VALUE GENERATION AND CAPTURE IN THE AGRI-FOOD VALUE CHAIN

by

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Dedicated to those who helped a kid from small-town West Virginia chase his dreams.

Thank you.

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TABLE OF CONTENTS

LIST OF FIGURES

ABSTRACT

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How do food and agribusiness firms capture more profit in their value chain? How do innovative managers identify attractive adjacency and disintermediation opportunities? What options are available to a manager facing these questions and what economic incentives might motivate their strategic behavior? This study sought to address these timely questions, more effectively understand the strategic decisions facing food and agribusiness managers relative to value chain profit pools, and uncover some of the hidden dynamics between chain participants. Specifically, this study defines and quantifies the U.S. animal protein industry value chain across three species – hogs, cattle, and broiler chickens. The study found evidence to suggest that governance structure has strong ties to value generation and that intra-value chain dynamics impact price transmission between chain nodes. Further, this study creates a foundation for other researchers to continue examining agri-food value chain dynamics and its link to firm-level profitability, value capture, and long-term sustainability.

INTRODUCTION

How do food and agribusiness firms capture more profit in their value chain? How do innovative managers identify attractive adjacency and disintermediation opportunities? What options are available to a manager facing these questions and what economic incentives might motivate their strategic behavior? This study sought to address these timely questions, more effectively understand the strategic decisions facing food and agribusiness managers relative to value chain profit pools, and uncover some of the hidden dynamics between chain participants.

This study was informed using industry data and conducted using economic models and theory as the foundation. The intent was to derive real-world, applicable findings for practitioners and academics alike on the impact of governance structures and shifts in profit distribution across value chain nodes. By mapping and analyzing a sample set of profit pools within the U.S. animal protein value chain, the goal of this study was to more thoughtfully understand and inform food and agribusiness management decisions within the animal protein subsector.

Understanding what motivates strategic decisions in the presence of shifting profit pools has long captivated economists and practitioners. The United States Department of Agriculture Economic Research Service has previously studied profit pools and cost transmission across the value chain. Economist have built entire careers around industrial organization economics in agricultural economics. Consultants and practitioners have studied the potential synergies of mergers and acquisitions, and vertical integration strategies for decades. Managers at Cargill, Tyson Foods, and The Wonderful Company have pursued strategies directly aligned with capturing and controlling a greater portion of their value chain’s profit pool.

Practitioners use profit pool analyses to map total profits earned in an industry at all points along a value chain. The estimates help determine where and how firms generate profit across a chain and how industry revenue relates to profits and value generation as goods move across the value chain. Additionally, the analysis can quantitatively model the distribution of profits in an industry, which could be very different from the distribution of revenues.

A manager who understands profit pools can identify new sources of profits, chart acquisition and expansion strategies, make informed decisions about customer and channel strategies, and guide operating decisions with an informed perspective. From an economist's perspective, mapping profit pool changes over time can also answer questions about industry structure development, impact of industry concentration and technological innovation on value chain profitability, and tradeoffs faced by managers. Understanding potential relationships between strategic options in the food and agribusiness industry and profit pools would be advantageous for both practitioners and economists as we continuously seek to understand the core drivers of competitive strategy in the agri-food industry.

While there has been substantial research on firms across the general economy, not much attention has been given to understanding profitability performance of food and agribusiness firms over the last five years. Additionally, little research has been performed to understand how profit pools have developed and align with strategic behavior – a core tenet of competitive enterprise strategy. The intent of this study was to shed light on how and why managers pursue specific strategies within the agri-food industry and what relationship it may have to profit pools.

With this context in mind, the focus of this study was twofold. 1) Identify the current state of profit pools within the U.S. animal protein industry, where margins have migrated over the last ten years, and the potential implications for profit pools and firms beyond 2018. 2) Identify stages in the U.S. animal protein value chain which add economic value, where value has been generated over the last ten years, and potential implications for economic profits in the future. The first issue with addressing this question was understanding the current state of profit pools within the U.S. animal protein subsector.

Conducting a profit pool analysis poses three main challenges. First, information asymmetry occurs when privately-held firms withhold financial performance data. Several research firms acquire and aggregate data on privately-held U.S. firms, but frequently lack the quality needed to construct reliable and insightful profit pool estimates. Accessing high quality and consistent financial data sources is also costly. Even if these were not barriers, reports still typically require a significant amount of time to analyze, verify, and prepare for analysis.

Second, conglomerates often participate in multiple sectors of the economy and report financial performance across business units, not economic sectors. Samsung, for example, operates a business unit manufacturing cell phones and another business unit manufacturing household appliances. The firm could report both cell phone and appliance revenues as a lump sum on its financial statements as "consumer goods manufacturing". Without having full visibility to the firm's breakdown of revenue and costs by economic sector, which in this case is two – cell phone manufacturing and household appliance manufacturing – detangling Samsung's finances by economic sector would be extremely challenging, if not impossible without inside knowledge.

Even if firms participate in only one sector of the economy, they may still vertically integrate and participate in multiple nodes, or steps, in the value chain. This third complexity, vertical integration, creates further issues by aggregating the economic performance of multiple value chain nodes as opposed to one. Take for example a steel manufacturer that mines its own ore for steel production. To adequately calculate the profit pool contributions for the firm, an analyst would have to know the revenue and costs of both the iron ore business unit and the steel manufacturing business unit. If the firm also produces consumer goods from its steel, the analyst would have to know the exact revenue and cost information for manufacturing the consumer goods as well. In many cases, financial reporting would show revenue and cost data for a steel business unit as opposed to disaggregated at the activity or traditional node level. In a perfect world, reports would show revenue and costs for all three activities – mining, steel production, and consumer good manufacturing. Without disaggregating at the activity or traditional node level, there is high risk of misallocating a firm's performance to the incorrect node estimate.

While these issues may seem minute, the time and effort necessary to overcome them poses a significant barrier to calculating industry-level profit pool estimates and may explain the limited number of prior profit pool estimates in the food and agribusiness industry. This study strives to overcome the three barriers to profit pool estimation using methods discussed in the Methods and Data section. With the profit pool estimate complete, we then return to the core research question: how has accounting and economic performance changed in the animal protein industry and what does it mean for the industry's future?

1. CORE RESEARCH OBJECTIVES

The core objectives below discuss the purpose of this study and core questions to be answered. It also outlines the ten hypotheses to be tested and discusses the contextual basis for testing each.

1.1 Core objectives

The overarching goal of this study was to thematically address the following two objectives through the lens of the U.S. animal protein industry. 1) Identify the current state of profit pools within the U.S. animal protein industry, where margins have migrated over the last ten years, and the potential implications for profit pools and firms beyond 2018. 2) Identify stages in the U.S. animal protein value chain which add economic value, where value has been generated over the last ten years, and potential implications for economic profits in the future.

1.2 Individual hypotheses and rationale

Ten hypotheses were developed to address the two core objectives.

Hypothesis 1: Value above the cost of goods sold differs between value chain nodes as the primary activity for each node is differentiable in the source-to-consume process

The purpose of this hypothesis is to determine if each node in the U.S. animal proteins value chain will produce a different level of value added as a percent of total revenue. Within this hypothesis, it is important to determine if value generation differs across the chain and if different, the order of magnitude and where value is captured. This will help quantify the chain and identify which nodes add economic value within the chain. If value added and value added as a percent of total revenue is different across the chain, the hypothesis will be confirmed.

Hypothesis 2 – Farm level nodes have the lowest level of value addition as they sell homogeneous products into a highly competitive supply-demand environment

This hypothesis is intended to determine if farm level nodes contribute the least to value addition compared to all other major nodes. It is no secret farmers believe larger input providers and transformers are squeezing their potential profit margins. Additionally, many farmers believe they do not receive a fair share of the final food dollar relative to the value they perceive to be contributing to the value chain. This hypothesis seeks to provide some quantifiable evidence for the debate and understand how farmers are contributing. If value added is lowest in farming compared to other parts of the value chain, the hypothesis will be confirmed.

Hypothesis 3 – Processing is the highest value adding activity given the presence of differentiated products, supply chain governance, and significant market concentration

The purpose of this hypothesis is to determine if processors capture the highest levels of value addition due to asset specificity and their significant influence over the chain. Transformers hold many of the bottleneck assets in the U.S. animal protein value chain and, because of their superior position in intra-value chain governance structures, may be able to capture a larger share of industry value added. If processing adds the highest level of value addition compared to all other value chain nodes, the hypothesis will be confirmed.

Hypothesis 4 – Wholesale gross margin is the most variable as it has relatively low market power and adds only time and place utility

The purpose of this hypothesis is to identify if and how significantly wholesalers add value to the animal protein value chain. Economic theory asserts that value is derived by increasing time, place, and/or form utility. Since wholesalers rarely, if ever, transform a good in the animal protein value chain, the estimates from this hypothesis can serve as a proxy for how market prices represent willingness to pay for time and place utility. It also assesses how effectively the wholesale node captures that value. If wholesale gross margin is the most variable relative to gross margins for the other major nodes, this hypothesis will be confirmed.

Hypothesis 5 – There is a positive relationship between market concentration and value creation

The purpose of this hypothesis is to understand the relationship between value creation and the presence of large firms which are typically more innovative and dictate the structure, conduct, and performance of their own and other nodes. It will also help quantify potential impacts of intra-node dynamics and how different nodes may perform with similar levels of concentration. Economists and strategists have studied the relationship between market concentration and firm performance for several decades. This hypothesis specifically looks at how those relationships hold constant across a value chain. Additionally, it expands upon current literature by examining how firms in highly concentrated nodes may manipulate value captured and the behavior of other nodes to capture larger portions of value chain profits. If there is a positive correlation between concentration and value creation, this hypothesis will be confirmed.

Hypothesis 6 – There is a negative relationship between farm level value creation and captive supply

The purpose of this hypothesis is to determine if captive supply, a proxy for market and governance power, has a negative relationship with value creation as other nodes may impair rent capture by farm level nodes. This hypothesis attempts to understand how value capture is impacted by vertical integration and captive supply levels which, in the case of animal proteins, is an indicator of the influence held by transformers over the chain. In addition, this hypothesis may help managers better understand the impact of vertical integration on farms and how it could potentially be leveraged within animal proteins or in other sectors of the farm economy. If negative correlation exists between captive supply levels and farm node value creation, this hypothesis will be confirmed.

Hypothesis 7 – There is a negative relationship between farm level value creation and interest rates

The purpose of this hypothesis is to determine the relationship between value creation and farm level interest rates. Debt is a notable contributor to the capital structure of US farms and farmers tend to frequently discuss current interest rates for long-term financing. Some farmers and economic historians also cite high interest rates as a driver for many farmers' woes in the 1980s Farm Crisis. This hypothesis seeks to understand any potential relationship which might exist between farm level value generation and farm level interest rates. If a negative correlation exists between value creation and interest rates, this hypothesis will be confirmed.

Hypothesis 8 – Downstream activities have higher economic profit during periods of increased farm income

The purpose of this hypothesis is to test if value chain dynamics enable downstream nodes to capture a larger share of industry value added during periods of increased farm income. One common question from farmers and regulators is how value creation and capture changes when farm level incomes increase. The question then typically extends to – do farmers reap the rewards of higher farm revenues and do they capture higher levels of value during those times? This hypothesis seeks to address that question. Additionally, this hypothesis can add value by helping us understand how future events, such as increases in farm income, impact value chain profits and distribution. If economic profits are higher in downstream nodes during periods of increased farm income, this hypothesis will be confirmed.

Hypothesis 9 – A lag effect exists in transferring production costs down the value chain as a result of the biological production cycle and value chain power dynamics

The purpose of this hypothesis is to test if value chain dynamics limit the transmission of input cost changes down the value chain. Much like hypothesis eight, this hypothesis takes another approach to identifying if downstream nodes dictate the terms of trade and and prices across the value chain. In an effectively performing value chain, a change in input costs should be transferred down the value chain as the good comes to market. For example, if hog feed costs increase five percent then there should be a relatively equal price increase reflected in final goods when that hog comes to market six months later. If those costs are not reflected, it may be indicative of issues in value chains reacting to changes in input costs and ineffectiveness of price transmission between nodes. If there is low correlation between changes in input costs and changes in the final good prices, this hypothesis will be confirmed.

Hypothesis 10 – Farm level value creation is most negatively impacted by periods of decreased export quantities

The purpose of this hypothesis is to test if farm value generation is most impacted by periods of increased export quantities. This hypothesis attempts to test how downstream nodes may dictate the prices and terms of trade across the value chain and what it might mean for future value chain performance during periods of high exports. International trade norms and dynamics have been challenged over the last twelve months and it is timely and relevant to understand impact of changes to exports on value creation. If farm value generation decreases during periods of decreased exports, this hypothesis will be confirmed.

2. LITERATURE REVIEW

2.1 Economic history

Strategically navigating, or altering, market structure has historically been a widely debated and frequently discussed strategic plan for food and agribusiness firms. However, a bigger debate has recently taken hold. Managers, policymakers, economists, and consumers now frequently discuss the merit and impact of market-structure-transforming activities on the agri-food industry and value chain. Agribusinesses also continue to feel a profitability crunch as commodity prices linger at prices much lower than their record-highs in the early 2010s. In several cases, managers see vertical integration and adjacency acquisition opportunities as a potential answer to their stakeholders' demands for profits. However, farmer and consumer groups are concerned that increased integration will lead to dominant market positions that allow agribusinesses to extract higher prices for food and agricultural products. Industry leaders argue that vertical integration is part of the natural evolution for an industry and leads to reduced risk, information symmetry, lower final good prices, and stable supply chains.

One vantage point for examining potential industry implications is through the structure-conduct-performance (SCP) model developed by Bain which connects supply chain governance and firm dynamics across a value chain (Bain, 1951). The framework suggests that industry performance measurements include: (1) how well supply matches demand; (2) technical and operational efficiency; (3) equitable sharing of rights, risks, and returns; (4) market access and ease of entry; and (5) sustainability (Boehlje M. , 1994). These measurements help to evaluate coordination effectiveness across the chain but explain little about profitability implications for firms and the impact of different governance structure on market performance.

In industrial organization economics, theory suggests that each value chain has a defined value of profit as shown in Figure 1. This value is commonly referred to as the value chain's revenue or potential profit pool (Gottfredson, 2008). As profit-maximizing actors, individual firms within the value chain extort market power, use internal resources, and implement competitive strategies to capture a larger share of the total value chain profit from other actors in the chain

(Porter, 1980). Coase (1960) referred to captured profits as economic rents, discussed further in the next section. Firms capture a portion of the total profit pool based upon how they navigate managerial decisions and, as profit-maximizing firms, continuously pursue a larger share of the industry's potential profits. By leveraging market power and value chain dynamics, individual firms and, by extension, individual value chain nodes may capture larger portions of total value chain rents over time. In some instances, market power and advantageous governance structures can lead to the double marginalization phenomenon whereby firms internalize other node's activities and capture what would otherwise be the rents of other firms (Cotterill, 2001).

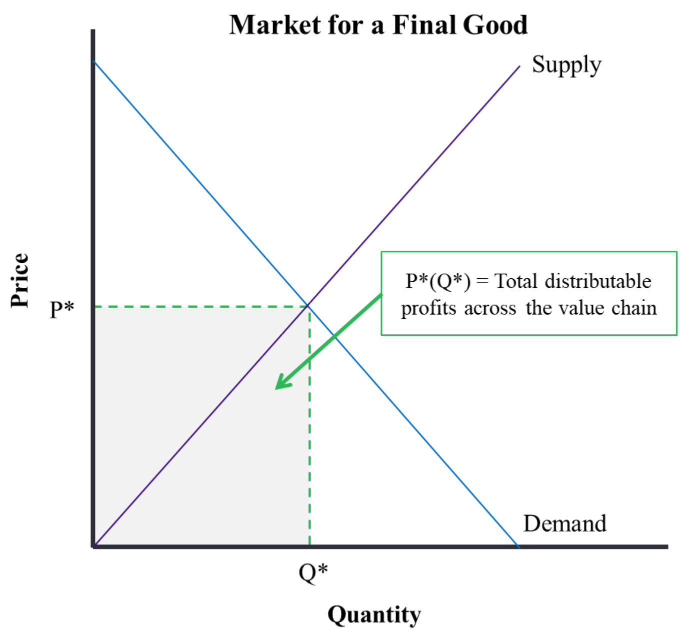


Figure 1: Conceptual approach to total market profit pools

While vertical integration increases coordination, facilitates information symmetry, and mitigates supply-side risk for individual firms, industry practitioners and economists have continued to debate its merit and impact on profitability. Additionally, increased integration and non-traditional acquisitions, such as Amazon acquiring Whole Foods, have put regulators in a tough spot when defining anticompetitive behavior and unfair market conditions for consumers and firms across value chains. Mergers and acquisitions in the agrichemical market between the Big Six, soon to be Big Three, also create a need to examine market dynamics across the agricultural value chain and its impacts on stakeholders. It also brings to question if transaction costs and economic rents create a significant issue for agribusiness value chains or if they are the primary motivator for firms to alter their channel strategy.

2.2 Transaction costs and market structure

Broadly, transaction costs are incurred in the market when acquiring goods and services from another party while agency costs occur inside the firm as a result of creating the goods or services internally rather than sourcing from the market (Coase, 1960). Minimizing transaction costs and agency costs are important factors that influence the decision to vertically integrate along a supply chain. Coordination certainly results in lower transaction costs, but also has raised questions concerning how efficient and equitably market outcomes are distributed.

Regulators, on several occasions, have sought to inform debate on supply chain governance structures, particularly in the food and agriculture sector. Several studies focused on the potential implications of vertical integration for contract growers and thin markets in food transformation and processing (Adjemian, 2016). One specific study by the USDA Economic Research Service focused heavily on the presence of thinning markets and, more specifically, the type of market relationships existing between farmers and processors in the cattle and hog markets (Adjemian, 2016). The researchers found a significant decline in open market buying agreements across both cattle and hogs. See Figures 2 and 3 on the following page. Generally, understanding the implications of shifts in buying agreements and vertical linkages can also inform manager decisions about how and where to participate in the value chain (Gottfredson, 2008).

Whether industry driven or regulation driven, meeting the new requirements would likely lead to tighter linkages between firms in the supply chain. Firms would respond by reconfiguring value chains and altering vertical boundaries which would likely shift profit pools across chain nodes (Besanko, 2016). While economists speculate potential outcomes, we have a foggy view of the current state of value chains and what it may mean for market performance and market structures in today’s agri-food industry.

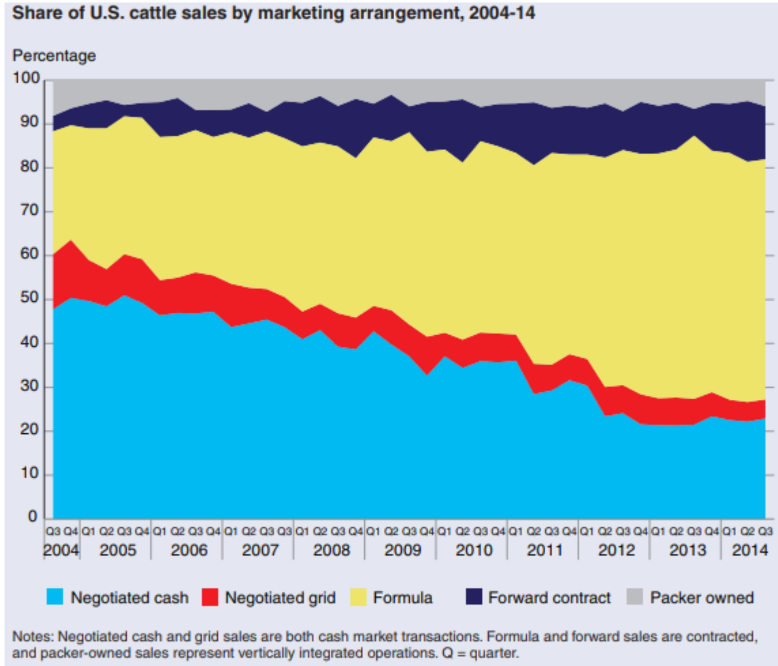


Figure 2: U.S. cattle marketing arrangements, 2004-14 (Source: USDA Economic Research Service using steer & heifer sales data from the USDA Agricultural Marketing Service, 2015)

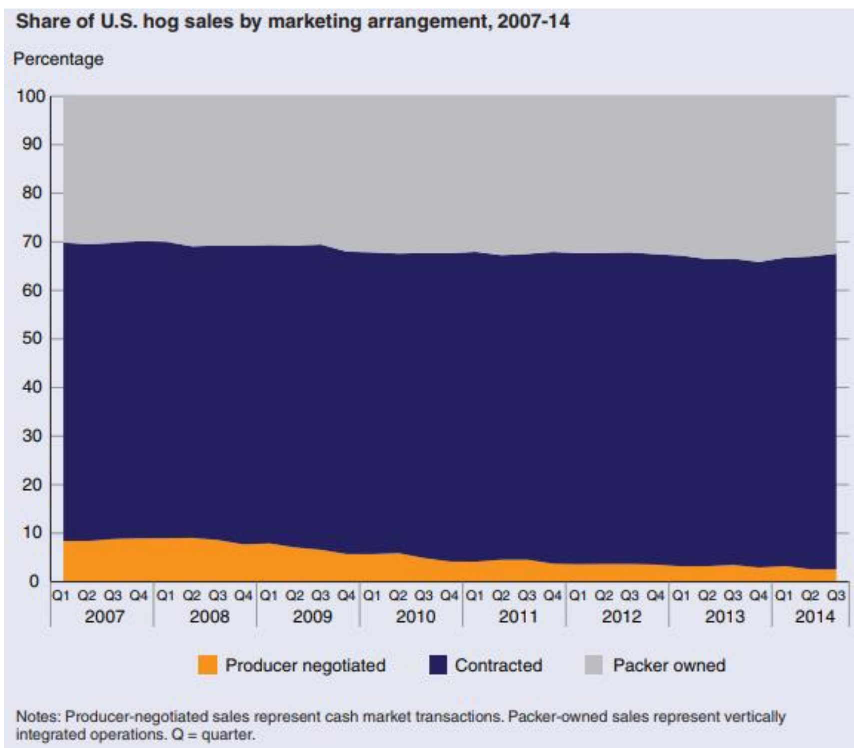


Figure 3: U.S. hog marketing arrangements, 2007-14 (Source: USDA Economic Research Service using barrow & gilt sales data from USDA Agricultural Marketing Service, 2015)

Very few, if any, markets today are extreme market structures – perfectly competitive or monopolistic – so the major focus of industrial organization economists has been the performance of imperfectly competitive markets (Tremblay, 2012). Economists in the market structure school of thought assert that market structure determines firm-level conduct and profits are derived by firms navigating the structure and altering it where advantageous (Tremblay, 2012). On the other hand, economists in the school of thought backed by superior efficiency hypothesis assert concentration is positively correlated with industry profits (Tremblay, 2012). Under the assumptions proposed by this hypothesis, markets are dynamic and comprised of successful firms with lower costs, superior products earn higher profits and economic rents, and as a result superior, more efficient firms capture a greater share of total market share and potential profits (Tremblay, 2012). This in turn drives up industry concentration and total industry profits. Economists cite this industry evolution as a basis for their assertion that positive correlation between concentration and profits.

While both schools seem to follow economic logic, they do not fully describe the interconnectedness between industry structure and intra value chain dynamics. This research helps to assert that firm value creation is differentiable across varying industry structures and governance structures, and that firms which expand their reach across the value chain can capture a higher share of total value created.

2.3 Analyzing agri-food value chains

A value chain is commonly defined as "the full range of activities which are required to bring a product or a service from conception, through the different phases of production (involving a combination of physical transformation and the input of various producer services), delivery to final consumers, and final disposal after use" (Klapisky, 2002). The agriculture industry has traditionally been regarded as a commodity industry comprised of interrelated nodes, or subsectors, working in cooperation to provide goods and services to end consumers (Boehlje G. N., 2014). To capture it succinctly, the agriculture industry is an end-to-end value chain. This deduction naturally lends itself to the notion of an agribusiness industry comprised of individual subsector value chains to create a holistic end-to-end agri-food value chain.

Analyzing value chains can provide significant insights into an industry and its participant firms, and can overcome several shortcomings of traditional sector analysis (Klapisky, 2002). As Klapisky et. al. note about economic research, "for in restricting itself to sector analysis, it struggles to deal with dynamic linkages between productive activities that go beyond that particular sector, whether they are of an inter-sectoral nature or between formal and informal sector activities." While many studies have been conducted on individual agri-food sectors, very few have focused on mapping and analyzing subsector value chains. Doing so can provide insights which may not be fully visible in a traditional sector analysis.

Further, mapping the value chain and transforming it into a quantitative model can reveal how the value chain is a repository for rents, governance structures dictate conduct across firms, and historical rents and governance structures may have impacted rents over time (Klapisky, 2002). While a value chain analysis provides deep insight, a gap exists with respect to conducting significant and meaningful value chain analysis on the U.S. agricultural industry. A more detailed literature review of the application of value chain analysis methods by other researchers is provided in the Section 2.8 of this literature review. For now, this review returns to economic concepts, specifically industry value added, which are relevant to understanding the U.S. animal protein industry and the current state of economic analysis within agri-food value chains.

2.4 Value-adding in the agri-food chain

This study relies on the IBISWorld estimate of industry value added which is quantified by calculating an industry's market value of goods and services and subtracting the cost of goods and services used in the productive process. More specifically, this value is calculated using the following identity: revenue plus the increase (or decrease) in the value of stocks, minus purchases, transfers in and selected expenses (IBISWorld, 2019). These calculations are given more attention in the methodology section, however it is important to note that the industry value added estimate from IBISWorld is aligned with the definition of value added commonly used by agricultural economists.

The root cause of industry value added, economic rents, is generated in several ways. At the root, economic rents are generated by differential value-creating factors such as entrepreneurship and barriers to entry (Klapisky, 2002). Rents can also be created through other mediums including technological capabilities, organizational capabilities, human capital, and marketing skills. In many cases, rent-producing activities are the core competencies of an industry's leading participants. In some cases, relational rents may be generated through group and firm cooperation across value chain nodes, which could be the case within a value chain like the U.S. animal proteins industry.

Agribusiness literature has traditionally emphasized that value is created when a firm changes a product's place, time, and/or form to characteristics more preferred in the marketplace (Coltrain, 2000) (Anderson, 2009). This study draws on the definition outlined by Cucagna et al (2017) which describes value adding as "an activity measure" (Cucagna, 2017). While it is valuable to understand the prevalence and level of rents in the value chain, it is also important to note that rents are dynamic and may change over time. In essence, understanding value chain rents involves monitoring and understanding creation across time versus just one observation in time. This study seeks to understand if relational rents are present, and if rents and the distribution of rents within the animal proteins industry has changed over time. Researchers have also found that value generation is differentiable across the input, farm, processor, and wholesaler major node groups of the agri-food value chain, but do not specifically dedicate a large body of work to understanding species or category-specific value chains such as animal proteins, tree fruits, or oilseed crops. This study seeks to expand the literature into category-specific value chains and further develop our knowledge of rents within the agri-food value chain.

2.5 Value-adding differs across agri-food nodes

The farm level stage of the value chain is typically characterized as having low product margins, high price dependence on market transactions, and low product differentiation (Cucagna, 2017). Over the last 70 years, the total number of farms has steadily decreased, and the contribution of large farms has grown in both quantity and gross revenue. Additionally, farms in general still depend heavily on the production and sale of commodity goods which, by nature, possess low differentiable qualities (USDA Economic Research Service, 2019). The price of commodity goods is also highly dependent on a function of consistency and quality (Phillips, 2007) (Carlson, 2004). In addition to farm consolidation, farms are also increasingly more reliant on vertical integration or contractual arrangements, especially within the animal protein value chain, which may improve efficiency and create more value for farms (Hendrikse, 2002) (Sporleder, 2006). However, in some instances, smaller farms may not be able to take advantage of the economies of scale available to large farms as a result of their contractual relationship with firms in downstream nodes (Humphrey, 2006) (Lobao, 2001). One example is the potential quantity discounts for feed or labor contracts. If the farmer is in a vertical integration arrangement, quantity discounts would be captured by the integrator, not the farmer, regardless of the farm's size. The question then arises – if animal protein producers are more reliant on contract relationships and have strong alignment with integrators, do they experience similar, or nearly the same, market outcomes as commodity crop or non-contracted producers ceteris paribus?

In an earlier piece of work, Boehlje et al (1999) describes how processor control may impact value creation. "In any supply chain, the source of power and control in that chain is to a significant degree a function of the most unique or least substitutable resource. In essence the owner of the least substitutable resource has the most power to capture rents, transfer risk to others and have significant impact on what the chain does or does not do." (Boehlje M. S., 1999) Within animal proteins, this sounds very similar to the actions taken by processors. A counterclaim to Boehlje's "lynch-pin" value capturing theory is that processors are also one of the most value-additive by traditional economic definitions by altering appearance, storage life, nutritional value, and content of the raw materials (Gopinath, 1996). By their very essence, processors add economic value to their products simply by the transformations they are created to perform. Increasingly, companies in this node also focus on branding and differentiated products which also creates additional value (Omidvar, 2006). If these same "high-value-adders" also have ownership over significant resources in the value chain as Boehlje et. al. note, they may be capturing an extremely high portion of the total value added across the chain.

When considering the value creation creditable to the wholesale node, it is important to revisit how value is created. Value creation is derived by transforming a good or service's place, time, and/or form (Coltrain, 2000) (Anderson, 2009). By their very nature, place and time value are typically less significant than form transformations. This would lead one to believe the wholesale node produces very little value in the total chain. However, there is evidence to suggest that increased market power as a result of increasing concentration and consolidation may increase wholesalers' portion of value captured within the chain (Humphrey, 2006) (Viaene, 1995). Additionally, firms in this node are able to derive value by innovating through service and retail brands to more effectively meet consumer demands (Burch, 2005) (Humphrey, 2006). In this case, wholesalers may be creating and capturing more value than economists previously believed.

2.6 Intra-node dynamics driving value addition

Understanding value creation between major nodes is only one element of understanding value generation. Having a grasp on the characteristics and dynamics resulting from interactions within of each node can also explain sources of value creation and distribution across a value chain. While this level of analysis pivots more directly towards sector analysis, understanding the context of each node's internal dynamics, such as market concentration, can help illuminate why value is or is not being generated.

Market concentration has long been an indicator of market power and superior market performance (Porter, 1980). In addition to the traditional strategy economics approach of market power, there is also evidence to suggest that firm size influences the intensity of a firm's new product development efforts (Damanpour, 2010) (Hecker, 2013) (Zona, 2013). This suggests that large firms may be more creative because of their access to financial resources, technological possibilities, access to highly skilled labor, knowledge capability, and economies of scope and scale (Cucagna, 2017). This would manifest as higher levels of value capture for nodes with large firms. The growing market power of downstream firms may also limit upstream firms from moving to high-value-added activities such as distribution, marketing and retailing (Farfan, 2005) (Liu, 2014). Greater market power down the chain also allows for greater control over information flows and thus a competitive advantage for innovation and arbitrage (Farfan, 2005) (Humphrey, 2006). In these instances, nodes with higher concentration levels may be creating more value relative to other nodes in the chain. This very well could be the case in the U.S. animal protein sector where a few top firms dictate the structure, conduct, and performance of actors within their own and other value chain nodes.

2.7 Value chain governance structures

A major topic from economic literature relevant to this study addresses the types of relationships existing between firms across value chain nodes. Commonly referred to as governance structures, these relationships provide insight on how a value chain is controlled and coordinated when certain actors or nodes have more power than others. Within in this analysis, governance specifically is derived from the authority and power relationships that determine how financial, material, and human resources are allocated and flow within the chain (Gereffi, 2016). When examining value creation in a value chain, it is critically important to understand what governance structures exist and how they may impact overall industry performance. Researchers defined five specific types of governance structures within the global economy: market, modular, relational, captive, and hierarchy. The following five paragraphs articulate definitions are directly credited to Gereffi et. al. of Duke University (Gereffi, 2016).

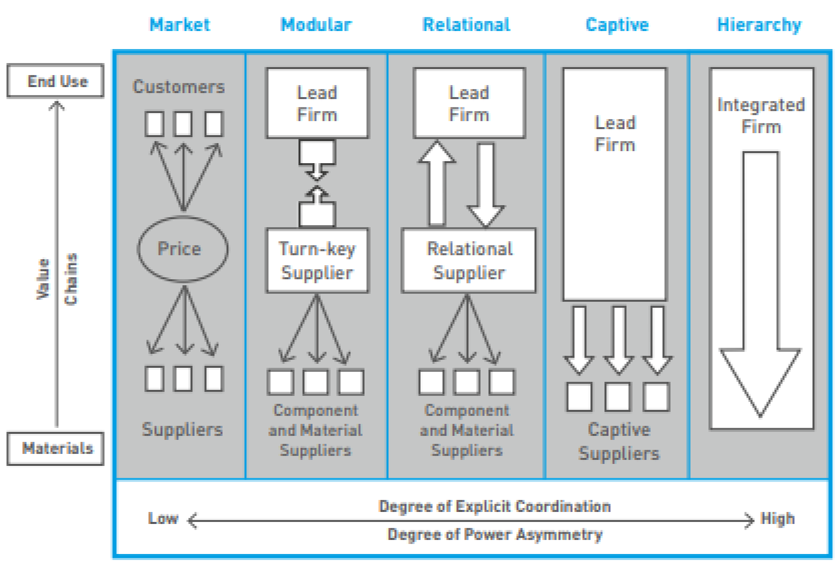


Figure 4: Five types of governance structures identified by Gereffi et. al. (2015)

"Market governance involves transactions that are relatively simple. Information on product specifications is easily transmitted, and suppliers can make products with minimal input from buyers. These arms-length exchanges require little or no formal cooperation between actors and the cost of switching to new partners is low for both producers and buyers. The central governance mechanism is price rather than a powerful lead firm." (Gereffi, 2016)

“Modular governance occurs when complex transactions are relatively easy to codify. Typically, suppliers in modular chains make products to a customer’s specifications and take full responsibility for process technology using generic machinery that spreads investments across a wide customer base. This keeps switching costs low and limits transaction-specific investments, even though buyer-supplier interactions can be very complex. Linkages (or relationships) are more substantial than in simple markets because of the high volume of information flowing across the inter-firm link. Information technology and standards for exchanging information are both key to the functioning of modular governance.” (Gereffi, 2016)

“Relational governance occurs when buyers and sellers rely on complex information that is not easily transmitted or learned. This results in frequent interactions and knowledge sharing between parties. Such linkages require trust and generate mutual reliance, which are regulated through reputation, social and spatial proximity, family and ethnic ties, and the like. Despite mutual dependence, lead firms still specify what is needed, and thus can exert some level of control over suppliers. Producers in relational chains are more likely to supply differentiated products based on quality, geographic origin or other unique characteristics. Relational linkages take time to build, so the costs and difficulties required to switch to a new partner tend to be high.” (Gereffi, 2016)

“In these chains, small suppliers are dependent on one or a few buyers that often wield a great deal of power. Such networks feature a high degree of monitoring and control by the lead firm. The power asymmetry in captive networks forces suppliers to link to their buyer under conditions set by, and often specific to, that particular buyer, leading to thick ties and high switching costs for both parties. Since the core competence of the lead firms tends to be in areas outside of production, helping their suppliers upgrade their production capabilities does not encroach on this core competency, but benefits the lead firm by increasing the efficiency of its supply chain. Ethical leadership is important to ensure suppliers receive fair treatment and an equitable share of the market price.” (Gereffi, 2016)

“Hierarchical governance describes chains characterized by vertical integration and managerial control within lead firms that develop and manufacture products in-house. This usually occurs when product specifications cannot be codified, products are complex, or highly competent suppliers cannot be found. While less common than in the past, this sort of vertical integration remains an important feature of the global economy.” (Gereffi, 2016)

These well-constructed definitions of value chain governance structures have not previously been applied thoughtfully to the U.S. animal proteins industry. This thesis will close the gap in literature to establish an initial analysis of relationships in the U.S. animal protein value chain.

2.8 Quantifying the agricultural value chain

The historical context for mapping and quantifying the U.S. agri-food value chain is rooted in Goldberg’s seminal work which mapped the end-to-end agri-food value chain (Goldberg, 1968). Goldberg’s commodity system approach (CSA) first emphasized the sequence of activities and transformations that converted inputs into final consumer goods. Researchers then began to conceptualize the agricultural value chain as a sequence of interconnected nodes comprising one connected agri-food chain imbedded in the general economy.

Researchers then pivoted to outlining the fundamental concepts and elements of a value chain. Specifically, Boehlje et. al. sought to define the value chain as a specific group of value creating activities with explicit structure for node linkages (Boehlje M. S., 1999). Boehlje et. al. also addressed the topic of value generation and noted, “In dynamic markets where new innovations are constantly occurring, the value of a product, attribute, or service will change over time.” Within this definition, Boehlje et al also identify five fundamental sources of value decay including loss of property rights, substitution, replacement, commoditization, and mitigation (Boehlje M. S., 1999). Quantitatively understanding how these five fundamental sources of value decay link to changes in value creation in the animal protein industry would also help us better understand the impact of varying governance structures and intra node dynamics.

Other agricultural economists have developed and implemented methods to quantify supply chains. The final deliverable is typically a tree of input-output flows that carry all the information gathered across the value chain (Klapisky, 2002). To procure much of the desired input information, researchers use various primary and secondary sources including annual reports, balance sheets, and interviews with subject matter experts involved in the value chain under analysis. Kaplinsky and Fitter (2001) leveraged these source types to quantify value generation along the coffee production chain. They employ data visualization and market quantification techniques to map geographic differences in value generation and capture (Kaplinsky, 2001). While they focused specifically on value creation, they did not extend their analysis to systematically quantify the entire value chain and further document how the major value chain nodes – inputs, farming, processing, wholesaling – create potentially differentiable levels of value across the chain.

While not directly used within this study, Dr. Marcos Fava Neve's work on mapping and quantifying value chains did inspire some of the proceeding analysis. Neves (2011) recommends three structural elements for describing a network: members, the structural dimensions, and link types. Members of the network accounts for primary players including whole companies or individual business units. Structural dimensions accounts for horizontal structure, defined as the number of tiers from suppliers to customers, and vertical structure, defined by Neves as the number of members in the same tier. Link types, a more minor focus in this process, are categorized as managed process, monitored process, unmonitored process, and non-member process links (Neves, 2011). Fava Neves (2011) also developed the GESis method to conduct economic accounting activities. The analysis is frequently used to inform Brazilian industry and public-policy decision-makers about specific food and agribusiness value chains. While not used within this study, it is important to discuss this study as it provides precedence for quantifying agri-food value chains as end-to-end chains.

The core methodology for this study, profit pool analysis, was derived from a contemporary management book, The Breakthrough Imperative (Gottfredson, 2008). Conducting a profit pool analysis begins by carefully defining the appropriate industry value chain based upon the value chain span under investigation and the analyst's desired level of complexity. Then, a profit pool analysis involves calculating the industry's total profit by aggregating revenue and a measure of profit, typically operating margin, of a sample of companies in the industry to estimate of the industry’s total revenues and profits. This study uses earnings before profit as the basis for financial performance, but other options such as gross margin, operating profit, and earnings before interest and taxes are appropriate given an analyst’s needs. The process continues with estimating the profit at each stage of the value chain. This requires disaggregating profit data for mixed players (those engaged in multiple activities across the value chain) and pure players (specialists in a single value chain activity). Finally, estimates are calculated using the collected data, and a Delphi analysis with industry veterans and experts. In some cases, the data collection and accounting activities are conducted by industry research firms who specialize in aggregating and estimating industry-level data. In other cases, some of the desired data can be extracted from annual reports and individual studies. However, there have not been widescale efforts to produce estimates on entire value chains for public dissemination. This study seeks to leverage the profit pool methodology, address the previous hypotheses, and attempt to close the identified gaps in literature through the lens of the U.S. animal proteins industry.

3. METHODS AND DATA

This technical note details the methods and data used in *Value Generation and Capture in the Agri-Food Value Chain*. The first section discusses the profit pool methodology and approach. The second section outlines the data and economic analysis used to test each hypothesis.

3.1 Profit pool methodology

3.1.1 Method overview and high-level process design

Executing the U.S. animal protein profit pool analysis involved five major steps. (1) Defining the value chain to be analyzed by pinpointing the overall value chain, and the head and tail nodes. This constrains the analysis to the appropriate span and layers and helps to produce the analyst's desired level of complexity. (2) Identifying nodes comprising the chain by listing all nodes directly participating in the value chain and within the head and tail bounds previously identified. (3) Estimate the revenue for each node by leveraging secondary data sources. If the secondary data source provider has not already, this step also requires disaggregating profit data for mixed players (those engaged in multiple activities across the value chain) and pure players (specialists in a single value chain activity). (4) Estimate profit performance for each actor group using secondary data sources. In many cases, industry benchmarks are summarized using NAICS (North American Industry Classification System) code system which simplifies the summary and analysis process. (5) Use the revenue and financial performance estimates from step 3 and 4 to estimate industry and node profits. These five steps help produce a quality profit pool estimate and generate a dataset for further hypothesis testing.

3.1.2 Defining the animal protein industry

The value chain under analysis consisted of nodes participating in the U.S. animal protein industry and upstream from consumer-facing retail. Out of scope nodes included feed and animal pharmaceuticals, and associated subsectors such as dairy products and synthetic proteins. Additionally, industries experiencing second-order effects, such as agricultural finance and farming equipment, were excluded. See Appendix A for a visualization of the value chain.

3.1.3 Identifying nodes in the animal protein industry value chain

High-level nodes were identified by mapping the major animal protein industry activities in the source-to-consume process. Value chains were then mapped for the three primary animal protein value chains in the U.S. - beef, pork, and chicken - and aligned with NAICS industry codes. Detailed mappings for each species-specific value chain can be found in Appendix B. The NAICS-aligned nodes were then used as the industry-wide nodes within this study. This reduced the number of observable spans and layers for analysis but presented considerably more sound data than other potential estimation and data collection techniques. It should be noted that no unique NAICS codes exist for rendering and meat byproduct processing. However, the major data provider for this study, IBISWorld, does produce a list of customized industry reports using a proprietary list of industry codes in which OD5787 represents the U.S. Rendering & Meat Byproduct Processing industry. See Appendix A for a detailed reconciliation of NAICS industry codes with the value chain nodes.

3.1.4 Valuing revenue for each node

Information asymmetry, conglomerate reporting, and vertical integration are significant barriers to executing a profit pool analysis, particularly in the U.S. animal protein industry value chain. IBISWorld, the data provider for the industry revenue and value added estimates used in this study, specifically addresses these measurement concerns using proprietary modeling techniques. IBISWorld brings together public, private, and industry information to generate over 700 unique industry reports annually. The firm generates reports using public data from the U.S. Census Bureau, U.S. County Business Patterns, Bureau of Economic Analysis, Bureau of Labor Statistics, and Securities and Exchange Commission (SEC) filings. Proprietary in-house data and statistical models are developed using public data and data representing macroeconomic variables, upstream and downstream supply chain links, demographic and customer data, and the demand for substitute goods and/or services.

Analysts then make manual adjustments to their findings using information collected from industry interviews, associations, and non-public data sources. In some cases, revenue and industry value added estimates were adjusted for this study to account for product segments relevant to the animal protein value chain. For example, revenue and industry value added for broiler breeder farms was sourced from the IBISWorld Chicken Egg Production industry report. One potential vulnerability of this method is that layering data with product segment data could bias the individual node's revenue and industry value added estimate. For example, broiler breeders are valuated using the chicken egg industry data which includes table and hatching eggs. Producing a table egg versus a hatching egg may generate different value which is not captured in the product segmentation data. Since the product segmentation data is calculated for industry revenue only, some caution should also be used when analyzing the industry value added data. (IBISWorld, 2019) (IBISWorld, 2009)

3.1.5 Estimating financial performance for each node

Financial benchmarking data was sourced from The Risk Management Association (RMA) Annual Statement Studies Financial Ratio Benchmarks. The RMA, a consortium of U.S. financial institutions, collects more than 260,000 financial statements from member financial institutions that represent financial performance of their commercial customers and prospective clients. Summary financial ratios are curated using level two through six NAICS codes. For the purposes of this study, the only relevant financial ratio was operating profit ratio which is calculated as gross profit minus operating expenses divided by total revenue. See the figure below for a detailed explanation of RMA's definition of operating profit.

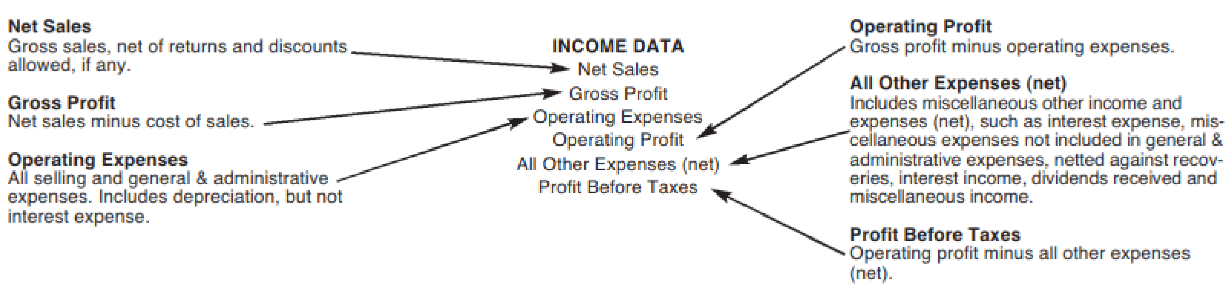


Figure 5: The Risk Management Association accounting identity schema (Source: RMA)

The RMA recommends using the financial ratio benchmarks data as a general guide, but not necessarily the industry norm. Several reasons could lead to potential bias:

1. **Data not random**: Financial statements are collected by RMA and consolidated to produce the reported benchmarks. Since the firms submitting financial documentation self-select and, in most cases, are applying for financing, there may be bias in the set.
2. **Categorized by primary product only**: Company financial statements are categorized by primary product lines and may be biased by companies with varied product lines.
3. **Small samples**: The observed financial statements for each NAICS code may be small in comparison to the total population of firms in the industry.
4. **Extreme statements**: A financial statement with outlier-like performance may exist in the dataset and could disproportionately impact the summary statistics, particularly for industries with fewer financial statements.
5. **Operational differences**: Companies in the set may have differing operational and management techniques which may directly impact their financial performance and the resulting benchmarks.
6. **Additional considerations**: The RMA also cautions some bias may be present in financial performance based upon labor markets, geographic location, different accounting methods, quality of products, sources and methods of financing, and terms of sale.
7. **Upper limit on total assets**: RMA only publishes data on companies with less than $250 million in total assets. In some cases, this may exclude some of the largest players an industry such as animal protein processors. This data limitation is addressed later for both the processor and renderers nodes.

These concerns are valid. However, in the absence of larger, statistically random, and precisely categorized financial performance statements, the positive insights derived from the RMA datasets far outweigh its limitations. Additionally, the RMA dataset is combined and compared with other datasets multiple times throughout this study. In those instances, there was no reason for concern that radically different conclusions would be reached or indicate potential data inaccuracy. Finally, the datasets were compared to other sources of financial performance data and sources focused on the agricultural value chain, and the comparisons brought no real reason for concern. For these reasons, this study more confidently relies on the RMA data to produce insights under the explicit caveat that the underlying data, per RMA's statement, should be used “only as general guidelines and not as absolute industry norms” and the estimates produce “in the ballpark” rather than explicit financial performance data.

3.1.6 Calculating individual node and animal protein industry profits

Once the data has been sourced, calculating the individual node and animal protein industry profits required a simple calculation. Revenue estimates for each node were sourced from IBISWorld and segmented as needed using product segment estimates. Segmentation produced a total node revenue estimate for each node relevant to the U.S. animal protein industry value chain. For example, the IBISWorld estimate for the chicken egg industry node accounts for hatching and table eggs. In this case, only the share of revenue contributed by hatching eggs are used to account for broiler chicken farming. The node revenue from IBISWorld was then multiplied by the operating profit ratio from the RMA Statement Study dataset to produce profit estimates. For industry value added, the IBISWorld dataset is used by dividing total industry value added by total industry revenue. This produced the final profit and industry value added estimates for each node. All node estimates were summated to produce the animal protein industry revenue, value added, and operating profit estimates. This process was duplicated for 2009-2018 to produce a ten year dataset.

3.1.7 Assessing node revenue and financial performance estimates

Using IBISWorld datasets limited the need for stringent reconciliation and quality control beyond crosschecking with similar data sources for similar estimates and datapoints. Crosschecks presented no reason for concern. Final estimates underwent several reviews with academic and industry specialists to rationalize and affirm final profit pool estimates. Using this process, we have reasonable confidence that the data and analysis are directionally accurate contingent to any potential error or misestimation in the original IBISWorld datasets, and the limits of the RMA dataset previously discussed.

3.2 Addressing individual hypotheses

3.2.1 Hypothesis 1 – Value above the cost of goods sold differs between value chain nodes as the primary activity for each node is differentiable in the source-to-consume process

This hypothesis implies that each node in the U.S. animal protein value chain will produce a different level of value added as a proportion of total revenue. Revenue and industry value added estimates were generated by IBISWorld and segmented as previously mentioned. Three charts were produced to test this hypothesis. The first was a mekko bar chart using the 2018 value added and revenue estimates. Bar width is equal to the proportion of total industry revenue and the height equal to the ratio of industry value added to total revenue. The second chart displayed industry revenue over the last ten years using a stacked bar chart. The third chart is an identically formatted chart using industry value added data.

3.2.2 Hypothesis 2 – Farm level nodes have the lowest level of value addition as they sell homogeneous products into a highly competitive supply-demand environment

This hypothesis implies that farm level nodes have the lowest level of value addition compared to all other major nodes. To address this hypothesis, IBISWorld industry value added estimates were summarized by high-level nodes: animal inputs, farming, transformers, and wholesalers. Animal inputs included the breeding services and genetics, broiler breeder farms, and cattle and hog stockers & breeders nodes. Farming included the hog farming, broiler chicken farming, and beef cattle farming & feedlots nodes. Transformers included the meat, beef & poultry processing, leather tanning & finishing, and rendering & meat byproduct processing nodes. Wholesaling included the chicken meat wholesaling, and beef & pork wholesaling nodes. The first chart was a stacked bar chart showing the total industry value added in absolute terms between 2009 and 2018. The second chart displayed total industry value added as a percent of total industry revenue. This method more adequately represents the industry value added contribution by node in relation to the total revenue generated by each node.

3.2.3 Hypothesis 3 – Processing is the highest value adding activity given the presence of differentiated products, supply chain governance, and significant market concentration

This hypothesis suggests processors capture the highest levels of value addition due to asset specificity and significant influence over the value chain. Four charts were produced to investigate this hypothesis. The first was a value chain map showing the traditional span of influence held by vertical integrators across each of the species-specific value chains. These chains were constructed using the author's first-hand experience and reviewed by industry experts. Governance structures were identified using the descriptions developed by Gereffi et al (2016). The second chart relied on the RMA Annual Statement Study data to show cost of goods sold as a percent of total revenue. Previous research indicates that cost of goods sold as a percent of total revenue is a reasonable proxy for product differentiation. The Meat, Beef and Poultry Processing node which was calculated using public company financial benchmarking data, and Rendering & Meat Byproducts node which was represented using Darling Industries as the proxy. Solely relying on RMA data for the processors and rendering nodes would have excluded some of the industry's largest and most significant players. For example, Darling Industries represents nearly half of the total applicable rendering market. Since Darling Industries is not represented in the RMA data and is the only pure-play firm in the node, it is reasonable to use its financial performance as a proxy for node financial performance. The third and fourth charts are duplicates of those used in hypothesis two to show industry value added in absolute terms and as a percent of total revenue across the major nodes.

3.2.4 Hypothesis 4 – Wholesale gross margin is the most variable as it has relatively low market power and adds only time and place utility

This hypothesis suggests that wholesalers add relatively little value to the U.S. animal protein value chain. While this could be assessed using the profit pool estimates, using the USDA Meat Price Spreads data yields deeper insight. The dataset presents average monthly prices, and the differences among those values, at the farm, wholesale, and retail stages of the production and marketing chain for selected cuts of beef, pork, and broilers (US Department of Agriculture, 2019). Retail prices are provided from the U.S. Bureau of Labor Statistics Consumer Price Index, and wholesale and farm values are from USDA's Agricultural Marketing Service (US Department of Agriculture, 2019).

Monthly beef and pork prices at the farm, wholesale, and retail prices, and monthly broiler prices at the wholesale and retail level were collected from the USDA Meat Price Spread dataset from January 1998 to December 2018. Gross margin was then calculated by treating the previous value chain node as the baseline cost of goods sold for the node under observation. For example, beef wholesale price minus beef farm price yields beef wholesale gross margin. The same calculation was performed across all three species and levels available. The coefficient of variation was then used to assess the variability of prices and gross margin across all three species and gross margin estimates.

The coefficient of variation, defined as the standard deviation divided by the average, is a relative measure of variability as a percentage or proportion of the average (Siegel, 2012). The formula is as follows:

$$Sample\ Coefficient\ of\ Variation\ = 100\left(\frac{S}{\bar{\bar{X}}}\right)$$

Standard deviation in the numerator produces a unitless ratio that is primarily an indicator of variability. This makes the coefficient of variation a strong proxy for the balance between risk and reward in a market price or investment portfolio. Scaling the coefficient by 100 simply transforms the number into a number friendlier for general audiences. Using this coefficient enables an analyst to directly compare prices and gross margin across nodes and species which, all else equal, should be nearly equal as the hypothesis suggests.

The first output to test this hypothesis was a bar chart showing the price coefficient for all available farm, wholesale, and retail prices using data from the last 20 years. The second output was a chart showing gross margin between each major price – wholesale and retail. This process was replicated for pork and beef to compare if variation was higher or lower across species, and at the wholesale versus retail levels.

3.2.5 Hypothesis 5 – There is a positive relationship between market concentration and value creation

This hypothesis suggests that market concentration has a strong relationship between value creation because larger firms can innovate more effectively and dictate the structure, conduct, and performance of their own and other nodes. Two charts were produced to address this hypothesis. The first was a summary table showing if each node had low, medium, or high level of concentration. Concentration levels were sourced from the IBISWorld industry reports and revised as needed. All farming nodes were determined to have low levels of concentration as they have numerous participants of varying size and major players do not control a significant portion of the market. The genetic input supplier node and wholesale node were determined to have medium levels of concentration. While they have regional market leaders, they lack a significant number of major players with national or international dominance. The processing and rendering nodes were both determined to have high levels of concentration because a very small number of firms control a very large portion of the U.S. market activity. Market concentration designations were then combined with the profit pool estimates to show the potential relationship between concentration and industry value added as a percent of total revenue.

3.2.6 Hypothesis 6 – There is a negative relationship between farm level value creation and captive supply

This hypothesis implies that captive supply negatively impacts value creation because other nodes can impair rents that would otherwise be captured by the farm level nodes. Three charts were produced to test this hypothesis. The first chart summarizes captive supply levels for beef, pork, and chicken. Beef and pork captive supply were calculated as the percent of packer purchasing which was not sold on some type of negotiated scheme in 2014 (Adjemian, 2016). Chicken captive supply was assumed to be 100 percent captive supply as there are no major U.S. processors who purchase chickens using negotiated or spot bidding. The second chart summarized industry value added as a percent of total revenue for the last ten years for all three farming nodes – hog, broiler, and cattle farming using the IBISWorld dataset. The third chart summarized the coefficient of variance for operating profit across each of the farming nodes. This provided insight into the consistency of profits across different buying schemes and captive supply levels, and if captive supply may influence the consistency of profits.

3.2.7 Hypothesis 7 – There is a negative relationship between farm level value creation and interest rates

This hypothesis implies that there is a relationship between value creation and interest rates. U.S. animal protein farms use debt as a sizable contributor to capital structure so understanding the impact of interest rates would be valuable for assessing how rate changes might impact value generation. The first chart uses data from the USDA Economic Research Service's Farm Income and Wealth Statistics Current / Non-Current Balance Sheet for debt data and the Returns to Operators, U.S. and State for interest expense data. The implied interest rate was calculated as total farm interest expense divided by the average of beginning and ending farm debt values for the current year. The USDA Economic Research Service's Farm Income and Wealth Statistics Value Added Years by State dataset served as the primary source for farm level value generation and was a summation of the production cash receipts for meat animals, and poultry and eggs line items. The second chart plots year-over-year change in implied interest rate and year-over-year change in the farm level value of animal products production.

3.2.8 1.2.8 Hypothesis 8 – Downstream activities have higher economic profit during periods of increased farm income

This hypothesis implies that value chain dynamics enable downstream nodes to capture a larger share of industry profits during periods of increased farm income because downstream nodes can dictate the terms and prices of trade across the value chain. The first chart shows the relationship between industry value added from IBISWorld and farm level gross cash income from animal products. Gross cash income for animal products was sourced from the USDA Economic Research Service's Farm Income and Wealth Statistics – Value Added Years by State dataset. It was calculated as the sum of meat animals, and poultry and egg line items under the animal and products cash receipts header. The second chart shows the correlation coefficient between percent change in farm level gross cash income from animal products and the percent change in value added for each of the major nodes. If the hypothesis is valid, farm income and downstream nodes should be positively correlated.

3.2.9 Hypothesis 9 – A lag effect exists in transferring production costs down the value chain as a result of the biological production cycle and value chain power dynamics

This hypothesis implies that value chain dynamics limit the transferability of input cost increases down the chain because downstream nodes can dictate the terms of trade and prices across the value chain. The USDA GRAINS database provides statistics on animal unit indexes of grain which can serve as proxies for changing farm feed input costs. Three ratios were used for the hog, cattle, and broiler farming nodes. The hog/corn ratio is the number of bushels of corn equal in value to 100 pounds of hogs, live weight (USDA Economic Research Service, 2017). The steer and heifer/corn ratio is the number of bushels of corn equal in value to 100 pounds of steers and heifers, live weight (USDA Economic Research Service, 2017). The broiler/feed ratio is the number of pounds of broiler grower feed equal in value to one pound of broilers, live weight (USDA Economic Research Service, 2017). Monthly hog/corn ratio and steer and heifer/corn ratio data was pulled beginning in January 1970 until December 2018. Broiler/feed ratio data was pulled beginning in January 1990 until December 2018, the largest date range available. USDA Meat Price Spread data for the corresponding dates was sourced for hog and cattle farm, wholesale, and retail prices, and broiler wholesale and retail prices. Month-over-month percent change was then calculated for each index and price.

The first chart summarizes instantaneous correlations between the cost indexes and market prices. If price transmission is instantaneous, the correlation coefficient should be strong and positive. However, this may not be the case if a temporal biological production lag exists between when costs at the farm level are incurred and the time those animals come to market. To compensate, the feed index and price index were offset by a period relative to the typical production cycle for each species – two months for broilers, six months for hogs, and eighteen months for cattle. The lagged correlation coefficients are presented in a second chart.

3.2.10 Hypothesis 10 – Farm level value creation is most negatively impacted by periods of decreased export quantities

This hypothesis implies that farm value generation is impacted most significantly by periods of decreased export qualities because downstream nodes can dictate the terms and prices of trade across the value chain. Species-specific export volumes were sourced from the USDA Livestock and Meat Domestic Data collection. Export volumes for broiler meat, beef, and pork were procured for the last ten years and summarized in the first chart. The second chart combines the IBISWorld industry value added estimates for each farming node and the export data from USDA to show a potential relationship.

4. ESTIMATIONS AND ANALYSIS

4.1 Results of Hypothesis 1

Hypothesis 1: Value above the cost of goods sold differs between value chain nodes as the primary activity for each node is differentiable in the source-to-consume process

The purpose of this hypothesis was to determine if each node in the U.S. animal protein value chain would produce a different level of value added as a portion of total revenue. As Figure 6 and 7 show, nodes produce different levels of value across the chain as a proportion of total revenue. The second set of charts show that sizable differences are not persistent in value generation over time, however they do show higher volatility within the farm level nodes versus other parts of the value chain.

The results of this hypothesis imply that there are underlying dynamics allowing different nodes to produce higher levels of value compared to others. For example, wholesaling produces sizably smaller levels of value as a percent of total revenue compared to farm level nodes. Additionally, the charts show processors pass through a sizable portion of the over $400 billion of total revenue flowing through the value chain nodes.

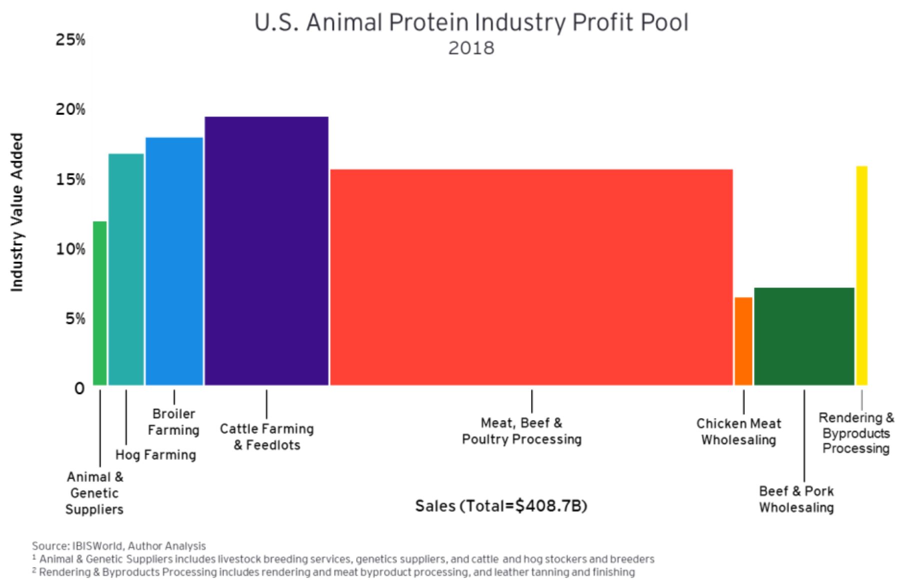
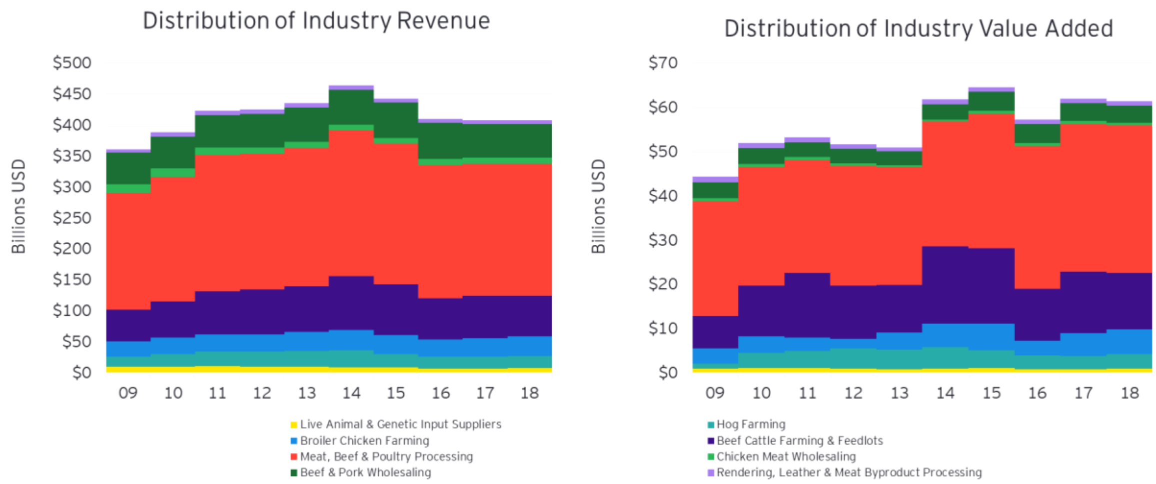


Figure 6: U.S. animal protein industry profit pool in 2018



Source: IBISWorld, Author Analysis
[1] Animal & Genetic Suppliers includes livestock breeding services, genetics suppliers, and cattle and hog stockers and breeders
[2] Rendering & Byproducts Processing includes rendering and meat byproduct processing, and leather tanning and finishing

Figure 7: Distribution of industry revenue and industry value added

4.2 Results of Hypothesis 2

Hypothesis 2 – Farm level nodes have the lowest level of value addition as they sell homogeneous products into a highly competitive supply-demand environment

This hypothesis was intended to determine if farm level nodes have the lowest level of value addition compared to all other major value chain nodes. The stacked bar chart on the left displays industry value added in absolute terms for the last ten years and shows that the farming group of nodes do not have the highest level of value added in absolute terms, but instead transformers. In this case, the hypothesis could be concluded as false. This conclusion, however, would be misleading as it does not control for the total revenue pass through for each node. Concluding farmers are not the highest value creators at this point would be misleading – they may contribute the highest level of value added relative to the total revenue the node passes through for the overall chain.

To compensate for this bias, industry value added by node is divided by total node revenue. This more adequately represents value added as it is relative to each node's total revenue. Under these conditions, industry value added is highest in the farming node. This may be a result of the high value added by transforming inputs into ready-to-slaughter animals and the underlying accounting identity which does not capture fixed costs associated with operating a farm. These findings confirm the hypothesis and show that farming does generate the highest level of value within the animal proteins value chain.

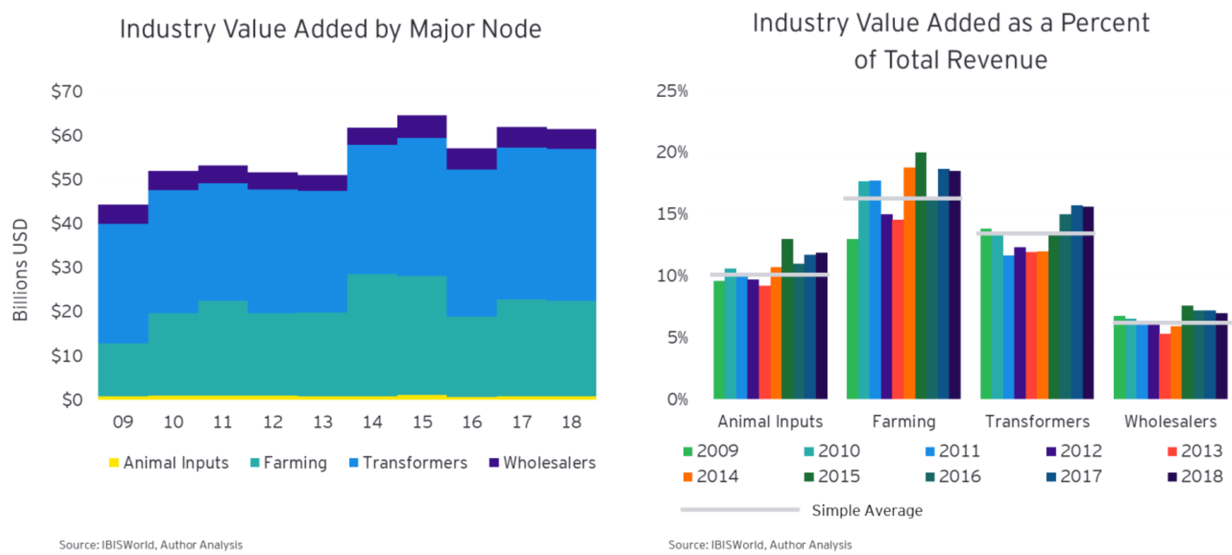


Figure 8: Value added in absolute and percent of revenue terms, specifically farming

4.3 Results of Hypothesis 3

Hypothesis 3 – Processing is the highest value adding activity given the presence of differentiated products, supply chain governance, and significant market concentration

This hypothesis suggested processors capture the highest level of value addition due to asset specificity and significant influence over the value chain. The first chart shows a visualization of each species-specific value chain and governance structures between nodes. This builds upon previous research by defining the type of governance relationships between each node. It also shows the specific span of influence which integrators have across the chains. As anticipated, the broiler value chain has the highest number of nodes influenced by vertical integrators. This finding helps to affirm that vertical integrators, which were almost exclusively founded as transformers, influence a significant portion of all three species-specific value chains.

The second chart provides data to analyze the assumption that nodes with a lower ratio of cost of goods sold to revenue have a higher level of product differentiation. The general assumption is that farms should have the lowest level of diversification because they simply sell livestock and transformers should have the highest level because they provide form utility and significantly alter the physical form of its inputs. Under this proxy theory, the analysis shows farms are the most diverse. This analysis suggests instead that cost of goods sold as a percent of total revenue is not an adequate indicator of output diversification within the animal protein value chain. This could, however, be caused by the data’s construction. For the RMA statement studies, firms choose their primary activity for NAICS classification versus segmenting their activities. Nonetheless, this evidence suggests it is as an inadequate proxy.

The third and fourth chart are identical to those produced to test hypothesis two. The first chart shows that in absolute terms, transformers do provide the highest level of value addition across the chain. As in the previous hypothesis, it was important to de-bias the conclusion by calculating the percent value added per dollar unit of revenue which is represented in the fourth chart. In this case, transformers do not add the highest level of value. The hypothesis is confirmed in absolute terms but rejected in relative terms. This tells us that transformers produce the highest level of value addition but not as a percent of total revenue. While this may make potential investment opportunities look less attractive, transformers may have the ability to perform higher on an EBIT basis than a value added basis compared to other nodes as a result of their ability to optimize capital investments and reduce fixed cost expenses. This may be a topic for future researchers to investigate.

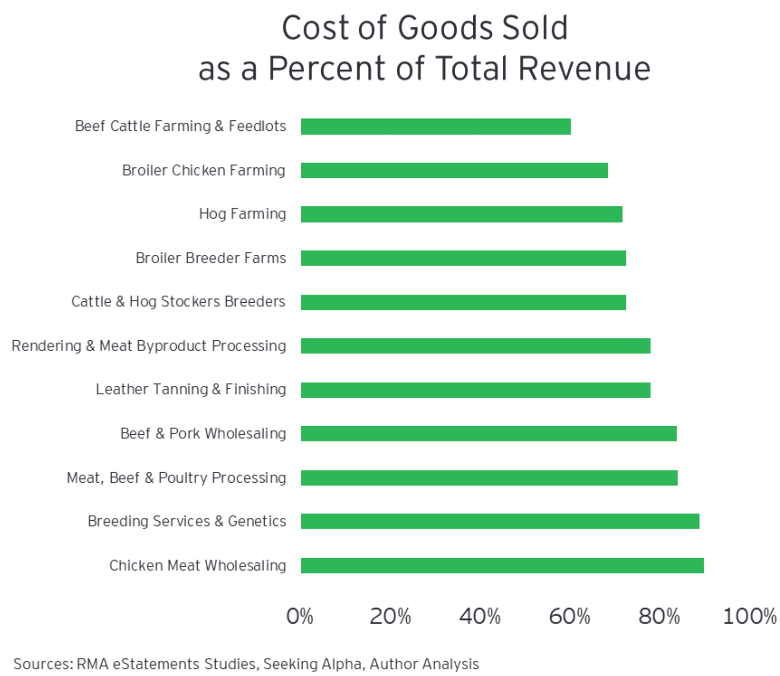


Figure 9: Summary of cost of goods sold as a percent of total revenue for each node

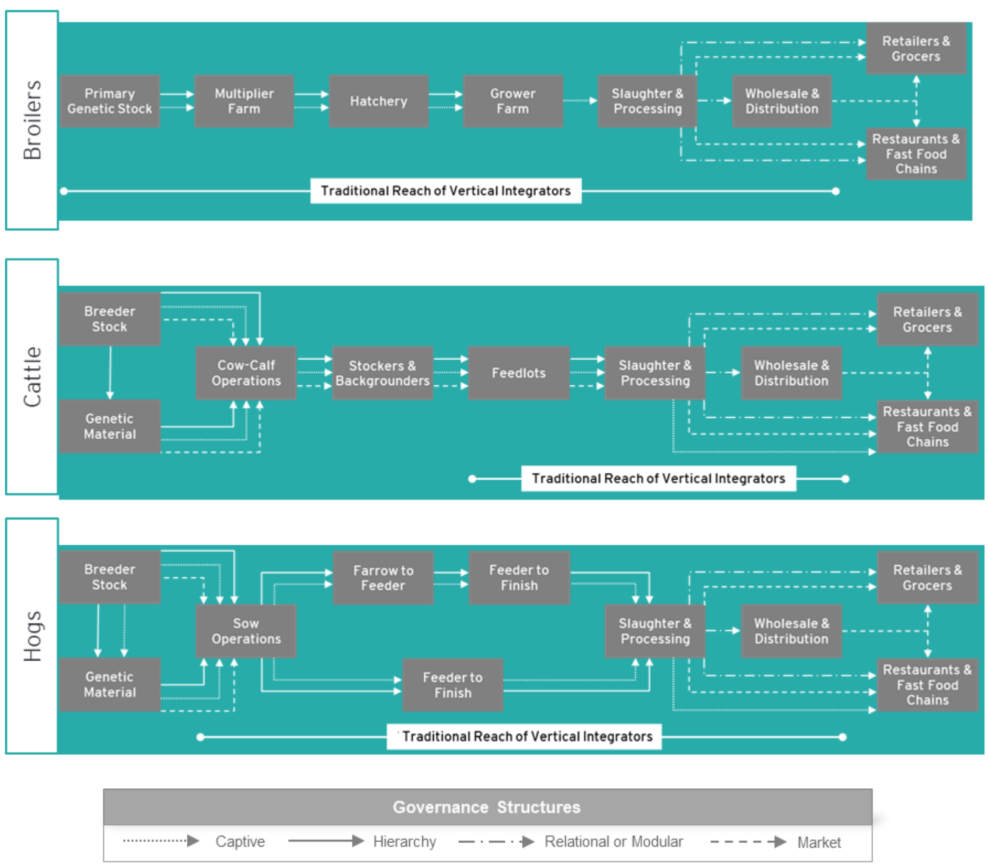
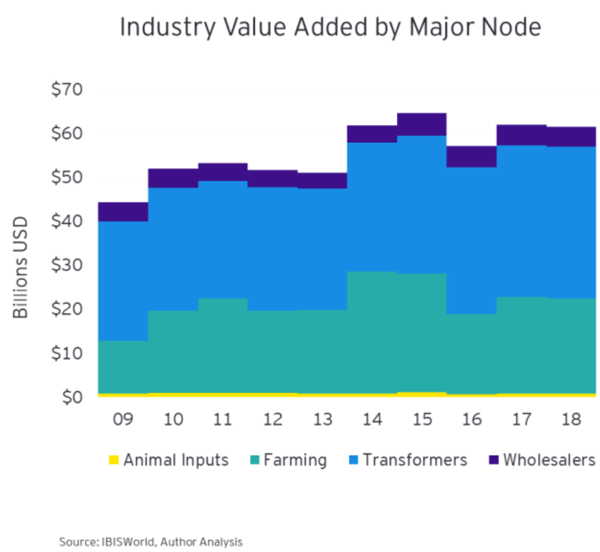


Figure 10: Species-specific value chains and governance structures



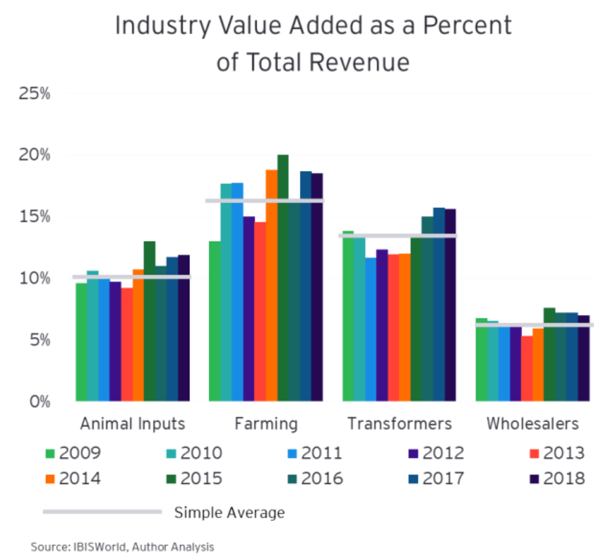


Figure 11: Value added in absolute and percent-of-revenue terms, specifically processing

4.4 Results of Hypothesis 4

Hypothesis 4 – Wholesale gross margin is the most variable as it has relatively low market power and adds only time and place utility

This hypothesis suggests that wholesalers add relatively little value to the animal protein value chain and as a result have the most variable gross margin because they rely on time and place arbitration to drive value, and possess low market power within the value chain. The first chart summarizes the coefficient of variance calculations for the prices at the farm, wholesale, and retail level for each species. It shows that broiler and pork values are the most variant over the 20 years of monthly data analyzed. This is counterintuitive as beef would be expected to be the most variant since vertical integrators have the narrowest span of influence in the beef value chain and the broiler value chain has the highest level of overall coordination. Another alternative explanation for the higher level of variance may be that the broiler and pork value chains are more responsive to changes in consumer willingness to pay. In this case, variance is not necessarily a negative for the value chain and price performance. Either way, this topic should be further investigated. The chart also shows that variability decreases as products move down the value chain from farm to wholesale to retail. This also provides interesting future research possibilities into why variability decreases as goods move down the value chain.

The second chart is the most relevant in addressing the hypothesis at hand. It shows the coefficient of variance for two figures in the pork and beef value chains – wholesale margin, which is the difference between wholesale and farm prices, and retail margin, which is the difference between retail and wholesale prices. Since gross margin is an indicator of profit potential, the coefficient of variance can be used as a proxy for how consistent profits are within the node. In this case, the analysis shows wholesale gross margin variance is significantly greater than retail gross margin variance. This indicates that wholesalers experience the most variance in potential profits. Without causal data, it cannot be confirmed that wholesale gross margin is most variable as a result of relatively low market power. However, one hypothesis could be that wholesalers add only time and place utility to goods and rely on time and place arbitrage to generate value for the chain. This may have significant implications for the future of the U.S. animal protein value chain. If the variance in gross margin has a negative impact on wholesaler profitability or long-term financial performance, it may become an attractive target node for future vertical integration activities or lead to significant firm consolidation within the node.

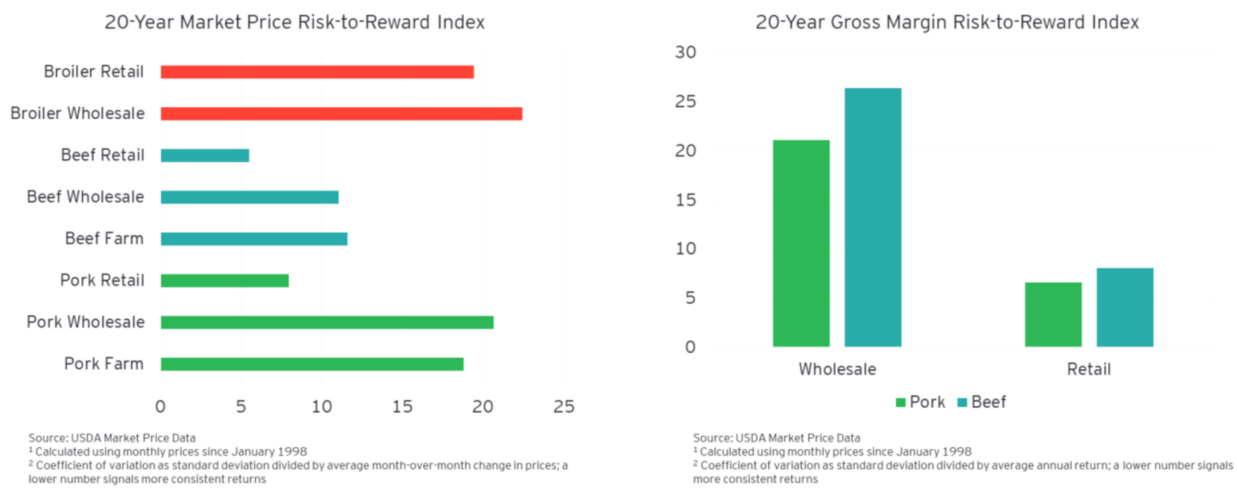


Figure 12: Summary of meat price coefficients of variance

4.5 Results of Hypothesis 5

Hypothesis 5 – There is a positive relationship between market concentration and value creation

This hypothesis suggested that market concentration has a strong relationship between value creation because larger firms can innovate more effectively and dictate the structure, conduct, and performance of their own and other nodes. The table summarizes the concentration level of each node. Farming nodes have notably low concentration which has been the historic norm within the United States. Wholesalers and input providers were found to have medium levels of concentration with very few, if any, national leaders and several regional leaders dominating geographically concentrated markets. The transformer group of nodes has the highest level of concentration with very few national players dominating the market in terms of both revenue and by quantity.

Concentration data was then combined with industry value added as a percent of total revenue to show the relationship between value generation and industry value added. It appears from this analysis that market, not concentration, seem to have a more significant relationship with industry value added. For example, the animal & genetic inputs node and the wholesaling nodes have very similar levels of concentration but have very different value added as a percent of total revenue. Similarly, farming nodes have very low concentration, but very high value added compared to transformer nodes. This data presents compelling insights that the dynamics between nodes, more simply put – governance structures, may significantly impact industry value added. This could have ramifications for both agribusiness managers and policymakers, and is discussed more thoroughly in 5.1.1 Insights on Objective 1.

Node	Low	Medium	High
Live Animal & Genetic Input Suppliers		✓	
Hog Farming	✓		
Broiler Chicken Farming	✓		
Beef Cattle Farming & Feedlots	✓		
Meat, Beef & Poultry Processing			✓
Chicken Meat Wholesaling		✓	
Beef & Pork Wholesaling		✓	
Rendering, Leather & Meat Byproduct Processing			✓

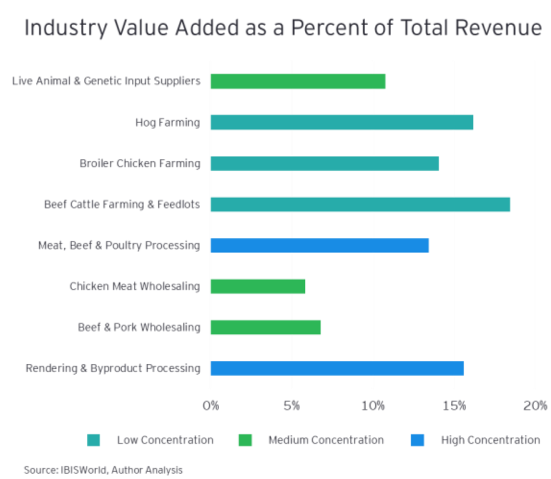


Figure 13: Summary of market concentration and industry value added by node

4.6 Results of Hypothesis 6

Hypothesis 6 – There is a negative relationship between farm level value creation and captive supply

This hypothesis implied that captive supply, a proxy for market and governance power, has a negative relationship with value creation because other nodes can impair rents being captured by the farm level nodes. The first chart summarizes captive supply levels for beef, pork, and chicken. Broiler chicken production had the highest level of captive supply, followed by pork, and then beef. The level of captive supply could have significant implications for the value chain since the level of true market quantity of livestock available for purchase varies between species. For example, chicken has nearly 100 percent captive supply and new entrants would have virtually no broilers to purchase in the open market. This could create a significant market information issue for farmers and buyers and, by extension, limit market prices from hitting their natural equilibrium levels via information asymmetry. Since no broilers are in the "open" market, the true market-going price for broilers cannot be observed and it could result in information arbitrage for vertical integrators. While this may not inherently be an issue or create ineffective or inefficient market outcomes if all players execute "fairly", farmers and vertical integrators should be wary of potential market manipulation on both sides of the buying relationship least regulators may increase control and mandate information symmetry.

Estimates of captive supply inform two additional charts produced for this hypothesis. The second chart summarizes industry value added as a percent of total revenue for the last ten years for all three farming nodes – hog, broiler and chicken farming using the IBISWorld dataset. Based upon the ten-year chart of industry value added, it appears that there is very little relationship between captive supply and value creation. In this case, the hypothesis would not be confirmed. This could be because captive supply does not significantly impact value creation within the farming nodes. However, it could also be a result of the type of governance structures and purchasing agreements constituting captive supply. For example, the type of purchasing schemes constituting pork captive supply includes contracted and packer owned, broilers includes contracted only, and beef includes formula, forward contract, and packer owned. These different purchasing schemes may create very different market outcomes exogeneous to their captive versus non-captive structure. With these characteristics, captive supply may not be the most fitting indicator of market power exerted on farmers. Future research may focus more on the impact of individual purchasing schemes versus the level of captive supply.

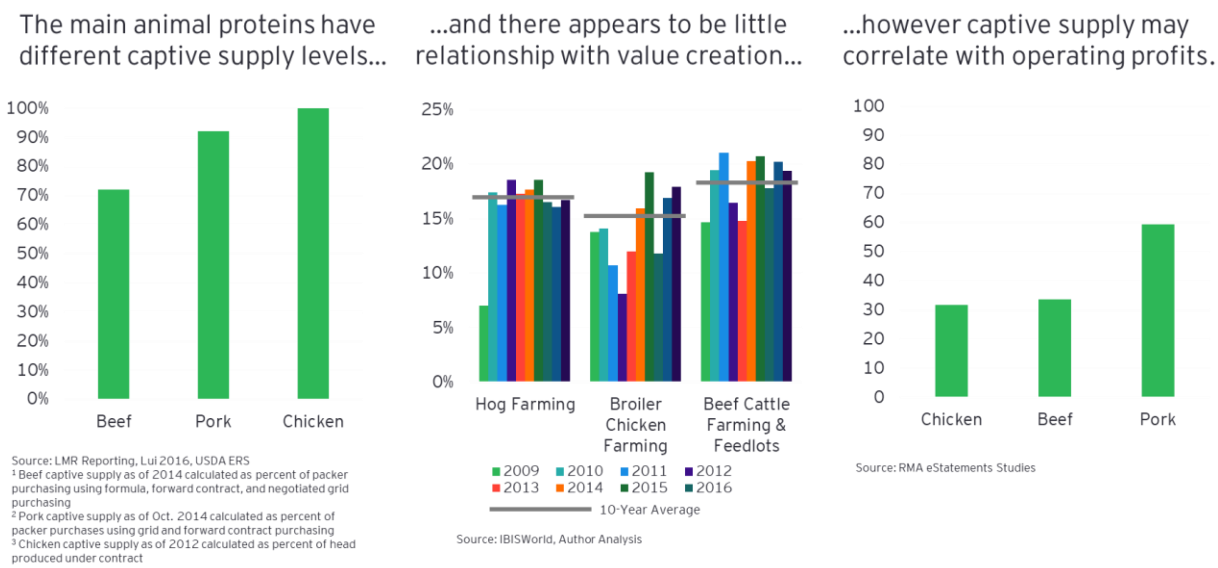


Figure 14: Summary of the impact of captive supply on value creation

4.7 Results of Hypothesis 7

Hypothesis 7 – There is a negative relationship between farm level value creation and interest rates

This hypothesis intended to understand the relationship between value creation and interest rates as debt is the major source of capital for U.S. animal protein farms. The first chart displays the implied interest rate over the last sixty years. It shows that farm level interest rates peaked in the 1980s during the Farm Crisis and have since trended downward. Within the last nine years, the implied interest rate for farms has not significantly increased. As farm debt levels and default rates continue to increase in US farms, it is possible that farm level interest rates may increase.

The second chart shows the relationship between the implied interest rate and value added by meat animals, and poultry and egg farming. There is very little, if any, relationship between implied interest rate and value added as the regression line shows. This may be because interest is a relatively low expense item for farms compared to other expenses. Even though debt comprises a significant portion of farm capital structure, the reality is that interest expense is not a significant expense for the nodes and most likely does not significantly impact industry value added at the farm level.

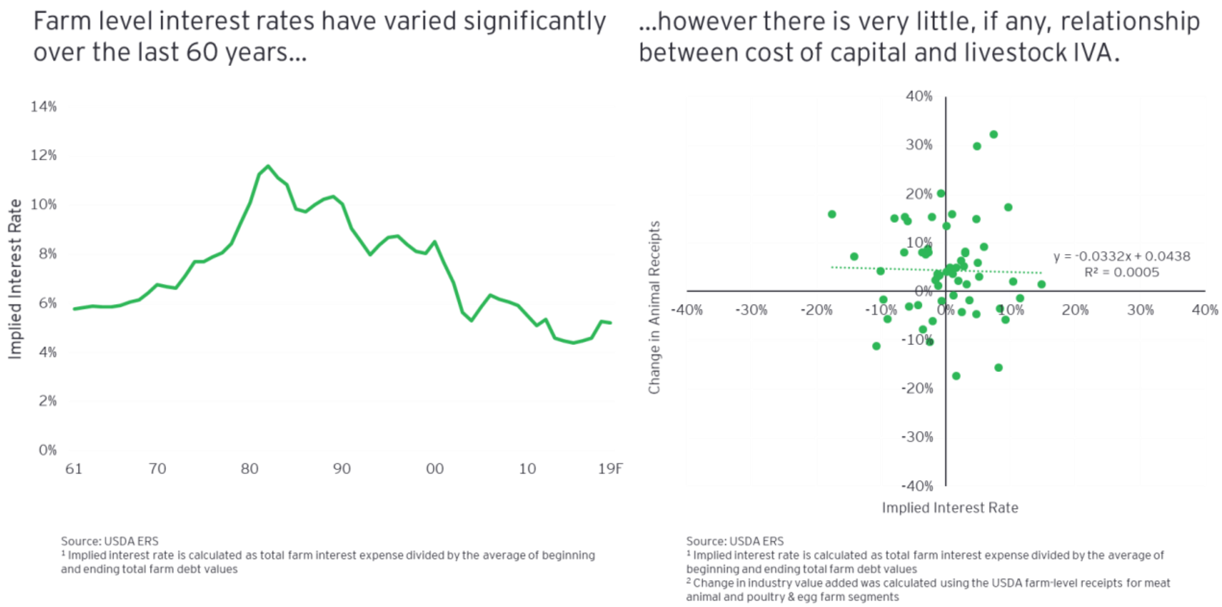


Figure 15: Summary of the impact of interest cost on farming industry value added

4.8 Results of Hypothesis 8

Hypothesis 8 – Downstream activities have higher economic profit during periods of increased farm income

This hypothesis implied that value chain dynamics enable downstream nodes to capture a larger share of industry profits during periods of increased farm income because downstream nodes can dictate the terms and prices of trade across the value chain. The first chart shows the relationship between industry value added as a percent of total node revenue and farm level income from meat animals, and poultry and egg farming. The chart shows that farm-level net cash income has increased significantly up until 2014 and has since decreased without a full recovery to the 2014 high.

The second chart shows the correlation coefficient between percent change in farm level gross cash income from meat animals and products, and percent change in value added for each of the major nodes. It shows that there is a significant negative relationship between farm receipts and value creation for transformers and wholesalers. In this case, we reject the hypothesis because higher farm receipts have a negative relationship between transformer and wholesaler value generation. This chart also shows a positive relationship between farm value generation which may mean during periods of increased farm income, farms do in fact retain some of the value they generate. In fact, this analysis shows that increased farm incomes negatively impact transformer and wholesaler value generation. Researchers may extend this analysis in the future to specifically look at species-specific value generation, cost transmission, and profit retention.

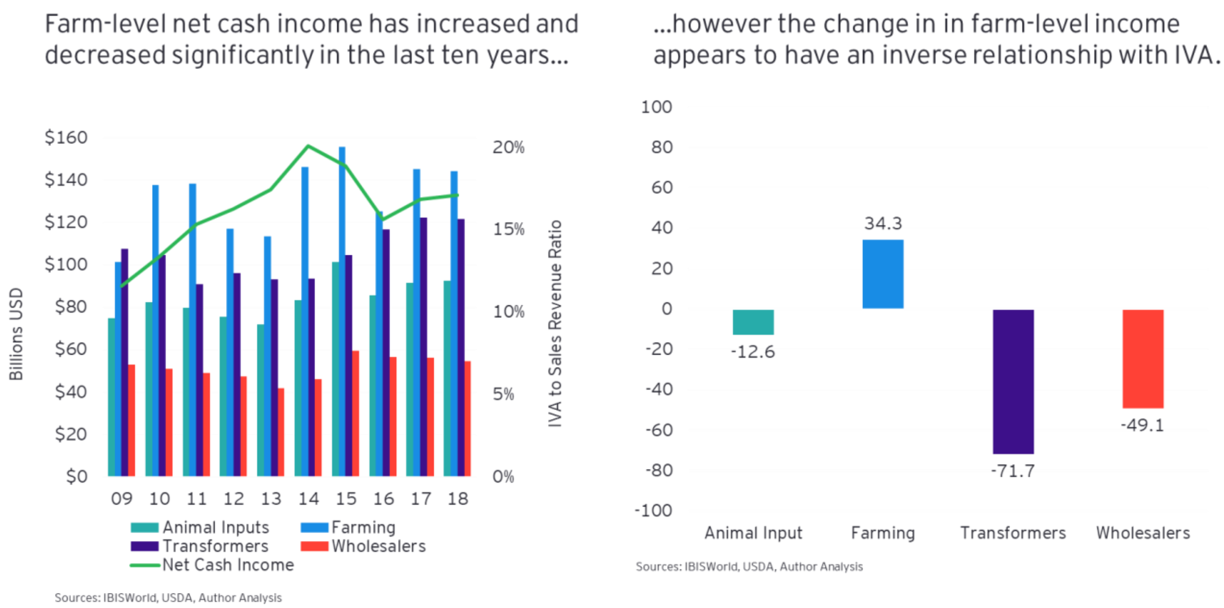


Figure 16: Summary of farm level income and value transmission across the value chain

4.9 Results of Hypothesis 9

Hypothesis 9 – A lag effect exists in transferring production costs down the value chain as a result of the biological production cycle and value chain power dynamics

This hypothesis implied that value chain dynamics limit the transferability of increased input costs because downstream nodes can dictate the terms and prices of trade across the chain. The first chart summarizes instantaneous correlations between the cost indexes and market prices, and shows prices seem to have nearly instantaneous price transmission between farm level production costs and market prices. In this case, the strongest correlation exists between instantaneous farm input costs and farm level prices and decreases as goods move down the value chain. The strongest correlation seems to exist between pork and the weakest with beef. Similar to in hypothesis six, correlation may exist because of the type of purchasing schemes implemented across the major species. This seems to show that there is not a lag effect as a result of the biological production cycle and instead price transmission is near instantaneous. In the second chart, correlation is calculated between the cost indexes and temporally lagged market prices – two months for broilers, six months for hogs, and eighteen months for cattle. In this case, the correct sign is present only for correlation for beef prices. Additionally, we see a negative relationship between increased costs and market prices.

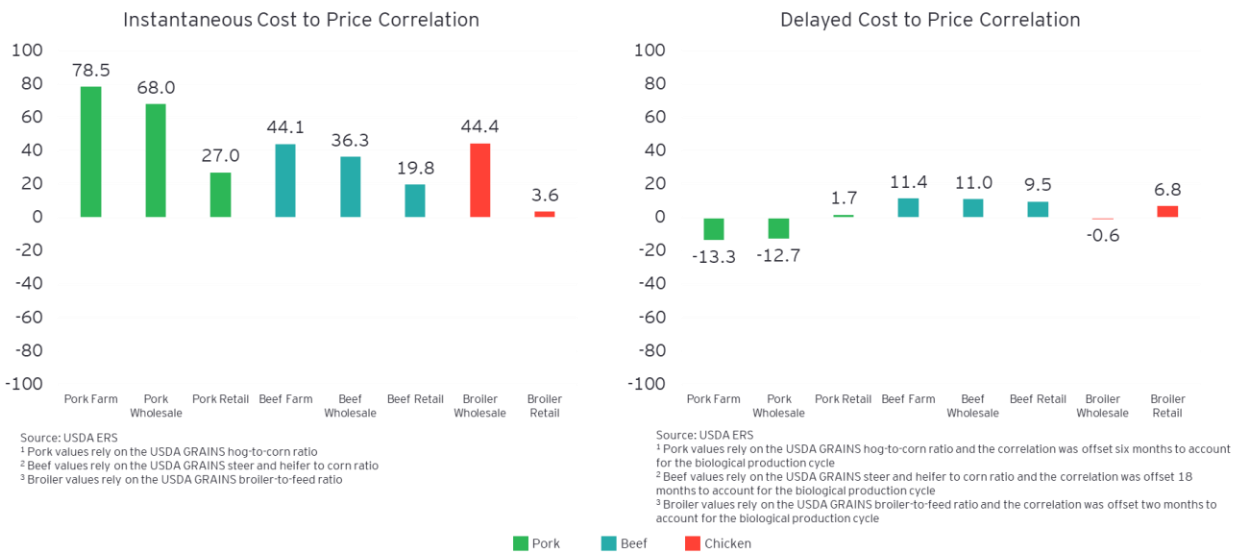


Figure 17: Relationship between farm input costs and market prices across the value chain

4.10 Results of Hypothesis 10

Hypothesis 10 – Farm level value creation is most negatively impacted by periods of decreased export quantities

This hypothesis implied that farm value generation was most impacted by periods of decreased export quantities because downstream nodes can dictate the terms of trade and prices across the value chain. The first chart summarizes export volumes for the three major species. Over time, these have not changed significantly with the exception of hog exports which has been driven primarily by increased demand in Asia. The second chart combines value added data for each farming node and the exported quantity data to show the correlation between the two. In this case, the analysis produces an inverse relationship with chicken, nearly no relationship for pork, and a positive relationship with beef. These results might be skewed by using quantity versus value of exports in the correlation calculation. In the case of chicken, export volumes might increase during periods when chicken meat prices are low, and it is economically feasible to ship chicken to international markets. In the case of beef, there may be a positive relationship because the US beef market more significantly relies on exports to generate value and increase market prices. Future researchers might dive deeper into the relationship between export value and node value generation. In the case of this hypothesis, we cannot confirm that value creation is most negatively impacted by periods of decreased export quantities.

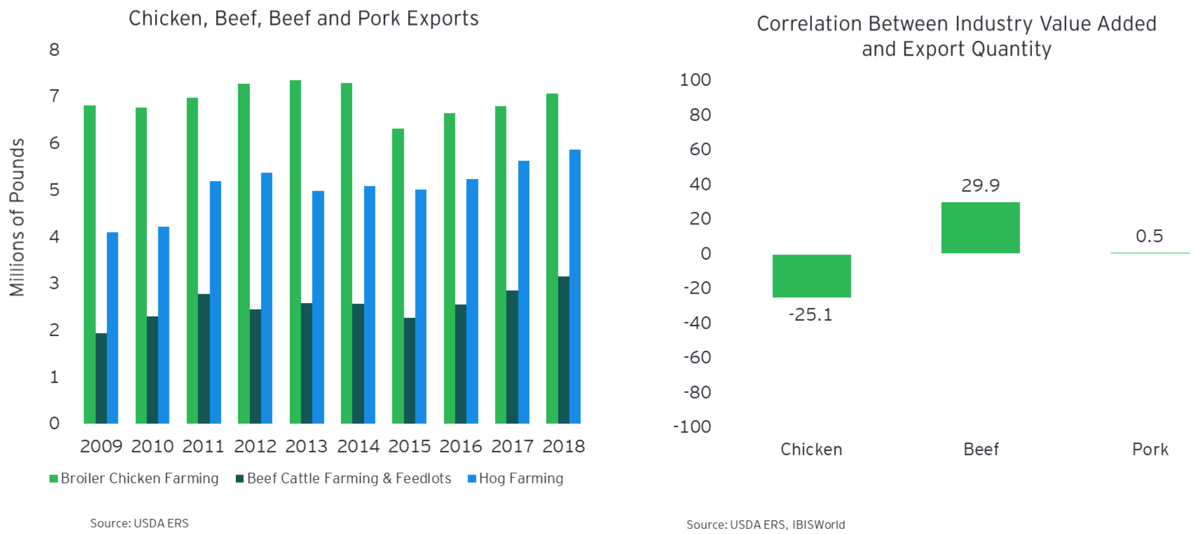


Figure 18: Summary of the relationship between exports and farm level industry value added

5. DISCUSSION AND IMPLICATIONS

5.1 Implications and Conclusions

In the Introduction, two main objectives were identified. 1) Identify the current state of profit pools within the U.S. animal protein industry, where margins have migrated over the last ten years, and the potential implications for profit pools and firms beyond 2018. 2) Identify stages in the U.S. animal protein value chain which add economic value, where value has been generated over the last ten years, and potential implications for economic profits in the future. We revisit these objectives and discuss key findings for both.

5.1.1 Insights on objective 1

The first objective focused extensively on identifying the current profit pool, where margins have migrated, and what might happen to profits beyond 2018. In hypothesis one, the study found each node produces different levels of value addition as a portion of total revenue. We show that there is also differing volatility over the ten years on which this study focused. These findings imply that there are underlying dynamics that allow different nodes to produce higher levels of value compared to others. For the agribusiness manager and economist, understanding the presence and source of these individual profit pools may be advantageous in developing competitive strategies and understanding key drivers for industry participants.

Another notable finding with respect to profits comes from the results of hypothesis four which focused on farm, wholesale, and retail price variance across the three major protein species. The analysis shows that variance differs significantly across the three species and mostly seems to have a relationship with the amount of influence that vertical integrators have within the value chain. Similarly, hypothesis four addresses variance in wholesale and retail gross margins. The data shows that wholesale gross margins are significantly less consistent than retail gross margins. For the economist, we may not necessarily imply the price variation is a negative outcome. It may imply the chain is effectively adjusting price to meet consumer willingness to pay. This should be investigated further. However, it is notable that variance is differentiable across the major species. For agribusiness managers in the beef chain, there may also be an arbitrage opportunity to better understand why prices are less variable and if there is foregone market opportunity by not quickly adjusting prices to consumer willingness to pay.

In hypothesis five, the analysis shows there is not a strong relationship between market concentration and value addition. This could have significant implications for managers and policymakers. Managers who have pursued concentration may need to consider value chain dynamics more than individual node performance when charting opportunities to grow profits within their firm. For attractive nodes, managers may need to consider if moats are protecting the node's superior value generation or if they are a target for value seizure by other actors and nodes across the value chain. Policymakers may need to more significantly consider how governance across a value chain outside the walls of a firm influence individual firm performance. Similarly, they may consider if the governance structures improve or hinder value generation across the chain. In both cases concentration, the current de facto metric for industry power and the ability of firms to leverage market power, may need to be reconsidered.

The last major insight related to objective 1 comes from hypothesis six which examined the relationship between value addition and captive supply. This analysis shows that there may be very little relationship between captive supply and value creation at the farm level. While this conclusion implies the value chain is adequately compensating and creating value at the farm level, agribusiness managers and policymakers should be cognizant of potential price manipulation in markets with high captive supply levels and very little, if any, visibility to true market price. Additionally, this hypothesis examines the relationship between captive supply and operating profits, and shows there may be a relationship between captive supply levels and operating profits. While not conclusive, managers and policymakers again should be cognizant that operating profits may be impacted by value chain relationships and types of vertical integration contracts across the chain. In this case, it is important not only to study the farm level prices, but also the farm financial performance within the node and chain. Future researchers should consider both when studying this topic.

5.1.2 Insights on objective 2

The second objective was specifically focused on value addition, its movement, and potential future outcomes for the animal protein value chain. The first major hypothesis relevant to this objective was hypothesis eight which showed a significant negative relationship between farm receipts and value creation for transformers and wholesalers. For the agribusiness manager, this may mean that care should be given to transfer costs down the value chain via contractual relationships. It also shows value generation can be protected by more effectively managing the transmission of higher farm level receipts. For economists, this may mean that there is further research to be done in understanding price and cost transmission between the nodes and across the entire animal protein value chain. Future researchers may also investigate this topic further to understand how increased farm income may impact operating profits and EBIT down the value chain.

The other relevant hypothesis to this objective is number nine. The analysis shows that there seems to be instantaneous, not lagged, cost transmission within the animal protein subsector. Similar to the findings in hypothesis six, this correlation may be because of the types of purchasing schemes that exist across the major species. This seemed to show that there is not a lag effect as a result of the biological production cycle and instead price transmission is near instantaneous. This could have significant implications for agribusiness managers. For farmers who are marketing pigs in increased input cost environments, they should be cognizant of potential issues with passing on additional production costs. Transformers might further examine if information symmetry exists between periods of increased prices to ensure they are justified in paying increased or decreased prices for livestock and not just responding to market noise. Future research might also dive deeper into if and at what level price transmission occurs in periods of increasing, versus decreasing, input costs.

5.2 Future Research

It is important to again acknowledge previously mentioned shortcomings. This study relies on two core data providers – IBISWorld and Risk Management Association – to test many of the hypotheses. While these providers are considered the gold standard for industry-level estimates and data insight within the animal protein subsector, a reasonable level of caution should always be given when making broad estimates about industry-level performance. Further, the data provided by the Risk Management Association is, as the provider states, meant to provide general insight into the industry and not meant to be treated as a truly representative sample of the subsector and its performance. This study still delivers insightful conclusions and leads to compelling future research in spite of its potential shortcomings.

One significant opportunity for future research is further investigating how cost transmission occurs within the animal protein industry and, more broadly, the agri-food value chain. Research has been conducted on this topic before, however two specific areas have not been addressed – how cost transmission has changed during the last hypercycle in the early 2010s, and if cost transmission has changed since then. Consideration should be given to how cost transmission may differ during periods of increasing versus decreasing costs.

Another opportunity for future research exists in examining how profit pools form within individual agribusinesses. A great deal of insights can be extracted from 10K reports and a patient researcher who is willing to look deeper into how and why profit pools, and by extension business units, exist within individual agribusinesses would likely prove fruitful. This research may also further support our understanding of rents across the agri-food value chain and how agribusinesses may respond in light of their existence within their industry value chain.

A final extension of this research would be to integrate the cost of capital into the profit pool estimates. While it is difficult to adequately assess the cost of equity for private firms and U.S. farms, it would bring significant insights for investors and practitioners. It would also be additive to the body of literature to compare the cost of capital and economic profit differentiation across crop and livestock farming. Additionally, similar research could be conducted to look directly at earnings before interest and taxes distribution across the value chain. This would be especially valuable as many businessowners and investors use EBIT as a significant proxy for enterprise performance and would capture fixed costs not always represented by operating income and industry value added.

As mentioned in the introduction, the intent of this study was to provide data which may serve as a basis for understanding how and why managers pursue specific strategic activities within the food and agribusiness industry and what relationship it may have with profit pools. Other researchers may implement event analysis or qualitative research with this dataset to further examine and study the competitive and strategic actions of animal protein firms.

Lastly, on a more general note – there are significant opportunities to uncover valuable and insightful findings within agribusiness data that may not implore sophisticated econometric or statistical techniques. As we continue to push forward the study of agricultural economics and agribusiness management, I hope that future researchers can use this as an example of research containing forgivable faults and rich insights for agribusiness managers. Agricultural economists, students, and practitioners will always find a friend in this author should they choose to endeavor into applied agricultural economics topics.

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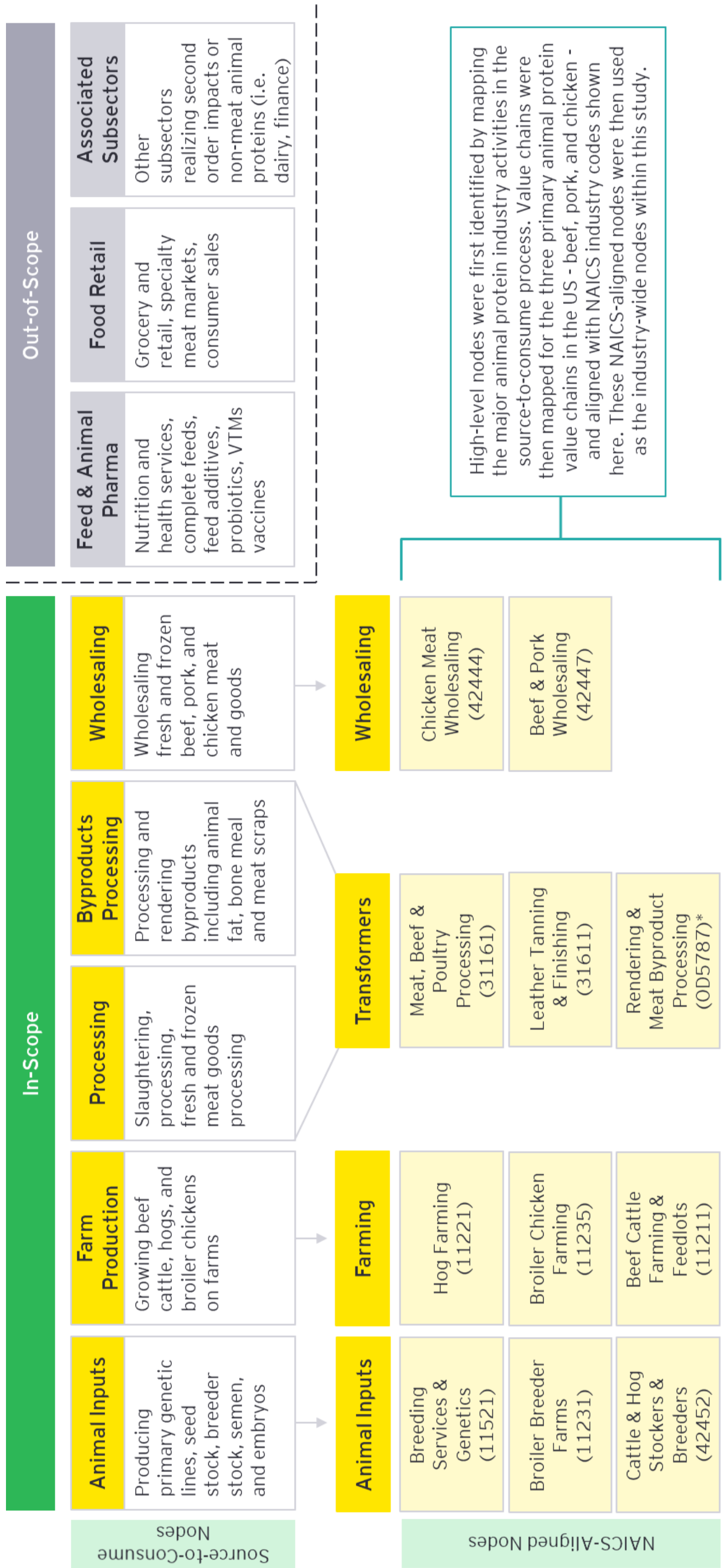
APPENDIX A: VALUE CHAIN NODES AND CORRESPONDING NAICS CODES



1 No unique NAICS code exists for rendering and meat byproduct processing. However, the major data provider for this study does produce a list of customized industry reports using a proprietary list of industry codes. OD5787 is the unique code for the US Rendering & Meat Byproduct Processing node.

APPENDIX B: SPECIES-SPECIFIC VALUE CHAINS AND FIRMS

Pork Industry Value Chain

	Animal Inputs				Farm Production	Processing & Byproducts	Wholesaling	Retailing		
	Breeder Stock	Genetic Material	Sow Operations	Farrow to Feeder	Feeder to Finish	Farrow to Finish	Slaughter & Processing	Wholesale & Distribution	Retailers & Grocers	Fast Food & Restaurant
Description	Produce and sell live hogs for production hog grandparent and/or parent genetic stock	Collect and sell hog sperm for use in breeding	Maintain a herd of sows for the production and sale of parent stock for production hogs	Provide weaned feeder piglets to be raised as production hogs	Purchase feeder piglets from sow operations and raise to slaughter weight	Farmers who raise piglets from sows to slaughter weight	Slaughter hogs and package and/or process the pork on-site	Coordinate the sale and distribution of quasi-finished and/or ready-to-sell pork	Facilitate sale of pork to consumers for consumption in the home	Facilitate sale of pork to consumers as prepared foods for consumption outside the home
Notable Firms	*No major market leader*, PIC (Genus plc)	*No major market leader*, PIC (Genus plc)	Smithfield, Seaboard, Iowa Select, Pipestone System, Maschhoffs, *Integrated activity*	*No market leaders; Integrated activity*	*No market leaders; Integrated activity*	*No market leaders; integrated activity*	Smithfield, JBS USA, Tyson Foods (IBP), Hormel, Clemens Food Group	*No market leaders; Integrated activity*	The Kroger Company, Walmart, Costco, Safeway, Publix, Ahold	Subway, McDonald's, Wendy's, Burger King, Taco Bell, Pizza Hut, Panera Bread, Sonic Drive-In, Arby's

Chicken Industry Value Chain

	Animal Inputs			Farm Production	Processing & Byproducts	Wholesaling	Retailing	
	Primary Genetic Stock	Multiplier Farm	Hatchery	Grower Farm	Slaughter & Processing	Wholesale & Distribution	Retailers & Grocers	Fast Food & Restaurant
Description	Produce and sell live chickens for use as broiler grandparent and/or parent genetic stock	Produce fertilized eggs from broiler breeder flocks to be used for hatching	Execute the incubation process and produce day-old broiler chicks	Traditional farmers who care for broiler chickens until they reach 2-6 pounds, or 4-16 weeks of age	Slaughter broiler chickens and package and/or process the chicken meat on-site	Coordinate the sale and distribution of quasi-finished and/or ready-to-sell chicken	Facilitate sale of chicken to consumers for consumption in the home	Facilitate sale of chicken to consumers as prepared foods for consumption outside the home
Notable Firms	Cobb-Vantress, Hubbard, Aviagen, Hendrix	*No market leader*	*Integrated activity*	*No market leader*	Tyson Foods, Pilgrim's Pride (JBS USA), Sanderson Farms, Perdue, Koch Foods	*Integrated activity*	The Kroger Company, Walmart, Costco, Safeway, Publix, Ahold	Subway, McDonald's, Wendy's, Chick-fil-A, Burger King, Taco Bell

Beef Industry Value Chain

	Animal Inputs			Farm Production		Processing & Byproducts	Wholesaling	Retailing	
	Breeder Stock	Genetic Material	Cow-Calf Operations	Stockers & Backgr-ounders	Feedlots	Slaughter & Processing	Wholesale & Distribution	Retailers & Grocers	Fast Food & Restaurant
Description	Produce and sell live cattle for beef cattle grandparent and/or parent genetic stock	Collect and sell cattle sperm and embryos for use in breeding	Breed cows to produce calves, which are kept on-site until weaned at 6-10 months of age	Hold cattle to increase live weight through pasture, range, and/or confined systems until 600-800 pounds, or 8-14 months of age	Feed grain to live cattle and increase weight to 900 to 1,400 pounds, or 12-22 months of age	Slaughter broiler chickens and package and/or process the chicken meat on-site	Coordinate the sale and distribution of quasi-finished and/or ready-to-sell chicken	Facilitate sale of beef to consumers for consumption in the home	Facilitate sale of beef to consumers as prepared foods for consumption outside the home
Notable Firms	Express Ranches, Gardiner Angus Ranch, Sandpointe Cattle, Leachman	Genus PLC, Genex (CRI), Alta Genetics, Semex USA, ST Genetics	Deseret Cattle, J.R. Simplot, King Ranch, Lykes Bros., Seminole Tribe, Padlock Ranch Co., Silver Spur, Koch	*No market leader*	Five Rivers, Cactus Feeders, Cargill Cattle Feeders, Friona Industries, J.R. Simplot, Cattle Empire	Tyson Foods, JBS USA, Cargill, Smithfield Foods, Hormel Foods, ConAgra, National Beef Packing Co.	*Integrated activity*	The Kroger Company, Walmart, Costco, Safeway, Publix, Ahold	Subway, McDonald's, Wendy's, Burger King, Taco Bell, Pizza Hut, Panera Bread, Sonic Drive-in, Arby's