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Dynamic Changes in the Structure and Concentration of the International Grain Trading Industry

William W Wilson
David Bullock
Isaac Dubovoy

Department of Agribusiness and Applied Economics
Agricultural Experiment Station
North Dakota State University
Fargo, ND 58108-6050

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Abstract

The international grain trading industry has a long history with varying documentation from the 1970s, including the Russian grain deal, into the 1980s, to more recent books and reports, to now, including Russian grain trading and optionality as a strategy for commodity trading firms. While many of these studies sought to explain the mystique surrounding the international grain trading industry, many are descriptive and/or refer to other studies. It is frequently claimed that the international grain trading industry is highly concentrated and controls 80% or more of world trade. Limited data is provided to support this claim or to suggest any geographical, temporal, or sectoral differences. None of these publications refers to the emerging competitive fringe firms, including but not limited to CHS, Glencore, Viterra, Olam, Wilmar, COFCO, Gavilon (now 100% part of Viterra), Soufflet (Invivo), Nibulon, etc., as well as the emerging Russian grain trading firms.

The purpose of this paper is to document the evolution of firm and industry strategies and to analyze detailed data on the structure of the international grain trading industry and to Specifically, data is developed from vessel nominations, and these were used to 1) analyze measures of concentration, 2) determine how these change across selected geographies and commodities, and 3) determine the composition of a cluster of firms in this industry. The results provide fresh documentation on the structure and concentration in the world grain trading industry. The results indicate that the levels of concentration are much less than traditionally suggested, there has been growth by many new entrants making up a viable competitive fringe, the industry seems to be comprised of three clusters of firms, and generally, competition in this industry would be characterized as being “fierce.”

Table of Contents

List of Tables

List of Figures

Dynamic Changes in the Structure and Concentration of the International Grain Trading Industry[1]

Introduction

The international grain trading industry has undergone significant and rapid changes over the past five decades, leading to a lack of comprehensive understanding of its current structure. Historically, the industry was dominated by private firms and heavily influenced by government interventions. However, it has transitioned into a more public domain with an increased number of firms and evolving government impacts. During the 1980s, the Export Enhancement Program (EEP) severed the traditional relationship between buyers and sellers. In recent years, notable shifts have occurred in the industry's landscape, the emergence of a viable competitive fringe, the rise of trading firms in China and Russia, and extensive geopolitical interventions resulting in embargoes and trade-related taxes. These factors have increased volatility in futures, basis, and shipping costs, and have resulted in volatile margins and distorted trade flows.

This study aims to analyze comprehensive data about the structure of the international grain trading industry and document the evolutionary patterns of firm and industry strategies. Specifically, we utilize data on vessel nominations to 1) analyze concentration measures, 2) assess how these measures vary across different geographical locations and commodities, and 3) determine the composition of clusters of firms within the industry. The results of this study offer fresh insights into the structure and concentration of the global grain trading industry, presenting a departure from existing literature and providing a more comprehensive depiction of the industry's organizational framework.

Background and Previous Studies

International grain trading is an old industry that has been undergoing radical changes for the past 50 years. There have been major changes in agriculture and policies, changes in factors impacting economies of scale, and an evolving international market environment. Partly in response to these changes, firm strategies have changed. As a result of these changes, the market structure of this industry has changed.

An escalation in the importance of an evolving competitive fringe has impacted the market structure for this industry. That segment includes many smaller firms, which is important for countervailing market power. The emergence and growth of COFCO have also impacted the market structure; a major Chinese grain trading firm is charged with importing a share of Chinese imports. However, COFCO has expanded beyond this role in many areas of international grain trading. The radical changes in

[1] This report is a summary of Wilson, Bullock and Dubovoy (2025a and 2025b). That report provides more detail on previous studies, strategies, new entrants, as well as more details on data and results.

Ukraine and Russian grain trading firms have also impacted the industry. The latter have increased their share, and Western firms have mostly exited that market.

Strategies for grain trading firms have also evolved. Historically, economies of international grain trading were primarily due to large-scale and onerous information requirements. Each of these had high fixed costs, which ultimately precluded entry. During the 1990s, optionality became important in part as a way to exploit black swan events. Since then, multi-origin strategies have become important and nearly essential to serve customers wanting relationships with suppliers capable of multiple origins. Hence, grain trading firms became 'masters of optionality.' During the past two decades, the industry has confronted changes in interior shipping mechanisms, ultimately inducing vertical integration and value-added strategies. The escalation in volatility in futures, basis, shipping costs, and margins has made risk measurement and management more essential. Finally, in recent years, the geopolitical pressures, exacerbated by shortages and climate problems, have resulted in more governmental intervention, which has distorted trade patterns and worsened volatility.

New Entrants and Growth of Competitive Fringe: The origins of the international grain trade were traced to Ancient Greece and Rome, including the inception of many important features of the modern trade (Atkin, 1992). The early major firms in the modern international grain trading were Andre, Bunge, Cargill, Continental, Dreyfus, and Cook. Each was a large, private, family-controlled corporation. Over time, some of these exited, others were acquired or became insolvent, and the remaining ABCDs (ADM, Bunge, Cargill, Dreyfus) came to be more subject to either public ownership or financial disclosure in varying means (e.g., as public stock-held firms, ESOPs, etc.). In addition to this structural change, numerous firms entered the international grain trading industry. These new entrants and others ultimately form the competitive fringe of firms in international grain trading.

Two significant additions to the above relate to the entry and/or expansion of trading for Chinese imports and Russian exports. Each is discussed below.

Chinese Trading: China emerged as a large and growing market for international agricultural commodities commencing in about 2000. Initially, China became the dominant soybean importer, and more recently, it became a dominant importer of corn, wheat, and beef cattle. As a result of this growth, China sought to diversify its suppliers and sources and "wanted less dependence on ABCD" (Roberts, 2014). Ultimately, it was said that "The Chinese Want Their Own Cargill" (Roberts, 2014), and more recent policies pursued diversification (National Development and Reform Commission, 2023). COFCO International[2] grew to assume the responsibility of managing some of China's imports. They initially acquired Nidera, Noble Agri Ltd., and subsequently others.

[2] In addition to COFCO International, there are other emerging and, in some cases, large Chinese trading firms in grain, including Wilmar, XMXYG, Pengdu Agriculture, Beidahuang Group and Shenzhen Cereals Holdings Group. SinoGrain was relegated a role for storage in 2022 (Chang, 2022).

COFCO International was formed in 2014 and is a subsidiary of COFCO, a state-owned enterprise (COFCO International). In 2024, they had operations in 37 countries. COFCO has heavily invested in supply chain functions, including origination, storage, ports, and shipping, and has logistical capacities in South America,[3] Eastern Europe, and the United States. COFCO International continues to grow and, in mid-2024, swapped assets to gain access to the US Gulf ports and indicated their intent to expand at each of these ports (Clayton, 2024). They ship to China and are significant shippers to many other countries. They are a large shipper of grains from the United States and other countries. It has grown in revenues and was planning an IPO (since 2021). COFCO International agribusinesses now have revenues second only to Cargill in 2022, exceeding that of ADM, Viterra, Wilmar, Bunge, and other major agribusiness firms.[4] Taken together, COFCO International has many characteristics of an STE.[5]

Russian Grain Trading: The Russian grain trading industry has evolved radically and is essential in world trade. Traditionally (pre-1990s), Russia's grain trade was controlled by Exportkhleb (Crawford, 2022). Under Perestroika, the industry was largely decentralized (Wilson & Belozertsev, 1995), and various forms of commodity markets have evolved. Major international grain trading firms expanded into varying functions within the interior and offshore markets, but by no means dominated the industry.

Following the Russian invasion of Ukraine, the Kremlin designated importing countries as "friendly" or "unfriendly," which became part of the export strategy. In late 2022, the Kremlin issued a decree prohibiting companies from "persons related to unfriendly states" from buying grain from Russian farmers. This action reduced trading opportunities for non-Russian firms and increased profits for Russian-trading firms. In early 2023, these developments, among others, effectively forced Western agricultural trading firms (including Cargill, LDC, and Viterra, as well as an earlier autonomous exit by Bunge) to liquidate their assets and exit Russia's grain-trade sector (Popva & Plume, 2023; Sonne et al., 2023; Terazono, 2023).

The structure of the exporting grain industry in Russia has evolved radically (Glauber, 2023; IFPRI, 2023; Quinn, 2024). In the 2023/24 crop year report, Quinn (2024) reported that the Russian grain trading firms increased their market share. By 2023/24, most of the Western trading firms had exited. Grain Gates, TD RIF, and Aston were the dominant exporting firms. TD RIF has since exited (AgriCensus, 2024), and Grain Gates is formally a private company but associated with Demetra, which, as a private company, is associated with VTB.

Taken together, the critical points for purpose of this study is that 1) Russia is a significant exporter, particularly of wheat; 2) following privatization, many western trading firms were active in Russia grain exports; 3) due in part to sanctions in 2014,

[3] See Cang, Gu and Sousa (2024) about COFCO's expansion in Brazil.

[4] ETC Group's Food Barons report of 2022 (Shand et al, 2022) put COFCO as the second largest company of the 'Leading Agricultural Commodity Traders'. https://www.etcgroup.org/files/files/food-barons-2022-full_sectors-final_16_sept.pdf

[5] Technically, COFCO International is a subsidiary of COFCO which is a STE.

there were efforts to expand domestic Russian grain trading firms; and 4) following the Ukraine invasion, western firms were primarily forced to exit, replaced by a cabal of Russian trading firms which are now consolidating to a few dominant exporters.

Evolution of Concentration Measures in International Grain Trading: Concentration in the international grain trading industry has been the subject of numerous studies and books, and, more recently, referenced in more popular studies and media.

Academic literature has evolved from Caves (1977/78) and Caves and Pugel (1982). Caves (1977/78) indicated a concentration ratio of 80% in international grain trading, though sources were not identified. Caves (1977, p. 109) indicated the CR4[6] for US domestic grain merchants at 33% and 21% in 1960 and 1972, respectively. Caves (1982)[7] suggested that for 1974/75, an unofficial CR4 of 61%, 42%, and 41% for wheat, corn, and soybean, respectively. CR4s fell for US exports to 1980/81 (citing USGAO, 1982). Using data from NAEGA, the 1974 CR4 for wheat, corn, and soybeans was 62%, 43%, and 53%, respectively. Thomson and Dahl (1979) indicated a CR4 of 85%. Their analysis questioned the ability to coordinate pricing dynamically. McCalla and Schmitz (1979) indicated a CR5 of 90% in 1970. Using data from USDA Grain Inspections, Foltz (2002) indicated concentration ratios for US grain exports of 81%, 47%, and 65% for corn, wheat, and soybeans, respectively.

Several books allude to concentration in international grain trading. Freivalds (1976, p. 116) indicated a CR5 of 90% for the United States and 70% for world grain trading. His results were concurrent with and/or based on investigations by the Federal Trade Commission in the industry. Morgan (1979) indicated a CR5 by origin country as 85%, 90%, 90%, and 80% for the United States, the European Union (EU), Canada, and Argentina, respectively, citing a USDA (1975) report. He referred to the 'pyramid of power' and the dominance of the major grain exporting firms (pp. 234-235). Gilmore (1982) reported values for US exports of wheat and corn at 96% and 90%, respectively, citing a Senate Committee on Foreign Relations (from Table 3.1, p. 27). Sewell (1992, p. 127) indicated that the concentration "…is largely as a result of these risks and pressures that the international grain trade became concentrated into so few hands…." Atkin (1992, p. 112) suggested that the five major grain trading firms account for 75% of grain shipments internationally, but acknowledged that 'the exact figure is not known." More recently, Kingsman (2019, p. 222) indicated that ABCD controlled 50% of the world trade in grain and oilseeds.

Many published studies recently cited varying concentration measures in international grain trading. Several published studies cite varying concentration measures, mostly from Murphy et al. (2012). That study indicated a CR4 of 73%. The basis of that study was an unpublished AWB reference.[8] Upon further investigation, it became clear that the consulting study, which addressed privatizing the Australian grain

[6] CR4 is the four-firm market share and defined as the sum of the market shares of the largest four firms (and defined below).

[7] Citing Wright and Krause (1976) and the USDA.

[8] Murphy et al (2012) cite the Australian Wheat Board (no date), which we subsequently identified that the source of this information was a non-public report referred as AWB (2004), p. 7 though conducted by Boston Consulting Group (2004).

trading industry, had significant limitations. Other studies have referenced the concentration in international grain trading, such as Clapp (2015) and Anderson et al. (2023), citing Shand et al (2022). In addition, Hietland (2024) cited Harvey (2022) and referred to Murphy et al. (2012), while DeSchutter (Share the World, 2022) and Public Eye (2019) also discussed this topic. More recently, Shaxson (2024) referred to these numbers, citing AgriFood Atlas (2017). These sources suggest that the concentration in international grain trading ranges from 70% to 90%. More recently, Wionn and Kuepper (2025) suggested the four-firm concentration ratio in cereals, oilseeds, and protein crops was 50-60%. These were derived (similar to the Australian Wheat Board, no date, study mentioned above) by aggregating volumes shipped by the top traders. However, as in the AWB study, they ignored the competitive fringe.

Other, more recent publications have cited varying concentration measures in international grain trading. These measures, mostly from Murphy et al. (2012), indicate a CR4 of 73%. The basis of that study was an AWB reference.[9] Upon further investigation, it became clear that the study, which addressed privatizing the Australian grain trading industry, had significant limitations. The analysis summed the total revenues from public annual reports for Cargill, ADM, ConAgra, Louis Dreyfus, Bunge, CWB, and AWB and derived the share controlled by the largest firms. It was inferred from this data that these firms control 73% of the market share for international grain trading. However, this approach is limited partly because it is based on *a priori* firm composition and firms having publicly accessible data. Further, using revenues as a proxy for market size in international grain trading would severely underestimate the market size, ignoring actual shipments and the impacts of competitive fringe. Specifically, the study only used data from the selected public firms. As a result, it ignores revenues, or more importantly, volumes, from the rest of the industry. Thus, the industry's total size is underestimated, creating an upside bias to their CR4 estimate.

Data Sources on International Grain Trading

The data used in this study are observations from individual shipments (nominations) of grains and oilseeds. Thus, each observation is a shipping record associated with an individual shipment. The data were taken from various sources that are generally publicly accessible, in some cases by subscription. These sources included various international shipping agencies, charter companies, etc.[10] In summary, the data comprised 62,271 FOB shipments and 48,098 CNF shipments. To verify that the data were representative, we derived the portion of world trade reflected in the data. The data comprises about 80% of world trade in grains and oilseeds.

[9] Murphy et al (2012) cite the Australian Wheat Board (no date), which we subsequently identified that the source of this information was a non-public report referred as AWB (2004), p. 7 though conducted by Boston Consulting Group (2004).

[10] Information on commodity flows and shipping is becoming more readily accessible through the growth of varying global vessel tracking and lineup services. Most are now likely in the public domain. Indeed, this is now becoming an important element of trading firms' data analytics.

Results

Overview: To provide a high-level description of the data, market shares were derived and illustrated for the firms defined as Majors, Other Majors, and Other grain trading firms. The majors include ADM, Bunge, Cargill, COFCO, LDC, and Viterra. The origins with the highest market shares for the Majors were Argentina and Brazil, whereas the United States, Australia, and the EU are much less concentrated. Other Majors were more dominant in Australia, Russia, and Ukraine.

Concentration by destination (or receiving) countries is relatively homogeneous across regions. For FOB and CNF trades, the Major's market shares are in the 20-30% range, with some being less. For FOB trades, Other Majors and Others are comparable to the Majors. For CNF trades, Other exporters are more prominent. As noted above, market shares vary across export origins but generally are at values that are not excessive. Notably, concentration in the United States is much less than in competing countries.

There is also variation in market shares among commodities. The results are generally comparable for FOB and CNF shipments. Corn and soybeans have more significant market shares for the Majors than wheat. Much of this reflects the emerging importance of Russia and that of the EU, where the Majors are less dominant. Generally, the Majors' market shares decreased from 2020 to 2023. As an example, the market share for corn of the Majors decreased from 57% to 46%.

CR4s and HHI: While the above summarizes the data treating the Majors as an *a priori* group of firms, more appropriate concentration measures are the CR4 and HHI. For this study, CR4 is defined as the simple sum of market shares from the four largest firms. Specifically, CR4 was defined as:

$$CR4 = \sum_{i=1}^{4} s_i;$$

and the formula for the HHI is:

$$HHI = \sum_{i=1}^{n} s_i^2 \cdot 10{,}000;$$

where n is the number of firms in the industry, and s_i is the i-th firm's market share (ranked from largest to smallest) expressed in decimal format (i.e., 5% would be 0.05). The HHI produces a value that ranges from near zero (extremely competitive industry) to 10,000 (a monopoly). Generally, values less than 2000 suggest a perfect or monopolistic competition market structure, and competition would be 'fierce'; values from 2000-6000 would be an oligopoly; and values from 6,000 to 10,000 would be approaching a monopoly (Besanko, 2016).

Table 1 summarizes the results for CR4s and HHIs. Figures 1 and 2 show the market shares for each firm from 2020 to 2023. These are shown for all origins and destinations for all specified commodities. Only the top 20 firms are shown in the figures (due to space).

Generally, the market share for the largest four firms is about 30%, but this varies across commodities and countries. The aggregate CR4 for FOB and CNF shipments is 31% and 27%, respectively. The dominant firms are Cargill, COFCO, ADM, and LDC for FOB shipments and COFO, Bunge, ADM, and Cargill for CNF shipments. Thus, there is a difference in market leadership for FOB shipments versus CNF shipments.

The results differ for China's imports. CR4s are higher at 44% and 39%, respectively, for FOB and CNF shipments. Cargill and COFCO are the top firms in FOB shipments, and COFCO and ADM are the dominant firms for CNF shipments.

Table 1. Summary of International Grain Trading Measures of Concentration (2020-2023)

Scope		FOB or CNF	CR4	HHI	Top 4 firms
All Grains & Oilseeds	World	FOB	31	855	Cargill, Cofco, ADM, LDC
		CNF	27	442	Cofco, Bunge, ADM, Cargill
All Grains & Oilseeds	US	FOB	45	1,241	ADM, Cofco, Cargill, Zennoh
		CNF	37	670	ADM, Cofco, Bunge, Cargill
All Grains & Oilseeds	China Imports	FOB	44	855	Cargill, Cofco, ADM, LDC
		CNF	39	769	Cofco, ADM, Cargill LDC
All Grains & Oilseeds	Russian Exports	FOB	33	623	Trade House RIF, Aston, Grain Gates/Mirogroup, United Grain
		CNF	26	408	Solaris, Asont, GTCS, Viterra
Corn only	World	FOB	43	723	Cofco, Cargill, ADM, Bunge
		CNF	36	540	Cofco, ADM, Cargill, Bunge
Soybeans only	World	FOB	45	930	Cargill, ADM, LDC, Bunge
		CNF	38	674	ADM, Bunge, Cargill, LDC
Wheat only	World	FOB	21	343	Viterra, Cargill, Cofco, Tradehouse RIF
		CNF	16	315	CBH, Viterra, Cofco, Cargill

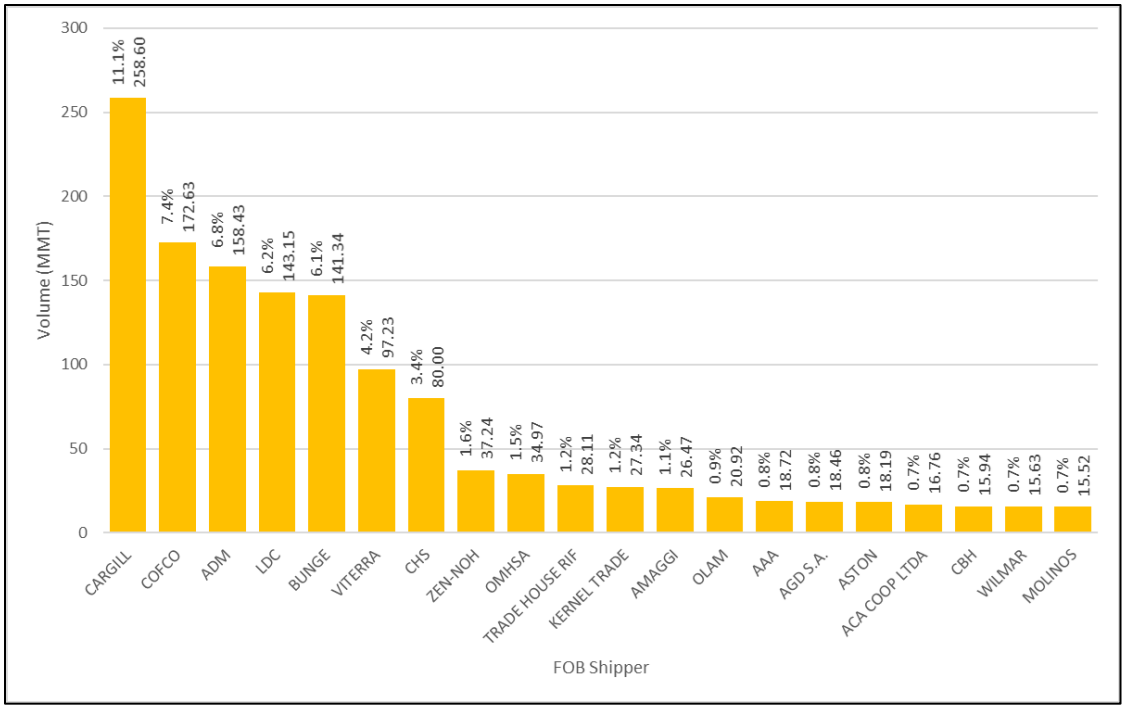

Figure 1. Volumes and market shares for FOB shipments, Top 20 firms, All Commodities, All Origins and Destinations, 2020-2023 (Values for each bar are market share and volume)

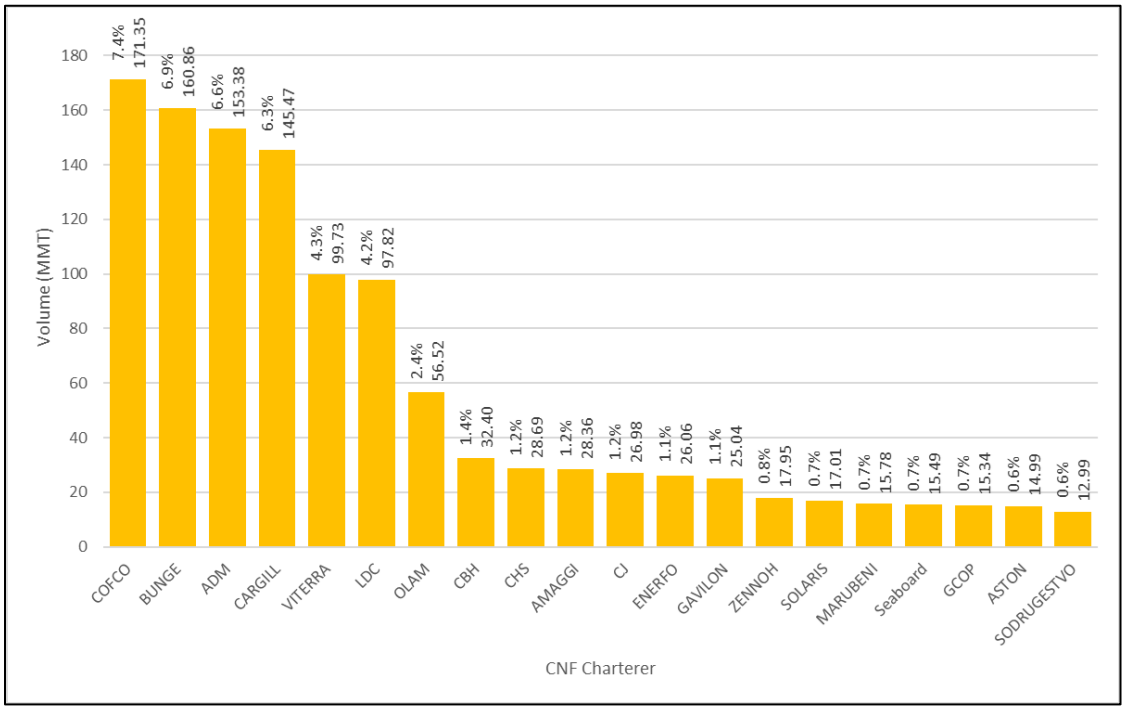

Figure 2. Volumes and market shares for CNF shipments, Top 20 firms, All Commodities, All Origins and Destinations, 2020-2023 (Values for each bar are market share and volume)

There have been drastic changes in Russian exports in recent years, resulting in Western firms exiting and Russian trading firms becoming more dominant (as discussed above). These results indicate comparable CR4s as above. The results reported here are for 2020-2023, whereas Quinn (2024) reports shares only for 2024. The dominant firms for FOB shipments are Trade House RIF, Aston, Grain Gates/Mirogroup, and United. For CNF shipments, the dominant firms are Solaris, Aston, GTCS, and Viterra. The market structure for Russian exports continues to change with further consolidation of exporters. When evaluated for individual years, the CR4 increased from 33% to 44% for FOB shipments between 2000 and 2023. TradeHouse RIF was the dominant firm each year, but Cargill fell from the fourth to the eighth largest firm. CR4s for CNF shipments range from 29-35% with no apparent trend. However, the dominant firm shifted from 2020 to 2023, with Aston, GTCS, Solaris, and Grainflower being the dominant firms in each year, respectively. Cargill became much less dominant (at the 8th largest).

Taken together, there have been some notable changes through time. Those of particular importance include 1) the growing penetration of COFCO for CNF and FOB China shipments and decreases by Cargill and ADM; 2) radical changes in Russia and reduction in western firms, particularly for wheat; 3) the increase in non-Majors and 'unspecified' in the case of wheat; and 4) the increase in 'unspecified' shippers in 2023, no doubt reflecting the impacts of EU, Black Sea and Danube shipments becoming less transparent.

In general, these results indicate that the international grain trading industry is highly competitive, and in most cases, the competition would be considered 'fierce.' The competitive fringe[11] component of this market is much greater than previously depicted. From these results and the value of HHI, there is no reason to expect that any firm would be able to exert market power or, taken together, operate as an oligopoly. In all cases, FOB shipments are more concentrated than CNF. Though about 20% of the shipments are unspecified and vary across commodities, these observations would not impact the results so long as they are not concentrated with the dominant shippers.

Finally, the concentration levels reported here are much smaller than in previous studies, which predominantly suggested an aggregate CR4 of 73%. The actual CR4 is much less; CR4s across countries and commodities are much less, and the firms insinuated to be dominant differ. There are several reasons for this distinction. First is the time period. Our period includes the most recent years and is summarized across 2020-2023. The most recent publications are unpublished studies from the early 2000s. Much has changed in this industry over this period, notably growth in competitive fringe, including Chinese and Russian trading firms. Second is the scope of analysis. The early studies used data for the US only, and the AWB (2004) study, which was the basis for others, used data on revenues, which is irrelevant. In this study, we use all origins

[11] The term competitive fringe is used here to be consistent with terminology used in the industrial strategy literature. Alternatively, the taxonomy could be referred to as 'layers' of firms within an industry.

and destinations. Third is the metric. Early studies used export data from the 1970s to the 1980s for shipments from the United States. The other most recent study (unpublished) inferred market shares (inappropriately) from revenues of the *a priori* assumed dominant grain trading firms. This study uses actual shipments, a more precise measure of trade and concentration. Finally, our analysis reports the CR4 and HHI, which are more appropriate measures of concentration and prospective market power. Earlier studies only reported CR4s.

Cluster Analysis: Part of the motivation of this study is that over time, the international grain trading industry has evolved to be referred to as ABCD, implying an industry dominated by these four firms. Another interpretation is that a single cluster comprises these four firms. Cluster analysis was used in this study to analyze the structure of the international grain industry and to more formally determine the number of clusters and the composition of firms within each cluster.

In analyzing the clusters of firms in international grain trade, k-means clustering offers a robust method to identify and understand distinct groupings among these firms based on various trade-related metrics. The variables used to delineate clusters include 1) the number of total shipments, 2) the number of origins, 3) the number of destinations, 4) the number of FOB shipments, 5) the number of CNF shipments, and 6) whether the firm trades wheat, corn, and soybeans. K-means clustering was used to segment firms into clusters that reveal patterns of strategic positioning. The data had four years of data from 2020 to 2023. We tested other variables such as whether the firm trades small grains, the number of shipments over time, other geographic variables, or reliance on specific trade routes, and average shipment size by volume. These additional variables were insignificant to the results and were omitted in the final analysis.

The results are summarized in Table 2. The silhouette scores indicate three clusters. The results suggest the existence of three clusters of firms in the international grain trading industry, i.e., three groups of firms have similar characteristics. Cluster 1 is comprised of seven firms. Thus, in contrast to the normal taxonomy of ABCD, this cluster has several firms. In addition to ABCD, it also includes COFCO, Viterra, and CHS (ABCCCDV). These firms account for 45% of global FOB shipments. This finding is fundamental in understanding the structure of the international grain trading industry. Cluster 2 comprises nine firms with similar characteristics and many other firms, which could be seen as the competitive fringe, a broad segment of similar firms. Finally, Cluster 3 contains many other firms, each individually small.

This is an essential finding in understanding the structure of the international grain trading industry. Cluster 2 includes nine firms with similar distinctions and many other firms. This could be interpreted as the competitive fringe, a large segment of similar firms. The named firms within that cluster are recognizable in most cases. Finally, Cluster 3 has nine named firms and many other firms, each of which is individually small.

The characteristics of the clusters are essential. Cluster 1 is comprised of firms that have a large volume of shipments. On average, shipments by Cluster 1 firms are 67 times those of Cluster 2 firms and 105 times those of Cluster 3 firms. Cluster 1 firms

ship from, on average, 14.4 origins to 92 destinations; shipments include all commodities, including wheat, corn, and soybeans. Cluster 2 is similar, except the volumes of shipments are much smaller, and these firms ship from an average of 1.8 origins to 11.9 destinations. Cluster 3 is similar but has a smaller set of origins, but significantly, it does not ship wheat, corn, or soybeans. Firms in each cluster ship both FOB and CNF; in all cases, the number of FOB shipments exceeds the number of CNF shipments. The critical difference between Clusters 1 and 2 supports the importance of size and the ability to be multi-origin and multi-destination shippers.

Finally, since firms in Cluster 3 do not handle wheat, corn, or soybeans, the model was re-run, excluding these firms. The results are an industry of 2 clusters, similar to the abovementioned clusters. Experimenting with 4 or 5 clusters had low silhouette scores and was insignificant.

These results are essential in understanding the structure of the international grain trading industry. First, rather than suggesting one segment called ABCD, there is a cluster comprising seven firms with similar characteristics. Second, a large group of other firms differs, but they have similar structural characteristics within the group. These firms would be the competitive fringe. Finally, there is a large cluster (3) with many small firms that do not handle wheat, corn, or soybeans. Taken together, this can be interpreted as an industry comprised of clusters, one of which represents larger firms that ship from a large number of origins to a large number of destinations. The competitive fringe is more complicated, as there are two clusters, with many firms. The impact of the competitive fringe has not been mentioned in earlier studies. However, as noted here, the competitive fringe is important and impacts the structure and conduct of the international grain trading industry.

Table 2. Cluster Results for International Grain Trading Firms

Cluster	1	2	3
n	7	37	15
Silhouette Score	0.60	0.55	0.64
Firms	Cargill	Olam	Agroholding Step
	ADM	Amagg	Prometey
	Cofco	Aston	Profit
	Bunge	Sierentz	Kernel
	Viterra	Ameropa	Grain Gates
	LDC	Gavilon	Solagro
	CHS	Nibulon	Grain Service
		NCH	Enerfo
		CBH	Marubeni
		28 Other Firms	6 Other Firms
Variables	Size of Total Shipments		
	Number of Origins		
	Number of Destinations		
	Number of FOB Shipments		
	Number of CNF Shipments		
	Does the company transport Corn, Soybean, and Wheat?		

Conclusions and Implications: Two concentration measures were evaluated: CR4 and HHI. The latter is the most relevant measure of concentration and captures the effect of the number and the size distribution of firms.

The results indicated that CR4s were 27% and 31% for all commodities from all origins to all destinations. The HHIs were 885 and 442 for FOB and CNF shipments, respectively. The result varied across origins, destinations, and commodities. The CR4s for Chinese imports were 44 and 39% for FOB and CNF Chinese imports. COFCO was the dominant exporter for CNF and Cargill for FOB shipments. In the case of Russia, the dominant firms were all Russian grain trading firms, with Western firms being near inconsequential competitors. Finally, there was a slightly greater concentration in export trading for corn and soybeans and much less for wheat. The latter is no doubt due to the changes in Russia, as well as those in Australia and Canada.

The dominant firms also differ from earlier studies. For the entire data set, the top four firms for FOB shipment are Cargill, COFCO, ADM, and LDC, whereas for CNF, the top firms are COFCO, Bunge, ADM, and Cargill. Hence, this illustrates that the conventional representation of ABCD is incorrect. Instead, COFCO has become more prominent. COFCO is one of the dominant firms for virtually every sub-aggregation measured, except notably Russia.

These results differ substantially from previously reported studies, which typically report CR4s in 80-90% or, sometimes, 73%. There are important reasons for these differences, including 1) time period, 2) scope of data, and 3) metric. Our analysis uses more detailed data not previously accessible for actual shipments, and we derived both the CR4 and HHI.

The overall results indicate that the international grain trading industry is structurally characterized as being competitively 'fierce'. In other words, competition is so intense that the ability of any individual firm to have a perceptible influence on price or trade terms is minimal. This is generally true across the different sub-aggregations of the international grain trading industry. These results are also valid for the different grain marketing functions, at least in the United States. COFCO, Russian grain trading firms, and others appear to be growing in dominance. The largest four firms typically control about 30% of the market.

The data were further analyzed to determine the clusters or segments of the international grain trading industry. The results indicated 3 clusters. Cluster 1 comprises seven firms that are very large in shipment volume and ship all commodities from many origins and destinations. The other two clusters had a larger number of firms, and in each cluster, the size of shipments was smaller, and they shipped from a few origins to a few destinations. One of these clusters was characteristically different because it did not handle the major commodities, corn, soybeans, and wheat. Hence, this industry is characterized by 3 clusters. One could be interpreted as the majors, but firms in this sector are greater than the ABCDs. The other is a large segment of small firms comprising the competitive fringe. Finally, Cluster 3 is a specialist group focusing on vegetable oils.

The result of this study has both private and public implications. For private firms, the results describe the changes in strategies, the emergence of new entrants, and the competitive fringe. The low HHIs indicate fierce competition, ultimately meaning that successful firms must have other strategies to be sustainable. Information is critical, and the ability to analyze information has become more critical due to its availability. Indeed, the data used in this study has now become an essential source of information not previously included in analytical strategy models. Last, it is clear that large firms must have optionality, or simply the ability to ship and switch among alternative origins.

The critical public implication is that this industry's concentration level is low in contrast to previous perceptions. It is low in terms of typical concentration measures and compared to other agricultural sectors. The concentration measures suggest that competition is intense and 'fierce'.

This study makes three important contributions. First, it provides a detailed description of the evolution of policies affecting this industry and the apparent changing strategies of firms in this industry. As described, they have changed sharply. Second, it uses a detailed and extensive data set that was not previously accessible or used in this

industry. Finally, the results suggest that the concentration level is much lower than reported in previous studies.

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