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Exclusivity of Agrifood Supply Chains: Seven Fundamental Economic Characteristics

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Abstract

This analysis focuses on defining and describing the unique economic characteristics of agrifood supply chains. The analysis includes seven specific economic characteristics of agrifood supply chains that distinguish them from other industrial manufacturing and service supply chains. The seven characteristics are: 1) risk emanating from the biological nature of agrifood supply chains, 2) the role of buffer stocks within the supply chain, 3) the scientific foundation of innovation in production agriculture having shifted from chemistry to biology, 4) cyberspace and information technology influences on agrifood supply chains, 5) the prevalent market structure at the farm gate remains oligopsony, 6) relative market power shifts in agrifood supply chains away from food manufacturers downstream to food retailers, and 7) globalization of agriculture and agri-food supply chains.

Keywords: agrifood supply chains, exclusive economic characteristics, risk, market power, globalization

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Exclusivity of Agrifood Supply Chains: Seven Fundamental Economic Characteristics

Are there meaningful economic characteristics that serve to make some supply chains unique and different from others? This analysis identifies and describes seven fundamental economic characteristics of agrifood supply chains that serve to distinguish them from other supply chains in the manufacturing and service sectors of the economy. The focus here is on the uniqueness of agrifood supply chains in terms of their economic character. This uniqueness has powerful implications for managers within agrifood supply chain firms and the long-term strategies that they might craft to enhance the long-term performance of their firm.

The complexity and length of agrifood supply chains serve to distinguish them from manufacturing and service sector supply chains. One example of complexity is the perishability of commodities and postharvest technology, such as hydrocooling sweet corn, that is used to assure quality and safety from the field to a processing facility or directly to a downstream consumer of a fresh product. Evidence of these complexities exclusive to agrifood supply chains is plentiful. For example, food chain management books are available which provide best practices for managing temperature controlled supply chains (Smith and Sparks 2007). Adding to the length of these complex agrifood supply chains is the long-term trend toward globalization where large-scale commercial operations, located and coordinated on an international basis, produce and process food sited globally to minimize costs.

Seven unique economic characteristics of agrifood supply chains are defined and described. The meaning, context, and consequences of each characteristic are discussed in some detail. Each characteristic serves to differentiate agrifood supply chains from manufacturing, service, and nonagricultural manufacturing supply chains.

The seven characteristics are: 1) risk emanating from the biological nature of agrifood supply chains, 2) the role of buffer stocks within the supply chain, 3) the scientific foundation of innovation in production agriculture having shifted from chemistry to biology, 4) cyberspace and information technology influences on agrifood supply chains, 5) the prevalent market structure at the farm gate remains oligopsony, 6) relative market power shifts in agrifood supply chains away from food manufacturers downstream to food retailers, and 7) globalization of agriculture and agrifood supply chains. Each of these economic characteristics is examined and implications for agrifood form managers are provided.

Risk Emanating from the Biological Nature of Agrifood Supply Chains

Unlike other industries where manufacturing takes place in controlled and closed-loop environments, agrifood production faces high yield risk both in terms of quantity produced and quality delivered. Production agriculture is different from numerous industries because of the supply risk due to weather, biological aspects of production cycles, and perishability. Risk is pervasive for all parties in the agrifood supply chain. The biological nature of agricultural production results in less predictable supplies of various grades or characteristics compared to manufacturing and service sector supply chains. Prices are meaningful in their allocative role within supply chains if and only if they relate to products of identified homogeneous quality. In the case of agrifood supply chains, this entails grading systems that are accepted and used by most supply chain participants for a particular commodity.[1]

Quantity risk is the temporal shortfall in supply, embedded in the biological nature of agricultural production (e.g., cows freshening, trees not bearing fruit, pest infestations in fruits and vegetables, etc.) to shortfall from weather vagaries or other unforeseen calamities. These issues impact supply and result in short-run or seasonal limits on available quantities to the market. Such haphazard supply limits are unanticipated and are not systematic. Numerous examples exist in the literature that highlights such phenomenon, including apples (Boland, Mancia, and Taylor 2010) and oranges (Seftel 1995). Beddow, Pardey, and Alston (2009) examine global variability in crop yields over the 1900 to 2006 time period and find that maize has the largest increase in productivity, measured by average crop yield increases relative to soybeans, wheat, and rice since 1960. Volatility in yields also has been the greatest in maize. This has an obvious impact on profitability of agrifood firms. Crop yields have greater uncertainty relative to milk or meat yields from animals due to greater unforeseen or unanticipated events.

Price risk is the fluctuating prices from changes in supply and demand. The typical methods for managing this type of risk are hedging in the futures market or entering into a fixed-price contract that often specify delivery quantities and quality attributes. For example, an examination of the contracts available on the Chicago Mercantile Exchange reveals that agricultural commodities are one of nine inputs that have futures contracts available for use by buyers. Others include metals, interest rates, exchange rates, energy and weather. Index funds are one of the largest traded futures but food commodity futures, although smaller volume, are essential for use by agrifood processors and producers in managing price risk. The Food and Agriculture Organization (2011) provides monthly price indices for food, meat, dairy, cereals, oils, and sugar. An examination of the 1990 to 2011 data shows substantial volatility since 2004 relative to the preceding years. This has an impact on agrifood firm profitability. The relative impact on profitability depends upon where the agrifood firm is embedded in the value chain. Upstream firms closer to production experience greater variability in profitability relative to those downstream firms closer to consumers.

Quality risk refers to the specific qualities or grades of a commodity or a product that are necessary as an input but that may not be available at a certain time. Various qualities or grades of a commodity are not fungible across processors, often because the complement of equipment in a processing line dictates use of a narrow range of existing commodity qualities. One example is a cotton mill processing line that is equipped to use only long staple cotton. In this instance, short staple cotton is not fungible for long staple (Hyson 1944). A similar example is processing tomatoes (Goodhue, Mohaptra, and Rausser 2010). A specific complement of machinery within a processing plant may influence the range of qualities or grades that can be an acceptable input in the production process.

[1]The broadest authorization for commodity grading systems in the United States is provided by the 1946 Agricultural Marketing Act, although commodities such as cotton, grain and tobacco also have their individual authorizations. The United States Department of Agriculture has a long history of involvement with commodity grades and standards.

Commodity characteristics include perishability and seasonality in production and/or consumption. Examples include fresh fruits and vegetables, fluid milk, and some meat animal production. Substantial price swings within a marketing season can result for commodities with these characteristics (Breimyer 1976; Rhodes, Dauve, and Parcell 2006). For example, price typically is lowest at the end of harvest and gradually begins to rise as supply begins to decrease (e.g., inventories are lowered) until the new marketing season begins. For crops in the northern hemisphere, the marketing year is generally September of the current year until August of the following year, except for summer crops such as hard red or hard white winter wheat.

Increases in global distribution channels have eliminated some of this seasonality, especially in horticulture production. Historically, fresh fruits and vegetables were available only during certain times of the year within season. Globalization has resulted in supplies now available year-round and, consequently, seasonal price variability is dampened, except for seasonal quantity or quality issues such as supplies damaged from frost or disease. This price effect, at least partially, is attributable to the biological nature of agricultural production. Adjustments in aggregate within-season supply through private or public inventory adjustments typically are not feasible for perishable commodities. In some instances, the biological nature of production involves longer periods spanning several years, as is the case with perennial tree crops such as almonds, which could lead to wide price swings across seasons (Boland, Pena, and Sumner 2010).

Perishability and production seasonality give rise to the concept of orderly marketing. The foundation of orderly marketing includes concepts of supply and demand levels, price levels and price variability over both time and space. The term 'orderly marketing' for a commodity means an orderly flow of the supply to market throughout the normal marketing season to avoid unreasonable fluctuations in supplies and prices as stated in Section 2(4) of the Agricultural Marketing Agreements Act of 1937. In U.S. legislation, orderly implies dampened within-season price variability compared to the price variability that might occur if the commodity were marketed in an unregulated purely competitive open spot market. An example of this is raisins which are governed by the Raisin Administrative Committee (Sanchez, Boland, and Sumner 2008).

Seasonality in production and marketing has played an important role in the development of United States marketing policies in milk, fruits, and vegetables. Orderly marketing appears as the central component in some marketing order policies (Black 1947). For example, milk marketing orders have an explicit orderly marketing legal mandate that underlies their promulgation and provisions. Assurance of adequate supply is a portion of the economic foundation which means having a continual supply available to consumers. In this instance, accuracy is rooted in the notion of perfectly competitive market structures where price differences over space reflect only differences in transportation costs through spatial arbitrage and that, within a geographic market area, prices are identical for the same quality to all buyers and all sellers. This is often referred to as von Thunen's model (1966). Similarly, price differences among qualities within a market are sufficient to provide accurate signals to sellers on the relative value of various qualities.

Yet another risk of agrifood supply chains participants is adulteration, a separate issue from the temporally-based quality issues discussed above. Risk of unsafe food is the risk that input supplies are substandard or adulterated, as one aspect of this risk type. This risk relates to the use of unsafe food or input supplies, regardless of whether the usage was intentional (i.e., using substandard or adulterated products) or unintentional (i.e., mistake or insufficient knowledge). This risk is typically unintentional yet supply chain interdependencies link multiple downstream participants to any one particular food safety incident. A fear of food manufacturing firm managers is that the products they distribute are unsafe and they then must issue an expensive recall (Sporleder and Goldsmith 2001). This risk can be financially devastating to a firm due to the cost burden of a recall or the diminished reputation of the firm or its brands that may result from a recall. Adulterated product, leading to recalls, is a systemic risk for the entire agrifood supply chain. Hudson Foods is one example of how devastating recalls can be for an individual firm. Hudson Foods is no longer in business because of their recall of hamburger. [2]

There are no shortages of adulteration incidents. Recent examples in the United States abound: 1) dog food ingredients, imported from China, contained toxins that resulted in dogs becoming ill (Quan et al. 2010); 2) contaminated peanut butter paste from a food manufacturing firm in Georgia that resulted in several deaths in the United States (Wittenberger and Dohlman 2010), 3) fresh spinach that was widely distributed but contained food borne pathogens (Palma et al. 2010), and 4) Colorado cantaloupe recall of 2011 due to *Listeria* which was the largest recall in U.S. history. Agrifood supply chains are unique in the United States because they are regulated by four federal agencies: the Animal and Plant Health Inspection Service (APHIS) of the U.S. Department of Agriculture, the Food and Drug Administration (FDA), the Environmental Protection Agency (EPA), and the National Oceanic and Atmospheric Administration (NOAA) of the U.S. Department of Commerce. [3] The agrifood sector is unique, compared with industrial sectors, in terms of federal regulations for product and process regarding the environment, plant and animal products, and processed food products.

The Role of Buffer Stocks with the Supply Chain

In the case of nonperishable (storable) commodities, such as wheat, cotton, and corn, the stocks in storage buffer intra-seasonal and inter-seasonal price movements (Breimyer 1976). Nevertheless, perishability precludes this buffering or moderating influence on within-season price of carryover stocks from one period to the next. This is why inventories of storable commodities, such as wheat and corn, are often referred to as buffer stocks. In addition, inventory stocks can buffer against the quantity and quality risks discussed above.

When a commodity is perishable, such as fluid milk, buffer stocks are not feasible. In these cases, contracts tend to replace spot market transactions and buffer stocks (Sporleder 1992; MacDonald and Korb 2011). In most conventional industrial supply chains, privately-held buffer stocks are a common means of hedging quality, quantity, and price risks by manufacturing firms in the supply chain. For example, if a supplier cannot make a just-in-time delivery of an input,

[2] Hudson Foods Company of Rogers, Arkansas was a beef processor involved in what was then (1997) the largest recall of food in the United States. The processing plant was in Columbus, Nebraska. The company recalled over 25 million pounds of ground beef due to *E. coli 0157:H7*.
[3] The National Oceanic and Atmospheric Administration (NOAA) oversees fisheries management and fresh fish grading in the United States. By authority in the 1946 Agricultural Marketing Act, the NOAA Seafood Inspection Program provides inspection services for fish, shellfish, and fishery products to the industry. The NOAA Seafood Inspection Program is a U.S. Department of Commerce (USDC) Seafood Inspection Program.

the manufacturer may draw down buffer stock inventory to keep production lines operating in a normal manner.

For less-perishable commodities, storage helps achieve vertical coordination in the supply chain (Working 1949; Breimyer 1976). Buffer stocks are held by private firms in upstream and downstream markets in an effort to mitigate quantity and quality risk and generally deal with unexpected events. For perishable commodities buffer stocks are neither practical nor cost effective. One consequence of these phenomena is that the supply chain coordination problem is more severe and alternative exchange mechanisms emerge beyond simple spot market transactions. Contracting is an important mechanism that substitutes for privately-held buffer stocks in terms of providing a similar economic function (Martinez and Reed 1996).

Contracting of perishable commodities can be a means of enhancing supply chain coordination and act as a surrogate for the economic role of privately-held buffer stocks that are prevalent among storable commodity supply chain participants. Contracts facilitate the contractor who is typically the downstream first-handler/processor to specify the quality and quantity that can be delivered under the terms of the contract. The contract may even be a fixed-price contract. These possible features of a contract mitigate the quality, quantity, and price risk discussed above, thus substituting for the economic role played by buffer stocks in storable commodities. Such contracts might be linked to publicly reported price data such as the Agricultural Marketing Service of the U.S. Department of Agriculture, *Milling and Baking News*, *Feedstuffs*, or the *Food Institute Report* which are widely used as a starting point for some price negotiations. James, Klein, and Sykuta (2010) and Dorsey and Boland (2009) synthesize numerous examples for agrifood firms.

The Scientific Foundation of Innovation in Production Agriculture has Shifted from Chemistry to Biology

Three eras of agriculture relative to innovation are worth noting (Gardner 2002). The first era is mechanical where the most significant innovations were based on mechanization of all kinds. This era is noted for tractor power replacing horse power; in general, the substitution of capital for labor. In the United States, this era faded in the 1950s to be replaced by the chemical era. The chemical era is marked by substantial gains in efficiency through various applications of chemistry, such as chemical fertilizers, pesticides, and antibiotics for farm animals that facilitated production practices such as large-scale confinement feeding. The third and present era is agricultural biotechnology.

The fundamental science for innovation in agricultural production has shifted rather quickly from chemistry to biology (Chandler 2005). The advent of commercial biotechnology influencing agricultural industries is rooted in the 1970's. Chandler (p.10) notes that "…by the 1970's, chemical science and engineering was no longer generating significant new learning, whereas at the same time biology and related disciplines, especially molecular genetics, witnessed an explosion of new research and insights. Based on this new learning, chemical and pharmaceutical companies built new integrated learning bases, erected new barriers to entry, and defined new strategic boundaries." For example, DuPont, even though its roots were firmly in chemistry, remade itself into a company whose research and development is predominantly based on the science of biology, beginning its transformation in the mid-1980s.

The advent of the first genetically engineered crops available to farmers as a result of agricultural biotechnology was in mid-1990. For example, genetically-modified soybeans and corn were widely available for the 1996 crop year, even though some genetically-modified seed was available the previous crop year. The fundamental change from chemistry to biology as the primary source for innovation provided opportunities, as never before, to accelerate food product innovation and open the potential for food to play an expanded role as a delivery mechanism for medical technology.

The expanded role as a delivery mechanism for medicine is in addition to the traditional role of human sustenance from caloric intake (Enriquez and Goldberg 2000). Historically the purpose of food consumption was sustenance through ingesting calories and nutrients (Stigler 1945; Southgate, Graham, and Tweeten 2007). After that need was met, taste became important in preferences (Kinsey 2001). More recently, convenience is one determinant of consumer food preferences (Boland 2010).

Today's modern consumers now ask for more. In addition to nutrients, taste and convenience, some consumers now consider personal health. These attributes are based on a sense of food safety and a longer-term attribute in the form of functional foods and nutraceuticals (Kinsey et al. 2009). As obesity has become an epidemic brought on by lifestyle choices and convenient but high-caloric food products, personal health attributes for many consumers already have become an important added bundle of expectations for their foodstuffs.

The shift from chemistry to biology as a source of innovation in agrifood supply chains has made biology the science of tomorrow. Biology, through genetics, is about information storage, duplication and transfer involving the most sophisticated devices ever imagined. Indeed, the transformation is so dramatic that synbiology synthetic biology now captures an emerging area of synthetic biology. Synbiology is the engineering of biological components and systems that do not exist in nature and the re-engineering of existing biological elements. Synbiology is determined on the intentional design of artificial biological systems, rather than on the understanding of natural biology. Synbiology aims at the design of artificially modified living systems, such as specialized cells for biosensing and biobased and highly controlled synthesis, or for high yield production of biological molecules for in vivo or in vitro use. Synbiology is determined on the intentional design of artificial biological systems, rather than on the understanding of natural biology (European Commission FP6 2005). This emerging area promises to construct new biofunctional systems to build novel proteins, genetic circuits and metabolic networks based on knowledge contributions from biology, engineering, mathematics, and physics.

Molecular genetics and synthetic biology will impact preventive and curative medicine at an accelerated pace as well as find applications in the food supply (University of Idaho 2010). For example, nanoparticles may be used to target certain genes and therefore aid in genetic engineering of food animals. In another application, nanomaterials might enhance the shelf stability of food products and help assure their safety. Nanotechnology allows integration of biology and information technology through nanoscale approaches that will find direct application in human medicine. For instance, DNA markers alert individuals through adapted information and communication systems to any alteration of the biological information system. Blood pressure and quality will be monitored real-time and continuously via biosensors. Biosensors also are increasingly employed in food science to detect pathogens without disrupting food processing or product flow.

The advent of personalized or individualized medicine, made possible by rapid and fundamental advances in biology, portends the day when prediction of future patient maladies is likely. The change is that medicine evolves from treatment of a condition after it is diagnosed to current active management so that the future condition is delayed, minimized, and/or avoided completely. This model for medical treatment is an evolutionary shift from reactive to proactive. The consequent change for the agrifood system is that food and even obligatory preventive diets may become commonplace. One prospect is that food and diet become a means of delivering customized medical knowledge to patients.

There are major implications of this evolution to food as a delivery platform for medical and biotechnology intellectual property. [4] One potential is for the proliferation of numerous small specialized niche markets for foods (Sporleder, Goldsmith, and Cordier 2008). Another example is probiotics in numerous foods (Sanders 1998). Rapid biotechnological advance will continue to blur the lines between food and medicine**.** Enhanced demand for nutraceuticals and functional foods results.

Cyberspace and Information Technology Influences on Agrifood Supply Chains

Cyberspace and information technology changes everything from business models to how feasible outsourcing is as a strategy for firms that operate in global agrifood supply chains.

The present and future are described as the Age of Knowledge because science and technology are integrated for increasing productivity and consumer value. The Age of Knowledge enhances the well-being of citizens and enhances the average global living standard (Federal Reserve Bank of Dallas 2006). Knowledge formation is increasing at increasing speeds to address the rapid development, shifts, and expansion of consumer demand.

Transportation and communication technology have allowed efficiency gains since the 1970's, cutting real *ad valorem* freight rates by more than 40 percent. The widening of the Panama Canal, slated for completion in 2014, will offer greater efficiencies for the eastern U.S. seaports. Goods are now moving around the world, not only at low cost but with containerized and parcel shipping from producer to final consumer using customized contracts or private third-party services. More recently, digital communications not only significantly decreased the average costs

[4] Sussex (2008) provides informative statistics on the evolution of agricultural biotechnology and how rapidly it developed globally. Sussex indicates that the first transgenic food crop to be commercialized was FlavrSavr, a delayed ripening tomato, in 1994. By 2006 transgenic crops were planted on 102 million hectares (252 million acres) in 22 countries (11 industrial countries and 11 developing countries) by 10.3 million farmers: 9.3 million of these farmers were resource-poor with small farms in developing countries. Soybean was the principal transgenic crop in 2006, occupying 58.6 million hectares, followed by maize (25.2 million hectares), cotton (13.4 million hectares), and canola (4.8 million hectares). The first field trials of transgenic crops were conducted in 1986 to test herbicide tolerance in tobacco. By 2005 nearly 3500 field trials had been conducted at more than15,000 sites in 34 countries on 56 crop species. The eight most frequently tested species were maize, canola, potato, tomato, tobacco, soybean, cotton, and melon. In 2007, it was estimated that 140 species of angiosperms had been genetically transformed.

of exchanging information, but allows knowledge transfer at near-zero marginal cost and without practical limits to speed. As a consequence, the supply of information in knowledge products is not limited, allowing increases in the quantity demanded without necessarily a rise in price.

Transactions in agrifood supply chains tend to be complex and often supply chain segments involve perishability, both in terms of spoilage and time-related degradation of product quality (Pritchett 2004). Information technology provides a foundation for cost effective just-in-time deliveries, enhanced ordering capacities, and facilitates traceback and identity preservation so that food recalls become more effective and efficient. It enables higher quality supply chain transactions at lower costs (Bailey, Jones, and Dickinson 2002).

There are two substantial direct impacts of information technology. First, processors can use economic incentives through production or marketing contracts to induce producers to grow a certain plant variety or animal breed that has some desired quality characteristic. For example, certain soybean varieties have lower levels of oil that yield a lower saturated fat (Sykuta and Parcell 2003). Certain animal breeds have less external or internal fat and processors can contract for such breeds (Roe, Sporleder and Belleville 2004). Second, processors can utilize current commodities and use research and development to remove the saturated fat or reduce the number of calories in a food as a response to economic incentives from consumers. The cost of doing so may be less than trying to acquire the seed germplasm, modify the genetics, and contract with producers to produce the plant. Many crops have potential for such differentiation. For example, Boland's (2001) *Economic Issues Series* summarizes the potential for value-enhancement in various crops provided in 15 different publications.

A large but relatively unnoticed part of information technology has been the harmonization of information used in business transactions between firms in different countries. For example, in 2002 the United States, Canada, and Mexico began using the North American Industrial Classification System. This system harmonizes industry definitions across international borders and makes data more meaningful and easier to use. In 2011, international accounting standards to report firm-level financial information emerged (International Financial Reporting System 2011). The adoption of the metric system in many countries has helped standardize weights and other measures globally. Veterinary and other scientific protocols are becoming more standardized across countries, which enhance trade (Marshall, Boland, and Conforte 2002). International Organization for Standardization (ISO) has developed similar standards for best organizational practices. In addition, the data collected on prices, volumes of imports and exports, and similar data is becoming harmonized across countries. All these efforts have resulted in better data for business intelligence and research purposes.

The ability to trace a food product back to its origin is becoming less complex due to information technology. This is useful because as food safety standards increase and trade becomes more prevalent, the need to rapidly respond to a potential food illness or product safety recall will become more important (Kinsey et al. 2009). Furthermore, as some countries adopt country-of-origin labeling in certain foods, the need for information technology becomes more necessary. Although information technology has imposed a cost on firms through regulatory compliance (e.g., food safety and/or reporting), it may reduce costs through the ability to better match consumer or societal demand for better nutrition or similar goals. Thus, information technology has become an important competency for agribusiness firms that can adopt global standards quickly (Bailey, Jones, and Dickinson 2002). Information technology facilitates building interfirm social capital and vertical ties of many kinds (Sporleder and Wu 2006).

Prevalent Market Structure at the Farm Gate is Oligopsony

For many agricultural commodities, the market power of sellers (farmers) and buyers (processors or other first-handlers) is unequal, with substantial market power enjoyed by buyers (Marion and Sporleder 1976; Marion and Kim 1991; Rogers and Sexton 1994). There is a great deal of evidence that suggests that food manufacturing exhibits characteristics of monopolistic competition (Boland et al. 2012). In the United States, this fundamental characteristic has resulted in substantial legislation and rule-making by various governmental agencies that are intended to redress the balance of market power or protect farmers from experiencing the full force of unequal market power.

In the United States, the 1920s and 1930s were decades of concern over the market power of first-handlers and buyers of farm products. This concern resulted in legislation intended to countervail oligopsonistic market power at the producer-first handler level in the agrifood supply chain. Legislation stemming from countervailing power concerns encouraged the formation of farmer cooperative organizations and a myriad of regulatory tools that allowed producers to work together on common marketing issues. Examples include the Capper Volstead Act of 1922 and marketing orders covering several agricultural commodities. While some of the fruit and vegetable marketing orders initially had provisions designed to suppress short-term supplies, these provisions were largely eliminated in the 1970s. The annual U.S. Department of Agriculture Rural Business Service's Cooperative 100 profile indicates that aggregate agricultural cooperative market share has been increasing over time in many industries (e.g., fluid milk, feed).

In the United States, the set of antitrust policies which bears directly on economic power at the producer-first handler level begins with the Sherman Antitrust Act of 1890 and continues through the 1970s with additional interpretations of Capper-Volstead from a rather complex set of case law. The Capper-Volstead Act is an important antitrust policy regarding farm gate economic power. The economic logic of Capper-Volstead, in an antitrust sense, is to allow producers to form organizations with countervailing power. The Sherman Act and additional antitrust legislation, such as the Robinson-Patman Act of 1936, seek to constrain exercise of market power by large firms. At the same time, Capper-Volstead seeks to encourage joint marketing among farmers as a countervailing activity.

The legislation influencing the nature of trade practices, together with public market information legislation, creates two meaningful sets of policies aimed at balancing economic power. The set of trade practice policies includes, but is not limited to, unfair trade regulation, prompt- and full-pay provisions, truth-in-trading requirements, and discriminatory practice regulation. Legislation in the U.S. includes the Packers and Stockyards Act of 1921, the Commodities Futures Trading

Commission Act of 1974, the Perishable Agricultural Commodities Act of 1930, the Agricultural Fair Practices Act of 1967, and the United States Warehouse Act in 1916. [5]

From an economic standpoint, both market information and trade practice regulation are policies intended to equalize information in commodity markets. Collection of unbiased and statistically accurate market information promotes competition in the long-run. In general, public price reporting is justified on grounds of promoting competition, efficiency and fairness, as well as providing the federal government with information it needs for regulatory monitoring.

The U.S. Department of Agriculture (USDA) is internationally recognized and accepted to have the most reliable and timely market information systems in the world. It begins with the statistically reliable systems developed by the National Agriculture Statistics Service and the Outlook and Situation Board. Internationally, it relies on country data, weather reports, surveillance systems, and regular reports on production, supplies, and stocks supplied by Foreign Agriculture Service officers located in the embassies of countries around the world. Private intelligence is also provided by a number of companies.

Prices are meaningful only if they relate to products of identified homogeneous quality. This requires a grading system, which began early in the history of USDA and in some instances even before USDA was established. The broadest authorization for grading systems is provided by the 1946 Agricultural Marketing Act.

Public price reporting has become a controversial market information component as private reports have developed that directly compete with USDA market news reports. Sumner and Mueller (1987) show that private information is quickly embedded into USDA prices. Further complications have developed as markets become vertically coordinated (ownership integration or contractual) and rely on pricing formulas that include prices from either residual spot markets or from finished product markets. In the case of eggs and meat, private price reporting evolved as the focus of the industry rather than USDA reports.

Private reporting is acceptable to economic agents in the supply chain when the belief is that the private reports more accurately reflect market conditions compared to public reports. An issue is when contracts and integration account for a large share of total trades at a pricing point, the information value of the spot market is eroded. It is difficult to analyze when the information value of spot markets is no longer useful. The Livestock Mandatory Price Reporting Act of 1999 is one example of the policy reaction to this dilemma. This Act requires large meatpackers to report all livestock transaction prices to the Agricultural Marketing Service of USDA. The broader coverage mandated in the Act is in response to a persistent decline in the volumes traded through spot markets. Dhuyvetter (2004) shows how the prices for segregated early-weaned pigs can be determined using market prices of inputs as a way to assist in price discovery when data is private.

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[5] Readers interested in more detail on these acts are urged to consult the Website of the Agricultural Law Center of the University of Arkansas [http://www.nationalaglawcenter.org/]. Details of each piece of legislation mentioned are provided along with recent case law interpretations. For a less technical treatment, see Breimyer (1976).

The market structure of oligopsony at the farm gate has resulted, over many years, in legislation that attempts in various ways to countervail or redress the imbalance of market power. This has evolved into a complex of institutional and legislative aspects that serve to make commodity marketing an exclusive feature of agrifood supply. Agrifood supply chains in the U.S. economy exhibit an extensive array of institutions and legislation aimed at redressing the balance of market power.

Relative Market Power Shifts in Agrifood Supply Chains Away from Food Manufacturers Downstream to Food Retailers

A longer-term agrifood supply chain trend is that market power has been shifting away from food processors to food retailers and restaurants as downstream businesses closer to the ultimate consumer. The uniqueness of agrifood firms is that this is a much longer process and has more complexity associated with the unique aspects of food. This trend is true in the United States and in other countries. In the United States, leading grocery retailers such as Walmart are now called "chain captains" because they possess relatively more influence in many agrifood supply chains when compared to other participants in the same chain, such as food processors (Sporleder and Peterson 2003). Sporleder and Peterson argue that chain captains possess economic market power within some agrifood supply chains sufficient to influence the behavior of participants within the entire chain. [6]

Market power concerns are considered by the U.S. Department of Justice often in the event of industry consolidation, where one firm merges with a rival firm in its industry. Complex and sophisticated quantitative tests have been developed to assist courts and regulators in determining firm conduct that may not in the best interest of the public (Abere et al. 2002). Evidence from Schumacher and Boland (2004) suggests that the persistence of accounting profitability in retail grocery supermarkets was the greatest and most long-lasting of any sector of the food economy. In addition, retail grocery supermarkets and restaurants are integrating upstream into wholesaling while processors are integrating downstream towards wholesalers (Dorsey and Boland 2009). However, the authors note that such integration by processors and restaurants into wholesaling has resulted in discounted accounting profits.

Some restaurants, such as McDonalds, while not engaged in vertical integration activities, have expanded their economic influence. This market power stems from their global market share and number of retail locations. Their substantial volume results in increased negotiating leverage with suppliers, access to information on consumer demand for food products through transac-

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[6] One specific example is the well-known case of Walmart's packaging scorecard for its suppliers. Walmart is now the largest grocery retailer. The packaging scorecard created by Walmart is their attempt to specify metrics useful to compare the sustainability of practices and the environmental friendliness of packaging among their suppliers. The scorecard evaluates the "green quotient" of product packaging based a number of attributes including 1) greenhouse gas emissions related to production, 2) materials used, 3) product to packaging ratio, 4) cube utilization, 5) recycled content usage, 6) innovation, 7) the amount of renewable energy used to manufacture the packaging, and 8) the recovery value of the raw materials and emissions related to transportation of the packaging materials. Walmart has sufficient market power to dictate that its suppliers will use the scorecard. This is a specific example of the Chain Captain notion within a supply chain.

tional data, and core competencies in logistics and inventory management. This culminates in lower average costs per unit of volume relative to their competitors.

Successful brands can provide enhanced market power over time. Interbrand's list of the top 100 most valuable global brands includes four restaurant brands (McDonald's, KFC, Pizza Hut, and Starbucks), six food manufacturing brands (Nescafe, Nestle, Danone, Campbell, Kellogg, Heinz), and three beverage brands (Sprite, Coca-Cola, Pepsi). Such brands suggest greater economic influence and tend to be more valuable as a percentage of total market capitalization relative to other industries. Boland, Freberg and Barton (2001) found that common indicators across successful Fortune 500 food economy firms included large market share, valuable brands, differentiated image or products, and a broad product line. The substantial market share enables global food processors, retail and restaurant firms with these brands to pursue other agendas, such as sustainability initiatives to reduce unneeded space in packaging (e.g., reduce size of boxes to minimize the amount of empty space), increase the use of recyclable materials in packaging, and improve the appearance and consistency of produce. While the substantial market share may be true of other industries, the length of the supply chain coupled with the many firms, agencies, and non-governmental organizations in the agrifood industry makes this process much more complex.

Similarly, the size of space used in cages for layer chickens, use of growth hormones in beef production, use of bovine somatotropin (bST) in fluid milk, and other issues have resulted in voluntary changes made by producers upon request from these retail supermarkets and restaurants (McCorkle 2009). Sumner et al. (2010) note that new regulations on cages in California will result in eggs being imported into California from other states rather than produced in California. Similarly, bST is no longer used by dairy producers. Scale of operation enables some retailers and restaurant chains to negotiate effectively and act in a manner consistent with chain captains.

Access to information on consumer demand also has led to enhanced relative market power for retail grocery supermarket and restaurant firms relative to food processors (Sexton 2000). Evidence suggests this holds even in emerging markets in Latin America and Asia (Cook et al. 2001). The use of scanner data and loyalty programs has enabled grocery retailers and food processors to better understand consumer buying behavior and purchasing patterns. The near instantaneous use of such data allows these firms to conduct experiments on pricing to better determine how consumers respond to relative price movements. This is especially useful when trying to determine the value of a brand relative to a store brand or private label brand (Kinsey 2001).

Globalization of Agricultural Production and Agrifood Supply Chains

Globalization is a complex reality fed by technological changes and inducing dynamics in living standards and consumer demands around the world (Gallo 2010). Globalization involves a feedback system. Information technology enables globalization, which in turn increases market size, returns to scale, competition, capital flows and therefore political pressure for multilateral trade agreements and market access among countries (Boehlje, Akridge, and Downey 1995). Globalization allows for and promotes foreign direct investments by permitting capital to seek its highest return anywhere in the world. The impact of globalization is extraordinary in many ways. Consumers directly benefit through better, faster, and cheaper products.

Global trade in many agricultural commodities is subject to market forces and government policy. These programs generally shield farmers from transitioning out of agriculture and provide income enhancement for farmers through numerous government programs and policies. The programs exist primarily in the United States and European Union countries. Resource adjustment over time is influenced by trade policy.

For example, U.S. farm policy is subject to a five year planning horizon since the authorizing legislation and legislation providing appropriating funds for the authorized programs is done every five years. Furthermore, trade agreements are negotiated by a President through treaties approved by the U.S. Senate. Many of the trade agreements have a provision for agriculture that is written outside of the Farm Bill (U.S. Office of the Trade Representative 2011). All of these policy issues have implications for agricultural production.

It is well-known that some U.S. agricultural programs have provided economic rents to landowners. Dhuyvetter and Kastens (2010) suggest that these rents are significant in determining farmland values and farmland leases are attributed to direct payments of income from the U.S. Treasury to landowners. These economic rents are significant enough that producers will not change cropping patterns quickly unless there are significant changes in relative commodity prices, such as during the 2005 to 2008 crop seasons. During these seasons the renewable fuels mandate drove relative corn prices high and consequently producers began moving more acreage into corn. Land retirement programs, such as the Conservation Reserve Program, are another example. This program idled millions of acres of land and slowed resource adjustment in agriculture. This program was part of the U.S. agricultural policy. In recent years, some of this land was brought back into production when agricultural prices began to increase.

Countries who are members of the World Trade Organization abide by certain rules which include not using agricultural programs that provide incentive distortions to producers and induce them to plant crops at prices not established in global markets. However, countries have undertaken other methods to enhance producer income such as direct payments, crop insurance subsidies, and marketing promotion programs. For all of these reasons, resource adjustment in production agriculture is slow to change over time.

Resource adjustment is not limited to production agriculture. The role of institutions also can limit how quickly agribusiness firms adjust. For example, Boland, Golden, and Tsoodle (2008) noted the high degree of closely-held, family-owned, or cooperative businesses in the U.S. food economy relative to other sectors of the economy. The governance structures of these firms are not unique to the United States. Indeed, family-owned businesses dominate the food economy of many countries and impact the political economy of many countries. Thus, resource adjustment may be slow to change among agribusinesses in many countries.

Globalization increases competition, making it more difficult for firms to raise prices when costs rise. Greater competition also drives managers to add value to goods or services to keep ahead of competitors. As a consequence, production is constantly transferred to the most efficient and innovative firms in a globalized marketplace. Consumers directly benefit through better, faster, and cheaper products. Furthermore, the impact of globalization has been a topic of many case studies in the *International Food and Agribusiness Management Review* and similar publications (for an example, see Boland and Gallo 2009).

Globalization affects agribusinesses in several ways. First, firms need to have a strategy for competing globally (Busch and Bain 2004). Commodity-oriented businesses compete on low-cost of production, handling, distribution, and shipping. Food processors must have a large domestic consumption of the good that is being traded so as to be able to trade the high-valued exports and utilize the lower-valued product in the domestic market. This is often true for products with jointness or fixed proportions such as chicken (legs and thighs vs. breasts), beef cattle (steaks vs. middle meats vs. ground hamburger), wine (reserve grapes vs. regular grapes), and ethanol (fuel vs. distillers grains).

For commodities where low-cost per unit is critical, trade is most prevalent. The United States has higher cost of production due to relatively high land prices and capital inputs, but enjoys lower shipping and transportation costs. In aggregate, this makes the United States cost competitive with other countries in South America. With regard to processed food products, countries in the European Union have the most integrated level of trade in food products between countries, especially Germany (Central Intelligence Agency 2011). With regard to agricultural commodities, Brazil is becoming larger due to its unique geographical position with much of its arable land between the equator and 30 degrees south latitude. This enables it to become a larger exporter of horticultural crops, row crops (soybeans) and livestock (beef and poultry).

Implications for Research

Cost competitiveness studies are important for developing a strategy to compete in the food economy. Such cost studies must include the entire supply chain because of the uniqueness of the agrifood economy and include such global dimensions as the sensitivity of competitiveness to changes in currency exchange rates. Examples of this are the Rabobank industry studies. As an illustration, Kiechel (2010) discusses why this type of study is an important activity for strategy consulting firms. Examples of how firms and their managers compete in this environment are critical for researchers to understand. For instance, Penrose's (1960) pioneering research case on Hercules Powder was one the first to use a case study approach in a scientific manner for research on industry analysis. This is an example of how an academician can conduct an in-depth analysis of a firm and the industry in which it operates in an effort to better understand how strategy evolves. The Industry Studies Association, which was established by the Alfred P. Sloan Foundation, is designed to share such scholarship.

The Nobel Foundation has recognized the achievements of North, Coase, Williamson, and Ostrum in recent years for their work in institutional economics. It is likely that these contributions will find their way into graduate degree programs in agricultural economics and management. The National Food and Agribusiness Management Education Commission reported that only four programs were teaching these institutional economics concepts (Boland and Akridge 2004). Over time, it is likely that this will increase because as numerous authors have noted, there are many applications to the food economy of these concepts (Sykuta and James 2004). For example, the prevalence of closely-held firms such as agricultural cooperatives as an institution globally is one aspect that requires greater exploration (Cook and Chaddad 2004). King et al. (2010) summarize much of the literature on cooperatives. As Boland, Golden, and Tsoodle (2008) note, the prevalence of family-owned firms and cooperatives are unique governance structures that are typically not studied within colleges of business programs.

The theoretical and empirical work to substantiate these theories is predominately based upon observation through the use of case studies and other qualitative data techniques. Methods such as research cases of firms within agrifood supply chains need to become part of the standard program for graduate student training in much the same way that econometric and mathematical programming are an important part of graduate training in agricultural economics and management.

This carries over to the choice of doctoral student topics. Boland and Crespi (2010) conducted a census of every dissertation published in agricultural economics and management in the United States over the 1950 to 2005 time period and among many findings, reported less than ten dissertations which used a case study type approach. In fact, there was a significant time gap between Goldberg's 1952 dissertation on the soybean processing industry and the next dissertation that used a similar qualitative approach. Many agricultural economics and management graduate faculty are likely to be uncomfortable with such methods. Two notable exceptions are Wysocki (1998) and Burress (2007). It is important to continue to promote the use of such techniques and educate our colleagues and graduate students on their use. Unfortunately, the majority of agricultural economics and management departments lack critical mass of such faculty.

The training most agricultural economists receive in their doctoral programs enables them to work with large complex time series and/or cross-sectional data sets, such as those often found in large retail groceries. These techniques are within the traditional domain of the agricultural economics discipline. The authors argue however, that a deep understanding of the uniqueness of the food economy, that can be derived primarily from case studies and qualitative analysis, is important for graduate students seeking eventual employment within agrifood industries.

A related issue, although much debated in the professional academies, is the relevance of agricultural economics and management. The short-term budget issues which are really longer-term in nature suggest that universities value the agribusiness management teaching function at the undergraduate level and the production economics and quantitative methods function at the graduate level for engaging with agricultural science colleagues on USDA National Food and Agriculture Institute mission research (Boland 2009). Cook and Chaddad (2000) provide an excellent historical perspective on agribusiness management research. In general, management research on agribusiness firms is not in that mission with the exception of cooperatives and those programs are heavily funded through faculty chair endowments and centers. Boyd et al. (2007) conducted an extensive literature review of management as an input in agribusiness firms and found little empirical evidence demonstrating that it had a significant impact on agribusiness performance. While it is evident that increased resources are needed for graduate program initiatives in agribusiness economics and management, it is difficult to see where they will emerge except through the social sciences rather than the agricultural sciences.

Managerial Implications

The exclusivity of agrifood supply chains provides a rich foundation for managerial implications that focus on industry forces that a firm must take into account when developing corporate strategy. The agrifood supply chain is globalized, requiring managerial knowledge regarding international trade and the complex labyrinth of regulations and stakeholders that influence commodity production in most countries.

Implications abound for the managers of firms in the agrifood supply chain. A clear picture emerges from the exclusivity aspects enumerated here that competition may materialize from sectors previously thought to be unrelated to food production and distribution. Big pharmaceutical companies are an example. The rapid pace of innovation in human medicine from biology and nanotechnology will influence future agrifood supply chains in unprecedented ways. Everything from new food products to new markets will develop and challenge existing firms to be nimble in planning.

The implications for agrifood supply chains and the firms operating within them are numerous. The future will be more complex than the present. The implication of enhanced complexity covers most choices that firm managers must make over time: strategic choices, external choices, organizational choices, and operational choices. The factors that comprise these choices offers some glance at the future decision-makers must face. For example, the number of products offered in the market, the geographic scope of the firm (i.e., number of countries), and the source and sustainability of differentiation (e.g., brands, products characteristics, etc.) are leading elements of strategic choices. Firms successful at growth will be adroit at knowing when to advance new products and services (strategic timing, exploiting new technology to enhance value to ultimate consumers, and at capturing this value). One small specific example of exploiting technology would be a food manufacturer taking advantage of the development of low-linoleic soybeans to produce healthier foods with little or no transfat.

Corporate social responsibility (CSR), defined in a broad sense, emerges from this analysis in several ways.[7] The so-called triple bottom line endeavors will continue to be important to firms in agrifood supply chains as well as firms in manufacturing and service sectors. However, because of exclusive aspects such as globalization and technologies like gene modification of germplasm, CSR emerges as a vital element that agrifood firm managers must recognize and supervise which differs by location within the supply chain, but becomes increasingly important to all the stakeholders of agrifood firms.

The role of trade associations, promulgating soft law self-regulation, will be more important in the future. Trade associations will have an essential future role in codification of best practices within their particular industries. The term *codification* implies identifying or creating codes, which are compilations of written statutes, rules and regulations that inform trade association members of best practices and of acceptable and unacceptable firm conduct. .The dynamics,

[7] The broad sense of CSR refers not just to 'social responsibility' but includes the additional elements of environmental responsibility and governance responsibility. While the environmental is well-known, the governance element encompasses anti-bribery, board independence, engaging outside directors, full disclosure of remunerations, and independence and effectiveness of an audit committee (UNCTAD).

length, and complexities of agrifood supply chains as discussed in this manuscript will enhance the role of trade associations and other non-governmental organizations in promulgating soft law self-regulation. Soft law self-regulation will take on renewed importance in the future. As a specific example, one only need consider the notion that food and medical technology are merging in some applications to create new food supply chains as a means to deliver certain medical technology to consumers. Complex alternatives will need resolution by managers in an unprecedented way.

The role of food manufacturing research and development is less clear in the future than it is under the current agrifood supply chain. Regulatory issues, the nature and intensity of competition within a particular manufacturing industry, and the speed of innovation within the industry are all external to the firm. The elements of organizational choice and architecture include the internal structure of the firm, the role of research and development and innovation within the firm, and other elements less well-understood by managers such as corporate culture and CSR. Grocery supply chains have trended toward chain captains with increasing market power at the retail level as noted earlier. One implication is that entire supply chains or networks may compete against one another in the future.

The future role of business policy will become more important in agrifood supply chains. The complexity, length, and number of different firms (e.g. producers, first-handlers, manufacturers, wholesalers, food service suppliers, retail groceries, and restaurants), regulatory bodies, and other agents (NGOs) make the agrifood industry much different and exclusive relative to other manufacturing and service industries. Demands by NGOs and others will continue to present dynamic situations that add complexity to the chain.

One recent example of these complexities within agrifood supply chains include the support received for fundamental shifts in the manner in which nutrition information is presented to consumers (Institute of Medicine of the National Academies 2011). The Institute of Medicine recently called for a four-star front-of-package voluntary labeling of healthfulness on all food products in the United States. The suggestion is to move away from protocols that mostly provide nutrition information to protocols that offer clear guidance to consumers about the healthfulness of the product. Even though such a shift in labeling may appear to be a food processor issue, the reality is that it is a chain issue. It must be managed from a supply chain perspective to be implemented in a credible and cost effective way. Upstream supply chain participants must be vigilant to understand the ultimate needs of downstream customers. The future, no doubt, will be toward enhanced vertical alliances in supply chains in an effort to manage these types of chain issues.

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