded in aggregate III.

Los et al. (2015) found that international demand was an important driver of employment in China in 2001–2006. However, it primarily resulted in creating new jobs for people with basic schooling. For instance, Sasahara (2019) shows a clear positive correlation between the increase in international demand and the creation of jobs in the textile industry, which is highly labor-intensive and has a large share in total Chinese exports. A similar analysis was carried out on natural raw materials and services but failed to conclusively identify a relationship between them.

Los et al. (2015) indicate that domestic demand has contributed much more to the creation of new jobs in China than international demand has since 2006. This seems to be a good explanation for the fact that an increase in employment in aggregate III of agribusiness was observed only from 2005 onwards, because that aggregate is largely based on capital productivity and a skilled workforce.

According to Brondino (2019), in 1995–2009, the entire Chinese economy witnessed a positive correlation between demand and employment. The largest increase in employment was experienced in high and medium-high technology industries, which also recorded the highest growth in demand accompanied by rapid improvements in labor productivity and efficiency. At the other end of the spectrum, agriculture faced constant demands for its products and a drop in employment figures. Obviously, agricultural labor productivity grew because a smaller workforce is needed to ensure adequate production volumes.

Rapid market changes, that is, industrialization and urbanization, were enabled by several factors, including the high mobility of labor within the Chinese territory. According to Qi et al. (2019), migration from rural to urban areas increased from 30 million in the late 1980s to 130 million in 2006, 220 million in 2010, and over 280 million in 2016. The main reason behind this migration was the disparity between urban and rural development, which widened after the 1978 economic reform (Kanbur and Zhang, 2012). In China, cities are much more economically developed than rural areas are, and the average household income of the rural population is much lower than that of urban dwellers (Xie and Zhou, 2014).

Another important factor impacting employment is China's hukou (household registration) system that divides the population into two unequal groups: privileged urban residents and the legally disadvantaged rural population. Introduced in the era of a centrally planned economy, the system was supposed to restrict large groups of the rural population

**Table 2**
Agribusiness employment and its share in the Chinese national economy in 2000, 2005, 2010, and 2014 (thousand people).

| Aggregates | 2000 | | |
|---|---|---|---|
| | Value | Aggregate share (%) in agribusiness employment | Aggregate share (%) in Chinese employment |
| Aggregate I (supply) | 64,725 | 22.0 | 9.0 |
| Aggregate II (agriculture-based) | 218,676 | 74.4 | 30.4 |
| Aggregate III (food-industry-based) | 10,501 | 3.6 | 1.5 |
| Agribusiness | 293,901 | 100.0 | 40.8 |
| Employment | 719,604 | | 100.0 |
| **Aggregates** | **2005** | | |
| | Value | Aggregate share (%) in agribusiness employment | Aggregate share (%) in Chinese employment |
| Aggregate I (supply) | 84,247 | 30.3 | 11.1 |
| Aggregate II (agriculture-based) | 184,095 | 66.3 | 24.2 |
| Aggregate III (food-industry-based) | 9,488 | 3.4 | 1.2 |
| Agribusiness | 277,830 | 100.0 | 36.6 |
| Employment | 759,770 | | 100.0 |
| **Aggregates** | **2010** | | |
| | Value | Aggregate share (%) in agribusiness employment | Aggregate share (%) in Chinese employment |
| Aggregate I (supply) | 98,457 | 40.1 | 12.5 |
| Aggregate II (agriculture-based) | 135,763 | 55.3 | 17.3 |
| Aggregate III (food-industry-based) | 11,295 | 4.6 | 1.4 |
| Agribusiness | 245,515 | 100.0 | 31.3 |
| Employment | 784,663 | | 100.0 |
| **Aggregates** | **2014** | | |
| | Value | Aggregate share (%) in agribusiness employment | Aggregate share (%) in Chinese employment |
| Aggregate I (supply) | 93,977 | 44.1 | 10.9 |
| Aggregate II (agriculture-based) | 104,069 | 48.8 | 12.1 |
| Aggregate III (food-industry-based) | 15 026 | 7.1 | 1.8 |
| Agribusiness | 213,072 | 100.0 | 24.8 |
| Employment | 858,367 | | 100.0 |

Source: Authors' calculation based on the World Input–Output Database.

**Table 3**
Global output of agribusiness (current basic prices, USD million) and its share in the Chinese national economy in 2000, 2005, 2010, and 2014.

| Aggregates | 2000 | | |
|---|---|---|---|
| | Value | Aggregate share (%) in agribusiness output | Aggregate share (%) in Chinese output |
| Aggregate I (supply) | 147,496 | 29.9 | 4.5 |
| Aggregate II (agriculture-based) | 211,232 | 42.8 | 6.5 |
| Aggregate III (food-industry-based) | 134,551 | 27.3 | 4.1 |
| Agribusiness | 493,279 | 100.0 | 15.2 |
| Output | 3,253,016 | | 100.0 |
| **Aggregates** | **2005** | | |
| | Value | Aggregate share (%) in agribusiness output | Aggregate share (%) in Chinese output |
| Aggregate I (supply) | 274,268 | 32.6 | 4.1 |
| Aggregate II (agriculture-based) | 294,823 | 35.0 | 4.4 |
| Aggregate III (food-industry-based) | 272,700 | 32.4 | 4.1 |
| Agribusiness | 841,792 | 100.0 | 12.6 |
| Output | 6,707,047 | | 100.0 |
| **Aggregates** | **2010** | | |
| | Value | Aggregate share (%) in agribusiness output | Aggregate share (%) in Chinese output |
| Aggregate I (supply) | 738,053 | 34.3 | 4.1 |
| Aggregate II (agriculture-based) | 558,179 | 25.9 | 3.1 |
| Aggregate III (food-industry-based) | 856,123 | 39.8 | 4.7 |
| Agribusiness | 2,152,355 | 100.0 | 11.9 |
| Output | 18,053,714 | | 100.0 |
| **Aggregates** | **2014** | | |
| | Value | Aggregate share (%) in agribusiness output | Aggregate share (%) in Chinese output |
| Aggregate I (supply) | 1,332,871 | 34.6 | 4.2 |
| Aggregate II (agriculture-based) | 855,575 | 22.2 | 2.7 |
| Aggregate III (food-industry-based) | 1,659,287 | 43.1 | 5.2 |
| Agribusiness | 3,847,733 | 100.0 | 12.1 |
| Output | 31,745,102 | | 100.0 |

Source: Authors' calculation based on the World Input–Output Database.

from moving to urban areas. However, it has been relaxed under subsequent market reforms (Hao and Tang, 2015). But even today, depending on their (urban or rural) hukou, the population may access totally different public services and public aid (Liu, 2005; Park and Wang, 2010; Fu and Ren, 2010; Yang, 2014). The eligibility for urban hukou certainly encourages a large part of the population to seek employment in cities (Hao and Tang, 2015). Another question is, how much the rural population wants to seize that opportunity[1].

Since the late 1990s, more and more Chinese migrants have moved back from urban to rural areas for various reasons (Liang et al., 2014). An important finding from the perspective of employment is that compared to non-migrants, these “homecomers” tend to seek jobs outside agriculture more frequently, even if they have previous experience in that sector (Chunyu et al., 2013). Recently, rural development and some aid measures taken by the government, such as the emergence of e-commerce agribusiness clusters (Taobao villages), have brought more opportunities for starting a non-agricultural business in rural areas. Previously, the homecomers struggled to find employment in the underdeveloped industrial and service sectors in rural areas, and ended up taking an agricultural job (Zhao, 2002; Chen and Wang, 2019). Non-agricultural employment opportunities were of importance during the 2008 global financial crisis, which resulted in some domestic migrants losing their urban jobs, mainly because of the decline in exports demand; many

[1] Many studies additionally suggest that certain factors exist that make some of the rural population unwilling to convert to urban hukou (for a review, see Hao and Tang, 2015).

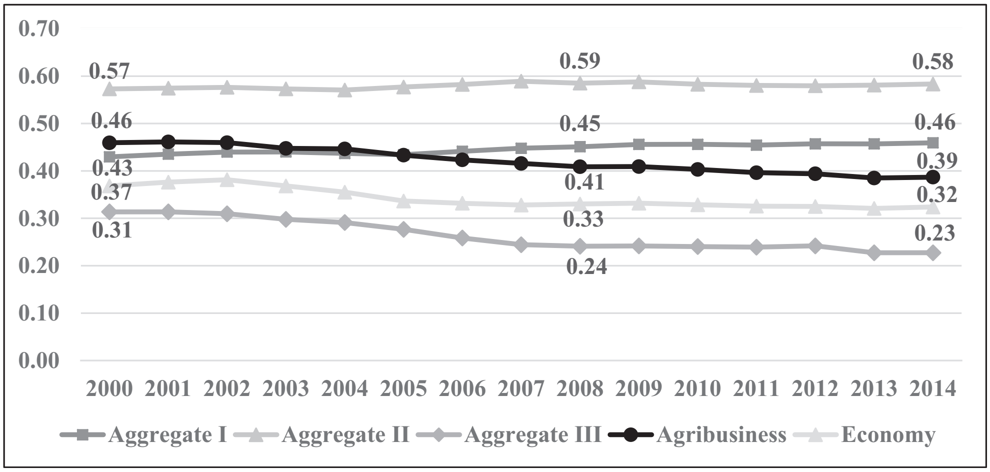


**Fig. 2.** Ratio of GDP to global output in China in 2000–2014. Source: Authors' calculation based on the World Input–Output Database.

decided to go back home (Chan, 2010; Qi et al., 2019).

Another important issue is surplus agricultural labor, also referred to as "inefficient labor" or "redundant labor" in the literature. It means the difference between labor requirement and agricultural labor. Thus, it indicates the proportion of labor force employed in agriculture which could be released to other sectors. While some studies reveal a high absolute size of surplus labor in China (e.g. Kwan et al., 2013), this is partially because the official statistics overestimate the employment rate in agriculture. In a study by Kwan et al. (2018) who tried to eliminate the problem of over-reported agricultural labor statistics, the surplus varies in the range of 18%–12% of agricultural labor between 2001 and 2013. Although it decreases over time, it remains significant. It should be assumed that if the surplus labor were released to other sectors, the share of agriculture and agribusiness in employment would clearly decrease.

The transformation of the labor market discussed above clearly demonstrates that China is shifting from an economy based on agricultural employment towards one where industrial and service sectors play a stronger role. Hence, although total employment in agribusiness goes down (Table 2), this is caused by a decline in employment figures only in aggregate II (the agriculture-based aggregate). Employment in aggregates I and III followed an upward trend over the study period. Obviously, there was a noticeable decrease in employment in aggregate I (and in its share in total employment) in 2014 (Table 2). This was mainly caused by the progressive decrease in the labor coefficient representing labor inputs from other sectors to agriculture and the food industry. This is related to the growing role of other sectors, especially the high and medium-high technology industries mentioned earlier in this paper. In China, they are considered to be the main driver of economic growth and are among the areas strongly supported under government policies (Mao et al., 2017).

### 4.3. *Agribusiness output and its relation to GDP*

Just as in the case of GDP and employment, the study period witnessed a decline in the share of agribusiness in global output (Table 3). This was mainly caused by the decreasing share of aggregate II from 6.5% in 2000 to 2.7% in 2014. However, as regards aggregates I and III, the changes in their share in both agribusiness and the entire economy took place at a different pace. The share of aggregate III in the global output of agribusiness rose from ca. 27% in 2000 (the lowest level of all aggregates) to over 43% in 2014 (the highest level). This translated into a growing share in the global output of the entire economy (to more than 5% in 2014). Aggregate I had a constant share in global output, at a level of ca. 4% throughout the study period.

Global output is determined not by value added alone but also by intermediate consumption, which is the very difference between the GDP figures presented in Table 1 and the global output values (Table 3). The above leads to the conclusion that the food industry, as the main component of aggregate III, is much more material-intensive than the other agribusiness components are. This makes it less resource-efficient (it delivers a smaller output per unit input) (Allwood et al., 2011)[2].

According to Song et al. (2019), in 2002–2012, China witnessed an increase in the share of the processing sector and a decrease in the share of agriculture in energy consumed by the national food production chain. Another factor of great importance is the shift in food consumption trends, which, as mentioned in 4.1., results in greater consumption of more processed products whose production requires greater intermediate consumption, including energy consumption.

Fig. 2 presents the ratio of GDP to global output, which is sometimes referred to in the literature as the profitability ratio or the macroeconomic efficiency index (Mrówczyńska-Kamińska, 2009). In that sense, the above ratio together with the coefficient of direct material intensity (i.e. the ratio between intermediate consumption and global output) can be interpreted as percentages because they sum up to 1. In the entire agribusiness, GDP per unit global output follows a downward trend, primarily because of a decline in aggregate III. Similar developments take place in the entire Chinese economy. In turn, the values of that ratio confirm that aggregate II of agribusiness has a higher macroeconomic efficiency, which remained at a near-constant level throughout the study period (Fig. 2).

As mentioned earlier, intermediate consumption has a considerable impact on that ratio. Chinese agriculture is mostly labor-intensive (Chen and Wang, 2019), and therefore its output can grow despite the lack of a relative increase in inputs. This situation can change as the economy grows. The above is evidenced by research carried out in the European Union by Baer-Nawrocka and Mrówczyńska-Kamińska (2019); the material intensity ratio of agriculture was observed to increase in highly developed countries, whereas other less developed countries were like China in that respect (i.e. reported a near-constant level or a decline). This seems to be related to the release of labor from agriculture to other sectors, a process which has already come to an end in highly developed countries. Therefore, agriculture has no other option but to become less labor-intensive, and greater material inputs are required in order to increase agricultural output. Conversely, in less developed countries, agriculture is mostly labor-intensive and has a greater share in total employment in the economy than it does in more developed countries.

Things look different in the more capital-intensive food industry. Consequently, large material inputs result in reducing the profitability ratio presented above. Another observation is that employment in

[2] An interesting discussion on input productivity can be found in a publication by Baptist and Hepburn (2013).

aggregate III followed an upward trend in China over the study period (Table 2). This is indicative of a shortage rather than a surplus of labor, which can be observed in aggregate II.

In 2000–2014, the profitability ratio was observed to follow a downward trend in the entire Chinese economy. Considering the relationships and facts referred to above, it must be stated that they are caused by the rapid development of material-intensive sectors, which include high and medium-high technology industries supported under government policies. At the same time, there was a noticeable improvement in the macroeconomic efficiency of aggregate I, which means that most goods and services are supplied to agriculture and the food industry from sectors that are relatively less material-intense than the average for the entire economy.

## 5. Concluding remarks

This study focused on the changing role of agricultural production in the rapidly developing Chinese economy. The proposed approach analyzes the changes in the entire agribusiness and its aggregates instead of focusing only on agriculture. The study spanned the period from 2000 to 2014 and was based on an ex-post input–output analysis. In that period, China experienced strong economic growth that led to considerable changes in the phenomena concerned.

As the entire agribusiness was covered by the study, one can conclude that its share in output and employment follows a downward trend due to a considerable decline in the share of agriculture. In the study period, the GDP of agribusiness grew mainly because of the increase in GDP in the supply aggregate. In turn, the global output of agribusiness was most positively affected by the food industry. Also, while agricultural labor was observed to rapidly move to other sectors, it did not entail an increase in the material intensity of agriculture, which remains highly efficient in the use of materials (this is an important element of sustainable development).

It should be emphasized that the agribusiness measurement method used in this study is not the only one available. Just like any other method, it only estimates the values of agribusiness output and employment. However, the authors believe this method provides a more complete picture of the key function of agribusiness, which is the production of food from the harvesting of raw materials through to serving food on the table. Carrying out a more detailed analysis of supply or extending the research with final demand for agribusiness products would be a valuable enhancement.

## Declarations

### *Author contribution statement*

Bartlomiej Bajan, Aldona Mrówczyńska-Kamińska: Conceived and designed the experiments; Analyzed and interpreted the data; Wrote the paper.

### *Competing interest statement*

The authors declare no conflict of interest.

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### *Additional information*

No additional information is available for this paper.

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