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Markets and Supply Chains: An Investigation of the Institutions Influencing the Farm-Supply Chain Interface

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An Investigation of the Institutions Influencing the Farm-Supply Chain Interface

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by

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Abstract

Farm-level operations have lasting and amplified impacts that promulgate the entire supply chain, and the farm is increasingly in the forefront of today's headlines on topics such as social responsibility, environmental sustainability, traceability, and food safety. Despite its significance, however, the farm remains a 'black box' and has traditionally operated independently with little information-sharing, trust, or collaboration with buyers downstream. This dissertation begins to unpack this 'black box' by employing different methodologies to identify the factors influencing exchange in the farm-supply chain interface. In Essay 1, I examine why the farm continues to be a challenge for 'traditional' collaborative approaches to buyer-supplier exchange. I use an interpretive approach to identify the individual and institutional factors influencing farmers' operations decision-making. Field interviews reveal that farmers approach buyer-supplier exchange differently and tend to rely more heavily on market mechanisms to coordinate activities with buyers and inform their decision-making. In Essay 2, I build on this finding to examine the institutional factors influencing exchange in the spot market, which accounts for a majority of the total value of agricultural commodity production. I use a proprietary data set and time series econometrics to investigate how spot market exchanges between farmers and buyers are influenced by the futures market—an institution serving critical informational and risk management functions in the industry. In line with the predictions of Austrian economics, the findings indicate that farmers and buyers use the information conveyed by the futures market as they negotiate prices in the spot market. In Essay 3, I build on this finding and further explore how the futures market influences spot market exchanges by examining how information asymmetry affects the price adjustment process. I draw on economic theory to develop hypotheses that are tested using a proprietary data set and nonlinear time series econometrics. The findings suggest that buyers

exploit their informational advantage by adjusting spot market prices asymmetrically. Taken together, the three essays demonstrate how institutions influence decision-making and exchange in the agricultural supply chain and offer important insights for theory, practice, and public policy.

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I. Introduction

Exchange is at the heart of supply chain management. Effective supply chain management involves managing the exchange of products, services, finances, and information between firms to create value for the ultimate customer (Mentzer et al., 2001), so understanding interfirm exchange has been a central focus of supply chain management research. Extant research has proposed various mechanisms to manage buyer-supplier exchange, such as contracts (e.g., Sluis & Giovanni, 2016), collaboration (Cao & Zhang, 2011), coordination (Fugate et al., 2006), information-sharing (Sahin and Robinson, 2002), trust and commitment (Narayanan et al., 2015), relationship-specific investments (e.g. Handley and Benton, 2012), and even supply chain integration (Flynn et al., 2010; Wong et al., 2011). As evidenced by these examples, the vast majority of extant research has focused on relational exchange – what Williamson (1991) referred to as 'hybrids and hierarchies'– despite the fact that the exchange continuum spans from transactional (i.e., "arm's length") to relational (Kim and Choi, 2015; Sheng et al., 2018). While this relational emphasis is understandable given the myriad of performance benefits (Cao &Zhang, 2011; Fugate et al., 2006), relational exchange is "is not, nor should it be, the goal for all interfirm relationships" (Davis-Sramek et al, 2007 p.45). Indeed, transaction cost economics suggests that firms should choose the mechanism that minimizes the costs of exchange (Williamson, 1981). Furthermore, in practice, buyer-supplier exchange in several critical industries, such as bulk ocean shipping (Stopford, 2009), trucking (Belzer, 2000), and agriculture (MacDonald, 2015), tends to be more transactional, and the recent growth of online business-to-business marketplaces like Alibaba and Amazon Business "has the potential to radically alter" the structure of exchange (Seifert et al., 2004 p.781).

Beyond the dyad, neo-institutional economics suggests that the structure of interfirm exchange is contingent on the institutional environment surrounding the exchange (Williamson, 2000; North, 1990). Supply chains are inherently embedded in a broader institutional environment

that includes sociopolitical institutions, like governments and regulatory agencies, and economic institutions, like financial markets and banking systems (North, 1990). These institutions – "the humanly devised constraints that structure political, economic, and social interaction" (North, 1991 p.97) – form the 'rules of the game' for exchange. In doing so, institutions shape firms' decision-making and intentions, as well as the performance outcomes of these decisions, by determining the associated transaction costs and value of engaging in exchange (North, 1991; Williamson, 1991), The structure and performance of interfirm exchange is thus a function of the institutional environment (Sheng et al., 2018).

Amidst a global macroenvironment characterized by heightened uncertainty, supply chain thought leaders have called for research that explicitly accounts for the role of institutions (e.g., Fugate et al., 2019; Joglekar et al., 2016). Recent studies have explored how institutions affect the outcomes of buyer-supplier exchange, such as the development of information-sharing practices and trust (Cai et al., 2010), contract effectiveness (Shou et al., 2016), and supply chain performance (Dong et al., 2016). In the context of emerging economies like China and India, recent studies have also examined the contingency effects of "weak" institutions (e.g., Bai et al., 2016; Zhou et al., 2016) and institutional voids (e.g., Craighead et al., 2017; Parmigiani &Rivera-Santos, 2015) on interfirm exchange. While understanding how institutions influence the *outcomes* of interfirm exchange is important, largely missing from this literature is an examination of their influence on the *structure* of interfirm exchange. This dissertation begins to fill this important gap by examining how institutions influence interfirm exchange in the farm-supply chain interface.

Idiosyncrasies of the agricultural supply chain allow me to contribute to extant research in supply chain management in two important ways. First, in contrast to the often "weak" institutions examined in previous studies, institutions play an active, significant role in the agriculture indusry

given concerns over farmers' welfare and global food security (MacDonald et al., 2004). While this generally comes in the form of government price supports and subsidized crop insurance (Orden et al., 1999), another important role played by institutions is the provision of information (Arbuckle et al., 2012). Government agencies, such as the U.S. Department of Agriculture, and futures markets play a vital informational role in the agricultural supply chain (e.g., Adjemian, 2012; McKenzie &Darby, 2017). In light of this involvement, political economy scholars have found that farmers have an elevated sense of the personal relevance of institutions (Wolfinger &Rosenstone, 1980), which makes examining the farm-supply chain interface a lucid context to investigate how institutions influence interfirm exchange. Second, the agricultural supply chain is facing increased scrutiny amidst consumer demands for transparency, social responsibility, environmental sustainability, food safety, and traceability (Castillo et al., 2018; Wowak et al., 2016), but the farm continues to pose a challenge to achieving many of these objectives. For example, overproduction and burdensome inventories at the farm-level have increased food waste, reduced operational efficiency, and threatened farmers' profitability and survival (Gunders &Bloom, 2017). While the recent development of technologies such as blockchain and various direct-marketing networks may help to decrease the distance between the farm and downstream buyers (e.g., Tongarlak et al., 2017), the agricultural supply chain has traditionally operated independently with little to no information-sharing, trust, or collaboration (Dillard & Pullman, 2017; Pullman &Dillard, 2010). This is in stark contrast to the often-relational nature of interfirm exchange in downstream echelons—e.g., manufacturers and retailers (Davis-Sramek et al., 2007), so understanding if and to what extent institutional factors are contributing to this structural difference is warranted.

The three studies comprising this dissertation employ different methodologies to understand the institutions influencing exchange in the farm-supply chain interface. In the first essay, I examine why the farm continues to be a challenge for 'traditional' relational approaches to buyer-supplier exchange. I use an interpretive approach to identify the individual and institutional factors influencing farmers' operations decision-making. Field interviews reveal that farmers approach buyer-supplier exchange differently and tend to rely more heavily on market mechanisms to coordinate with buyers and inform their decision-making. In the second essay, I build on this finding to examine the institutional factors influencing exchange in the spot market, which accounts for approximately 65% of the total value of farm production. I use a proprietary data set and time series econometrics to investigate how spot market exchanges between farmers and buyers are influenced by the futures market—an institution serving critical informational and risk management functions in the industry. In line with the predictions of Austrian economic theory, the findings indicate that farmers and buyers use the information conveyed by the futures market as they negotiate prices in the spot market. In the third essay, I build on this finding and further explore how the futures market influences spot market exchanges between farmers and buyers by examining how information asymmetry affects the price adjustment process. I draw on economic theory to develop hypotheses that are tested using a proprietary data set and nonlinear time series econometrics. The findings indicate that buyers exploit their informational advantage by adjusting spot market prices asymmetrically.

Taken together, the three essays demonstrate how institutions influence decision-making and exchange in the agricultural supply chain and offer important insights for theory and practice. For research, this dissertation illustrates the role of the market as a coordination mechanism and informational conduit, which is in contrast to extant studies focused primarily on how 'hybrids and

hierarchies' are used to govern buyer-supplier exchange and inform decision-making (Williamson, 1991). In doing so, this dissertation also extends the current conception of institutions beyond their role as contingency factors to include their direct influence on exchange and informational role (Ostrom, 1990). For farmers and supply chain managers, this dissertation sheds light on both the value of and challenges with using the futures market – a longstanding institution in the industry – to inform their decision-making and approach to buyer-supplier exchange. For policymakers, this dissertation identifies unintended consequences of their involvement in the agriculture industry and provides timely guidance regarding the provision of information amidst declining federal budgets and heightened concerns surrounding financialization of futures markets.

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II. Essay 1: Understanding the Factors Shaping Farmers' Operations Decision-Making

Introduction

Environmental, social, and economic sustainability, transparency and traceability, and even traditional operational performance outcomes have at least one important commonality: each directly or indirectly hinges on decisions made at the raw materials echelon of the supply chain (Shafiq et al., 2014; Touboulic et al., 2014; Narasimhan et al., 2015). Operations decisions made by actors within this echelon, particularly farmers, have profound environmental, social, and economic outcomes that promulgate the entire supply chain. For example, farmers are tasked with making production decisions, including what, how much, and how to produce, and storage decisions, including when and how much to sell versus store as well as where to sell, how, and to whom.

For merchandisers, processors, and manufacturers downstream, farmers' operations decisions determine the quality and availability of critical inputs. Inconsistent and/or unpredictable supply throughout the year creates significant challenges for downstream buyers' operations, including production scheduling, raw materials inventories, and cash flow. In fact, large buyers have attributed poor operational performance in recent years to the "persistent problem of slow farmer selling"—a phenomenon in which farmers are reluctant to sell and instead store their goods on-farm with the hope that prices will rise in the future (Singh et al., 2017). For example, the Chief Executive Officer of Bunge Limited, an international food company, noted in an interview that, although farmers eventually decide to sell, their reluctance "postpones the timing of when [Bunge] might buy that grain" (Meyer, 2014).

Beyond downstream buyers, farmers' operations decisions also have implications for retailers and, ultimately, consumers. Retailers face increased pressure from consumers to provide more information; consumers want to know where the product came from, who produced it, how

it was produced, and if the environment and employees were treated appropriately throughout the course of production (Parmigiani et al., 2011; Wowak et al., 2016). The products and quantities farmers decide to produce determines the price and availability of consumer goods with those products as inputs, and the method of production (e.g., conventional, organic) farmers choose has substantial social and environmental sustainability implications (e.g., Touboulic et al., 2014).

Despite the significance of farm-level decisions, however, the farm continues to be a "black box" within the supply chain. Farmers have traditionally operated independently with little to no information-sharing, trust, or collaboration with the rest of the supply chain (Pullman & Dillard, 2010; Dillard & Pullman, 2017), and even the use of contracting has declined (MacDonald, 2015). Further, farm-level operations decisions do not easily lend themselves to be examined by traditional decision models because the decision-making process and who is involved in that process differ from echelons downstream. First, the farm sector is overwhelmingly comprised of family businesses and small and medium enterprises (SMEs), with small and midsize family farms accounting for 95.8% of farms in the United States (Hoppe & MacDonald, 2016). Recent research suggests that SMEs (Kull et al., 2018) and family businesses (Maloni et al., 2017) differ from large, non-family firms along several important dimensions that influence their approach to supply chain operations. Second, the farm sector is characterized by significant involvement from various institutions because of concerns over farmers' welfare and global food security (Arbuckle et al., 2012). Government agencies, futures markets, non-governmental organizations, and university extension services play a prominent role in the industry, as they provide information to help farmers make various decisions (e.g., Feder & Slade, 1985). These institutions form the "rules of the game" and shape farmers' decision-making and intentions (North, 1991; Coase, 1992).

We begin to unpack the "black box" that is the farm by delving into the minds of farmers to understand their operations decision-making processes. Specifically, I explore farmers' underlying objectives, information acquisition activities, and approach to buyer-supplier exchange and how these aspects of operations decision-making are influenced by idiosyncrasies of the farm echelon. To do this, I use an interpretive qualitative approach – the hermeneutic method (Geertz, 1973) – which is effective for understanding experience *in context* and providing "thick descriptions" for conceptual development and richness. Whereas the positivist qualitative approach is typically used for theory construction (Ketokivi & Choi, 2014; Narasimhan, 2014), the interpretive approach is used for theory contextualization because its epistemology emphasizes a particularistic approach to studying phenomena in a particular time and place (Hudson & Ozanne, 1988). At this early stage of understanding farm-level operations decisions, our goal is not to construct a general overarching "theory" but to illustrate idiosyncrasies of farmers' decision-making by middle-range theorizing (Craighead et al., 2016; Stank et al., 2017).

Understanding idiosyncrasies of the farm echelon and their effect on farmers' operations decisions offers important insights for both research and practice. For research, this study expands understanding of the factors influencing operations decisions by focusing on idiosyncrasies of the farm echelon—particularly the prevalence of small and midsize family businesses and the prominent role of institutions. In doing so, I contextualize farmers' decision-making process and also contribute to the nascent literature on SMEs (Kull et al., 2018), and family businesses (Maloni et al., 2017). For practice, our research provides guidance on the farmers' perspective, which can help buyers better gauge if and when farmers would be willing to sell versus store. Lastly, for policymakers, our research sheds light on the role of public information in farmers' operations

decisions and corroborates the continued importance of government agencies and futures markets in the farm echelon.

The structure of the remainder of this research is as follows: The relevant literature and theoretical foundations are reviewed in the following section to conceptualize the orienting frame-of-reference. The hermeneutic method is then introduced with a detailed discussion of the philosophical assumptions and methodological and analytical procedures. The empirical findings are then described followed by a discussion that contextualizes the orienting frame-of-reference. Lastly, the implications for theory and future research, supply chain practice, and public policy are discussed.

Background and Literature Review

Operations Decisions in the Farm Echelon

Farmers are tasked with making various operations decisions. At the beginning of the season, farmers make production decisions, which involve what to produce, how to produce[1], and how much to produce. Upon harvest, farmers then have to decide how much to sell versus store—what I refer to as storage decisions.[2] Because there is continuous demand year-round, farmers are tasked with making storage decisions during the pre-harvest, harvest, and post-harvest periods. Most farmers have their own on-farm storage—e.g., bins, sheds, and other structures (National Agricultural Statistics Service, 2019), so farmers continuously decide if, how, when, and how much to sell versus store, as well as where to sell and to whom.

[1] For the purposes of this study, this refers to the method of production—e.g., conventional, organic, free-range, etc.
[2] The nature of storage decisions differs based on the storability of the agricultural product. Many field crops (e.g., corn, soybeans, wheat, rice, etc.) can be stored for over a year, whereas the storability of fresh produce varies. Further, live poultry and livestock are typically not "stored" but raised to a particular age or weight then sold within a matter of weeks. Given the low storability of some agricultural products, storage decisions are also referred to as marketing decisions, which involve when, how much, where, and to whom to sell.

While there are numerous decisions involved in farm management, I focus on production and storage decisions for three primary reasons. First, production and storage decisions are in line with the "traditional" decisions examined in previous research (e.g., Bierman, Jr., & Thomas, 1977; Sogomonian & Tang, 1993); this allows us to contribute by identifying idiosyncrasies in farm-level decision-making processes. Second, production decisions are long-term and typically made once per year whereas storage decisions are short-term and made much more frequently throughout the year—almost daily in some cases. This allows us to explore idiosyncrasies of farm-level decision-making across different time horizons. Lastly, as discussed previously, farmers' production and storage decisions have significant implications for the operational performance of firms downstream in the supply chain.

Idiosyncrasies of the Farm Echelon

In a similar vein to the conceptual framework used in positivist qualitative research, the orienting frame-of-reference is what is used in the interpretive approach to provide a framework for the methodological and analytical procedures (Prasad, 2017). Our orienting frame-of-reference aims to understand how farmers' operations decision-making processes are influenced by three idiosyncrasies of the farm echelon. First, the farm echelon is overwhelmingly comprised of family businesses with 99% of farms classified as family farms and accounting for 89% of farm production (Hoppe & MacDonald, 2016). Recent research suggests that family businesses tend to have more diverse objectives that include financial and non-financial goals (LaPorta et al., 1999; Maloni et al., 2017). Non-financial goals, such as family legacy (Astrachan, 2010), long-term sustainability (Tongarlak et al., 2017), and socioeconomic wealth (Gómez-Mejía et al., 2007), are often emphasized more than financial goals, although the nature and degree of emphasis can vary widely across family businesses (Maloni et al., 2017). As a consequence, family businesses tend

to approach buyer-supplier exchange differently and generally take a more passive role (e.g., Smith et al., 2014). For example, contractual arrangements and strategic partnerships can be perceived as a threat to their independence and longevity (Roessl, 2005; Stanley & McDowell, 2014). This desire for autonomy and diversity of objectives thus may influence how farmers make operations decisions.

Second, most family farms are SMEs; small and midsize family farms represent 95.8% of farms in the U.S. and account for 45% of total farm production (Hoppe & MacDonald, 2016). Recent research suggests that SMEs differ from large corporations in several important ways that influence their approach to supply chain operations (Kull et al., 2018). For example, SMEs differ from their larger counterparts in terms of resources and capabilities. On the one hand, SMEs may have unique resources and capabilities due to the small number of employees and cohesive nature of intrafirm relationships (e.g., Arend, 2014). These concentrated governance structures provide greater discretion for SMEs to make decisions quickly and pursue different strategies (e.g., Terziovski, 2010). On the other hand, however, SMEs have limited time and resources (Freeman et al., 1983; Bruderl & Schussler, 1990) and may face "disadvantages in accessing other resources such as professional managers, technical assets, and external financing" (Kull et al., 2018 p.25). While unique resources may be an asset, resource constraints pose potential challenges for operations decision-making, particularly related to information acquisition (Harland et al., 2007).

Lastly, the farm echelon is characterized by significant involvement from institutions given concerns over farmers' welfare and global food security. While this generally comes in the form of government price supports and subsidies (Orden et al., 1999), another important role played by government institutions is the supply of information (Arbuckle et al., 2012). The U.S. Department of Agriculture (USDA) and National Agricultural Statistics Service (NASS) have long provided

information to "aid market participants in making impending and future production and marketing [storage] decisions" (MacDonald et al., 2004 p.55). For example, the USDA and NASS provide various monthly reports, including U.S. and World Agricultural Supply and Demand Estimates (WASDE), production forecasts, prospective plantings estimates, and crop acreage estimates. On a weekly basis, the USDA also provides prices and sales information for various locations across the country. These monthly and weekly reports are considered to be useful, low-cost sources of information for operations decisions (e.g., U.S. Department of Agriculture, 2019).

Since the late 1800s, futures markets have also played a prominent role in the farm echelon. A futures market is a centralized financial exchange where futures contracts are bought and sold for delivery on a specified date in the future (CME Group, 2019). While many firms downstream use the futures market to manage price risk (e.g. Weiss & Maher, 2009; Wang et al., 2015; Kouvelis et al., 2018), farmers tend to use the futures market as a source of information. A futures contract is a financial derivative, so its value is, by definition, directly tied to the underlying asset (CME Group, 2019). The futures market thus acts as "an information processing system" (Bowles et al., 2017 p.215), and information is quickly communicated via price changes (Hayek, 1945). For example, a futures price increase implies a decrease in supply and/or an increase in demand (or a combination of the two) whereas a decrease implies the opposite. Futures market information is easily accessible and publicly available in real time for farmers to use in their operations decisions.

Beyond government institutions and futures markets, non-governmental organizations, university extension services, and consumer groups (among others) also play a prominent role in the farm echelon (Maloni & Brown, 2006). Farmers are thus subject to competing influences because they operate within multiple institutional spheres—a phenomenon known as institutional

pluralism (Kraatz & Block, 2008; Dunn & Jones, 2010). In light of this involvement, political economy research suggests that farmers have an elevated sense of the personal relevance of institutions (Wolfinger & Rosenstone, 1980). Underlying institutional perspectives is the idea that "institutions matter" because they form the "rules of the game" (North, 1991), so it is important to understand how different institutions shape farmers' decision-making and intentions.

Methodology

The purpose of this section is to outline a methodology from which the orienting frame-of-reference can be contextualized—or understood in the context of the actual lived experiences of farmers. At the core of our orienting frame-of-reference is the premise that farmers' operations decisions are not solely the product of personal intentions and desires but are also the outcome of aspects of the cultural context, such as sociocultural, political, and institutional forces with which farmers interact on a daily basis (Arnold & Fischer, 1994). Farmers make operations decisions continuously throughout the pre-harvest, harvest, and post-harvest periods, so it is important to examine farmers' everyday experiences to understand how these decisions are made and the factors influencing these decisions. Recognition of the value of everyday life experiences warrants an interpretive approach (Mello & Flint, 2009), which is effective in explicating empirical narratives and providing insights and descriptive details that are difficult to obtain from quantitative methods (Narasimhan, 2014).

While there is some overlap in the *methods* that are used in interpretive research and positivist qualitative research and both share a common commitment to rigorous empirical research (Thompson et al., 1989), the approaches differ in their aims and underlying philosophical assumptions (Hudson & Ozanne, 1988; Narasimhan, 2014). Positivist qualitative research, such as grounded theory and case studies, tends to be used for theory construction (Mello & Flint, 2009;

Ketokivi & Choi, 2014), whereas interpretive research is typically used for theory contextualization because its epistemology emphasizes a particularistic approach to studying phenomena in a particular time and place (Hudson & Ozanne, 1988). At this early stage of understanding farm-level operations decisions, our goal is not to provide a general overarching "theory" but to better understand idiosyncrasies of farm-level decision-making. An interpretive approach is thus suitable for this study because it allows us to identify *particular* factors *in context* (Geertz, 1973). Further, the interpretive approach maintains a dynamic, holistic view of reality and a voluntaristic view of human behavior (Hudson & Ozanne, 1988), so its ontology is aligned with the individualized, autonomous nature of decision-making on small and midsize family farms and the simultaneous nature of the actor-institution relationship present in institutional pluralism (i.e., institutions are constitutive of actors and their actions and actors are also "self-directed" – Kraatz & Block, 2008). Indeed, interpretive research is "aimed at producing an understanding of the context" and the process whereby the actor "influences and is influenced by the context" (Walsham, 1993 p.4-5). This aim is in line with our orienting frame-of-reference, which emphasizes how farmers' operations decisions are influenced by the context in which they are embedded. It is important to note that this in no way suggests the interpretive approach is "better" than the positivist approach; rather, I highlight the differences here to illustrate the alignment of the interpretive approach with our research context, purpose, and orienting frame-of-reference.

There are a number of methods within the interpretive approach, such as existential-phenomenology, semiotics, and ethnography. Fundamental to each of these interpretive methods is the part-to-whole process – the hermeneutic circle – depicted in Figure 1 (Klein & Myers, 1999). The hermeneutic circle represents an iterative spiral of understanding wherein the "parts" can only be understood in relation to the "whole" (Prasad, 2017), which includes relevant histories, social

customs, and economic and sociopolitical institutions. Underlying the hermeneutic circle is empathetic understanding, in which the researcher "feels one's way inside the experience of the actor" (Blumer, 1969; Hudson & Ozanne, 1988 p. 518) to identify relevant motives, meanings, and experiences. The motives, meanings, and experiences are then used to understand the influences that are driving actors' decisions and behaviors *in context*, and empathetic understanding is conveyed through detailed "thick descriptions" that are time- and context-bound (Geertz, 1973).

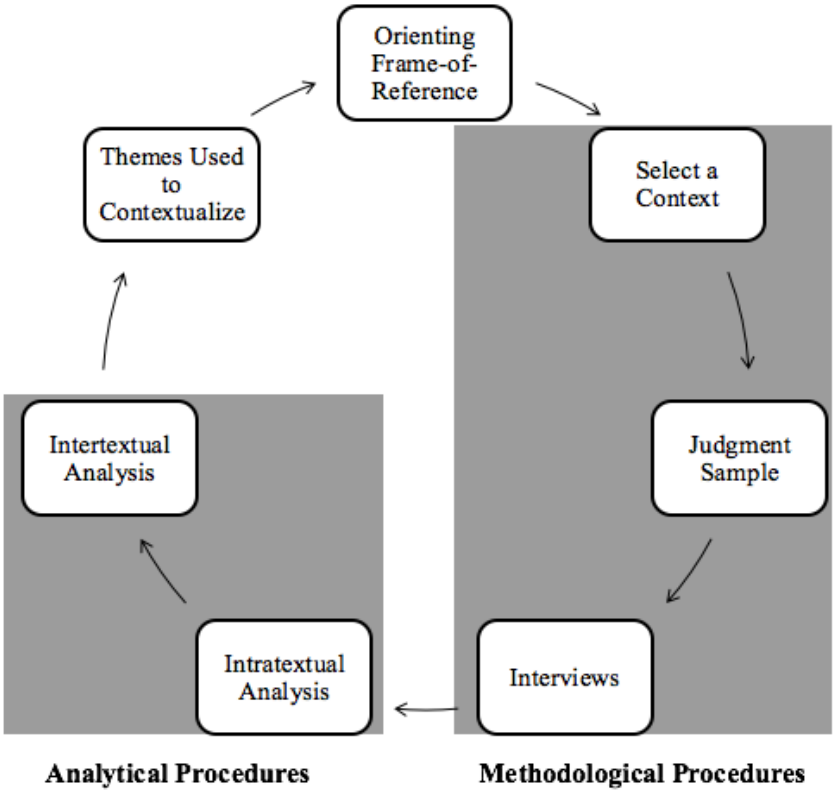

Figure 1: The Hermeneutic Circle
Copied from Darby et al. (2019) p.402

Methodological Procedures

The orienting frame-of-reference outlined in the previous section is the first step of the hermeneutic circle and provides the framework for the methodological and analytical procedures

that follow. The orienting frame-of-reference was first used as a guide to form criteria and select potential informants. Because interpretivism's axiology is depth of understanding (Geertz, 1973), the number of informants interviewed in hermeneutic studies is typically small and has ranged between three (Fournier, 1998) and twenty (Thompson & Haytko, 1997).

Farmers that represent a wide range of crops/livestock produced, size of farm, involvement with institutions, and other individual characteristics were solicited to participate in the interviews. From a pool of thirty potential informants, a judgment sample of eighteen farmers was selected based on their potential to provide conceptual insights. In interpretive research, the purpose is not to make generalizations to a population of farmers, but rather to provide depth of understanding (Geertz, 1973). Representative of the industry, seventeen of the eighteen informants interviewed were males (although wives also participated in three of the interviews), ranging from 28 to 73 years of age. All of the informants were from the U.S., representing states primarily in the Midwest and Southeast given the strong agricultural presence in those regions. The education level of informants ranged from high school diploma to Doctor of Veterinary Medicine with the vast majority of informants falling somewhere in between. In line with our orienting frame-of-reference, all of the farms in the sample are family farms and are primarily small and midsize farms according to the classification developed by the USDA.[3] A diverse range of crops and livestock are represented, including conventional varieties like broiler chickens, beef cattle, rice, corn, soybeans, wheat, and cotton, and more contemporary varieties, such as grass-fed, grass-finished, and pastured beef cattle and lambs, organic produce and herbs, and free-range pullets (young hens).

[3]Although four of the eighteen farms included in the sample are classified as "large scale" according to the USDA (Hoppe & MacDonald, 2016), they are still family farms and have less than twenty employees. A farm with one million dollars or more in gross sales is formally considered a large farm, but it is a small business by most standards of business size and owned and operated by a farm family (MacDonald et al., 2004).

Following selection of the judgment sample, multiple rounds of interviews were conducted. The purpose of the interviews was to provide a first-person description of a domain of experience (Thompson et al., 1989), so both existential-phenomenological and ethnographic techniques were utilized (Miles et al., 2013). The general purpose of the research was first explained to the informant. The informant was then provided with an assurance of confidentiality and anonymity, and the research team requested to record the interview. If the informant did not permit recording of the interview, extensive field notes were taken.

Given the underlying emphasis on experience (Prasad, 2017), the ideal interview consists of short open-ended questions from the research team followed by lengthier informant responses. An interview guide based on the orienting frame-of-reference was followed and is provided in Appendix A. The interviews, however, were semi-structured (Miles et al., 2013), as directed by the stated purpose of the research team and relevant experiences of the informant. This is in line with the epistemology underlying interpretive research, which holds that the researcher and subject interact to create a cooperative inquiry (Lincoln & Guba, 1985; Wallendorf, 1987; Wimpenny & Gass, 2000). Moreover, allowing for the "interaction between the researcher and the subjects" is one of the seven principles upon which interpretive research is evaluated (Klein & Myers, 1999 p.74).

The strength of interpretive interview techniques is to provide descriptive detail, so the interview setting should be one in which informants are willing to describe their experiences freely and openly (Thompson et al., 1989). The interviews were conducted in various settings, including farmers' homes, trucks, tractors, combines, chicken houses, and irrigated rice fields. The setting in which each interview was conducted was at the discretion of the farmer to ensure open conversation and facilitate understanding by creating opportunities to experience the empirical

context directly. This is in line with the contextualization principle underlying interpretive research, which "requires that the subject matter be set in its social and historical context" to facilitate understanding between the researcher and informant (Klein & Myers, 1999 p.73).

The length of the interviews ranged from 35 minutes to almost four hours, with the majority lasting approximately two hours. The interviews were recorded and transcribed verbatim in order to provide data quality in the analysis. For the interviews conducted on the farm, a technician was hired to extract the interview dialogue from the background noise. Table 1 profiles the judgment sample of farmers; pseudonyms were used to protect anonymity.

Table 1: Characteristics of Judgment Sample

Farmer (Pseudonym)	Farm Size Classification*	Crop/Livestock Produced
James	Small	Rice, Soybeans
Robert	Large Scale	Free-Range Pullets
Gary and Dorothy	Small	Beef Cattle
Mark	Midsize	Broilers, Beef Cattle
Peter	Midsize	Corn, Soybeans, Beef Cattle
Jack	Large Scale	Soybeans, Corn, Wheat, Rice, Cotton
George	Large Scale	Cotton, Soybeans, Rice, Corn
Roger	Midsize	Soybeans, Rice, Cotton, Corn
Scott and Henry	Large Scale	Corn, Soybeans, Cotton, Rice
Brian	Midsize	Soybeans, Rice, Cotton, Corn
Benjamin	Small	Broilers, Beef Cattle
Jacob and Elizabeth	Midsize	Cornish Game Hens, Beef Cattle
Chad	Midsize	Rice and Soybeans
Michael and Diane	Midsize	Non-GMO Corn, Rice, Soybeans
Tucker	Midsize	Corn, Soybeans, Wheat, Rice
Elijah	Small	Organic Produce
Abraham	Small	Organic Produce, Herbs
Alice	Small	Grass-Fed Beef Cattle, Lambs

*We use the farm classification developed by the USDA; farm size is measured by Gross Cash Farm Income (GFCI), which includes sales, government payments, and other-farm related income such as fees from production contracts. Small family farms are characterized by GCFI less than $350,000; midsize family farms have GFCI between $350,000 and $999,999; large scale family farms have GFCI in excess of $1,000,000 (Hoppe & MacDonald, 2016).

Analytical Procedures

The level of analysis is another important point of differentiation between interpretive and positivist qualitative research. In interpretive research, the transcribed interview and empirical narrative provided through the interview reflect the individual's lived experience *in the context* of their lifeworld (Lakoff & Johnson, 1980). The "level" of analysis for the hermeneutic method thus is the context in which the informant is embedded, which includes layers such as behavioral, cognitive, material, historical, and so on (Prasad, 2017). It is this emphasis on the informant's lived experience and the premise that their experience cannot be understood outside of the context that provides the empirical insights key to understanding farmers' decision-making (Thompson, 1997).

The orienting frame-of-reference provided the framework to interpret the text in context for each informant, and the first phase of analysis was *intratextual* analysis (Stern, 1995). To do this, the research team began with one informant at a time and read and reread each interview transcript (Thompson, 1997). The first analytical challenge was to understand the temporal sequencing of key events in the informant's empirical narrative (Thompson, 1997; Prasad, 2017). From this, a summary was identified for each informant that captured an in-depth description of the informant's experience in context (Denzin, 2001). Each summary was then used to inform additional readings of the respective interview transcript, and each interview transcript was reanalyzed to identify contextual details, decision patterns, and other relevant factors not noted in the initial analysis (Thompson & Haytko, 1997). This process continued until the researcher captured each informant's empirical narrative in its *full contextual detail* (Prasad, 2017) because the strength of the hermeneutic method is "thick description" (Geertz, 1973). The resultant empirical narratives are an emic interpretation (i.e., from the perspective of the farmer) of farmers' decision-making processes and the factors influencing their operations decisions.

Upon completion of this initial phase, *intertextual* analysis was conducted. Intertextual analysis is an iterative process that uses a "part-to-whole reading strategy" (Thompson & Haytko, 1997 p.19), in which the researcher read each interview transcript independently while also noting similarities *across* transcripts. In this phase of analysis, the researcher identified common storylines across the empirical narratives and moved up a level of abstraction (Prasad, 2017). The goal was to conceptualize an etic[4] interpretation across informants; that is, as farmers perceive, interpret, and react to relevant aspects of their environments, what do they have in common? Based on these commonalities, each individual transcript was then reanalyzed to identify patterns not noted in the initial analysis and further develop the etic interpretation. This iterative movement across the interview transcripts, empirical narratives, and themes is an analytical technique referred to as "dialectical tacking" (Geertz, 1973). In line with previous research (e.g., Arnould & Wallendorf, 1994), several rounds of dialectical tacking were conducted to identify the themes described in the next section. At this stage, extant research was also used to further interpret and link these themes to our orienting frame-of-reference (Murray, 2002). Following convention (e.g., Osborne, 1991), the process of moving toward an etic interpretation continued until the orienting-frame-of-reference was contextualized.

Assessment of Rigor

Interpretive and positivist approaches to qualitative research both share a common commitment to rigorous empirical research (Thompson et al., 1989). Previous studies have established a set of criteria to evaluate the rigor of case study research (e.g., Barratt et al., 2011; Ketokivi & Choi, 2014; Touboulic et al., 2014). However, these criteria are based on the

[4] An etic view is from the perspective of the observer (i.e., researcher), whereas an emic view is from the perspective of the informant (e.g., Morris et al., 1999). Intertextual analysis moves beyond the emic view of the interview transcripts and empirical narratives by identifying themes and making connections with existing research to develop an etic interpretation (Thompson & Haytko, 1997).

"conventions of positivism" and are thus "inappropriate for interpretive research" (Klein & Myers, 1999 p.68) because the two approaches are founded on very different philosophies (Hudson & Ozanne, 1988; Narasimhan, 2014). Instead, to evaluate the rigor of interpretive research, Klein and Myers (1999) outline seven principles that are consistent with interpretivism and its underlying assumptions. Table 2 details how this study addresses each of these seven principles.

Table 2: Principles for the Evaluation of Interpretive Field Research

Principle	Assessment of the Principle in This Study
1. Principle of the Hermeneutic Circle This principle suggests that all human understanding is achieved by iterating between considering the interdependent meaning of parts and the whole that they form. This principle of human understanding is fundamental to all other principles.	• The research explicitly recognizes the principle of the hermeneutic circle. • The research describes the hermeneutic circle, its underlying assumptions, and how it informed the methodological and analytical procedures employed.
2. Principle of Contextualization This principle requires critical reflection of the social and historical background of the research setting, so that the intended audience can see how the current situation under investigation emerged.	• The nature of farmers' decision-making processes is described in their historical, political, and economic contexts. • The setting in which each interview was conducted was at the discretion of the farmer to ensure open conversation. The interviews were conducted in various settings, including farmers' homes, trucks, combines, chicken houses, and fields. • The general purpose of the research was explained to each farmer. • The farmer was provided an assurance of confidentiality and anonymity. • The extent to which the interview was recorded was at the farmer's discretion.
3. Principle of Interaction Between the Researchers and the Subjects This principle requires critical reflection on how the research materials (or "data") were socially constructed through the interaction between the researchers and participants.	• The general purpose of the research was explained to each farmer. • The interview prompts and "grand tour" questions are provided in Appendix A. • Following the purpose and initial questions, the interviews progressed based on the recurring interaction of the researcher and farmer. • The progression of the interview was influenced by what the farmer deemed to be relevant experiences.

Table 2 (Cont.)

Principle	Assessment of the Principle in This Study
4. Principle of Abstract and Generalization This principle requires relating the idiographic details revealed by the data interpretation through the application of principles one and two to theoretical, general concepts that describe the nature of human understanding and social action.	• The orienting frame-of-reference was used as a "sensitizing device" with which the interview transcripts were interpreted. • The emergent findings were related back to the concepts drawn from the literature on SMEs, family businesses, and institutional pluralism.
5. Principle of Dialogical Reasoning This principle requires sensitivity to possible contradictions between the theoretical preconceptions guiding the research design and actual findings ("the story which the data tell") with subsequent cycles of research.	• The research describes the philosophical assumptions underlying the interpretive approach and the methodological and analytical procedures involved in the hermeneutic method. • The research discusses the strengths and weaknesses of the hermeneutic method relative to the purpose of the research.
6. Principle of Multiple Interpretations This principle requires sensitivity to possible differences in interpretation among the participants as are typically expressed in multiple narratives or stories of the same sequence of events under study; similar to multiple witness accounts even if all tell as they saw it.	• Family members, employees, and even pesticide consultants participated in the interviews alongside the farmers. • The research discusses the viewpoints of various stakeholders in terms of the political and economic interests of the actors.
7. Principle of Suspicion[1] This principle requires sensitivity to possible "biases" and systematic "distortions" in the narratives collected from the participants.	• The research discusses the institutions, family business factors, power structures, vested political and economic interests, and resource constraints to sensitize readers to alternative meanings. • Direct quotes and relevant contextual details are provided to allow readers to interpret farmers' narratives on their own.
[1]Klein and Myers (1999 p.78) note that the principle of suspicion is optional because "there is considerable disagreement among interpretive researchers concerning the extent to which social research can (or should be) critical."	

Left column copied from Klein and Myers (1999 p.72); right column added to demonstrate this study's alignment with each of the seven principles

Findings

At the core of the orienting frame-of-reference was the idea that farmers' operations decision-making is shaped by idiosyncrasies of the farm echelon—particularly family business, SME, and institutional factors. With this in mind, there were three primary themes that emerged from the analysis: (1)" Diversity of Objectives: Farming as a Business and a Way of Life", (2)

"Resource Constraints: Controlled Chaos or Just Chaos?", and (3) "Institutional Pluralism: Part of the Whole or Apart from the Whole?". Following convention (e.g., Press et al., 2014), descriptions of each theme will be provided in the subsections that follow using a combination of empirical narratives and excerpts from interview transcripts. Then, in the Discussion section, these themes will be used to contextualize the orienting frame-of-reference and develop propositions.

Diversity of Objectives: Farming as a Business and a Way of Life

The first theme emerging from the analysis was the diversity of objectives underlying farmers' decision-making processes, as agriculture is perceived as both a business *and* a way of life. The empirical narratives of two informants, Peter and James, are used as exemplars to describe this theme, and Table 3 profiles excerpts from other informants that were also representative.

Peter is a fourth-generation row crop farmer whose family farm dates back to 1895. Peter grew up working in corn and soybean fields alongside his father and has since bought into the family farm. As the operation has expanded to include beef cattle, the management responsibility has shifted mostly to Peter, but he still relies heavily on his father's experience and opinion as a source of information for his decisions.

Peter allocates most of his time to managing the row crops, as corn and soybeans make up the majority of the farm's production. Before production decisions are made, Peter uses futures prices to determine the acreage he allocates to corn and soybeans: "*The futures markets dictate when we plant more because the market is telling us at those prices 'hey, we want more' when the price goes up."* If the harvest-time futures price is high enough for one of the crops, he will shift some acreage to that particular crop. However, Peter generally tries not to deviate from the fifty-fifty rotation his father has cultivated historically, so futures price information only has a marginal impact on his production decisions.

After production decisions are complete, Peter and his father continue to track futures prices throughout the year to determine the best time to sell. When he is in the tractor or combine, he tunes to the local radio stations that announce the market prices every hour. When he is out in the fields, he is subscribed to a text message service that sends him market updates every hour. Peter generally knows the price where he will break even and waits to sell when the futures price is at or above that threshold; otherwise, he stores the crop in his on-farm storage bins as he waits for prices to rise. Prices, however, have not risen much in recent years given the consistent surplus of grain. Peter is cognizant of the market fundamentals, but he continues to farm despite the economic losses. For Peter, running his family's farm is more than just a business; it is a calling, as illustrated in the following quote:

> *You know, for me personally, I almost feel like it's a calling from God, you know, He works through us, and I produce food to feed the world. And, if I have done something – if I lose a calf, or I have a crop that fails for reasons – a management decision that wouldn't fail completely but maybe doesn't do as well – you know, I feel that responsibility is kind of placed on me to perform and provide. And, I know there's still a lot of world hunger, but I, you know, I'm feeding people in a sense, and I feel that's a calling from God. We own some of this land only for the time that we're here, and uh, I think it's more – it all belongs to God, and He's just providing through us.*

Unlike Peter, James was not born into agriculture, nor did he expect to enter into agriculture. In high school, however, James met a woman who would later become his wife, and during the summers, James worked on her family's farm. Her father had moved to the area in the early 1980s to start farming. A couple of years into James' new career at a nearby hospital, James' father-in-law became ill. With limited options to transition the family farm given that his wife was an only child, James and his wife took over the family's farm.

James has been farming for almost twenty years now, but he still feels like a newcomer. Not growing up in agriculture generated a sense of animosity in James towards other farmers. Many of the farms in his area have been in the same family for over a hundred years and have

longstanding relationships with local buyers. James feels that some of the large-scale family farms native to the community are "*too friendly*" with buyers, who James believes control the market and take advantage of small farmers. Indeed, a consistent theme throughout his narrative was the feeling of being "*starved out*," as illustrated by the following quote:

> *If you don't make it more friendly for small growers and quit concentratin' your producers, which is just, you know, less producers, if they don't make it where we can make a living, one of these days… we'll be starved out… you know, there's just so much that we can do.*

Despite the challenges he faced as a small farmer, James was willing to deal with the risks and market hostility because he felt that it was his duty to preserve American agriculture, as illustrated by the following quote:

> *Because there's… somebody's gotta do it… unless you don't want to eat. The things we grow feed the cattle and chicken and turkeys that you eat, and the rice, you know what I mean? It's not just a career. It's a life, you know what I mean? It's not just a job. It's more than a job... If we don't do it, you know what I mean, they're gonna buy it from another country and it's going to be reflected in the cost of food.*

Table 3: Representative Excerpts for "Diversity of Objectives: Farming as a Business and a Way of Life"

Informant	Excerpt[1]
Gary & Dorothy	"For the most part, it's been good to me. It's given me something to do and kept me off the streets and out of the pool halls. Uh, I've enjoyed it. If I didn't have my cattle, I don't know what I'd do."
Mark	"And, some of it is, I think the lifestyle of it. I mean, a lot of times, ones my age and younger, maybe their family farmed."
George	"[My boss] was ready to give me the opportunity for promotion, you know, and, in my heart, I wanted to farm… It hasn't been a very lucrative thing the last couple years, so, with these markets, and last year, the weather just took our crop, but I still love it. [points to the dash in his truck] You know, this is my office. I enjoy it. I love puttin' seed in the ground. I love watchin' it grow. Uh, and the markets will always be tough. That's why I do what I do."
Benjamin	"The chicken business was good to me, not financially, but I never missed a school play, I never missed a ball game. When my son got off the school bus, I was there and we worked on the farm and we done things, worked on construction equipment, ran bulls, and he's a man… We are very close. My daughter and I are very close, and that is the one thing I will never regret about the chicken business because had I stayed in corporate America, not only would I probably had a heart attack or strangled someone, I would have missed all that."
Brian	"I'm not talking about feeding [Town]. I'm talking about feeding the world."

Table 3 (Cont.)

Informant	Excerpt[1]
Jack	"That farm means nothing to them, and you know, truth be known, their daddy was out there sweat and blood to provide that farm so they could have it one day."
Jacob	"The poultry industry gets such a bad rap all the time that I told [the visitors], I said 'that'd be fine', and later on, I told him 'if I can cast one positive every once in a while, then it's well worth it for doing all this.'"
Abraham	"Agriculture is like this rare bird now in our urban-based culture... We find our newsletters very popular with our customers because they're kind of fascinated by our lifestyle. What does life look like waking up on a farm in the [Region] when you're going out to take care of the summer squash? You know, it's an unusual, um, it's not a shared reality so the people in town find that fascinating, and also I feel like it's a very balancing force to the kind of chaos people can experience living in urban areas… I think that kind of grounding in the local landscape is very grounding to the culture at large. I feel like it [farming] has almost a limitless kind of healing effect once someone cues into it."

[1]A critical foundation of the hermeneutic method is the hermeneutic circle, which is an iterative spiral of understanding in which "the parts" (i.e., the farmers' operations decisions) can only be understood from "the whole" (i.e., the context in which farmers are embedded), and "the whole" can only be understood from its "parts" (Prasad, 2017). That is, the hermeneutic circle suggests that the meaning of the quotes does not reside solely in the words and sentences (Prasad, 2017). Although the quotes included in the table are most representative of the thematic category, their comprehensive dimensionality can only be understood as embedded in the farmers' *full* narratives, which are not included due to page limits. Further, the quotes included in the table were determined to be the *most representative* from the sample of informants and not intended to be an exhaustive list. Again, the purpose is not to make generalizations to a population of farmers but to provide conceptual insights.

Constraints: Controlled Chaos or Just Chaos?

The second theme emerging from the analysis was the multitude of constraints that farmers must contend with as they make day-to-day operations decisions. The very nature of farming magnifies the effect of time and resource constraints typically facing SMEs. The empirical narratives of two informants, Tucker and Jack, are used as exemplars to describe this theme, and Table 4 profiles excerpts from other informants that were also representative.

Tucker is a row crop farmer and grows corn, soybeans, rice, and wheat on the midsize family farm he now owns with two of his nephews. Tucker's father served in World War II, and his mother saved every check his father sent home. When his father returned from the war, Tucker's parents had saved enough money to purchase some acreage. Over the next few years, the farm and the family continued to grow.

Tucker started working on the family farm in third grade and has worked on the family farm every year since then. Tucker was the first member of his family to earn a college degree, and he is now responsible for all farm management decisions. Tucker believes successful farming is "*all in the details*," as he puts it, so he is eager to adopt new technologies that streamline operations and provide real-time information to his smartphone. In fact, every tractor and sprayer working the family's farmland is guided by GPS, all of the chemicals and fertilizers are precision-applied, and all of the data is documented and analyzed extensively on the computer at the office he shares with his nephews in town. Despite this desire for precise decision-making, however, the immediacy imposed by other decisions involved in farm management limits Tucker's ability to focus on operations decisions—particularly storage, as illustrated by the following quote:

> *I was the sole person that made all of the selling decisions for grain. I get the markets on my phone six times a day, so I'd kind of watch the futures market and say 'that's a pretty good price', and I'd sell. But, as far as me, I'm not the one to sit behind the computer all day and analyze charts, watch weather patterns, look at drought maps, that sort of thing. I can't do that because I'm busy trying to operate this farm, get the crops in, get 'em harvested, fertilized, get 'em weed free, irrigated, that sort of thing, so that [marketing and storage] is just like the least of my worries, but really it's the most important because you can make, you can do fifty thousand dollars either way in a day if you're not careful with the way you market your crop.*

Like Tucker, Jack also grew up in agriculture. Jack was born and raised in the rural town where he still resides, and his house is only a mile and a half from the house he grew up in. Jack had always known he wanted to farm, as his father and grandfather had before him. Jack's grandfather had previously owned farmland in the rural town, but he was no longer actively farming by the time Jack was old enough to work during the summers. So, Jack went to work for another farmer in town until he graduated high school. After high school, Jack worked various jobs in order to save enough money to purchase the family's old farmland. Sometimes, Jack regrets that he went straight into the workforce instead of going to college, as he believed college may

have helped him with some of the decisions involved in farm management. Ultimately, however, he believes that he would not have been able to save enough money to buy the family farm back if he had not gone straight to work after high school.

Jack has since grown his family's farm from a couple hundred acres to thousands of acres and diversified the production to include corn, wheat, soybeans, rice, and cotton. As the sole farmer and operator of a large-scale family farm, Jack has a multitude of decisions to consider on a daily basis. The day-to-day operations mostly consist of managing his employees, but there is no such thing as a "typical" day on the farm. Every day, it seemed, posed a new challenged, as illustrated in the following quote:

> *I've got a crew gettin' rice all ready to go to water with, I've got a harvest crew, and a bean plantin' crew. You never know. You know they may change tomorrow. Some of these guys will be over there or vice versa, or in their trucks, or whatever… Most of the days it's controlled chaos. Other days it's just chaos. [laughs] You know what I mean?*

The daily stresses of farm management and recent downturn in commodity prices have further impacted Jack's ability to make decisions. Already limited in terms of time and resources, additional constraints posed by nature are detrimental, especially when combined with market uncertainty. As Jack explains in the following excerpt, low prices highlight the necessity for precise decision-making but also magnify the effect of constraints on his ability to make informed decisions:

> *Everything, you know, you can rock and go and do okay as long as, uh, your yields are good, but, uh, then you get a year when your yields are off and there's nothin' you can do – you know, nothin' you've done wrong, there's nothing you could've done different. There's just years when, during pollination, the heat hits, or you get a late planting 'cause the spring was so wet, or some stress or too much water in the spring when the plants are young. There's nothing you can do. You don't plan on that, and you mix a low price with a low yield, and then you're where everybody's at right now around here. I mean, they're just strangling. Banks are strangling, farmers are strangling, you know, there's a lot of nervousness and worry. When you start worrying, you don't make good decisions 'cause you're worryin' about every decision.*

Table 4: Representative Excerpts for "Resource Constraints: Controlled Chaos or Just Chaos?"

Informant	Excerpt[1]
Scott	"People are concerned all the time about what's their perceived risk. I use the word perceived importantly because it's different than speaking of their greatest risk."
Brian	"Weather is a big thing, and that's something I can't do anything about, so you see the insanity involved there."
Mark	"I mean, but uh, we still – the responsibility aspect of, you know, we still have to do things on weekends. We don't get Sunday off… I mean, weekends and week nights. If the power goes out, you know, things have to be taken care of very quickly out here." "I mean, we watch the cattle prices and stuff. So, not that we don't watch it, but time crunch wise, when it comes time to sell them, we just have to sell them. That's just it. We're kinda time-crunched that we have to, you know, we kind of have a window because we don't have a place 'cause once they get so big of a cow, you're gonna have to do somethin' with them, and we don't have another forty acres or eighty acres that we could take and wean 'em off and then. You know, some people have more flexibility in that they can do that if the market's high whenever they take them off the cows, they can sell them or they can take and what they call 'background' 'em for a while, and some people do that, and some people are big enough around here – I mean, we're not."
Peter	"For me, it's more that it's a whole 'nother layer of management that I really don't have time for... It is stressful. I mean, it is a whole other layer. I think maybe, as a farmer, we're already – we're accountants, we're supervisors and business managers, we're the, we're not the vet, but we're the animal health specialist when we're out looking at our livestock and making sure they're healthy, and we're also the operator, and you know we also do the electric. You just wear SO many hats. It's absurd."
Jacob	"But I've also been in the top ten literally out of the [hundreds] in one year, then in the bottom ten in the next year doing nothing wrong … Something was in there, and they just wouldn't do what we needed. Dead last, dead last, dead last, dead last, extremely dead last… I'm doing everything I can think of, the field tech is out there doing everything he can think of…"
Michael	"You got to make those decisions, or you're out. I mean, to make it all work, a lot of companies don't have to do that. You got to look at us like a company. [Retailer], they can change things on a daily deal. Well, you understand what I'm saying. We can't do that. We got to plan in the fall for the next year coming up, so you can talk to the bank and lock in all the seed, and you've pretty well set your program before it's even time to plant."
Elijah	"I really try to let good data drive my decision-making, but that's hard to do working in a, you know, nature-based business. You're working hundred-hour weeks from March to November."
Abraham	"In the early part of the season, it's, um, trying to, um, just get down on paper all of things that have to be done and just how to prioritize them so that you don't have to carry that around with you worrying about it all the time. Um, so that you have, if you have ten things floating around in your mind that are pressing on you that need to be done, the first thing to do is write them all down and then prioritize, and then start doing them (laughs) instead of worrying about them. I mean, it's too easy just to worry. Um, it's never all done, so this is an ongoing problem, you know? You have to find a way to reduce anxiety, um, about the things that have to be done."

Institutional Pluralism: A Part of the Whole or Apart from the Whole?

The third theme emerging from the analysis was the fragmented nature of the institutional environment. Farmers operate within multiple institutional spheres and deal with competing pressures from formal and informal institutions.[5] Farmers vary in the pressures they focus on and how they respond, so institutions influence each farmer's decision-making differently. The empirical narratives of two informants, Elijah and Roger, are used as exemplars to describe this theme, and Table 5 profiles excerpts from other informants that were also representative.

Elijah is the owner and operator of a small family farm that is certified organic by the USDA. Prior to purchasing his own farm, Elijah spent fifteen years making production and storage decisions for his family's fifth generation vegetable and row crop farm. Although he grew up working in "conventional" agriculture, Elijah became passionate about organic production practices and sustainability after selling the family's vegetables at farmer's markets during high school. Unable to convert his family's farm, Elijah started his own farm to pursue his passion for sustainability, as illustrated in the following quote:

> *Farming has been the way to get the experience I need to effect real change in the food policy world… I'm trying to be one of those agents of change for organic production and try to bring a very level-headed 'hey, I come from the conventional world, but also I'm going this way, and this is where I want to take my community and the people around me.' I want to loop towards sustainability. How are we keeping our families fed, our kids in college, taxes paid, you know, and land paid? To me, that's all sustainability and I try to talk about it through that lens. How are we keeping our family farms alive?*

Although his experience making decisions for his family's farm and selling at farmer's markets during high school has been helpful, Elijah still faces challenges in dealing with buyers because of the size of his operation, as illustrated in the following quote:

[5] I conceptualize formal institutions as organizations that are formally structured and established, such as firms, non-governmental organizations, and government agencies, whereas informal institutions are traditions, norms, and social customs emanating from family, communities, and society (North, 1991).

> *If there is anything I've learned, that's one thing small growers are really good at – and that is totally pissing off major customers… They [buyers] are used to dealing with big brokers and outfits that never miss a delivery and have never missed deliveries period… They're brokers. They make deliveries; that's what they do. I'm a farmer. I just grow food. You know, I do deliveries too, but I'm a farmer, not a delivery man… I still need logistics support and resources. Otherwise, it's just overwhelming. I've been there, done that. I mean, I've done as many as eight farmer's markets a week and delivered to twenty, thirty, forty wholesale customers and managed retail accounts. It's a nightmare.*

However, despite the pressures he faces from major buyers, Elijah is proud to be part of the local food system and enjoys the connections he has created by supplying his local community with organic produce. A consistent theme throughout his narrative was the role that consumers and local communities play in defining the norms that govern his production decisions, as illustrated in the following quote:

> *I think it comes back to this direct interaction with customers. You know, I think that's what makes a lot of people go this [organic] route… when you have to see your customers day in and day out and your customer is not the back of a truck, it really does make you look at your practices.*

Roger owns a midsize family farm and grows a variety of row crops, including soybeans, cotton, rice, and corn. Roger grew up on the family farm he now owns, as his father and grandfather had before him. Before the introduction of cellphones and computers, Roger remembered watching his father and grandfather check the futures prices every day in local newspapers and on local radio stations to determine how to allocate acreage and when to sell their crops. These memories stuck with Roger after he inherited the family farm; as the futures markets became more sophisticated and the farm grew, Roger began acquiring additional pricing information from various third-party marketing services to use in his operations decisions. The services provided recommendations based on his operations and desired profits, but Roger was ultimately the one who made the final decisions. The autonomy to make his own decisions was important to Roger. As markets became more volatile and third-party services increased their fees, he soon became disenchanted with

outside information. Roger became wary of outside information, particularly from buyers, and built grain storage bins on his farm so that he would not have to rely on buyers at harvest time, as illustrated in the following quote:

> *I always put it in my own grain bins. Otherwise, I've got two choices. I could either sell it for whatever the price is at that time… or I can carry it to a customer's and wait until later. Do you know what it's like to go to the person that owns the bin after you came, and your corn has already been in there for two months and try to negotiate a good price? He's already got your damn grain!*

As the owner of a midsize farm, Roger has enough experience and capital to "*stick it to the man*" (as he puts it). However, Roger expressed substantial concern for small family farms, who he believes are at the mercy of buyers to store their grain as they wait for prices to rise. In an effort to help them achieve greater autonomy, Roger contracts with fellow farmers and allows them to store their grains in his storage bins at a significantly lower price than buyers currently charge. Further, Roger is a member of a farmers' cooperative that is developing a program to circumvent the current chain of middleman and go directly to the manufacturers, who he perceives to be less adversarial and more receptive to allowing farmers to manage their own operations.

Table 5: Representative Excerpts for "Institutional Pluralism: Part of the Whole or Apart from the Whole?"

Informant	Excerpt[1]
Formal Institutions	
James	"You know, what we get as producers is such a small part of the retail. That's what's frustrating as a producer. There's so many steps in the supply chain, and those guys in the middle are making more than the producer. You know, uh, that's where everyone seems to like to get it from – the farmer!"
Jack	"We know if the crop's short, if people are holding rice, because we are sittin' in rice country. I mean, it's not very big. It's a small market... and they'll just burn you every time and go the other way… [Buyers] control it… We're narrowed up in our area. There's four people we can sell to now, and I'm scared to death of all four of 'em." "My banker tells me 'gosh, darn, you are one of the best damn operators I've ever seen, but you are the absolute worst at paperwork!' I'm just tryin' to keep up, and there's a lot of paperwork involved from recordkeeping to FSA Farm Service Agency) to NRCS (Natural Resources Conservation Service) to I don't know on yields, farms, inputs, anything."

Table 5 (Cont.)

Informant	Excerpt[1]
Benjamin	"I had a perfect place between [Town] and [Town], and [the buyer's management team] didn't have to go on a dirt road because it was on the highway, so that's where they met up… [The managers would] all meet up there and have their meetings at my farm. One time they were there and they had all these kids who were going to work for [Company], and she asked 'so what advice would you give to someone who wanted to [enter this industry]' and I said '[buy land] on the roughest dirt road you can find', and she said 'why?', and I said 'so [the buyers] won't come to your [farm].' You did not want to be that guy that was easy to get to."
Chad	"We walked in the dryer after working so hard to make a bean crop. We walked in the dryer to sell our beans, and they were over nine dollars, which was a great price at that time, and, so, I walked in – dad and I did. We had ten thousand bushels of beans to sell, and there was a couple guys around a little ticker tape machine sitting there in the corner, and every ten minutes, it was spitting out the commodity prices, and so, uh, I, uh, they said 'what are you guys gonna do?' and I said 'well, we're selling our beans', and they said 'man, don't sell your beans, they're going to eleven dollars', so to make a long story short, we walked out of there and only sold one thousand bushels out of that ten thousand. Well, two weeks later, beans are down at seven fifty a bushel, and I thought 'that is the dumbest move I have ever made in my life.'"
Scott	"We had an audit from the State Plant Board on Thursday and Friday. Of course, they don't tell you when they're comin', so that takes a lot of our time…We're running a little behind."
Jacob	"[Buyer] has representatives out here telling us they have multiple fields where they have flown drones on farms and tried to catch people doing stuff… I can tell you right now, if [Buyer] walks on the farm and sees something they do not like, especially when it comes to culling – the euthanization, you will not get any more business with [Buyer], and I am serious about that."
Informal Institutions	
Brian	"We depend on this ground year after year to make a living. I'm farming ground that my father and grandfather farmed. It's our most important asset." "If you want to buy [organic], buy it, have at it. If you've got that kind of money, have at it. I'm not gonna campaign against it. On the other hand, [consumers] campaign against me. They spend money to put down what I'm doing [with conventional agriculture], which they're talking about these community gardens and all this. I'm not talking about feeding [his hometown]. I'm talking about feeding the world."
Jack	"That farm means nothing to them, and you know, truth be known, their daddy was out there sweat and blood to provide that farm so they could have it one day."
Roger	"Most people think their food comes from grocery stores. I'm not trying to be facetious, but I am not so sure that people want to be educated. They like what they've got, and, uh, they're comfortable with it, so when someone is comfortable, they like it the way it is, and it's hard to teach somebody something."

Table 5 (Cont.)

Informant	Excerpt[1]
Scott	"Most farmers, most of the land is – a lot of it is – still farmed by, you know, a father and a son or a father and an uncle or they may have just one person, and it's a three or four-person deal… You know, they grew up together."
Jacob	""The biggest challenge I face as a poultry farmer is public opinion. You've got the animal welfare issues, no antibiotics, the feed to satisfy the consumer, and some of it's real and the others is just, you know… It depends on the people. People get on one side or the other side strong."

Discussion

The empirical narratives suggest that farmers prefer to make decisions autonomously. Consider Roger, for example, who built on-farm storage so he would not have to rely on buyers at harvest time, or Benjamin, who advised young farmers to buy land "*on the roughest dirt road*" to make it undesirable for buyers to visit the farm. This tendency to keep buyers at "arm's length" is a consequence of the family owned-nature of the farm and the diversity of objectives underlying farmers' decision-making (Theme 1). Farmers perceive more integrated arrangements with buyers as a threat to their personal independence and the family's autonomy to retain decision-making control. For example, Benjamin inherited the family's poultry farm from his father but sold it as soon as he got the chance to raise beef cattle with his son instead. Benjamin valued the autonomous decision-making that raising cattle allowed, which was in stark contrast to the poultry farming he grew up with:

> *I can really make decisions in the cattle business that can make or lose money. Now, I can't control the market for the cattle, but I have infinitely more control over raising cattle than I do for chickens. I don't miss the absolute lack of control when you're a contract grower. I had no choices [in the poultry business]. There's a lot more flexibility in the cattle market, and it gives you more control. You know, work with your rations and figure out what works best for your feed program.*

Farmers are also wary of more integrated arrangements with buyers due to size asymmetries. Exchanges between farmers and buyers are characterized by many small and midsize farms selling to a few large buyers. Jack, for example, explained that there were only four buyers

in his area, and he was "*scared to death of all four of 'em*." Mark also shared that his cattle were "*bought by just a few big packers*." Such size imbalances are common in conventional agriculture (e.g., Touboulic et al., 2014), but organic farmers also discussed issues related to size imbalances. For example, Elijah talked about the expectations large buyers have because of their experiences dealing with large suppliers. As a small farmer, Elijah felt that he needed more "*logistics support and resources*" to meet large buyers' demands.

The empirical narratives suggest that such size asymmetries also foster perceptions of power asymmetries (Handley & Benton, 2012). For example, some of the farmers discussed the pricing power that large buyers have—large buyers "*got the market cornered*" (Tucker), "*dictate the price*" (Peter), or "*will just burn ya every time*" (Jack). To overcome the asymmetries, James explained that farmers could work together and pool their resources, but farmers were "*a funny bunch. We're kind of independent you know what I mean? Farmers, in general, and that's what's kept us from doing some of that stuff. Everybody does their own thing.*" Elijah also shared: "*You need a lot of growers to do that, and it's been challenging, I have to say. I feel like I've not had the other farmers beside me to push through these barriers and gain at these markets.*"

In combination, the empirical narratives suggest that farmers prefer to operate independently and sell their products via local markets instead of via contracts or other arrangements.[6] The grain and oilseed farmers called local buyers when they decided it was time to sell; livestock farmers brought their livestock to auctions when they were ready to sell; organic farmers sold most of their produce and herbs at local farmer's markets. Selling via local markets

[6] I note that the poultry farmers in our sample are the exception; poultry farmers – sometimes begrudgingly (e.g., Benjamin) – contract with buyers. The poultry supply chain is highly integrated relative to other agricultural supply chains, and virtually all poultry farmers – more than 90% – operate under production contracts (MacDonald, 2014). Production contracts dictate when and how many chicks farmers receive, as well as feed, veterinary, and technical requirements. However, similar to other farmer groups, poultry farmers operate independently in the sense that they manage other aspects of production and are compensated based on their performance and the average market price.

allows farmers to maintain their sense of autonomy; they decide if, when, where, how much, and to whom to sell. For example, like Roger, Brian built his own grain bins on-farm to provide autonomy in his storage decisions:

> *I have grain bins, so I can sell soybeans on January delivery or March delivery, and I can, you know, I can break up the income flow. You know if I need to get some delivered… I can play with it however I want to, so just makin' sure I have options to do what needs to be done.*

I thus posit:

Proposition 1: Resource constraints and diversity of objectives interact to influence farmers' approach to exchange such that farmers prefer market-based exchange.

Farmers' approach to exchange influences how they make decisions and the information they need. Given their preference for market-based exchange, it is imperative for farmers to understand the future course of prices in order to plan and execute their operations decisions. Scott, for example, uses prices to determine what to produce: "*I grow corn and cotton in rotation, and I grow rice and soybeans, and if the price is right, I grow wheat."* Peter uses prices to determine how much to produce: *"The market is telling us at those prices 'hey, we want more' when the price goes up."* Gary shared that prices drive production decisions for cattle farmers as well: "*Well, from what prices were, they're down a bunch. Because of all those good prices a few years back, everybody started producing more or trying to."*

Beyond production decisions, farmers also use prices to inform their storage decisions. Peter (Theme 1) and Tucker (Theme 2), for example, track prices continuously throughout the year to determine when and how much to sell versus store. Michael also uses prices to determine when to sell: "*I've kind of got a target price. Like rice, if we can get five, five and a quarter with it, I'll sell it."* As Gary shared, however, prices are not always at the level farmers require to make

optimal storage decisions: "*I've held on to some (cattle) this last go-around a little longer than what I should have, but prices is down and I waited to let them come back a little bit 'fore I sold."*

Prices are thus an imperfect but critical source of information given farmers' preference for market-based exchange. For example, Brian shared: "*The market is where I get paid*. *I mean, what that price is, that's where I make my money*." Scott also shared: "*Prices are how you measure better in this business. Whoever gives you the most money."* By communicating important information about supply and demand, prices guide farmers' decision-making and serve as a signal for resource allocation. Accordingly, I posit:

Proposition 2: Resource constraints and diversity of objectives interact to influence farmers' information acquisition activities such that farmers rely on prices to inform their operations decisions.

There are, however, significant costs associated with discovering prices (Stigler, 1961), and these costs are greater for small and midsize farms because they are more limited in the time and resources they can devote to acquiring relevant information (e.g., Freeman et al., 1983; Bruderl & Schussler, 1990). Consider Peter, for example: information search is:

> *a whole 'nother layer of management that I really don't have time for... It is stressful. I mean, it is a whole other layer. I think maybe, as a farmer, we're already – we're accountants, we're supervisors and business managers, we're the, we're not the vet, but we're the animal health specialist when we're out looking at our livestock and making sure they're healthy, and we're also the operator, and you know we also do the electric. You just wear so many hats. It's absurd*.

Similarly, Jack referred to his experience managing day-to-day farm operations as "*controlled chaos*," and Tucker did not have the time to search for technical information because he is the "*sole person making selling decisions*" and is "*busy trying to operate this farm, get the crops in, get 'em harvested, fertilized, get 'em weed free, irrigated, that sort of thing."* As these

excerpts illustrate, farmers are limited in the time and resources they can devote to acquiring the information needed to determine current and future prices.

Further, because farmers prefer to operate independently from the rest of the supply chain, they typically do not have access to information about downstream markets beyond the aggregate demand forecasts provided by the USDA. Given the transactional – and sometimes even adversarial – nature of exchange, buyers are not incentivized to share such information with farmers. For example, Mark shared: "*the thing about it is it's so hard to find buyers that will share beef prices*." Benjamin's eighty-seven-year-old grandfather (who also farms) did not like selling to the new buyers in town because they were too transactional:

> *It only takes them fifteen seconds to unload my truck. You used to have time to go in and get a cup of coffee and talk to the guys that work there. Now, before I can even get out of the truck, the damn thing is empty. It's terrible. It's ruining my life!*

Moreover, when buyers do share information, farmers do not always trust the information. Chad, for example, talked about a negative experience with a buyer who he perceived to have shared "false" information (see Table 5) and explained that the negative experience was the impetus for him to learn more about futures markets and *"how they worked to do something to better my situation*."

In line with Chad's story, the informational role of futures markets was prominent during the field interviews. Farmers received texts when we were out in the fields or in tractors or farm trucks with futures market updates. Sometimes they would grumble or curse, but other times, they would immediately call local buyers to see if they were interested in buying at current prices. For example, Peter consistently tracks futures prices throughout the year to determine the best time to sell based on his breakeven price. Tucker also tracks futures prices to determine the best time to sell based on if it's a "*good price.*" The empirical narratives thus suggest that farmers rely on

futures markets to acquire price information—but to varying degrees. Futures markets are not available for all agricultural products, including specialty breeds of poultry and livestock, produce, and herbs. Instead, the specialty poultry and livestock farmers used more general poultry and livestock futures prices as a baseline, and the organic produce and herb farmers used their own historical price data. For example, Abraham explained that he used his "*own thirty-two-year track record*" to guide his production decisions.

Given their stated missions (e.g., U.S. Department of Agriculture, 2019), I expected that monthly and weekly reports from government agencies would play a larger role in farmers' information acquisition activities—especially for organic produce farmers who do not have other sources of public information available (i.e., futures markets). However, the acquisition of government information was not apparent in the field interviews. Few farmers mentioned the information that government agencies provided; the farmers who discussed government agencies typically did so regarding reference prices—thresholds the USDA uses to determine whether insurance indemnities are paid to farmers, required paperwork and recordkeeping, and regulations. One potential explanation for the less prominent role of government agencies is that futures prices quickly reflect supply and demand information contained in reports promulgated by the USDA and NASS (e.g., Summer & Mueller, 1989; Garcia et al., 1997; Adjemian, 2012). As expected, futures prices rise in response to forecasted increases in aggregate demand and/or decreases in aggregate supply and fall in response to forecasted decreases in aggregate demand and/or increases in aggregate supply. For example, Brian shared: "*I'll use some of those government numbers like ending stocks, and then I'll look at the futures prices."* Futures prices thus may be a more "efficient" way for farmers to acquire price information and gauge market conditions. That is, just as stock prices summarize many pieces of information about a firm, futures prices summarize

many pieces of information about supply and demand. The easily accessible and heuristic nature of futures prices is particularly important given the resource constraints small and midsize farms face. I thus posit:

Proposition 3: Resource constraints and diversity of objectives interact to influence farmers' information acquisition activities such that farmers acquire price information via public sources to inform their operations decisions.

In addition to buyers, government agencies, and futures markets, the empirical narratives suggest that farmers' operations decisions are also subject to influences from informal institutions, including family, local communities, and society. For example, Chad described his farm as "*a one-man operation with some of my family helping me all these years*." He had the opportunity to expand the size of his operation but ultimately chose not to because "*that's kind of the way I wanted it. I mean, I could've expanded, but, you know, I'm kind of a family guy, and I wanted to be able to work and spend time with my family*." Robert was also "*family-oriented*" and loved that his sons were involved in the family farm, but he felt that did not always fare well for his decision-making:

> *I have a couple old cows I need to get rid of. I have a tendency to keep them too long. I have a few too many head. I want to try to get rid of some. They're not a good moneymaker, but, of course, my boy likes to rope, so we keep 'em around.*

Similarly, Gary shared that his wife, Dorothy, influenced his decision-making: "*I sold my last bull because of her. She didn't think he was doin' his job. When I bought a new one, it cost me twice as much! But she was happy."*

Beyond family influences, farmers' operations decisions are also influenced by local communities. For example, George waited to harvest one of his fields because it was so popular in the local community: "*I left that cotton field ready to pick for three weeks just so people could get their pictures, then came back to it. People were taking their engagement pictures out here,*

their graduation pictures." Abraham delivered newsletters about his daily farming operations to help connect with the local community: "*I feel like it's a very balancing force to the kind of chaos people can experience living in urban areas. I think that kind of grounding in the local landscape is very grounding to the culture at large."*

The role of consumer pressures was also prominent during the field interviews, as consumers increasingly demand information about farming practices. Some farmers expressed concerns about consumers' demands and worried about public perceptions. For example, Peter shared:

> *As farmers, the number one thing that I want and that a lot of organizations want involved with agriculture is an educated consumer. I say that based on, I'll use [Company] for an example. They have taken this big stance, you know, 'hey, we only use organic, non-medicated, non-GMO, that sort of thing', and I think that creates a little bit of hysteria in the marketplace for the consumer. It can shed a negative light on the producer because I mean, we want to take the best care of our crops, the best care of our land, the best care of our animals because it means more money for us*.

Abraham, an organic farmer, also noted: *"There's a big gap between what actually happens on farms in production and what the public actually is aware of, and I'm not quite sure of how to bridge that."* Jacob felt that the biggest challenge he faced as a poultry farmer was "*public opinion*," and he hosts tour groups on his farm to "*cast a positive image on the poultry industry and farming in general*" (Table 3). However, Jacob also noted that everything he'd changed in the last few years was "*to satisfy the consumer because of public opinion*." Like Jacob, other farmers also changed their production practices in response to consumer demands. Elijah, for example, grew up on a conventional farm but switched to organic after interacting with consumers at farmer's markets (Theme 3). Michael and Diane also switched to non-GMO corn and soybeans because "*that's what our customers expect us to do*."

Overall, the empirical narratives suggest that farmers face an extremely fragmented institutional environment as they make operations decisions. Balancing influences from numerous institutions (e.g., government agencies, futures markets, buyers, family, local communities, and consumers) is particularly challenging for small and midsize farms because they lack the resources to be continually focused on *all* aspects of their institutional environment. To overcome this pluralism, the empirical narratives suggest that underlying objectives direct farmers to focus on particular aspects of their institutional environment. Similar to the underlying assumption in traditional operations decision models (e.g., increasing profits or reducing costs), farmers aim for economic viability in order to ensure the long-term sustainability of the family farm for future generations. However, Theme 1 illustrated that farmers also have strong beliefs about their role in society and rural communities—they support local economies and "*feed, fuel, and clothe the world*," as Brian put it. For example, Benjamin shared that farming allowed him to raise two productive children (Table 3), and Peter believed that it was a "*calling from God*."

The pursuit of non-financial objectives directs farmers to focus on informal institutional pressures as they make operations decisions. Pressures from non-economic actors such as family, local communities, and society are more salient because they are aligned with farmers' sense of greater purpose. For example, Peter and James (Theme 1) continue to farm despite low prices and economic losses because "*somebody's gotta do it… unless you don't want to eat*." Moreover, the empirical narratives suggest that most farmers perceive pressures from informal institutions as normative rather than coercive, which allows farmers to maintain their sense of autonomy. That is, farmers can decide if and to what extent they respond to normative pressures whereas their autonomy is lessened in response to coercive pressures from government agencies or buyers. This is in line with institutional pluralism research suggesting that actors are more likely to adhere to

institutional pressures that affect *how* they pursue their goals rather than *which* goals they pursue (Pache & Santos, 2010). I thus posit:

Proposition 4: Resource constraints and diversity of objectives interact to influence the relative balance among competing institutional pressures such that farmers focus on informal institutional pressures to a greater extent than formal institutional pressures.

To cope with institutional pluralism, the empirical narratives suggest that farmers default to existing decision-making processes. Among the farmers interviewed, very few planning tools, forecasts, or computer models were used; farmers instead made do with a rough intuitive estimate. The value of additional information and precise decision-making are perceived in terms of its effect on farmers' most important objectives, which are not entirely economic in nature. When coupled with limited time and resources, this encourages the use of intuition and experience in decision-making. For example, Jack felt that the stress of farming operations constrained his ability to acquire additional information:

> *I love information. My memory's just gone. Stress, it just. I used to have a memory of an elephant. Now I can't remember what I eat for lunch. You know, I think it'll get better when the stress level goes down and things get a little better. I hope it does.*

Mark also shared that the size of his farm limited the time he had to make "optimal" storage decisions based on price levels: "*We watch the cattle prices and stuff, but time crunch wise, when it comes time to sell them, we just have to sell them. That's just it*." Jacob also expressed a desire to acquire additional information but admitted that he typically relied on existing decision-making processes:

> *What we've done for so long is so set in what we have been doing. I'll read, I'll read whatever. I'm always looking for information, but nowadays, our program is so set, unless somebody comes up with something really new, which they're trying to do. But then we have to unlearn the old ways*.

The normative and intuitive nature of decision-making was prominent during the field interviews. For example, Peter explained that he "*shoots for as close as we can get to 50-50 rotation, where half of our acres will be in beans and the other half in corn*" because that is what his father has cultivated historically. Abraham also shared:

> *The way I think that most farmers do [make production decisions] is they have a general idea of what's enough, and then they, that's how much they plant. A beginning grower might try to do it a little bit more mentally, but as growers get experience, they sort of rely on their gut-level instincts about how much to plant given their past experience.*

Even as a relatively new farmer, Elijah also explained that his production decisions were largely based on experience: "*It was just kind of a feeling; my experience tells me to grow this. Forward projections have been a big help for me, but I think that takes decades of experience of growing before you can get into that*." As these examples illustrate, farmers tend to rely on their own experience or norms that have been passed down across generations to make production decisions. We thus posit that farmers' pursuit of non-financial objectives and limited bandwidth and resources encourage the use of intuition and experience in decision-making. Stated formally:

Proposition 5: The interaction of institutional pluralism, resource constraints, and diversity of objectives encourages the use of intuition and experience in farmers' decision-making.

Institutional pluralism also has implications for the extent to which farmers incorporate and use objective price information to inform their decision-making process. For example, consider the competing institutional pressures farmers face as they make storage decisions at harvest time. At the macro-level, the USDA promulgates reference prices, which anchor farmers' expectations and predispositions to store or sell based on current prices. Within local communities, buyers pressure farmers to sell because prices are typically the lowest at harvest time with the influx in supply, whereas fellow farmers may encourage other farmers to "hold out" or establish cooperatives to collectively store their goods until prices rise (e.g., Roger's story in Theme 3). At

the farm-level, farmers face pressures from family members and employees related to the preservation of the family farm for future generations. At the individual-level, farmers face internal pressures stemming from the tension between economic viability and a sense of greater purpose (Theme 1). Farmers thus contend with competing institutional pressures as they make operations decisions. The relative importance of price, an "economic" variable, is perceived differently in light of each of these institutional pressures, which dampens the extent to which farmers use prices to inform their operations decisions. I thus posit:

Proposition 6: Institutional pluralism dampens the role of price information in farmers' operations decisions.

Conclusion and Implications

We sought to understand how farmers make operations decisions by exploring their underlying objectives, information acquisition activities, and approach to buyer-supplier exchange and how these aspects of decision-making are influenced by farm-level idiosyncrasies. Field interviews revealed that farmers' operations decisions are shaped by internal factors related to the small, family-owned nature of the farm and external factors stemming from numerous institutions involved in agriculture. Overall, the findings provide important insights on the perspective of the farmer and, as detailed below, offer important implications for theory, supply chain practice, and public policy.

Theoretical Implications

In response to recent calls for research on family businesses (Maloni et al., 2017) and SMEs (Kull et al., 2018), I explored how family business and SME factors "manifest" in different aspects of operations decision-making. In terms of family business factors, the field interviews revealed that farmers have diverse underlying objectives; farmers pursue economic objectives to ensure the

longevity of the family farm for future generations, but non-economic objectives such as "feeding the world" and a sense of greater purpose typically take center stage. Further, in order to preserve their autonomy and ensure the family retains decision-making control, farmers tend to keep buyers at "arm's length" and prefer to sell their products via local markets instead of contracts or more integrated arrangements. This finding is in contrast to previous family business research positing that family businesses "will more frequently use integration and partnerships" (Maloni et al., 2017 p.129). One potential explanation for the difference could be contextual; there may be something idiosyncratic about family farms relative to other family businesses that discourages integration. However, Maloni et al. (2017) focus on relationships with suppliers whereas I focus on relationships (or lack thereof) with buyers. Thus, another potential explanation is that buyers may be perceived as more threatening to the family's sense of autonomy. There are only a few large buyers, and family farms are dependent on these buyers for survival, which fosters perceptions of potential coercion (Pfeffer & Salancik, 1978). We thus contribute by illustrating how family business factors influence their approach to exchanges with *downstream* supply chain actors differently from upstream supply chain actors.

In terms of SME factors, the field interviews revealed that farmers are much more limited in the time and resources they can devote to operations decision-making. The farmers I interviewed expressed a desire to "*use good data*" (Elijah) and make informed decisions, but the immediacy of other decisions such as irrigation or pest management typically took precedent. Farmers thus tend to default to existing decision-making processes and rely on intuition and experience. The field interviews also revealed that futures markets provide a low cost, efficient "heuristic" for farmers to quickly gauge market conditions. This is in line with previous research suggesting that small

organizations tend to seek information from external sources because they have fewer resources to develop information sources in-house (Moriarty & Spekman, 1984).

By illustrating how and why farmers use the futures market to inform their supply chain decisions, I also contribute to the body of operations management research on futures markets. Previous studies have primarily focused on the hedging function of futures markets, which is a strategy wherein futures contracts are used to reduce the risk of adverse price movements (e.g., Weiss & Maher, 2009; Wang et al., 2015; Zsidisin et al., 2016; Kouvelis et al., 2018). Extant research has also examined how futures market information can be used to design flexible contracts and reduce commodity price volatility across echelons of the supply chain (Goel & Tanrisever, 2017; Li et al., 2018). While many large firms use futures contracts alongside operational strategies to manage their exposure to price risk, only a small percentage of farmers actually trade futures contracts to hedge due to resource constraints and risk aversion (e.g., Heifner et al., 1993; Pannell et al., 2008). Instead, the findings revealed that farmers use the futures market as a source of information. I thus contribute to this body of research by expanding the role of futures markets in supply chain operations beyond risk management and contracting to include their informational role.

In addition to SME and family business factors, I explored how institutional factors shape farmers' operations decisions. The field interviews revealed that farmers operate in multiple institutional spheres and face competing pressures from government agencies, buyers, fellow farmers, family members, local communities, and consumers. It is challenging for farmers to cope with this institutional pluralism because they lack the resources to focus on all aspects of their environment. The findings suggest that farmers rely on underlying objectives to "filter" through all of the pressures they face. That is, resource constraints limit the number of institutional

pressures farmers can respond to, and farmers' sense of greater purpose directs them to focus on informal, normative pressures to a greater extent. This study thus contributes to political economy research suggesting that farmers have an elevated sense of the personal relevance of institutions (Wolfinger & Rosenstone, 1980) by illustrating *which* institutions farmers focus on. Moreover, by examining how farmers cope with institutional pluralism, this study contributes to the interdisciplinary body of work on institutional pluralism (e.g., Kraatz & Block, 2008; Hsu et al., 2014). Previous studies have focused on professional occupations, such as medical professionals (Dunn & Jones, 2010), state attorneys (McPherson & Sauder, 2013), and mutual fund managers (Lounsbury, 2007), to the neglect of other occupations that may not possess the resources or "skills to maneuver institutional pluralism" (Yu, 2015 p.470). This study thus contributes by focusing on farmers and illustrating how resource constraints influence how SMEs and family businesses navigate fragmented institutional environments.

More broadly, this study contributes to interdisciplinary research on farm-level decision-making by providing a more nuanced perspective on how farmers make decisions and the information they use. The field interviews revealed that farmers prefer market-based exchange to maintain their independence and sense of autonomy. Given this preference for market-based exchange, farmers rely heavily on prices to inform their operations decisions. In this sense, the findings corroborate agricultural economics research demonstrating the role of price in farmers' decision-making (e.g., Coase & Fowler, 1935; 1937; 1940; Williams, 1951; 1953). However, the findings differ from previous studies in terms of *how* farmers acquire information and discover prices. Previous studies suggest that farmers use "backward-looking expectations" to inform their price expectations (e.g., Chavas, 1999 p.20; Boetel et al., 2007). For example, Chavas (1999) found that a significant proportion of pig farmers – approximately 73% – base their price expectations

on historical data. While this was the case for the organic farmers I interviewed (e.g., Elijah and Abraham), the majority of farmers instead relied on futures markets to inform their price expectations. Taken together with the body of agricultural economics research, the findings suggest that price continues to play a critical role in farmers' decision-making.

Beyond its influence in decision-making, price has been touted as a supply chain coordination mechanism (Sahin & Robinson, 2002) because it allows buyers and suppliers to adjust their activities independently —a process Williamson (1991) referred to as "autonomous adaptation" (p.278). For example, suppliers often use price discounts as a "means to induce the buyer to shift to a different order size." (Rubin & Benton, 2003 p.174) to align buyers' purchasing behaviors with their own production and replenishment activities. Price thus acts as a conduit though which supply chain actors can exchange information indirectly (Shamir, 2013). The findings suggest that this coordinating role of price is particularly important in the farm echelon because farmers prefer to operate independently and typically do not have access to information about downstream markets.

Practical Implications

Acknowledging the distinct needs of small and midsize family farms can help to ensure that relevant information is utilized in operations decisions and lessen farmers' reliance on market-level information from the futures market. The findings suggest that farmers have less time and resources to devote to decisions, especially with regards to acquiring information. While the amount of available time to make decisions cannot be increased given resource constraints, the search productivity and the types of information farmers use could be improved. For example, many downstream firms have their own internal price indices and forecasts; supply chain managers could share these with farmers. Such partner-level information is more complete than the aggregate

supply and demand information conveyed by futures prices, so farmers can better gauge local market conditions. Further, the information is in a familiar format (price), which allows farmers to use the information efficiently. Of course, supply chain managers are not necessarily incentivized to share such information with farmers given tight margins in the industry, and the field interviews revealed that farmers do not always trust the information buyers do share. One of the directions that supply chain managers can take to encourage use of such information lies in working with fellow farmers and local communities so that the action is visible to others and can serve as a normative signal. Indeed, the findings suggest that farmers are motivated by a sense of greater purpose and are thus more responsive to informal, normative pressures from family, society, and local communities.

For exchange executives and policymakers, this study corroborates the continued significance of government agencies and futures markets in agriculture. The field interviews revealed that farmers continue to use low-cost, publicly available information from futures markets to inform their supply chain operations decisions but do not directly use information from the USDA or NASS. Farmers may, however, use information from government agencies indirectly given that this information is quickly reflected in futures prices (e.g., Garcia et al., 1997). Nonetheless, this finding suggests the need for a potential reevaluation of the types – and format – of information provided by government agencies. The provision of information should be examined in light of the consequences for farmers' profitability and overall welfare, as well as the implications for the rest of the supply chain.

Since the impetus of agricultural policy in 1933, the government has played a significant role in agriculture. The proponents of the continuation of agricultural policy have often used the "way of life" argument, asserting that there is something special about farming that must be

preserved and protected (Blank, 2002). Promoting an idea or mythology of traditional agrarian values without acknowledging the competing pressures farmers face from buyers, family members, non-governmental organizations, and consumers may unintentionally preserve this "way of life" and discourage farmers from responding to other – perhaps more "economic" – pressures. As illustrated in Theme 1, farmers pursue a variety of aims that include economic *and* non-economic objectives. Thus, policies aimed at protecting agriculture as a "way of life" should be informed by understanding of farmers' diverse objectives as well as the other institutional spheres in which they operate.

Limitations and Future Research

The middle-range, interpretive approach I used emphasizes the particulars of the farm echelon, which is both a strength and a limitation of this research. The advantage is in-depth understanding and appreciation of particular factors influencing farmers' decision-making, but the disadvantage is lower generalizability to other contexts (Craighead et al., 2016). The framework developed in this study provides *mechanisms* to understand other domains that are also characterized by significant involvement from institutions, and future research could leverage this to investigate other empirical contexts and identify the *particular* institutions at play. For example, future research could investigate other raw materials industries, such as mining, energy, and forestry, to determine if institutional influences differ despite the fact that they occupy the same echelon of the supply chain. Indeed, Bhakoo and Choi (2013) found that institutional involvement is more prevalent in upstream echelons due to "the government's perception of upstream players as a bottleneck" (p. 445).

Additionally, by focusing on the farm echelon, this study demonstrates how characteristics differentiating SMEs and family businesses influence decision-making. To build on this, future

research could focus on other echelons that are also characterized by a high prevalence of family businesses and/or SMEs. For example, future research could focus on the motor carrier industry because truck drivers continue to be a challenge in the implementation and performance of logistics operations and strategies (e.g., Miller et al., 2017). Indeed, given the dichotomy of individual owner-operators and large carriers, the motor carrier industry would be a lucid context to understand the effects of SME and/or family business factors. In particular, it would be interesting for future research to examine which factors influence truck drivers' perceptions and predispositions to engage with shippers.

With regards to methods, an interpretive approach was suitable given the assumptions and purposes of this study, but there are a number of other methods that could be leveraged in future research to further investigate the farm echelon. For example, one limitation of the interpretive approach is the focus on a single individual (i.e., the farmer), so future studies could use case study analysis (e.g., Narasimhan, 2014; Touboulic et al., 2014) to capture the perspective of managers in farm-facing roles in downstream firms. Future research could also use design science approaches (Holmström et al., 2009) to understand why the farm continues to be a challenge for more "traditional" or relational approaches to exchange and develop solutions. Further, the existential-phenomenological and ethnographic interview techniques employed in this study are not longitudinal, so future research could also spend more time with farmers *across* decision periods to understand how decision-making processes change and if the influence of SME, family business, and institutional factors varies over time. In a similar vein, future research could also leverage secondary data to connect farmers' operations decisions with farm-level profitability and overall supply chain performance.

Lastly, this study focuses on operations decisions as the "dependent variables" of interest, but there are a number of other farm-level decisions that have important consequences for the rest of the supply chain. For example, future research could examine farmers' decision-making processes related to risk management (e.g., Talluri et al., 2013), environmental and social sustainability (e.g., Touboulic et al., 2014), and technology adoption (e.g., Martens et al., 2012).

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Appendix A: Semi-Structured Interview Guide

The researcher first explained the general purpose of the study and provided the farmer with an assurance of confidentiality and anonymity. The researcher then requested to record the interview and informed the farmer that the recording could be stopped at any point during the interview.

The researcher began the interview with a "grand tour" question – "if you were to write a book about your life, how many chapters would there be?" – to obtain general background information about the farmer (e.g., education, family history), as well as information about his or her farm (e.g., primary crops, size, time in operation). The researcher then shifted to the topic of supply chain decision-making by asking the farmers: "when you think about supply chain management, what comes to mind?" In line with previous research (e.g., Thompson & Haytko, 1997), this opening question was intentionally general to begin the interview in a nondirective and unobtrusive manner (McCracken, 1988) and ensure open conversation.

The dialogue that followed covered a variety of topics, ranging from technical discussions about planting, irrigation, and pest management to emotional discussions about challenging experiences with downstream buyers. Throughout the interview, the researcher asked follow-up questions (e.g., "could you tell me more?"; "could you elaborate on that?") and encouraged the farmer to provide specific examples and lived experiences (e.g., Thompson & Haytko, 1997). We provide example questions below but note that the progression of the interview was set largely by the farmer; this facilitates understanding because it allows the farmer to articulate the factors relevant to decision-making.

1. What is your role on the farm? How long have you been in your current role?
2. What is the primary crop grown on your farm? How long has the farm been in operation?

3. Within your role, what do you perceive as the most important decisions?
4. What is your goal when you're making those decisions?
5. What information do you use to help you make those decisions? Where do you find that information?
6. When issues arise in decision-making, what happens?
7. How do you decide what to produce?
8. How do you decide when to sell?
9. Could you provide an example of a recent decision you made and how you came to that decision?

III. Essay 2: Examining the Role of Futures Market Information in Spot Market Exchange

Introduction

Small and medium enterprises (SMEs) constitute a significant proportion of the competitive landscape. According to the U.S. Census Bureau (2016), firms with fewer than 500 employees and fewer than 20 employees account for 99.7% and 89.0%, respectively, of all firms in the United States. SMEs play a particularly dominant role in industry sectors, such as agriculture and trucking, that continue to pose a challenge to traditional supply chain management practices (e.g., Martinez et al., 2011; Marucheck et al., 2011; Parmigiani & Rivera-Santos, 2015). In agriculture, for example, small and midsize farms make up 95.8% of farms in the United States and account for 45% of total farm production (Hoppe et al., 2016). Further, in trucking, small and midsize carriers account for 98% of carriers, with the vast majority operating fewer than six trucks (Owner-Operator Independent Drivers Association, 2016). The ubiquity and economic significance of SMEs suggest that they play a critical role in the supply chain.

Recent research, however, suggests that SMEs behave differently from their larger counterparts in several important ways that influence their approach to supply chain management (Kull et al., 2018; Maloni et al., 2017). For example, the majority of SMEs are family-owned businesses (La Porta et al., 1999), which tend to have more diverse objectives that include financial and non-financial goals (e.g., Gomez-Mejia et al., 2007). As a consequence, SMEs also tend to approach interfirm exchange relationships differently (Smith et al., 2014) and take a more passive role (Kull et al., 2018). While issues related to power imbalances can create higher transaction costs for SMEs (Arend & Wisner, 2005), contractual arrangements and strategic partnerships are often perceived as a threat to their independence (Roessl, 2005). Instead, interfirm exchange tends to be more transactional as SMEs interact with buyers in spot markets, which are local markets where prices are negotiated “on the spot” (e.g., Boyabath et al., 2011). In agriculture, for example,

the use of contracting has declined, particularly over the last decade, and spot market transactions now account for approximately 65% of the total value of commodity production (MacDonald, 2015).

Because spot markets allow buyers and suppliers to adjust prices based on current market conditions, research has demonstrated the informational and performance benefits they provide for supply chain operations and planning (e.g., Mendelson & Tunca, 2007; Seifert et al., 2004). Despite these benefits, however, spot markets are characterized by greater volatility, which exposes buyers and suppliers to significant price uncertainty (Seifert et al., 2004). This is particularly the case for SMEs, who face scale constraints related to resources and investments in information acquisition and processing (Gedajlovic & Carney, 2010; Mesquita & Lazzarini, 2008). Thus, a key challenge for SMEs is predicting spot market prices in order to plan and execute supply chain operations decisions, such as when and how much to sell versus store.

While extant research has illustrated the primary benefits of spot markets and provided important insights on their proper utilization in supply chain operations, less is understood about the factors that influence spot market prices and how they evolve over time. Given that spot market prices are private and costly for those outside of the transaction to acquire, actors often rely on other sources of information to predict spot market prices. One low-cost, publicly available source of information is the futures market, which is a centralized marketplace wherein prices are determined through the interactions of buyers and sellers (CME Group, 2019). Futures prices are updated and disseminated in real-time and convey important information to market actors about macro-level supply and demand fundamentals (e.g., Adjemian et al., 2013; Garbade &Silber, 1983). For example, a futures price increase implies a decrease in aggregate supply, an increase in aggregate demand, or a combination of the two whereas a futures price decrease implies the

opposite. This information is then used by market actors as a benchmark for local supply and demand as they negotiate prices in local spot markets. Accordingly, this study aims to shed light on the factors driving spot market prices and how they evolve over time by investigating two research questions:

(1) How do current and lagged changes in futures prices affect subsequent changes in spot market prices?

(2) How does the difference between the futures price and spot market price – a phenomenon known in practice as the basis – affect subsequent changes in spot market prices?

Drawing on transaction cost economics (Williamson, 1981; 1991) and Austrian economic theory (Hayek, 1945; Kirzner, 1963), I develop hypotheses that examine how buyers and suppliers use information conveyed by price changes to coordinate their activities in the spot market. Leveraging futures market data from the Chicago Mercantile Exchange and proprietary spot market transaction data provided by a market intelligence and advisory firm, I fit a series of time series regression models (Enders, 2015) to test the hypotheses. The hypotheses are tested in the agriculture industry, which is a suitable context for a number of reasons. First, the majority of extant research on spot markets has been in the business-to-business (B2B) context and focused on industrial goods such as memory chips, steel, and chemicals (e.g., Seifert et al., 2004; Zhao et al., 2015). In agriculture, the spot market accounts for a significantly greater proportion of interfirm exchange – approximately 65% (MacDonald, 2015) – as compared to industrial procurement, which ranges from 5% of volume in chemicals and steel to almost 30% in memory chips (Seifert et al., 2004). Second, in contrast to the large, non-family firms involved in "traditional" B2B spot markets, small and midsize family farms represent 95.8% of farms in the United States and account for 45% of total farm production (Hoppe et al., 2016). Extant research

suggests that firms of different sizes may behave differently in the spot market due to the costs associated with discovering price (Scott, 2018; Stigler, 1961). Family farms – and SMEs more generally – have limited time and resources (Kull et al., 2018; Maloni et al., 2017), and the costs of seeking private information often outweigh the potential benefits. I thus expect that idiosyncrasies related to both the prevalence of spot market transactions and nature of buyers and suppliers involved in the agriculture industry may result in different dynamics and allow me to contribute new insights.

Overall, the findings support the hypotheses and offer important insights for both research and practice. For research, this study sheds light on the factors that drive spot market prices over time and also extends the body of knowledge on how futures markets shape supply chain operations and planning to include their effect on spot markets. More broadly, this study illustrates the role of price as a coordination mechanism (Williamson, 1991). In doing so, I contribute to the literature on buyer-supplier exchange, which has focused more extensively on the hybrid and hierarchy forms of governance given the extant focus on large firms' approach to supply chain management (Kull et al., 2018). For practice, this research provides empirical insights that can be used by both buyers and suppliers to more effectively use futures market and spot market information in their supply chain operations and planning. Lastly, for policymakers, the findings offer timely policy guidance for the U.S. Commodity Futures Trading Commission and U.S. Department of Agriculture.

The structure of the remainder of this study is as follows: The relevant literature is reviewed in the next section, and the contributions of this study are highlighted. In the subsequent section, transaction cost economics and Austrian economic theory are introduced and applied to develop the hypotheses. The empirical context, proprietary data set, and preliminary analysis are then

described followed by the model specification and results in the penultimate section. Lastly, the implications for theory, supply chain practice, and public policy are discussed, as well as the limitations and directions for future research.

Literature Review

Role of SME and Family Business Factors in Supply Chain Operations

Recent studies suggest that SMEs differ from large firms, which have been the primary focus of extant research, in several ways that influence their approach to supply chain management (Gray et al., 2017; Kull et al., 2018). First, many SMEs are family-owned businesses (LaPorta et al., 1999), which tend to be "more long-term oriented, fiscally conservative, and risk-averse" (Maloni et al., 2017 p.124). As a consequence, non-financial goals such as family legacy (Astrachan, 2010), long-term sustainability (Tongarlak et al., 2017), and socioeconomic wealth (Gomez-Meija et al., 2007) are often emphasized more than financial goals. These "idiosyncratic performance metrics and goals" (Astrachan, 2010 p.10), in turn, affect how SMEs approach interfirm exchange (Smith et al., 2014). Research suggests that SMEs' long-term orientation and social capital can result in closer ties with suppliers and customers (Dyer Jr. &Whetten, 2006; Lester &Canella, 2006; Zahra, 2010), but it is often complicated by their risk-averse, conservative nature (George et al., 2005; Memilli et al., 2011). For example, to preserve their independence and minimize the risks associated with loss of control, SMEs often avoid interfirm integration (Roessl, 2005).

Second, SMEs also differ from their larger counterparts in terms of resources and capabilities (Done et al., 2011; Harland et al., 2007; Kull et al., 2018). On the one hand, research suggests that SMEs may have unique resources and capabilities due to the cohesive nature of intrafirm relationships (Habbershon & Williams, 1999). For example, SMEs have greater

discretion to quickly make decisions and capitalize on opportunities (Carney, 2005) and are generally more responsive (Allio, 2004) than large non-family firms. On the other hand, previous literature also suggests that SMEs have more limited time and resources and are often at a disadvantage in accessing external financing, technical assets, and professional management (Kull et al., 2018). For example, SMEs have less time, capital, and personnel to devote to information acquisition and processing capabilities (Bruderl & Schussler, 1990; Freeman et al., 1983), so they often make decisions with incomplete information. These information asymmetries can lead to inventory management issues and other operational inefficiencies (Cheung et al., 2011), which have significant implications for SMEs' profitability and long-term viability.

I contribute to the nascent literature on SMEs' approach to supply chain management by exploring if SMEs incorporate information conveyed by futures price changes into subsequent spot market transactions. SMEs in several critical industries, such as bulk ocean shipping (Stopford, 2009), trucking (Belzer, 2000), and agriculture (MacDonald, 2015), conduct a large share of their business through exchanges in local spot markets due to both the size of the transactions and their risk-averse nature. However, there is substantial uncertainty surrounding whether or not SMEs, due to resource constraints, will use the information conveyed by futures price changes to inform their negotiations in local spot markets as predicted by Austrian economic theory (Hayek, 1945).

Role of Spot Markets in Supply Chain Operations

Spot markets are real-time often regional markets where goods and services are purchased on the spot, which allows buyers and suppliers to adjust prices based on current information (Boyabath et al., 2011; Scott, 2018). Because of the prevalence of spot markets in practice, a growing body of research has explored their effects on supply chain operations and planning (e.g., see Haksöz & Seshadri, 2007 for a review). Research in this stream has focused primarily on the

informational and performance benefits of using spot markets to manage procurement and improve the design of supply chain contracts (e.g., Mendelson & Tunca, 2007; Seifert et al., 2004). For example, a number of studies have modeled the optimal balance between contracts and spot market transactions (e.g., Seifert et al., 2004; Boyabath et al., 2011) and have demonstrated how spot markets can be used to reduce procurement costs. Building on this, previous studies have also modeled the conditions under which information from the spot market can be used to develop and improve supply chain contracts (e.g., Cachon, 2003). For example, Mendelson and Tunca (2007) demonstrated how spot markets can be used to improve fixed-price contracts and, ultimately, supply chain performance. In a similar vein, Zhao et al. (2015) found that incorporating information from spot markets can improve the design of supply chain contracts—like through the use of renegotiation options that are contingent on movements in spot market prices (e.g., Feng et al., 2013).

Despite the fact that spot markets have long been used in agriculture, extant research has focused heavily on Internet-based marketplaces for the procurement of intermediate goods in B2B contexts (e.g., Grey et al., 2005; Kleindorfer & Wu, 2003).[7] I thus extend this body of knowledge by focusing explicitly on spot markets in the agriculture industry, which are different from the spot markets examined in previous studies in three important ways. First, as discussed previously, the farm sector is overwhelmingly comprised of family farms with 99% of farms being classified as family farms and accounting for 89% of farm production in the United States (Hoppe et al., 2016). The spot market thus accounts for a significantly greater proportion (approximately 65%) of buyer-

[7]An important exception is Boyabath et al. (2011), which focuses on the beef cattle industry. This study differs from Boyabath et al. (2011) in two important ways. First, Boyabath et al. (2011) focuses on the optimal mix of spot market transactions and contracting rather than the factors driving spot market prices. Second, extant research has shown that the poultry and livestock supply chains are characterized by significantly greater vertical integration and contracting than other agricultural products (MacDonald, 2015; Pullman & Dillard, 2010).

supplier exchange in agriculture (MacDonald, 2015) as compared to chemicals and steel (approximately 5%) (Seifert et al., 2004), memory chips (30%) (Seifert et al., 2004), and truckload freight (approximately 10%) (Caplice, 2007) that are characterized by larger non-family firms. Consequently, examining behavior in a context where most transactions take place in the spot market is warranted. Moreover, for practice, understanding how spot markets operate in various contexts is important for managers to identify the products and services for which spot markets can be used profitably in supply chain operations.

Second, spot markets in agriculture are characterized by greater volatility (Geman & Nguyen, 2005), but, unlike Internet-based spot markets that have been the focus of extant research, spot market prices in agriculture are typically private and not publicly available in real time. Instead, actors often rely on other sources of information, such as futures prices, to gauge spot market prices (Sandor, 2012). This is particularly the case for small and midsize family farms, who are more limited in the time and resources they can devote to information acquisition and processing (e.g., Freeman et al., 1983). Third, in contrast to spot markets for industrial goods (Seifert et al., 2004) and truckload service (Scott, 2018), the spot market in agriculture does not always command a premium for added flexibility. Spot market prices can be above or below futures prices; the *difference* between the two is known in industry as the basis, which is also used by actors to gauge spot market prices (CME Group, 2019). In combination, the private nature of spot market prices and the subsequent use of other sources of information suggest that spot market prices may be endogenous. This is in contrast to previous studies that have modeled spot market prices as exogenous factors or stochastic processes (Mendelson & Tunca, 2007). Accordingly, by focusing on the agriculture industry and identifying the factors that influence spot market prices

and how they evolve over time, I also contribute empirical evidence to a body of research that has been largely analytical.

Role of Futures Markets in Supply Chain Operations

Due to the private nature of spot market transactions and the costs associated with acquiring private information (Stigler, 1961), actors rely on other sources to inform their price negotiations in the spot market. One low-cost, publicly available source of information is the futures market, which provides a medium for price discovery and allows market actors to cost effectively determine the value of a commodity (Sandor, 2012). While there are a number of studies that examine the role of futures markets in supply chain operations, the focus has largely been the hedging function of futures markets, which is a strategy wherein futures contracts are used to reduce the risk of adverse price movements (e.g., Brusset & Bertrand, 2018; Gaur & Seshadri, 2005; Kouvelis et al., 2018; Wang et al., 2015; Weiss & Maher, 2009; Zsidisin et al., 2016). For example, in agriculture, futures contracts are used by farmers and buyers, such as merchandisers, processors, and manufacturers, to "lock in" a particular price in the future (Zsidisin et al., 2016). Similarly, in transportation, shippers and carriers use the Baltic Dry Index (Hampstead, 2018a) and now Trucking Freight Futures (Hampstead, 2019) to hedge against price volatility.

In addition to risk management, futures markets play an important price discovery and informational role (Garbade & Silber, 1983). A futures contract is a financial derivative, so its value is, by definition, directly tied to the underlying asset (CME Group, 2019). Futures prices thus convey important information to market actors about macro-level supply and demand fundamentals. For example, previous studies have demonstrated how information from futures markets can be used to design flexible contracts and reduce commodity price volatility across echelons of the supply chain (Feng et al., 2013; Goel & Tanrisever, 2017; Li et al., 2018). Overall,

these studies have illustrated the important informational role that futures markets play in the development of contracts.

While these studies have demonstrated how futures markets affect supply chain operations in terms of risk management and contracting, their effect on spot market transactions has not been explicitly considered. This is an unfortunate omission because spot market prices are the primary mechanism coordinating the activities of farmers and buyers but are not available to those outside of the transaction. To overcome this information gap, small and midsized family farms instead rely extensively on futures prices as a benchmark for negotiating prices in local spot markets. Accordingly, examining how futures prices influence spot market prices over time is important for practice and also expands understanding of the effect of futures markets on supply chain operations.

Theory and Hypotheses Development

Coordination – particularly the matching of supply and demand – is foundational to effective supply chain management (Esper et al., 2010; Fugate et al., 2006; Mentzer et al., 2001). To facilitate coordination, extant research has proposed various mechanisms, such as contracts (Sluis & Giovanni, 2016), collaboration (e.g., Cao & Zhang, 2011), trust (Narayanan et al., 2015), relationship-specific investments (e.g., Handley & Benton, 2012), and even supply chain integration (Flynn et al., 2010; Wong et al., 2011). While these hybrid and hierarchy forms of governance are efficacious for "traditional" buyer-supplier exchange, they are not used as extensively in the agricultural supply chain – particularly upstream echelons (Jones et al., 2007). Buyer-supplier exchange in this context is characterized by minimal information-sharing, trust, and collaboration (Pullman & Dillard, 2010). Small and midsized family firms often view contractual arrangements and strategic partnerships as a threat to their sense of autonomy (Roessl,

2005). Instead, the market mechanism – specifically the spot market – is often used to govern transactions and coordinate the activities of buyers and suppliers. The market mechanism is what Williamson (1991) referred to as "autonomous adaptation" (p.278), which allows individual buyers and suppliers to adjust their behavior independently in response to price changes.

To understand *how* the market coordinates the activities of buyers and suppliers, we, like Williamson (1991), draw on Austrian economic theory (Hayek, 1937; 1945; Kirzner, 1963; Mises, 1949), which emphasizes the "market process" (Jacobson, 1992) and the informational role of prices. Underlying Austrian economic theory is the assumption that information is dispersed among many actors, and each actor possesses imperfect and incomplete knowledge (Hayek, 1945). The market thus acts as "an information processing system" (Bowles et al., 2017 p.215), and prices are the mechanism through which information is communicated to market participants (Hayek, 1945). As prices change, additional information is conveyed, and actors "adjust their activities to changes of which they may never know more than is reflected in the price movement" (Hayek, 1945 p. 527). The adjustment process results in further price changes as actors continue to adapt and respond to changing market conditions (Kirzner, 1997). It is this dynamic and continuous adjustment that is central to the theory of the market process and, thus, the focus of my theorizing. According to Austrian economic theory, prices are what guide market participants toward "decisions that tend to consider implicitly all the relevant conditions prevailing in the market" (Kirzner, 1963 p.39). As it relates to the present study, spot market prices are the primary mechanism coordinating supply and demand, and actors use spot market prices to make operations decisions. However, unlike many online spot markets in B2B contexts (e.g., Seifert et al., 2004), spot market transactions in agriculture tend to be private bilateral arrangements (i.e., between a single buyer and a single farmer), so it is costly for those outside of the transaction to access price

information in real time (Scott, 2018). To overcome this private information gap, actors instead rely on futures prices, which are low cost, publicly available, and convey real-time information about the current state of the global market (CME Group, 2019).

Just as stock prices summarize many pieces of information about the performance of a company, futures prices summarize macro-level supply and demand fundamentals. For example, an increase in the futures price implies a decrease in supply and/or an increase in demand whereas a decrease in the futures price implies an increase in supply and/or a decrease in demand. Austrian economic theory thus predicts that actors will use the information conveyed by futures price changes and adjust their actions in the spot market accordingly (Kirzner, 1963). This is in line with the "law of one price" (e.g., Protopapadakis & Stoll, 1983), which suggests that futures price movements and spot market price movements should be positively correlated because they exist as a "common market" (Garbade & Silber, 1983; Stigler & Sherwin, 1985). Accordingly, I posit that actors will incorporate the information conveyed by futures price changes as they negotiate prices in the spot market. Stated formally:

Hypothesis 1: Contemporaneous changes in futures prices will positively affect changes in spot market prices.

While Austrian economic theory predicts that price changes will result in *some* immediate adjustment from market actors, it also suggests that there is always a "degree of ignorance" in the marketplace that prevents *complete* adjustment (Kirzner, 1973; 1979). As boundedly rational individuals (Simon, 1978), actors face limitations in their ability to process and incorporate the information conveyed by futures price changes. Actors make the best decision they can with the information available at the time, but the processing of that information is subject to delays (Arimault et al., 2006). This is particularly the case for small and midsize family farms, who have

limited time, resources, and personnel to devote to information acquisition and processing. I thus posit that futures price changes will also exhibit lagged effects.

Moreover, Austrian economic theory suggests that knowledge is constantly changing, which keeps the market in perpetual motion (Jacobson, 1992). The dynamic nature of the market poses additional challenges for actors to process and incorporate the information conveyed by price changes (Hayek, 1945). Indeed, futures markets have exhibited unprecedented volatility in the past decade (e.g., Pellegrino et al., 2018), which makes inferring information about underlying supply and demand fundamentals from price changes even more challenging. The increased volatility is often attributed to the financialization of commodity futures markets (e.g., Bekiros et al., 2017), which is characterized by an increase in trading activity from institutional investors, index funds, and speculators. While the financialization hypothesis has largely been debunked (e.g., Garcia et al., 2015; Irwin et al., 2011), actors may nonetheless attribute futures price changes to factors unrelated to supply and demand. Actors will thus wait to see if the changes persist (Leibtag et al., 2007) before incorporating this information as they negotiate in the spot market. As such, I posit that futures prices changes will also exhibit lagged effects on spot market prices. Stated formally:

Hypothesis 2: Lagged changes in futures prices will positively affect changes in spot market prices.

In addition to information about supply and demand, Austrian economic theory suggests that there is an equally important body of knowledge regarding particular circumstances of time and place, such as information related to people, local conditions, and special circumstances (Hayek, 1945). This information, too, is dispersed among many actors and is conveyed as actors transact in the marketplace. Thus, the "relevant knowledge" that market actors have at their

disposal is not limited to futures price changes but also includes information about local market conditions (Kirman et al., 2005). In practice, the *difference* between the futures price and spot market price is used to determine the value of the commodity at the local level (Chicago Board of Trade, 2004). This difference – known in industry as the basis (CME Group, 2019) – is used by market actors to determine the best time to buy or sell and when to accept an offer or bid (Chicago Board of Trade, 2004). A positive basis (i.e., when the spot market price is greater than the futures price) implies limited supply or greater demand in local markets relative to the macro-market, which encourages sellers to accept bids rather than store the commodity. In contrast, a negative basis (i.e., when the spot market price is less than the futures price) implies oversupply or limited demand in local markets. In this sense, the basis "localizes" the futures prices and reveals additional information about the current state of the *local* market relative to the macro-market (Hayek, 1945).

As long as there is a difference between futures prices and spot market prices, I posit that there will be subsequent revisions to correct for this difference (Kirzner, 1963). Indeed, "would-be buyers and sellers who were disappointed in their past activity – or who, even if not disappointed in the past, do not wish to be disappointed in the future – must revise their bids or offers to make them more attractive to the current market" (Kirzner, 1963 p.28). For example, if the local spot market price is higher than the futures price, this suggests that supply and demand fundamentals in the macro-market are not necessarily there to support higher prices. This difference will then lead to a downward revision in the spot market price in the subsequent period as buyers try to negotiate lower prices. Conversely, if the local spot market price is lower than the futures price, farmers are likely to hold out and demand higher prices from buyers, which will lead to an upward revision in the spot market price in the subsequent period. I thus posit that differences in the

immediate past (where the difference is equal to the spot market price less the futures price) will negatively affect current spot market transactions. Stated formally:

Hypothesis 3: Differences between spot market prices and futures prices in the immediate past will negatively affect changes in spot market prices.

Methodology

Empirical Context

Within agriculture, he empirical context for this study is the U.S. rice industry, which is suitable for a number of reasons. First, in stark contrast to other agricultural commodities in the U.S. such as corn and soybeans, there is a distinct lack of publicly available spot market prices and information supplied by private analytical firms in the rice industry (Food and Agriculture Organization, 2004; McKenzie & Darby, 2017). In line with my theorizing, futures prices are *the* primary mechanism through which information is communicated to small and midsize family farms in the U.S. rice industry. Further, methodologically, this private information gap allows me to isolate the effect of futures prices on spot market prices because it is not cofounded by the presence of other sources of third-party information typically found in other agricultural market settings. For example, for other grains and oilseeds in the U.S. (e.g., corn, wheat, soybeans), the Agricultural Marketing Service (2019) disseminates daily reports with spot market prices and contract prices at various locations across the U.S., and Farm Journal, Inc. (2019) also has a free tool that farmers can use to see daily spot market bids from various buyers based on their zip code.

Second, rice is a predominant food staple in many regions of the world and a critical component of the diets of more than half of the world's population (Food and Agriculture Organization, 2004). As a top five exporter and accounting for approximately ten percent of world trade (U.S. Department of Agriculture, 2019), the rice industry has a critical role to play in feeding

the world's population, particularly low-income, food-insecure consumers in developing economies (U.S. International Trade Commission, 2015). Despite its significance, however, the U.S. rice industry has been largely unexamined—likely due to the unavailability of public data. As such, focusing on the U.S. rice industry allows me to articulate important implications for practitioners and policymakers (Joglekar et al., 2016) and also contribute to the established body of economics research on price adjustment (e.g., Fama & French, 1987; Garcia & Leuthold, 2004; Garcia et al., 1988; Reeve & Vigfusson, 2011). Third, the physical requirements for growing rice are limited to particular areas of the U.S. due to availability of water, soil type, and the need for high average temperatures during the growing season (Childs, 2001). The high geographical concentration of rice production helps to alleviate concerns related to delays in adjustment (Hypothesis 2) or differences in futures prices and spot market prices (Hypothesis 3) being due to transportation factors. Lastly, focusing on a single industry helps to ensure internal validity and allows me to explore specialized variables that may not be accessible in interindustry studies (Joglekar et al., 2016).

Data and Measures

A futures contract is "a legally binding agreement to buy or sell a commodity or financial instrument at a later date" (CME Group, 2008). Each contract specifies the quality and quantity of the underlying asset, as well as the physical delivery time and location (CME Group, 2008). For example, the underlying commodity for the rice futures contract is long-grain rough rice, the quantity is 2,000 hundredweights (100 tons), and the quality is U.S. No. 2 or better with a milling yield of at least 65% (CME Group, 2008). The contract specifications related to the underlying asset are standardized, so every futures contract is instead referred to by its delivery month and year. Rice futures contracts are available for January, March, May, July, September, and

November and can be traded up to fifteen months in advance. For example, in April 2019, the rice futures contracts for May 2019, July 2019, September 2019, November 2019, January 2020, March 2020, and May 2020 were being traded. However, the liquidity of futures contracts that are further into the future is significantly less than the liquidity of nearby futures contracts. Extant research has shown the nearest-to-maturity contract reflect the most current (at the time of retrieval) set of information and generally has the highest ratio of volume to open interest (e.g., Thomson Reuters, 2010; Bekiros et al., 2017), which is important for reliability.

Daily futures prices for the nearest-to-maturity rice futures contract were obtained from Quandl's Chicago Mercantile Exchange futures database and validated with data provided by the Registrar's Office at the Chicago Mercantile Exchange. To create a continuous price series, I used the Type 0 roll method (Thomson Reuters, 2010)[8], which uses the futures price for the nearest-to-maturity contract until the first business day of the contract month. At this point, the futures price "rolls over" to the next contract month. For example, the futures price for the week ending on February 6, 2004 was calculated based on the March 2004 futures contract, which was the nearest-to-maturity contract. Settlement prices are available each day at the end of trading[9], and the weekly futures price was calculated by averaging across the five trading days (February 2-6) in that week. The subsequent weeks in February 2004 ending on February 13, 20, and 27 respectively were also based on the March 2004 contract and calculated in the same manner. The first business day of the contract month (March) was March 1, 2004, so the futures price was "rolled over" to the May 2004

[8]While the first business day of the contract month is the most intuitive and traditionally used (e.g., Bekiros et al., 2017), trading often continues to occur during the time between the first business day of the contract month and the contract's expiry date, and futures prices are still disseminated. Thus, as a robustness check, the futures price series was calculated based on the Type 1 roll method (Thomson Reuters, 2010), which is detailed in Appendix A. There were no substantive differences in the results when using the Type 1 roll method.

[9] Some daily futures price observations were missing due to bank holidays, but the number of missing values was less than one percent of the total observations. Linear interpolation was used prior to averaging to replace any missing values.

contract on this date. For the week ending on March 5, 2004, the futures price was calculated by averaging the settlement price for the May 2004 futures contract, which is now the nearest-to-maturity contract, across the five trading days (March 1-5) in that week.

As discussed previously, there is no comparable spot market price available publicly for rice, which is in stark contrast to other agricultural commodities. To overcome this, I obtained proprietary spot market transaction data from Firstgrain, Inc., a widely respected market intelligence and advisory firm in the U.S. rice industry. The data are weekly and calculated based on a weighted average of spot market transactions in each of the respective locations. The spot market price represents the price paid for rice that meets the quantity and quality standards equivalent to those established in the futures contract; I am limited in the amount of detail I can disclose about these data due to confidentiality agreements.

For the purposes of this study, I focus on the Arkansas spot market location for three important reasons. First, the underlying commodity for the rice futures contract is 2,000 hundredweights of long-grain rough rice, and the majority (approximately 57%) of long-grain rice produced in the U.S. is in Arkansas (Economic Research Service, 2019). Second, the locations declared regular for delivery on the Chicago Board of Trade are all located in Arkansas (See *Deliverable Commodities Under Registration* report issued by the Chicago Mercantile Exchange for a list). Thus, futures prices should, in theory, be the most informative for spot market prices in Arkansas as compared to other locations. This also allows me to control for the effect of transportation costs. Third, in line with my theorizing and research purpose, 96% of the 2,500 rice farms located in Arkansas are family-owned (USA Rice Federation, 2019).

While the futures price series dates back to the 1980s, time series of equal length are necessary, so the start date of futures prices is limited to the start date of the proprietary spot market

transaction data. The final estimation period is January 9, 2004 to August 29, 2017, which yields 711 weekly observations in total for each price series. Following common practice when working with prices (e.g., Peltzman, 2000), I took the natural logarithm of each series. The futures price is denoted as $ln\_futures_t$, and the spot market price is denoted as ln_spot_t. The difference between the futures price and spot market price was calculated as: $difference_t = ln\_spot_t - ln\_futures_t$. Additionally, to control for the effects of increased financialization in commodity futures markets, I included $speculation_t$, which measures the proportion of long and short open interest positions held by non-commercial traders (i.e., non-hedgers) such as swap dealers, managed money accounts, and index funds (U.S. Commodity Futures Trading Commission, 2019). This data is published in the weekly *Commitment of Traders* report.

Preliminary Analysis

To provide a visual representation of the nature of the data, both prices series are plotted in Figure 1. There are a few observations worth noting. First, in early 2008, what came to be known as the "global rice crisis" occurred, and the price of rice skyrocketed in international markets (Slayton, 2009). The global rice crisis occurred in tandem with the world food price crisis in 2007 and 2008, but the effects persisted through late 2008 due to various export restrictions and policies that were implemented by governments throughout Asia to protect citizens from rising rice prices (Slayton, 2009). Second, between 2010 and 2012, spot market prices became increasingly decoupled from futures prices; see Figure 2, which graphs the difference between the two series. As concerns over this decoupling made its way into regulatory circles, the Chicago Mercantile Exchange and U.S. Commodity Futures Trading Commission increased the fixed storage rate for warehouses declared regular for delivery at the end of 2012 (CME Group, 2012). Following the

policy change, it appears that the two series were more closely tied in the remainder of the estimation period.

Figure 1: Weekly Spot Market and Futures Prices

Figure 2: Difference Between Spot Market Prices and Futures Prices (Spot – Futures)

Unit Root Tests

Given the nature of the series illustrated in Figures 1 and 2, the first step is to test for stationarity (Enders, 2015). Standard Augmented Dickey-Fuller test results are reported in Table 1 and indicate that ln_spot_t and $ln_futures_t$are both I(1) processes and $difference_t$ is an I(0) process. That is, $difference_t$ is stationary in the level, and ln_spot_t and $ln_futures_t$are non-stationary in the level but are stationary in first differences. As such, ln_spot_t and $ln\_futures_t$ were transformed using week-over-week differences. This is also in line with my theorizing, which focuses on the effect of price *changes*. The resultant variables are denoted as Δln_spot_t and $\Delta ln\_futures_t$ respectively.

Table 1: Unit Root Tests

	Augmented Dickey-Fuller Test (Level)		Augmented Dickey-Fuller Test (First Difference)	
	Test Statistic	**1% Critical Value**	**Test Statistic**	**1% Critical Value**
ln_spot_t	-1.944	-3.439	-31.330**	-3.439
$ln\_futures_t$	-1.955	-3.439	-15.492**	-3.439
$difference_t$	-6.091**	-3.439	-17.041**	-3.439

* p < .05; ** p < .01

Descriptive Statistics and Correlation Matrix

The descriptive statistics and correlations are summarized in Table 2. In line with economic theory (e.g., Stigler & Sherwin, 1985), movements in spot market prices and futures prices are positively correlated. However, the average change in spot market prices is greater than the average change in futures prices, and the standard deviation of the change in spot market prices (σ = 0.043) is also greater than the standard deviation of the change in futures prices (σ = 0.037). The difference between the two is statistically significant, which suggests that local spot markets may be more volatile than futures markets and hence subject to extreme price realizations.

Table 2: Descriptive Statistics and Correlation Matrix

	Mean	Std. Dev.	Δln_spot_t	$\Delta ln\_futures_t$	$difference_t$
Δln_spot_t	4.56×10^{-4}	0.043			
$\Delta ln\_futures_t$	4.19×10^{-4}	0.032	0.341		
$difference_t$	-0.070	0.081	0.075	-0.268	
$speculation_t$	0.560	0.123	-0.001	0.038	-0.192

Model Estimation and Results

To test the hypotheses, I fit a series of time series regression models. First, to test Hypothesis 1 and Hypothesis 2, which posit that futures price changes will exhibit contemporaneous and lagged effects on spot market price changes, I use the distributed lag approach developed by Almon (1965). The distributed lag approach reduces the number of parameters being estimated by imposing a shape on the lag distribution (Almon, 1965). In doing

so, the distributed lag approach reduces the effects of multi-collinearity. Based on anecdotal evidence regarding the rapid adjustment between spot markets and futures markets (Chicago Board of Trade, 2004), I specified a linear distributed lag model that included a contemporaneous effect and four lags.[10]

I control for previous changes in spot market prices by including Δln_spot_{t-1}. Dummy variables for each month ($Month_t$) and year ($Year_t$) were included to capture seasonality and macroeconomic conditions, and $speculation_t$ was also included to control for increased financialization in commodity futures markets. The model to test Hypothesis 1 and Hypothesis 2 was specified as Model (1):

$$\Delta ln\_spot_t = \alpha_0 + \alpha_1 \Delta ln\_spot_{t-1} + \alpha_2 \Delta ln\_futures_t + \alpha_3 \Delta ln\_futures_{t-1} + \alpha_4 \Delta ln\_futures_{t-2} + \alpha_5 \Delta ln\_futures_{t-3} + \alpha_6 \Delta ln\_futures_{t-4} + \alpha_7 speculation_t + \sum_{j=8}^{18} \alpha_j Month_t + \sum_{i=19}^{31} \alpha_i Year_t + \varepsilon_t$$

The distributed lag approach (Almon, 1965) constrains $\alpha_2 - \alpha_6$ to lie on a linear function such that:

$$\alpha_2 = \varphi_0$$

$$\alpha_3 = \varphi_0 + \varphi_1$$

$$\alpha_4 = \varphi_0 + 2\varphi_1$$

$$\alpha_5 = \varphi_0 + 3\varphi_1$$

$$\alpha_6 = \varphi_0 + 4\varphi_1$$

[10]As a robustness check, various lag distributions (e.g., polynomial specifications) and lag lengths (e.g., two, three, and five lags) were also modeled. There were no substantive differences in the results.

The results of Model (1) are reported in Table 3. First, as hypothesized in Hypothesis 1, the coefficient for contemporaneous futures price changes is positive and statistically significant ($p < .01$). Second, the coefficients for lagged futures price changes are also positive and statistically significant for weeks one, two, and three ($p < .01$), which provides evidence in support of Hypothesis 2. However, the lagged effect of changes in futures prices becomes non-significant in week four, which suggests that the adjustment process takes place during the current period and the three weeks that follow. As illustrated in Figure 3, the magnitude of the effect of changes in futures prices decays over time with changes in the current period (*t*) having the greatest effect followed by changes in the immediate past (*t –1*). In addition to examining the intertemporal dynamics of the adjustment process, the distributed lag approach also allows me to examine the long-run effect of changes in futures prices (Wooldridge, 2009). The sum of the coefficients for the changes in futures prices ($\alpha_2$to α_6) is 0.866, which suggests that a one percent change in futures prices results in an 0.866 percent change in spot market prices. The implications of this finding will be explored further in the discussion. Overall, Hypothesis 1 and Hypothesis 2 are corroborated by the results of Model (1).

Table 3: Model (1) Regression Results

Dependent Variable: Δln_spot_t	
Constant	0.011
	(0.012)
Δln_spot_{t-1}	-0.161**
	(0.034)
$\Delta ln\_futures_t$	0.344**
	(0.027)
$\Delta ln\_futures_{t-1}$	0.258**
	(0.020)
$\Delta ln\_futures_{t-2}$	0.173**
	(0.016)
$\Delta ln\_futures_{t-3}$	0.088**
	(0.019)
$\Delta ln\_futures_{t-4}$	0.003
	(0.026)
$speculation_t$	-0.007
	(0.015)
Year Dummies	Included
Month Dummies	Included
Observations (T)	706
R_2	0.469

Standard errors reported in parentheses are traditional OLS standard errors. Diagnostic checks indicated approximately normally distributed residuals and no autocorrelation (Durbin-Watson = 2.01). Two potential outlier observations were identified and controlled for using dummy variables.

* p < .05; ** p < .01

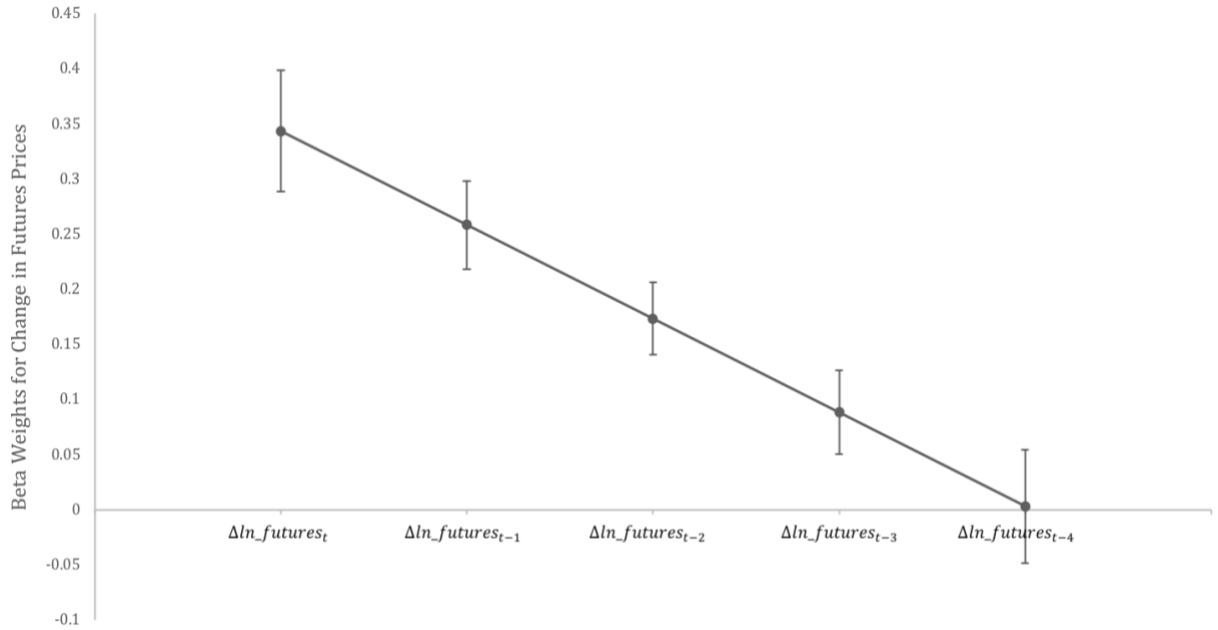

Figure 3: Distributed Lag Effects of Changes in Futures Prices on Changes in Spot Market Prices (95% Confidence Intervals)

To test Hypothesis 3, which posits that the *difference* between futures prices and spot market prices in the immediate past will affect current spot market prices, I added $difference_{t-1}$ to Model (1). I also altered Model (1) slightly to include only the contemporaneous effect of changes in futures prices ($\Delta ln\_futures_t$) because $difference_{t-1}$ is a lagged measure and already incorporates lagged futures prices. The model to test for Hypothesis 3 was specified as Model (2):

$$\Delta ln\_spot_t = \alpha_0 + \alpha_1 \Delta ln\_spot_{t-1} + \alpha_2 \Delta ln\_futures_t + \alpha_3 difference_{t-1} + \alpha_4 speculation_t + \sum_{j=5}^{15} \alpha_j Month_t + \sum_{i=16}^{28} \alpha_i Year_t + \varepsilon_t$$

The results are reported in Table 4. As hypothesized, the coefficient on the difference between futures prices and spot market prices is negative and statistically significant ($p < .01$), which provides evidence in support of Hypothesis 3. Additionally, the coefficient on contemporaneous changes in futures prices is positive and statistically significant ($p < .01$), which provides further evidence in support of Hypothesis 1. The magnitude of the effect (α_3 = -0.219)

of past differences rivals that of contemporaneous changes in futures prices ($\alpha_2 = 0.429$), which suggests that actors use futures prices both as a source of information and a benchmark to gauge local market conditions. This finding underscores Austrian economic theory's emphasis on "local" knowledge (Hayek, 1945) and provides empirical evidence of the "localizing" role of basis (Chicago Board of Trade, 2004).

Table 4: Model (2) Regression Results

Dependent Variable: Δln_spot_t	
Constant	0.000
	(0.011)
Δln_spot_{t-1}	-0.042
	(0.030)
$\Delta ln\_futures_t$	0.429**
	(0.036)
$difference_{t-1}$	-0.219**
	(0.020)
$speculation_t$	-0.008
	(0.014)
Year Dummies	Included
Month Dummies	Included
Observations (Weeks)	709
$R2$	0.526

Standard errors reported in parentheses are traditional OLS standard errors. Diagnostic checks indicated approximately normally distributed residuals and no autocorrelation (Durbin-Watson = 2.02). Two potential outlier observations were identified and controlled for using dummy variables.

* p < .05; ** p < .01

Discussion

Given that SMEs and family businesses rely heavily on spot markets to transact with buyers but face distinct challenges in predicting spot market prices due to resource constraints, this study aimed to understand the factors influencing spot market prices and how they evolve over time. In particular, I investigated how (1) futures price changes and (2) the difference between the futures price and spot market price affect subsequent spot market price changes. As posited in Hypothesis

1, futures price changes convey supply and demand information in real-time, and contemporaneous futures price changes were found to positively affect spot market price changes. However, due to limitations in actors' information processing capacities, futures price changes also exhibited lagged effects on spot market price changes with the adjustment process taking place during the current period and subsequent three weeks, which is in line with Hypothesis 2. Beyond the information conveyed by futures price changes, *differences* between spot market prices and futures prices reveal information about the local market and were found to negatively affect spot market price changes in subsequent periods, which corroborates Hypothesis 3. Overall, these findings illustrate how actors use price information to inform their negotiations in local spot markets and, as detailed below, offer important implications for theory, supply chain practice, and public policy.

Implications for Theory and Future Research

Previous studies have identified a myriad of characteristics that distinguish SMEs and family businesses from large non-family firms and called for studies that examine how these characteristics influence their approach to supply chain management (Kull et al., 2018; Maloni et al., 2017). Of particular relevance to this study is how SMEs' tendency to be risk-averse and take a more passive role shape their approach to buyer-supplier exchange (George et al., 2005; Memilli et al., 2011). Instead of the contracts and long-term partnerships often used by large firms (e.g., Goffin et al., 2006; Harland et al., 2007), SMEs and family businesses in critical sectors such as agriculture tend to rely more heavily on local spot market exchanges. I thus contribute to this nascent stream of literature by examining the factors that influence these spot market transactions. In particular, I demonstrate how small and midsize family farms use information conveyed by futures price changes as they transact with buyers in local spot markets.

Because their exchanges with buyers tend to be transactional rather than collaborative, SMEs and family businesses face significant information asymmetries, which can lead to operational inefficiencies. These information asymmetries are further confounded by the private nature of spot market prices and the fact that it is costlier for SMEs and family businesses to acquire such private information (Stigler, 1961; Scott, 2018). I thus posited that SMEs and family businesses rely instead on publicly available sources of information – specifically the futures market – to gauge spot market prices. The analysis found support for this prediction but also revealed that actors face limitations in their ability to fully incorporate the information conveyed by futures price changes and coordinate their activities accordingly. Moreover, the inherent volatility in futures markets makes it challenging for actors to infer information about underlying supply and demand fundamentals. There is thus a lag in the adjustment process as actors process the information, and the analysis suggests that it takes approximately four weeks for this adjustment to occur.

The focus on the short-run intertemporal dynamics of the price adjustment process also allows me to contribute to the literature in economics and finance (e.g., Garbade & Silber, 1983; Garcia & Leuthold, 2004; Garcia et al., 1988). Extant studies exploring the relationship between futures markets and spot markets have primarily focused on long-run futures market efficiency (e.g., Fama, 1970) and the extent to which futures prices accurately forecast spot market prices (e.g., Fama & French, 1987; Reeve & Vigfusson, 2011). While these perspectives have important implications for exchange executives and policymakers, they tend to overlook the informational role of futures prices and the influence that futures markets have on spot market transactions and coordination. That is, actors use the information conveyed by futures price changes and adjust their activities accordingly regardless of how well futures markets perform relative to these technical

standards (Hayek, 1945). Thus, I contribute to this stream of research by adopting a supply chain perspective and demonstrating how futures price changes inform spot market transactions between suppliers and buyers. Understanding the informational role of futures prices is particularly important for the U.S. rice industry, which is characterized by a paucity of alternative sources of information and a significant number of small and midsize family farms, who have limited time and resources to devote to information acquisition and processing.

While SMEs and family businesses must often make short-term operations decisions with incomplete information, the findings suggest that they also tend to be relatively responsive in acting on the information they do have. As detailed in Model (1) results, the sum of the coefficients for futures price changes ($\alpha_2$to α_6) was 0.866, which suggests that a one percent change in futures prices results in an 0.866 percent change in spot market prices. In agriculture, supply tends to be relatively inelastic given the time lag in production between planting and harvest. However, farmers generally store large stocks from the previous crop year (known as "old crop"), which allows them to respond to price changes throughout the year (e.g., Gunders, 2012). Indeed, a long run-effect close to one implies that supply may be relatively elastic, but the fact that it is slightly less than one suggests that farmers respond conservatively to price changes.[11] One potential explanation for the conservatism is that farmers may view futures price changes as having some degree of measurement error due to market volatility and financialization (e.g., Cheng & Xiong, 2014; Irwin et al., 2011). That is, futures price changes signal important supply and demand information but are also subject to noise, so farmers may rationally choose not to respond fully to price changes. More broadly, this finding suggests that SMEs and family businesses incorporate

[11] A Wald Coefficient Test indicated that the sum of the coefficients $\alpha_2$to α_6 was statistically significantly different from 1 ($p < .001$).

price information in their operations decisions and respond to market dynamics in a similar manner to large non-family firms.

In addition to the information conveyed by futures prices, I posited that actors also use information conveyed by *differences* between spot market prices and futures prices to gauge local market conditions. The analysis found support for this hypothesis, as the difference had an effect on subsequent spot market price changes even when controlling for previous spot market price changes and contemporaneous futures price changes. This finding underscores Austrian economic theory's emphasis on the importance of information related to particular circumstances of time and place (Hayek, 1945) and industry reports that refer to basis as a "local phenomenon" (Chicago Board of Trade, 2004). Because the difference between spot market prices and futures prices reflects *local* market conditions, it varies *across* spot market locations. It would thus be interesting for future research to explore if and to what extent this difference has an effect on spot market prices in other locations (e.g., Karali et al., 2018) as well as how spot market prices in different locations are connected via transportation costs.

More broadly, this study illustrates the role of the market as a coordination mechanism (Williamson, 1991) by exploring how buyers and suppliers use price to inform transactions. This is in contrast to extant supply chain research, which has focused extensively on how hybrids and hierarchies are used to coordinate the activities of buyers and suppliers (e.g., Hill & Scudder, 2002; Sahin & Robinson, 2005; Sluis & Giovanni, 2016). In his seminal piece, Williamson (1991) noted that markets are a "marvel" in terms of adaptation (p.279) because they allow actors to respond autonomously to changes, whereas hybrids are "arguably the most susceptible" (p.291) to disturbances because they require coordinated responses. Ironically, however, the coordinating role of prices has received less empirical inquiry in supply chain management given the emphasis

on long-term collaborative relationships (e.g., Cao & Zhang, 2011). Further inquiry is needed to understand how the market – in its various forms – acts as a coordination mechanism in other supply chain echelons and contexts. For example, ocean bulk shipping and truckload freight are also characterized by a combination of spot markets and futures markets to coordinate the activities of carriers and shippers (e.g., Adland & Alizadeh, 2018).

Implications for Practice and Public Policy

By empirically estimating the relationship between futures prices and spot market prices, this study offers important insights for farmers and supply chain managers. Farmers can use these insights to forecast spot market prices, which, in turn, can be used to better plan and execute short-term operations decisions, such as when and how much to sell. This is particularly important for small and midsized family farms, who have limited time and resources to devote to acquiring additional information and rely heavily on spot markets to transact with buyers. Likewise, supply chain managers can also leverage the insights from this study to better plan and execute the timing of commodity purchases in local spot markets. For example, this study suggests that it takes approximately four weeks for spot market prices to fully adjust to changes in futures prices. Armed with this knowledge, supply chain managers can achieve a cost advantage by buying sooner in times of increasing prices (i.e., before the futures price increase is fully incorporated) and later in times of decreasing prices (i.e., after the futures price decrease is fully incorporated). Holding all else constant, a futures price change of $0.50 results in a $0.17, $0.04, and $0.01 change in spot market prices in the current period and subsequent two weeks, respectively. During times of rising prices, supply chain managers can save $0.05 in the spot market by buying in the current period; conversely, during times of decreasing prices, supply chain managers can save $0.05 in the spot

market by waiting two weeks to buy. Given current prices of approximately $10, a $0.05 savings translates to a 0.5% cost reduction—a potential $15 million in cost savings.[12]

However, the analysis also revealed that the adjustment of spot market prices to changes in futures prices is "incomplete". One potential explanation for this incomplete adjustment is that futures price changes include a market signal and some degree of noise, so actors rationally choose not to respond fully to price changes. An alternative explanation, however, is that power imbalances in the supply chain may prevent complete adjustment to futures price changes. Buyers may be able to dictate prices in local spot markets given their size and concentration relative to farmers. Accordingly, the futures market may not be filling the "informational void" facing small and midsize family farms. This suggests that there may be an opportunity for third-party organizations to profitably provide additional sources of information to U.S. rice farmers and also provides guidance for the U.S. Department of Agriculture with regards to the provision of information. Currently, the Agricultural Marketing Service provides a national rice summary on a weekly basis, which details prices for milled rice and rice byproducts. While informative for general trends and sentiments downstream, prices for milled rice and rice byproducts are not as informative for transactions between farmers and buyers upstream because they include the costs of drying, milling, processing, etc., which are variable and often opaque. The findings suggest that the development of a daily report that includes spot market prices for rough rice – similar to that provided for corn, soybeans, and wheat – may be warranted to provide transparency and improve decision-making in the industry.

This study also offers important insights for exchange executives and policymakers. Although many futures markets have been around since the late 1800s, there are also a number of

[12] Calculations are based on the total output value of United States rice farmers, which is approximately $3 billion. (Richardson & Outlaw, 2010).

futures markets (e.g., frozen pork belly) that have "failed" due to contract specifications (Garcia et al., 2015) and insufficient information to attract speculation and aid in price discovery (Sandor, 2012). The Chicago Mercantile Exchange and U.S. Commodity Futures Trading Commission are currently reviewing underlying contract specifications and delivery locations for the rough rice futures market, as some stakeholders have lobbied for the implementation of a variable storage rate and the addition of New Orleans as a delivery location given the rice industry's reliance on export markets. The findings underscore the importance of policies and contract specifications that limit the extent to which futures price changes are due to factors other than supply and demand fundamentals. Ensuring that the regulatory environment is conducive to the continued functioning of the rough rice futures market is particularly important given the prevalence of small and midsize family farms who rely on futures prices as their primary source of information in light of the private information gap (Food and Agriculture Organization, 2004; McKenzie & Darby, 2017).

For the U.S. Department of Agriculture, the findings suggest the need for a potential reevaluation of the crop insurance and revenue protection policies. Currently, the Risk Management Agency uses futures prices as the basis for farmers' insurance indemnity payments (U.S. Department of Agriculture, 2018). While I found that price movements in futures markets and spot markets are indeed correlated, which is suggestive of a "common market" (Stigler & Sherwin, 1985), I also found that the two are not perfectly correlated (e.g., see Figure 2). This finding suggests that payments based on futures prices may not fully compensate farmers because their revenues are based primarily on spot market prices. Understanding how changes in futures prices are transmitted to local spot markets can thus help policymakers determine payments that are more representative and create revenue protection policies that are localized and more appropriate for helping small and midsize family farms manage price risk.

Limitations and Directions for Future Research

This study has several limitations that provide opportunities for future research. First, the empirical context was the U.S. rice industry. Given the purposes and assumptions of this study, focusing on the U.S. rice industry (cf. agriculture industry more generally) was suitable and allowed me "to explore specialized variables and operating trade-offs that may not be accessible through inter-industry or broader intra-industry studies" (Joglekar et al., 2016 p.1985). However, it also limits the generalizability of the findings to other industries characterized by spot markets and futures markets. While generalizability is not the goal, this study may offer preliminary insights into the truckload freight industry because it shares some characteristics with the rice industry, such as the prevalence of SMEs and family businesses, opaqueness, and volatility. Indeed, small and midsize carriers account for an overwhelming proportion of carriers (Owner-Operator Independent Drivers Association, 2016), and spot market prices exhibit substantial volatility (Miller, 2018). Moreover, with the recent launch of the freight futures market, industry experts have touted the potential risk management benefits (Hampstead, 2018b), but questions remain regarding how informative the freight futures price will be for the determination of contract prices and spot market prices. How representative the futures contract is of the underlying commodity plays an important role in determining the extent to which the information conveyed by futures price changes is incorporated by market actors (Sandor, 2012). I thus expect that the nature of the price adjustment process in truckload freight could be similar because of these shared idiosyncrasies. Of course, the magnitude of the effects will differ, so empirically examining the price adjustment process in the truckload freight industry is a fruitful avenue for future research to better understand the factors influencing spot market prices and the informational role of futures markets for supply chain and logistics operations.

Second, the analysis was based on the assumption that actors respond symmetrically to futures price increases and price decreases. While this was a reasonable assumption to establish the baseline relationship between futures price changes and spot market price changes, a logical next step would be to examine if there are asymmetries present in the adjustment process. For example, is information conveyed by (1) futures price increases or futures price decreases and (2) positive differences or negative differences incorporated into spot market prices more quickly? Identifying if there are asymmetries would enrich understanding of the factors influencing spot market prices and how SMEs and family businesses approach buyer-supplier exchange.

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Appendix A: Type 1 Roll Method

The Type 1 Roll Method (Thomson Reuters, 2010) uses the futures price for the nearest-to-maturity contract until the futures contract reaches its expiry date. At this point, the futures price "rolls over" to the next contract month. For example, the futures price for the week ending on February 6, 2004 was calculated based on the March 2004 futures contract, which is the nearest-to-maturity contract. Settlement prices are available each day at the end of trading, and the weekly futures price was calculated by averaging across the five trading days (February 2-6) in that week. The subsequent weeks in February 2004 ending on February 13, 20, and 27 respectively were also based on the March 2004 contract and calculated in the same manner.

Rice futures contracts expire on the final business day preceding the fifteenth calendar day of that contract month (CME Group, 2012). The final business day preceding the fifteenth calendar day of the contract month (March) was March 14, 2004, so the futures price was "rolled over" to the May 2004 contract on this date. So, for the weeks ending on March 5, 2004 and March 12, 2004 respectively, the futures prices were based on the March 2004 contract, whereas the week ending on March 19, 2004 was based on the May 2004 contract.

Table 1A: Unit Root Tests

	Augmented Dickey-Fuller Test (Level)		**Augmented Dickey-Fuller Test (First Difference)**	
	Test Statistic	**1% Critical Value**	**Test Statistic**	**1% Critical Value**
ln_spot_t	-1.944	-3.439	-31.330**	-3.439
$ln\_futures_t$	-2.032	-3.439	-17.531**	-3.439
$difference_t$	-3.907**	-3.439	-17.737**	-3.439

Table 2A: Descriptive Statistics and Correlation Matrix

	Mean	Std. Dev.	Δln_spot_t	$\Delta ln\_futures_t$	$deviation_t$
Δln_spot_t	4.56×10^{-4}	0.043			
$\Delta ln\_futures_t$	4.47×10^{-4}	0.030	0.384		
$difference_t$	-0.063	0.075	0.089	-0.259	
$speculation_t$	0.560	0.123	-0.001	0.022	-0.161

Table 3A: Model (1) Regression Results

Dependent Variable: Δln_spot_t	
Constant	0.008
	(0.012)
Δln_spot_{t-1}	-0.176**
	(0.033)
$\Delta ln\_futures_t$	0.374**
	(0.028)
$\Delta ln\_futures_{t-1}$	0.273**
	(0.020)
$\Delta ln\_futures_{t-2}$	0.172**
	(0.016)
$\Delta ln\_futures_{t-3}$	0.071**
	(0.019)
$\Delta ln\_futures_{t-4}$	-0.030
	(0.026)
$speculation_t$	-0.006
	(0.015)
Year Dummies	Included
Month Dummies	Included
Observations (T)	706
R_2	0.482

Standard errors reported in parentheses are traditional OLS standard errors. Diagnostic checks indicated approximately normally distributed residuals and no autocorrelation (Durbin-Watson = 2.02). Two potential outlier observations were identified and controlled for using dummy variables.

* p < .05; ** p < .01

Table 4A: Model (2) Regression Results

Dependent Variable: Δln_spot_t	
Constant	-0.002
	(0.011)
Δln_spot_{t-1}	-0.047
	(0.029)
$\Delta ln\_futures_t$	0.482**
	(0.037)
$difference_{t-1}$	-0.234**
	(0.021)
$speculation_t$	-0.005
	(0.014)
Year Dummies	Included
Month Dummies	Included
Observations (Weeks)	709
R_2	0.545

Standard errors reported in parentheses are traditional OLS standard errors. Diagnostic checks indicated approximately normally distributed residuals and no autocorrelation (Durbin-Watson = 2.03). Two potential outlier observations were identified and controlled for using dummy variables.

* p < .05; ** p < .01

IV. Essay 3: Examining the Role of Futures Markets in Managing Information Asymmetry in Spot Market Exchange

Introduction

Prices have been the subject of empirical inquiry for centuries (e.g., Menger, 1883; Smith, 1776) because they guide decision-making (e.g., Hayek, 1937), serve as a signal for resource allocation (e.g., Green et al., 2010), coordinate supply and demand (e.g., Williamson, 1991), and act as a link between actors in the supply chain (e.g., Sahin & Robinson, 2002). For example, economic theory suggests that prices guide market participants toward "decisions that tend to consider implicitly all the relevant conditions prevailing in the market" (Kirzner, 1963 p.39). Prices are then used by individual buyers and suppliers to adjust their activities independently—a process Williamson (1991) referred to as "autonomous adaptation" (p.278). The coordinating role of price has also been recognized by supply chain scholars, and price is considered a foundational supply chain coordination mechanism (see Fugate et al. (2006) and Sahin and Robinson (2002) for reviews). For instance, in the classic example, suppliers use quantity discount pricing schemes to align retailers' purchasing behaviors with their own production and replenishment activities (e.g., Sluis & Giovanni, 2016). In addition to this coordinating role, supply chain scholars have also illustrated how price acts as a conduit through which supply chain actors can exchange information indirectly (Mendelson & Tunca, 2007; Shamir, 2013).

The coordination and informational benefits of price are particularly important for small and medium enterprises (SMEs), who differ from their large-firm counterparts in several important ways (Kull et al., 2018). One way that SMEs differ is in their approach to buyer-supplier exchange (Arend & Wisner, 2005; Smith et al., 2014). Due to their risk-averse and conservative nature (George et al., 2005; Memilli et al., 2011), buyer-supplier exchange tends to be more transactional, as SMEs often keep other firms at "arm's length" in order to minimize the risks associated with loss of independence (Roessl, 2015). In agriculture, for example, small and midsize family farms

transact with buyers in local spot markets wherein prices are negotiated "on the spot" for a particular commodity (e.g., Boyabath et al., 2011); these spot markets account for the majority – approximately 65% – of commodity production (MacDonald, 2015). Similarly, in truckload freight and bulk ocean shipping, small and midsize carriers conduct a large share of their business in local spot markets (e.g., Belzer, 2000; Stopford, 2009). Given their reliance on market exchange, it is thus imperative for SMEs to understand the future course of prices in order to plan and execute their operations decisions, such as when and how much to produce and when and how much to sell versus store.

There are, however, significant costs associated with discovering price (Coase, 1937; Stigler, 1961; Williamson, 1991) because market transactions are typically private, bilateral arrangements between two parties (Scott, 2018). Extant research suggests that SMEs are at a disadvantage when it comes to information search and acquisition due to the lack of available resources to dedicate to such activities (e.g., Bruderl & Schussler, 1990; Freeman et al., 1983). Further, the information conveyed in market exchange has "degrees of imperfection" (Rabinovich, 2007 p.21) because managing access to such information can favor one exchange party to the detriment of the other. Thus, due to their lack of visibility and influence in buyer-supplier exchange (e.g., Thomas & Esper, 2010; Touboulic et al., 2014), SMEs face significant information asymmetries when it comes to anticipating prices—a critical input to their operations decision-making. To overcome this, SMEs often rely on external sources of information (Moriarty & Spekman, 1984) and even "rely on market forces as an information arbiter" (Bergh et al., 2019 p.138). For example, in agriculture, small and midsize family farms use the futures market, which is a centralized marketplace that disseminates prices in real time and conveys information about macro-level supply and demand (CME Group, 2019).

While such external sources of information help SMEs reduce the asymmetries they face in buyer-supplier exchange, the information is "imperfect". This imperfection allows a large firm to exploit its informational advantage in a way that "ensures that price changes that squeeze its margin are passed on more rapidly [or fully] than changes that stretch its margin" (Meyer & von Cramon-Taubadel, 2004 p.592). For example, in agriculture, farmers often complain that buyers are quick to adjust prices in local spot markets during times of decreasing futures prices but slow to adjust local spot market prices during times of increasing futures prices. Similarly, in truckload freight, carriers often resist reducing contract prices when spot market prices fall but try to raise their contract prices when spot market prices increase (e.g., Scott et al., 2017). Asymmetries in the price adjustment process may undermine the potential informational and coordination benefits that spot market prices provide for SMEs' operations decision-making. Accordingly, the overarching purpose of this study is to shed light on the factors driving spot market prices and identify potential asymmetries in the price adjustment process.

The empirical context is U.S. agriculture, which is suitable for the purposes of this study for three primary reasons. First, the business-to-business (B2B) spot markets examined in previous research are typically characterized by large firms (e.g., Seifert et al., 2004; Zhao et al., 2015), whereas the farm sector is overwhelmingly comprised of small and midsize family farms, which account for 95.8% of farms and 45% of total farm production in the U.S. (Hoppe & MacDonald, 2016) Second, unlike the Internet-based spot markets examined in previous research (e.g., Haksöz & Seshadri, 2007; Seifert et al., 2004), spot market transactions in agriculture are generally private, bilateral arrangements, so the prices are not readily available in real time. This allows me to examine the role of information asymmetry in buyer-supplier exchange and how SMEs use other sources of information to inform their transactions in the spot market. Third, in agriculture, buyers

– rather than suppliers – have significant pricing power (e.g., Kinnucan & Forker, 1987; Ma et al., 2019), so spot market prices do not always command a premium for added flexibility. This is in contrast to the spot markets that have been examined in previous research, such as those for truckload service (Scott, 2018) and industrial goods (Seifert et al., 2004). Spot market prices can be higher or lower than futures prices, so it is important to understand how spot market prices are adjusted in response to positive *and* negative spreads. In sum, I expect that idiosyncrasies related to the structure of buyer-supplier exchange and the nature of the spot market in the agriculture industry will result in different dynamics and allow me to contribute new insights.

Drawing on economic theory (Hayek, 1945; Kirzner, 1963; Stigler, 1961), I develop hypotheses that examine if buyers adjust spot market prices asymmetrically in response to (1) positive and negative futures price changes and (2) positive and negative spreads between futures prices and spot market prices. To test the hypotheses, I compile a proprietary data set that combines futures market data from the Chicago Mercantile Exchange with proprietary spot market transaction data provided by a market intelligence and advisory and fit time series regression models with two-piece spline terms (Cudeck & Klebe, 2002; Enders, 2015; Flora, 2008). Overall, the findings provide evidence in support of the hypotheses and offer important insights for research, practice, and public policy. For research, this study sheds light on the factors driving spot market prices and identifies asymmetries in their effects on the price adjustment process. More broadly, this study illustrates how information asymmetry affects the market mechanism (Williamson, 1991), which has received less empirical inquiry in supply chain management given the extant emphasis on 'hybrids and hierarchies' (Williamson, 1991), particularly collaboration (Cao & Zhang, 2011) and information-sharing practices (Sahin & Robinson, 2002). For practice, I offer quantitative insights that can be used by both farmers and buyers to more effectively use

price information in their operations decision-making. This study also provides important guidance for regulators and policymakers, particularly the U.S. Department of Agriculture and U.S. Commodity Futures Trading Commission, regarding asymmetric price adjustment, which has been shown to have negative effects on farmers' welfare (e.g., Shrinivas & Gomez, 2016).

The structure of the remainder of this study is as follows: The relevant literature is reviewed in the next section, and the contributions of this study are highlighted. Theoretical explanations from economics are introduced and applied to develop the hypotheses in the following section. The empirical setting, proprietary data set, and preliminary data analysis are then outlined, followed by the model specifications and results in the penultimate section. Lastly, the implications for theory, practice, and public policy are discussed, as well as the limitations of this study and recommended directions for future research.

Literature Review

Information Asymmetry in Buyer-Supplier Exchange

"Information asymmetries exist in all exchange relationships" (Hambrick & Mason, 1984 p.390) such that one party possesses more – or better – information than the other party in the exchange (Akerlof, 1970; Mishra et al., 1998). Some suggest that information asymmetry is a critical "power resource" (Cox, 2001) that often results in "opportunistic exploitation of superior knowledge" (Rehme et al., 2016 p.178) by the party with the informational advantage. Consequently, information asymmetry in buyer-supplier exchange has been linked to a number of negative consequences, such as reduced supply chain performance, inventory management issues and operational inefficiencies (Cheung et al., 2011), decreased supply chain satisfaction (Benton & Maloni, 2005), and the well-known bullwhip effect (Lee et al., 1997).

Given its ubiquity in practice and negative consequences, extant research has identified a number of factors contributing to information asymmetry in buyer-supplier exchange. A comprehensive review of the literature (Bergh et al., 2019) suggests three primary categories of factors: structural, strategic, and behavioral barriers. First, structural barriers are factors that limit actors' ability to access relevant information (Bergh et al., 2019) by preventing or disturbing information flows between firms or between the focal firm and the market (Johanson & Wiedersheim-Paul, 1975) Structural barriers are commonly observed in market transactions (Lado & Wilson, 1994) due to the constant entry and exit of market actors (Stigler, 1961) and the continuously changing nature of supply and demand (Hayek, 1945; Kirzner, 1997). Indeed, "information is not homogenously distributed in the market… nor is access to relevant information open to all firms in the market" (Schmidt & Keil, 2013 p.214). Second, strategic barriers are factors that disincentivize actors from sharing relevant information with other actors because of the potential benefits arising from the possession of private and/or different information (e.g., Rabinovich, 2007). Strategic barriers are commonly observed in competitive industries because "full information revelation can exacerbate competition and drive prices down" (Knill et al., 2006 p.1476). Further, strategic barriers are also prevalent in exchange relationships characterized by power imbalances because powerful actors can exploit their informational advantage to capture more of the value conferred by the exchange (Bowles & Gintis, 1993). Lastly, behavioral barriers stem from limitations on information acquisition and processing capabilities, such as bounded rationality (Simon, 1978) and absorptive capacity (Cohen & Levinthal, 1990).

To overcome these structural, strategic, and behavioral barriers, extant research has identified a number of remedies using various theories of interfirm exchange (see Bergh et al., 2019 for a review), such as resource dependence theory, (Pfeffer & Salancik, 1978), transaction

cost economics (Williamson, 1981), and agency theory (Eisenhardt, 1989). For example, the development of information-sharing practices (e.g., Klein et al., 2007; Sanders & Graman, 2016), coordination mechanisms (e.g., Sahin & Robinson, 2002), and various formal and informal governance mechanisms (e.g., Liu et al., 2009; Srinivasan & Swink, 2015; Wang & Wei, 2007) are often cited as "generic cure[s]" for information asymmetry in buyer-supplier exchange (Sahin & Robinson, 2002 p.510). Despite the popularity and reported benefits of such mechanisms (e.g., Cao & Zhang, 2011), however, they are not used as extensively in the agricultural supply chain – particularly upstream echelons (Jones et al., 2007). In agriculture, buyer-supplier exchange is often characterized by little to no information-sharing, trust, or collaboration (Pullman & Dillard, 2010), and even the use of contracting has declined (MacDonald, 2015). I thus contribute to this stream of research by demonstrating how small and midsize family farms use an alternative mechanism – specifically the futures market – to overcome the information asymmetry they face in buyer-supplier exchange.

Asymmetric Price Adjustment

Asymmetric price adjustment is a common phenomenon wherein prices are adjusted differently in response to increases and decreases (see Frey and Manera (2007) and Meyer and von Cramon-Taubadel (2004) for reviews). Asymmetry comes in many forms and is typically classified according to three criteria (Meyer & von Cramon-Taubadel, 2004). The first criterion refers to whether prices adjust more rapidly (i.e., speed) or more fully (i.e., magnitude) in response to increases or decreases (Meyer & von Cramon-Taubadel, 2004). The second criterion refers to whether the asymmetry is positive (i.e., prices adjust more fully or rapidly to *increases* relative to decreases) or negative (i.e., prices adjust more fully or rapidly to *decreases* relative to increases)

(Peltzman, 2000). The third criterion is based on whether the price adjustment is horizontal[13], which refers to the transmission of prices across markets for similar products or services within the same echelon of the supply chain (e.g., across different locations), or vertical, which refers to the transmission of prices across echelons of the supply chain (e.g., from wholesaler to retailer).

Various underlying causes have been proposed to explain why asymmetric price adjustment occurs, including market power (e.g., Peltzman, 2000), adjustment costs (e.g., Blinder et al., 1998), government intervention (Kinnucan & Forker, 1987), distorted price reporting processes (e.g., von Cramon-Taubadel et al., 1995), and information asymmetry (e.g., Bailey & Brorsen, 1989), but the "bouquet of often casual explanations" has often lead to ambiguous and sometimes contradictory results (Meyer & von Cramon-Taubadel, 2004 p.591). For example, Peltzman (2000) found overwhelming support for the existence of positive asymmetries (i.e., prices are adjusted more fully in response to increases relative to decreases) in downstream consumer and producer markets but found conflicting results for the relationship between market power and asymmetric price adjustment. Markets with fewer competitors were associated with greater asymmetry, but markets that were more concentrated had less asymmetry (Peltzman, 2000). A potential explanation for the inconsistent support for the relationship between market power and asymmetric price adjustment is the extent to which market power creates information asymmetry. For example, Bailey and Brorsen (1989) found that if a firm expects that its competitors will match a price increase (decrease) but not a price decrease (increase), then positive (negative) asymmetric price adjustment will result. However, without "perfect" information about the prices charged by competitors, firms will tend to immediately raise prices in response to cost

[13] Horizontal price adjustment is often also referred to as spatial price adjustment (Meyer & von Cramon-Taubadel, 2004). For clarity, horizontal is used because the analysis focuses on the transmission of prices between the futures market – a financial market – and a physical spot market location.

increases in order to preserve margins but wait to cut prices in response to cost decreases (Borenstein et al., 1997; McShane et al., 2016). The resultant positive asymmetry is based on the assumption that, in the presence of imperfect information, firms use previous prices as a proxy for competitors' future behavior to ensure competitiveness (Borenstein et al., 1997).

As these examples illustrate, the vast majority of the underlying causes for asymmetric price adjustment have been used to explain asymmetries in the *vertical* context, such as from wholesaler to retailer or from retailer to consumer (Meyer & von Cramon-Taubadel, 2004). I thus contribute to this literature by adopting a supply chain perspective to explain how the "traditional" causes of pricing asymmetries – particularly market power and information asymmetry – contribute to asymmetric price adjustment in the *horizontal* context (i.e., between spot markets and futures markets). That is, I examine how *vertical* market power and information asymmetries (i.e., across echelons of the supply chain) lead to *horizontal* asymmetric price adjustment. In the next section, I adopt a "top-down" approach to middle-range theory (Craighead et al., 2016) and contextualize these theoretical explanations from economics related to market power (e.g., Peltzman, 2000) and information asymmetry (e.g., Bailey & Brorsen, 1989) by accounting for idiosyncrasies of buyer-supplier exchange in agricultural spot markets.

Theory and Hypotheses Development

To develop the hypotheses, I must make three key assumptions about the nature of buyer-supplier exchange in the spot market. First, in line with previous research (e.g., Kinnucan & Forker, 1987; Ma et al., 2019), I assume that buyers have a relative power advantage and are able to significantly influence spot market prices. It seems reasonable to conclude that buyers have pricing power in this context because of the undifferentiated nature of the product being supplied (Williamson, 1981) and the oligopsony structure of the spot market (i.e., many small and midsize

family farms selling to a few large buyers). Further, this assumption is in line with economic theory, which suggests that a buyer possesses local market power to the extent that there are few (or no) competitors within a certain radius (Meyer & von Cramon-Taubadel, 2004), and resource dependence theory, which posits that one of the primary factors determining the power of one actor over another is the concentration of resource control— the extent to which transactions are made with relatively few exchange partners (Pfeffer & Salancik, 1978). Second, I assume that, barring extreme market conditions (e.g., severe shortages), buyers tend to resist increasing spot market prices in order to preserve their margins. This is in line with observations from industry experts (e.g., U.S. International Trading Commission, 2015) and empirical findings suggesting that a buyer that "enjoys such local market power may use it to ensure that price changes that squeeze its margin are passed on more rapidly than changes that stretch its margin" (Meyer & von Cramon-Taubadel, 2004 p.592). Third, I assume that buyers have greater access to private information but are strongly incentivized *not* to divulge such information to farmers in order to preserve their margins. Indeed, a key tenet of information economics is that "information in transactions has degrees of imperfection" (Rabinovich, 2007 p.21) because managing access to such information can favor one exchange party to the detriment of the other (Akerlof, 1970). For example, buyers often have access to information about supply and demand in downstream markets (Shrinivas & Gomez, 2016), which provides insights into how prices will evolve in the near future (Knill et al., 2006) It seems reasonable to conclude that there is an information asymmetry favoring buyers due to the general lack of information-sharing and collaboration in the agricultural commodity supply chain (e.g., Pullman & Dillard, 2010; Touboulic et al., 2014) and the resource constraints small and midsize family farms face related to information search (Bruderl & Schussler, 1990; Freeman et al., 1983).

To reduce information asymmetry, small and midsize family farms rely on alternative sources of information. Indeed, extant research suggests that smaller organizations tend to seek information from outside sources because they have fewer resources and personnel to devote to information exchange and the development of in-house information sources (Moriarty & Spekman, 1984). One low-cost, publicly available source of information that small and midsize family farms use to inform their transactions in the spot market is the futures market, which is a centralized marketplace wherein prices are determined and disseminated in real-time through the interactions of buyers and sellers (CME Group, 2019). Futures markets have long been touted as an important medium for price discovery (Garbade & Silber, 1983; Sandor, 2012), and futures prices convey information about macro-level supply and demand fundamentals. For example, a large body of empirical evidence suggests that futures prices quickly reflect supply and demand information contained in reports promulgated by the U.S. Department of Agriculture, such as the monthly World Agricultural Supply and Demand Estimates (Adjemian, 2012; Garcia et al., 1997; Isengildina-Massa et al., 2008; Sumer & Mueller, 1989). As expected, futures prices rise in response to increases in aggregate demand and/or decreases in aggregate supply and fall in response to decreases in aggregate demand and/or increases in aggregate supply. The futures market thus acts as "an information processing system" (Bowles et al., 2017 p.215), and information about macro-level supply and demand fundamentals is quickly communicated to market participants via price changes (Hayek, 1945).

Because futures prices are publicly available in real-time, they are accessible to both small and midsize family farms and large buyers. Indeed, industry interviews revealed that actors across the supply chain use various services that provide free market updates in real-time, and extant research suggests that futures prices are less costly for market actors to acquire and utilize

compared to other third-party sources (e.g., Min & Najand, 1999). Buyers thus do not have an informational advantage with regards to macro-level supply and demand information because small and midsize family farms can – and do – infer such information from futures prices. Accordingly, I posit that buyers will be compelled to adjust spot market prices *symmetrically* in response to increases and decreases in futures prices in order to ensure supply and remain competitive. That is, buyers will adjust spot market prices upward when there is an increase in futures prices and downward when there is a decrease in futures prices. The magnitude of the adjustment in response to positive and negative changes in futures prices will be similar because such changes are easily observed by small and midsize family farms, which puts them in a stronger position to demand proportionate adjustments. Stated formally:

Hypothesis 1: Futures price changes exhibit symmetric effects on spot market price changes such that a futures price decrease (increase) of a given magnitude will result in a similar decrease (increase) in subsequent spot market prices.

In addition to the macro-level information conveyed by futures price changes, Austrian economic theory suggests that there exists an equally important body of information related to particular circumstances of time and place (Hayek, 1945). That is, "relevant knowledge" is not limited to macro-level supply and demand but also includes information about local market conditions and special circumstances (Hayek, 1945). This information is dispersed among many actors and is conveyed in the process of transacting in the local spot market (Kirman et al., 2005). Indeed, extant research suggests that one of the secondary benefits of the spot market for supply chain operations is that it serves as a conduit through which actors can exchange information indirectly (Mendelson & Tunca, 2007; Shamir, 2013). For example, each spot market bid offered by the buyer conveys information to farmers about local demand conditions, and each acceptance

or refusal of that bid conveys information to the buyer about local supply conditions and farmers' price expectations (Kirman et al., 2005).

However, unlike many online spot markets in B2B contexts (e.g., Seifert et al., 2004), spot market transactions in agriculture tend to be private bilateral arrangements (i.e., between a buyer and a farmer). Spot market prices are thus typically unavailable to those external to the transaction until *after* the transaction is completed, which makes acquiring timely and accurate spot market price information costly (Scott, 2018). Acquiring such information is even costlier for small and midsize family farms because they are more limited in the time, personnel, and resources that they can devote to information search (Bruderl & Schussler, 1990; Freeman et al., 1983), whereas large buyers can often achieve economies of scale in information acquisition (Bailey & Brorsen, 1989). Large firms also tend to have formal mechanisms for information exchange and the development of internal information sources (Moriarty & Spekman, 1984), such as creating their own internal indexes of spot market rates (Bignell, 2013).

In addition to advantages related to information acquisition and processing capabilities, buyers interact more frequently with the spot market. For example, in truckload transportation, large brokerage operations have a very strong understanding of spot market prices because they source capacity from motor carriers on a spot basis, whereas small asset-based motor carriers that infrequently engage in spot exchanges are less informed regarding spot prices (Scott, 2018). Information economics suggests that "inexperienced buyers pay higher prices in a market than do experienced buyers" because "the former have no accumulated knowledge of asking prices" (Stigler, 1961; p.218-219). Building on this insight, I expect that buyers are able to achieve an informational advantage relative to farmers because of the experience they obtain through ordinary business activities. Buyers are constantly making bids to small and midsize family farms in the

spot market and acquire information about local supply conditions and farmers' price expectations through these frequent interactions (Kirman et al., 2005). In contrast, farmers tend to be more concerned with their own operations and often do not know the price that other farmers are willing to sell for in the spot market. Further, although farmers interact with a limited number of buyers, they may not be able to quickly gather spot market bids from other buyers due to the costs of search (Stigler, 1961; Scott, 2018). For example, farmers may observe a price change from one local buyer but may be uncertain if other buyers have also changed their prices (Miller & Hayenga, 2001). Given the continuously changing nature of spot market prices, small and midsize family farms cannot afford to search for better prices and tend to receive lower prices in the short run (Miller and Hayenga, 2001) because they have less experience and more limited knowledge of prices in the local spot market.

In the presence of imperfect information about current spot market conditions, the previous price is often used as a proxy (e.g., Borenstein et al., 1997). A large body of agricultural economics research suggests that farmers use "backward-looking expectations" to inform their price expectations (e.g., Boetel et al., 2007; Chavas, 1999 p.20). For example, in the pork market, Chavas (1999) found that a significant proportion of farmers – approximately 73% – base their price expectations on historical data. In practice, farmers use the spread between the futures price and spot market price in the previous period – known as the basis (Chicago Board of Trade, 2004) – as a benchmark for future spot market prices (CME Group, 2019a). The spread "localizes" macro-level futures price information and conveys additional information about the state of the local market relative to the macro-market (Hayek, 1945). Farmers thus infer information about local market conditions based on the spread between the futures price and spot market price to

determine the best time to sell and when to accept a spot market bid (Chicago Board of Trade, 2004).

Inferences based on information conveyed by the *spread* between the futures price and spot market price will, of course, be imperfect, because small and midsize family farms only have "half the equation" and are restricted in their ability to assess demand and downstream prices. Accordingly, I posit that buyers will exploit their informational advantage by adjusting spot market prices *asymmetrically* in response to positive and negative spreads in the immediate past such that the magnitude of adjustment is greater in response to negative spreads relative to positive spreads. A positive spread (i.e., when the spot market price is greater than the futures price) implies limited supply or greater demand in *local* markets relative to the macro-market. The positive spread – or premium – encourages small and midsize family farms to accept bids in local spot markets rather than store the commodity. The positive spread also implies that supply and demand in the macro-market are not necessarily there to sustain the price premium, which encourages buyers to adjust local spot market prices downward in subsequent periods. However, under such circumstances, buyers are not incentivized to adjust spot market prices as much. Given that supply and demand fundamentals in the local market support higher prices, buyers risk setting their bids too low and failing to procure the commodity if prices are adjusted too far downward. Further, farmers are already receiving a premium in local spot markets and are less price sensitive (Wu et al., 2018).

Conversely, a negative spread (i.e., when the spot market price is less than the futures price) implies oversupply or limited demand in the local spot market. Under such circumstances, buyers are incentivized to adjust spot market prices downward to a greater extent in order to use the local surplus to their advantage and expand their margins. Only armed with futures price information related to macro-level supply and demand, farmers will try to negotiate higher prices to bring spot

market prices closer to futures prices. However, because buyers have significant pricing power (especially under local surplus conditions), farmers are not in a position to demand higher prices in local spot markets. Buyers can thus capitalize on their power advantage and farmers' imperfect information by adjusting spot market prices more fully in response to negative spreads. Stated formally:

Hypothesis 2: Spreads between futures prices and spot market prices exhibit asymmetric effects on subsequent spot market price changes such that a negative spread will result in a larger change in subsequent spot market prices than a positive spread of the same magnitude.

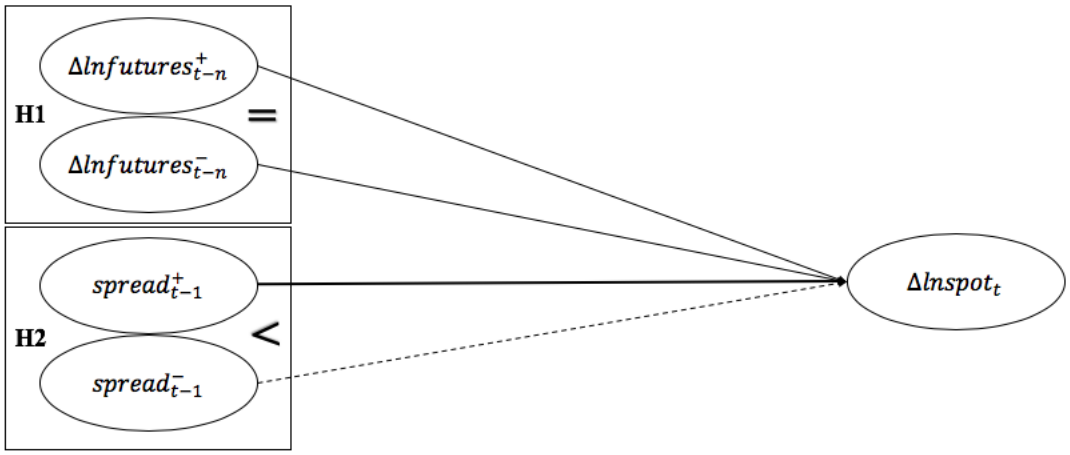

Figure 1: Conceptual Model

Methodology

Empirical Context

Within agriculture, the empirical context for this study is the U.S. rice industry, which is a suitable context for four primary reasons. First, there is a distinct lack of publicly available spot market prices and information provided by third-party organizations in the rice industry (McKenzie & Darby, 2017; U.S. International Trading Commission, 2015), which is in stark

contrast to other agricultural commodity industries in the U.S. For example, the U.S. Agricultural Marketing Service (2019) provides daily reports with spot market prices and contract prices for other grains and oilseeds (e.g., wheat, soybeans, and corn) at various spot market locations, and private analytical firms provide free tools that farmers can use to access spot market bids from buyers based on their zip code (e.g., Farm Journal, Inc., 2019). In the U.S. rice industry, however, futures prices are *the* primary mechanism through which small and midsize family farms access relevant information. This private information gap is in line with my theorizing and, methodologically, allows us to isolate the effects of futures prices and spreads between futures prices and spot market prices because it is not confounded by the presence of other sources of information typically provided in agricultural commodity industries in the U.S.

Second, rice is a critical component of the diets of approximately four billion people across the world (Food and Agriculture Organization, 2004). A cornerstone of national history and cultural identity, rice has been consumed for almost five thousand years but was not traded in the global market until the last century (Childs, 2001). Today, only eight percent of the world's rice supply is traded on the global market (Hamilton, 2013), and the U.S. is one of the top five exporters and accounts for approximately ten percent of world trade (U.S. Department of Agriculture, 2019). The U.S. rice industry thus plays a critical role in feeding the world's population, particularly those in developing economies who are often low-income and food-insecure (U.S. International Trading Commission, 2015). Despite its global significance, however, the U.S. rice industry has been largely unexamined in academia—likely a consequence of the lack of publicly available data. Accordingly, focusing on the U.S. rice industry allows us to contribute to the established body of research on asymmetric price adjustment (e.g., see Frey and Manera (2007) and Meyer and von

Cramon-Taubadel (2004) for reviews) and also articulate important industry-specific insights for both practitioners and policymakers (Joglekar et al., 2016).

Third, due to requirements related to availability of water, soil type, and high average temperatures during the growing season, rice production is limited to particular areas of the U.S. (Childs, 2001). The relatively high concentration of production and the relatively short distances between farmers and buyers, as well as the fact that many of the buyers are declared regular for delivery on the exchange (see the Chicago Mercantile Exchange's *Deliverable Commodities Under Registration* for a list), helps to alleviate concerns related to transportation factors, which are often cited as a reason for asymmetries in horizontal price adjustment (e.g., Meyer & von Cramon Taubadel, 2004). The high spatial concentration of rice production also helps to alleviate concerns related to spreads in futures prices and spot market prices (Hypothesis 2) being due to transportation costs. Lastly, focusing on a particular industry allows us to examine specialized variables that may not be accessible in inter-industry studies (Joglekar et al., 2016), helps to ensure internal validity, and is suitable given that the purpose is to elaborate middle-range theory (Craighead et al., 2016).

Data and Measures

The Chicago Mercantile Exchange (2008) defines a futures contract as a "legally binding agreement to buy or sell a commodity or financial instrument at a later date". Each futures contract has standardized specifications related to the underlying commodity, including the quality, quantity, physical delivery time, and delivery location (CME Group, 2008). For the rice futures contract, the underlying commodity is long-grain rough rice, the quantity is 2,000 hundredweights—or 100 tons, and the quality is U.S. No. 2 or better with a milling yield of at least 65% (CME Group, 2008). Because the specifications are otherwise standardized across futures

contracts, each futures contract for a particular commodity is differentiated by its delivery month and year. For rice, futures contracts are listed for every other month (January, March, May, July, September, and November) and can be traded up to fifteen months in advance. For example, in June 2019, the rice futures contracts for July 2019, September 2019, November 2019, January 2020, March 2020, May 2020, and July 2020 were being traded on the exchange. While futures contracts that are further into the future are available, their liquidity is significantly less than that of the nearest-to-maturity futures contract. The nearest-to-maturity futures contract reflects the most current (at the time of retrieval) set of information and has been shown to have the highest ratio of volume to open interest (e.g., Bekiros et al., 2017; Thomson Reuters, 2010), which is important for reliability.

For the present study, I obtained daily rice futures prices for the nearest-to-maturity futures contract from Quandl's Chicago Mercantile Exchange futures database, which were cross-referenced with data provided by the Registrar's Office at the Chicago Mercantile Exchange for data validation purposes. I used the Type 0 roll method (Thomson Reuters, 2010) to create a continuous futures price series. The Type 0 roll method uses the futures price for the nearest-to-maturity contract until the first business day of the contract month. Following the first business day of the contract month, the futures price "rolls over" to the next contract month. For example, the futures price for the week ending on April 7, 2017 was calculated based on the May 2017 futures contract, which was the nearest-to-maturity contract. The weekly futures price was calculated by averaging the settlement prices, which are available each day at the end of trading[14], across the five trading days in that week (April 3 through April 7). The weekly futures price for

[14] There were an insignificant number (less than one percent of the total observations) of daily futures price observations that were missing due to bank holidays. Linear interpolation was used prior to averaging to replace any missing values.

the subsequent weeks in April 2017 ending on April 14, April 21, and April 28, respectively, were also based on the May 2017 contract and calculated in the same manner. In 2017, the first business day of the contract month (May) was May 1, so the futures price was "rolled over" to the July 2017 contract on this date. For the week ending on May 5, 2017, the weekly futures price was calculated by averaging the settlement price of the July 2017 contract – which is now the nearest-to-maturity contract – across the five trading days (May 1 through May 5) in that week.

In stark contrast to other agricultural commodities in the U.S., there is no comparable spot market price publicly available in the rice industry. I thus obtained proprietary spot market transaction data from Firstgrain, Inc., a well-established market intelligence and advisory firm. The data are weekly and calculated based on a weighted average of spot market transactions in each of the respective spot market locations. The spot market price represents the price paid for rice that meets the quality and quantity standards specified in the rice futures contract; due to confidentiality agreements protecting the proprietary and sensitive nature of the data, I am limited in the amount of detail I can disclose about these data.

For the present study, I focus on the spot market location in Arkansas for three primary reasons. First, the commodity underlying the rice futures contract is 2,000 hundredweights of long-grain rough rice, and Arkansas is the number one rice producer and produces approximately 57% of the long-grain rice produced in the U.S. (Economic Research Service, 2019). Second, all of the warehouses declared regular for delivery by the Chicago Board of Trade are located in this area of Arkansas (see the Chicago Mercantile Exchange's *Deliverable Commodities Under Registration* for a list). Given that the delivery locations for the futures market and Arkansas spot market are similar, the futures price should, in theory, be the most informative for the Arkansas spot market price as compared to other major spot market locations (e.g., Texas and Louisiana). This also

allows me to control for transportation costs, which can contribute to asymmetries in horizontal price adjustment. Lastly, in line with the theorizing and purposes of this study, family farms account for an overwhelming majority – approximately 96% – of the 2,500 rice farms located in Arkansas (USA Rice Federation, 2019).

Time series of equal length are necessary for the analysis, so the estimation period is limited to the start and end date of the proprietary spot market transaction data. The estimation period begins on January 9, 2004 and ends on August 29, 2017, which yields 711 weekly observations for each price series. Following convention (e.g., Peltzman, 2000), I first took the natural logarithm of each price series. The natural logarithm of the weekly spot market price is denoted as $lnspot_t$, and the natural logarithm of the weekly futures price is denoted as $lnfutures_t$. The difference between the two – denoted as $spread_t$ – was calculated by subtracting the futures price in time *t* from the spot market price in time *t* (i.e., $spread_t = lnspot_t - lnfutures_t$).

Additional data was collected from the weekly *Commitment of Traders* report to control for the effects of increased financialization in commodity futures markets. Following convention, I calculated the proportion of short and long open interest positions held by non-commercial traders (i.e., non-hedgers) including swap dealers, managed money accounts, and index funds (U.S. Commodity Futures Trading Commission, 2019) to include as a measure of financialization, which is denoted as $speculation_t$.

Preliminary Analysis

The spot market price and futures price series are plotted in Figure 2 – and the spread between the two series is plotted in Figure 3 – to provide a visual representation of their relationship and evolution over time. There are a few events that occurred during the estimation period that are worth noting. First, in 2007 and 2008, the world food price crisis occurred, and the

price of rice skyrocketed in international markets. Various trade restrictions were implemented throughout Asia to protect citizens from rising rice prices during this time, and the "global rice crisis" persisted through late 2008 (Slayton, 2009). Second, the spread between the spot market price and futures price became increasingly large during the time period from 2010 to 2012, and concerns over this decoupling were brought to the Chicago Mercantile Exchange and U.S. Commodity Futures Trading Commission. At the end of 2012, the fixed storage rate for warehouses declared regular for delivery by the Chicago Board of Trade was increased in an effort to narrow this spread (CME Group, 2012; Seamon, 2010). Following the storage rate increase, the spot market price and futures price appear to be more closely coupled for the remainder of the estimation period.

Figure 2: Weekly Spot Market and Futures Prices

Figure 3: Spread Between Spot Market Prices and Futures Prices (Spot – Futures)

Unit Root Tests

With time series data, there are additional steps that are necessary prior to analysis (Enders, 2015). The first step is to test each data series for stationarity—the extent to which the statistical properties of the series are constant over time (Enders, 2015). To do this, Augmented Dickey-Fuller tests were conducted using optimal lag lengths based on Schwarz information criterion (SIC), and the results are reported in Table 1. The results indicate that $lnspot_t$ and $lnfutures_t$ are both non-stationary in the level ($p > .01$) but are stationary in first differences ($p < .01$). Both price series were thus transformed using week-over-week differences to ensure stationarity and are denoted as $\Delta lnspot_t$ and $\Delta lnfutures_t$, respectively. Note that this transformation also aligns with my theorizing, which focuses on whether there are asymmetric effects of positive and negative price *changes*. Because the results indicated that it is stationary in the level ($p < .01$), $spread_t$ was not transformed and the level is used for the analysis.

Table 1: Unit Root Tests

	Augmented Dickey-Fuller Test (Level)		Augmented Dickey-Fuller Test (First Difference)	
	Test Statistic	**1% Critical Value**	**Test Statistic**	**1% Critical Value**
$lnspot_t$	-1.944	-3.439	-31.330**	-3.439
$lnfutures_t$	-1.955	-3.439	-15.492**	-3.439
$spread_t$	-6.091**	-3.439	-17.041**	-3.439

* p < .05; ** p < .01

Descriptive Statistics and Correlation Matrix

Table 2 summarizes the descriptive statistics and correlations. As economic theory would suggest (e.g., Garbade & Silber, 1983; Stigler & Sherwin, 1985), spot market price changes and futures price changes are positively correlated. However, the standard deviation of spot market price changes (σ = 0.043) is greater than that of futures price changes (σ = 0.030). There is a statistically significant difference between the standard deviations, which suggests that local spot markets are characterized by greater volatility and may be subject to more extreme price realizations (e.g., Seifert et al., 2004).

Table 2: Descriptive Statistics and Correlation Matrix

	Mean	Std. Dev.	$\Delta lnspot_t$	$\Delta lnfutures_t$	$spread_t$
$\Delta lnspot_t$	4.51×10^{-4}	0.043			
$\Delta lnfutures_t$	4.56×10^{-4}	0.030	0.384		
$spread_t$	-0.070	0.081	0.075	-0.273	
$speculation_t$	0.560	0.123	-0.001	0.022	-0.192

Model Estimation and Results

First, to test Hypothesis 1, which posits that futures price changes will exhibit symmetric effects on spot market price changes, we use the distributed lag approach developed by Almon (1965) with two-piece spline terms (Cudeck & Klebe, 2002; Flora, 2008). The distributed lag approach imposes a shape on the lag distribution, which reduces the number of parameters being estimated and the effects of multi-collinearity. We specified a linear distributed lag model that

included a contemporaneous effect and four lags[15] for positive futures price changes and negative futures price changes, respectively. The inclusion of a contemporaneous effect and four lags is also in line with industry observations that spot market prices are adjusted immediately and rapidly in response to futures price changes (Chicago Board of Trade, 2004).

Following common practices (e.g., Enders, 2015), dummy variables for each month ($Month_t$) and year ($Year_t$) were included to capture seasonality and macroeconomic conditions. We also included $speculation_t$ to control for increased financialization in commodity futures markets. The model to test Hypothesis 1 was specified as Model (1):

$$\begin{aligned}\Delta lnspot_t = {} & \alpha_0 \\ & + \beta_1^+ \Delta lnfutures_t^+ + \beta_2^+ \Delta lnfutures_{t-1}^+ + \beta_3^+ \Delta lnfutures_{t-2}^+ \\ & + \beta_4^+ \Delta lnfutures_{t-3}^+ + \beta_5^+ \Delta lnfutures_{t-4}^+ + +\beta_6^- \Delta lnfutures_t^- \\ & + \beta_7^- \Delta lnfutures_{t-1}^- + \beta_8^- \Delta lnfutures_{t-2}^- + \beta_9^- \Delta lnfutures_{t-3}^- \\ & + \beta_{10}^- \Delta lnfutures_{t-4}^- + \alpha_1\, speculation_t + \sum_{j=2}^{12} \alpha_j Month_t + \sum_{i=13}^{25} \alpha_i Year_t \\ & + \varepsilon_t\end{aligned}$$

where:

$$\Delta lnfutures_{t-n}^+ = \begin{cases} 0 \; if \; \Delta lnfutures_{t-n} < 0 \\ \Delta lnfutures_{t-n} \;\; if \;\; \Delta lnfutures_{t-n} \geq 0 \end{cases}$$

$$\Delta lnfutures_{t-n}^- = \begin{cases} \Delta lnfutures_{t-n} \;\; if \;\; \Delta lnfutures_{t-n} < 0 \\ 0 \;\; if \;\; \Delta lnfutures_{t-n} \geq 0 \end{cases}$$

$\Delta lnfutures_{t-n}$ is the *n*th futures price change, and *n* = 0, 1, 2, 3, 4. The coefficients β^+ and β^- measure the magnitude of adjustment of the spot market price to a futures price increase and a

[15]Various lag distributions (e.g., polynomial specifications) and lag lengths (e.g., two, three, and five lags) were also modeled as a robustness check. There were no substantive differences in the results.

futures price decrease, respectively. Note that Model (1) allows for the *n* series to begin at zero in order to examine the contemporaneous adjustment of spot market prices to positive and negative futures price changes. Hypothesis 1 posits that β^+ and β^- in each respective period ($t - n$) will not be statistically significantly different.

For $\Delta lnfutures^+_{t-n}$, the distributed lag approach (Almon, 1965) constrains $\beta_1^+ - \beta_5^+$ to lie on a linear function such that:

$$\beta_1^+ = \varphi_0$$

$$\beta_2^+ = \varphi_0 + \varphi_1$$

$$\beta_3^+ = \varphi_0 + 2\varphi_1$$

$$\beta_4^+ = \varphi_0 + 3\varphi_1$$

$$\beta_5^+ = \varphi_0 + 4\varphi_1$$

Similarly, $\Delta lnfutures^-_{t-n}$, $\beta_6^- - \beta_{10}^-$ are constrained to lie on a linear function such that:

$$\beta_6^- = \omega_0$$

$$\beta_7^- = \omega_0 + \omega_1$$

$$\beta_8^- = \omega_0 + 2\omega_1$$

$$\beta_9^- = \omega_0 + 3\omega_1$$

$$\beta_{10}^- = \omega_0 + 4\omega_1$$

The results of Model (1) are reported in Table 3. Beginning with the control variables, the effect of $speculation_t$ is negative but not statistically significant ($p > .05$), which is line with previous studies demonstrating that financialization does not necessarily spill over to spot markets (e.g., Garcia et al., 2015; Irwin et al., 2011). Moving to the variables of interest for Hypothesis 1, the effect of contemporaneous futures price changes is positive and statistically significant. The effects of lagged futures price changes are also positive and statistically significant ($p < .01$) in

weeks one and two for futures price increases and weeks one, two, and three for futures price decreases. The lagged effect of *positive* futures price changes becomes non-significant in week three, whereas the lagged effect of *negative* futures price changes becomes non-significant in week four. This suggests that the adjustment process for futures price increases takes place during the current period and two weeks that follow, whereas the adjustment process for futures price decreases takes place during the current period and subsequent three weeks. For both positive and negative futures price changes, the magnitude of the effect decays over time with contemporaneous changes (*t*) having the largest effect followed by changes in the immediate past (*t –1*). The distributed lag effects of positive and negative futures price changes, respectively, are depicted in Figure 4.

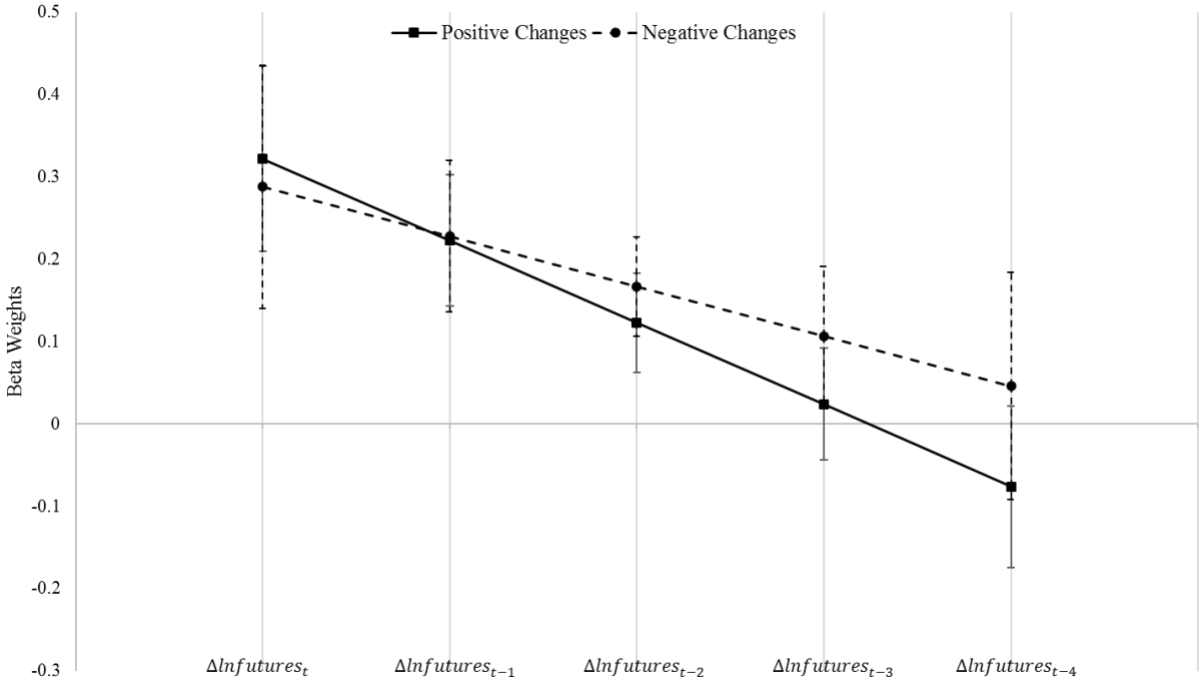

Figure 4: Distributed Lag Effects of Positive and Negative Futures Price Changes on Spot Market Price Changes (95% Confidence Intervals)

Table 3: Model (1) Regression Results

Dependent Variable: $\Delta lnspot_t$	
Constant	0.013
	(0.008)
$\Delta lnfutures_t^+$	0.322**
	(0.056)
$\Delta lnfutures_{t-1}^+$	0.223**
	(0.040)
$\Delta lnfutures_{t-2}^+$	0.123**
	(0.030)
$\Delta lnfutures_{t-3}^+$	0.024
	(0.034)
$\Delta lnfutures_{t-4}^+$	-0.076
	(0.049)
$\Delta lnfutures_t^-$	0.228**
	(0.074)
$\Delta lnfutures_{t-1}^-$	0.228**
	(0.046)
$\Delta lnfutures_{t-2}^-$	0.167**
	(0.030)
$\Delta lnfutures_{t-3}^-$	0.107**
	(0.042)
$\Delta lnfutures_{t-4}^-$	0.046
	(0.069)
$speculation_t$	-0.005
	(0.010)
Year Dummies	Included
Month Dummies	Included
Observations (T)	706
R^2	0.452

Standard errors reported in parentheses are Newey-West standard errors robust in the presence of heteroscedasticity and autocorrelation. Diagnostic checks indicated approximately normally distributed residuals and no autocorrelation (Durbin-Watson = 2.28). Two potential outlier observations were identified and controlled for using dummy variables.

* = $p < 0.05$; ** $p < 0.01$

To test Hypothesis 1, which posits that futures price changes will exhibit a symmetric effect on spot market price changes, formal asymmetry tests were conducted based on Model (1) estimates. The results of the Wald test with four separate null hypotheses H_0: $\beta_n^+ = \beta_n^-$ for n = 0,

1, 2, 3, 4 are reported in Table 4. The results indicate that I fail to reject the null hypothesis for contemporaneous (*t*) and lagged futures price changes (*t –n*), which suggests that futures price increases and decreases result in similarly sized adjustments in subsequent spot market prices and provides evidence in support of Hypothesis 1. In addition to examining if there are asymmetries in the intertemporal dynamics of the adjustment process, the distributed lag approach also allows us to examine if there are asymmetries in the long-run effect of futures price changes (Wooldridge, 2009). The sum of the coefficients for positive futures price changes (β_1^+ to β_5^+) is 0.617, which suggests that a one percent *increase* in futures prices results in an 0.617 percent change in spot market prices. In comparison, the sum of the coefficients for negative futures price changes (β_6^- to β_{10}^-) is 0.836, which suggests that a one percent *decrease* in futures prices results in a 0.836 percent change in spot market prices. While the magnitude of the effect suggests that futures price decreases may be incorporated more fully than futures price increases, a Wald test with the null hypothesis H0: $\sum_{i=1}^{5} \beta_i^+ = \sum_{j=6}^{10} \beta_j^-$ indicated that I fail to reject the null hypothesis of symmetric effects (t-statistic = -0.782). In combination, these findings suggest symmetry in both the short-run and long-run effect of futures price changes, and the implications of this will be explored further in the discussion. Overall, Hypothesis 1 is corroborated by the results of Model (1).

Table 4: Model (1) Tests for Asymmetry

	H0	**t-Statistic**
$\Delta lnfutures_t$	$\beta_1^+ = \beta_6^-$	0.302
$\Delta lnfutures_{t-1}$	$\beta_2^+ = \beta_7^-$	-0.066
$\Delta lnfutures_{t-2}$	$\beta_3^+ = \beta_8^-$	-0.832
$\Delta lnfutures_{t-3}$	$\beta_4^+ = \beta_9^-$	-1.196
$\Delta lnfutures_{t-4}$	$\beta_5^+ = \beta_{10}^-$	-1.136

* p < .05; ** p < .01

To test Hypothesis 2, which posits that previous spreads between futures prices and spot market prices will exhibit asymmetric effects on subsequent spot market price changes, we added

a two-piece spline term for $spread_{t-1}$ to Model (1). We also altered Model (1) slightly to include only a two-piece spline term for contemporaneous futures price changes ($\Delta lnfutures_t$) and removed the two-piece spline terms for lagged futures price changes ($\Delta lnfutures_{t-n}$) because $spread_{t-1}$ is a lagged measure and already incorporates previous futures prices. The model to test Hypothesis 2 was specified as Model (2):

$$\Delta lnspot_t = \alpha_0 + \beta_1^+ \Delta lnfutures_t^+ + \beta_2^- \Delta lnfutures_t^- + \gamma_1^+ spread_{t-1}^+ + \gamma_2^- spread_{t-1}^- + \alpha_1\, speculation_t + \sum_{j=2}^{12} \alpha_j Month_t + \sum_{i=13}^{25} \alpha_i Year_t + \varepsilon_t$$

where:

$$\Delta lnfutures_t^+ = \begin{cases} 0 \; if \; \Delta lnfutures_t < 0 \\ \Delta lnfutures_t \quad if \quad \Delta lnfutures_t \geq 0 \end{cases}$$

$$\Delta lnfutures_t^- = \begin{cases} \Delta lnfutures_t \quad if \quad \Delta lnfutures_t < 0 \\ 0 \quad if \quad \Delta lnfutures_t \geq 0 \end{cases}$$

$\Delta lnfutures_t$ is the contemporaneous change in futures prices, and the coefficients β_1^+ and β_2^- measure the magnitude of adjustment of the spot market price to a futures price increase and a futures price decrease in the current period, respectively; and

$$spread_{t-1}^+ = \begin{cases} 0 \; if \; spread_{t-1} < 0 \\ spread_{t-1} \quad if \quad spread_{t-1} \geq 0 \end{cases}$$

$$spread_{t-1}^- = \begin{cases} spread_{t-1} \quad if \quad spread_{t-1} < 0 \\ 0 \quad if \quad spread_{t-1} \geq 0 \end{cases}$$

γ_1^+ and γ_2^- measure the magnitude of adjustment of the spot market price to a positive spread and a negative spread in the previous period, respectively. Hypothesis 2 posits that γ_1^+ and γ_2^- will be statistically significantly different such that $|\gamma_2^-|$ is greater than $|\gamma_1^+|$.

The estimates for Model (2) are reported in Table 5. In line with Model (1), the effect of $speculation_t$ is again negative and not statistically significant ($p > .05$). Turning to our focal independent variables, the effects of positive and negative contemporaneous futures price changes is positive and statistically significant ($p < .01$), and a Wald test indicates that we fail to reject the null hypothesis of a symmetric effect of positive and negative futures prices changes. Model (2) thus provides further evidence in support of Hypothesis 1.

Turning to Hypothesis 2, the effect of *positive* spreads (i.e., when the spot market price is greater than the futures price) is slightly negative (-0.08) but not statistically significant ($p > .05$). In line with our theorizing, this result suggests that positive spreads have essentially a null effect on spot market prices in subsequent periods. Given local market conditions, buyers may be willing to adjust spot market prices upward to avoid potential shortages, but they are also wary of adjusting spot market prices too much because the macro-level market conditions are not there to sustain the price premium. Consequently, the results of Model (2) suggest that buyers do not really adjust spot market prices in response to positive spreads.

In contrast, the effect of negative spreads (i.e., when the spot market price is less than the futures price) is negative (-0.262) and statistically significant ($p < .01$). This finding suggests that buyers are able to use their informational and power advantages to a greater extent following periods of negative spreads by adjusting spot market prices downward. Farmers will try to negotiate higher prices to bring spot market prices in line with futures prices, but they have limited information about the local market and limited power to do so. The results of Model (2) suggest that buyers can thus capitalize on surplus conditions in the local market by adjusting spot market prices downward – and to a greater extent – in order to expand their margins. Moreover, the results of a Wald test with the null hypothesis H_0: $\gamma_1^+ = \gamma_2^-$ indicate that the null hypothesis can be rejected,

which suggests that spot market prices are adjusted differently in response to positive and negative spreads. In line with Hypothesis 2, the asymmetry is such that $|\gamma_2^-|$ is greater than $|\gamma_1^+|$, which suggests that buyers adjust spot market prices more fully in response to negative spreads relative to positive spreads. Overall, Hypothesis 2 is corroborated by Model (2).

Table 5: Model (2) Regression Results and Tests for Asymmetry

Dependent Variable: $\Delta lnspot_t$

Model Estimates		**Wald Test**	
		H0	**t-Statistic**
Constant	-0.003	-	-
	(0.009)		
$\Delta lnfutures_t^+$	0.499**	$\beta_1^+ = \beta_2^-$	1.286
	(0.072)		
$\Delta lnfutures_t^-$	0.349**		
	(0.078)		
$spread_{t-1}^+$	-0.080	$\gamma_1^+ = \gamma_2^-$	2.551**
	(0.056)		
$spread_{t-1}^-$	-0.262**		
	(0.029)		
$speculation_t$	-0.006		
	(0.012)		
Year Dummies	Included		
Month Dummies	Included		
Observations (T)	710		
R_2	0.529		

Standard errors reported in parentheses are Newey-West standard errors robust in the presence of heteroscedasticity and autocorrelation. Diagnostic checks indicated approximately normally distributed residuals and no autocorrelation (Durbin-Watson = 2.08). Two potential outlier observations were identified and controlled for using dummy variables.

* = p < 0.05; ** p < 0.01

Discussion

Implications for Theory and Future Research

Small and midsize family farms face significant information asymmetries in anticipating how prices for their commodities will evolve, which are critical input to their decision-making

given their heavy reliance on spot market exchange and limited resources to dedicate to the development of in-house information (e.g., MacDonald, 2015; Moriarty & Spekman, 1984). To overcome this information asymmetry, small and midsize family farms often rely on the futures market to inform their exchanges in local spot markets. Given that the futures market is a low cost, publicly available source of information that is widely used in industry (Chicago Mercantile Exchange, 2019), I posited that buyers would be compelled to adjust spot market symmetrically in response to positive and negative changes in futures prices. The analysis found support for this hypothesis, as positive and negative futures price changes exhibited similarly sized effects on subsequent changes in spot market prices.

In addition to examining the short-run intemporal dynamics of the price adjustment process, the distributed lag approach (Almon, 1965) also allowed me to examine if there are asymmetries in the long-run effect of futures price changes. The analysis also found support for symmetry in the long-run effect of futures price changes, as the sum of the coefficients for positive futures price changes (0.749) was not statistically significantly different from the sum of the coefficients for negative futures price changes (0.974). However, a long-run effect of close to one implies elasticity, whereas a long-run effect of less than one suggests inelasticity. One potential explanation for the inelasticity is that actors view futures price changes as having some degree of "noise" due to increased financialization (e.g., Cheng & Xiong, 2014; Irwin et al., 2011) and rationally choose not to respond fully to futures price changes. However, the *elastic* adjustment of spot market price in response to futures price *decreases* and relatively *inelastic* adjustment in response to futures price *increases* calls into question this "conservatism" hypothesis. Further, the effect of increased financialization – as measured by $speculation_t$ – was not statistically significant in either model. Instead, I contend that these findings suggest that buyers may adjust

spot market prices symmetrically in response to positive and negative futures price changes in the short-term but, in the long-term, are able to adjust spot market prices in a way that stretches their margins by incorporating futures prices decreases more fully and over longer periods. Indeed, the findings indicated that spot market prices continue to be adjusted for four weeks – the current period and subsequent three weeks – following *negative* futures price changes versus three weeks – the current period and subsequent two weeks – following *positive* futures price changes.

While futures prices convey important information about macro-level supply and demand fundamentals, small and midsize family farms also need information about supply and demand in local spot markets. This information, however, is private and costly to acquire in a timely manner (Scott, 2018) due to the costs of search (Stigler, 1961) and the continuously changing nature of prices (Hayek, 1945; Kirzner, 1963). Acquiring this private information is particularly costly for small and midsize family farms, who interact less frequently with the spot market and are more limited in the time, resources, and personnel they can devote to information acquisition (Bruderl & Schussler, 1990; Freeman et al., 1983). Farmers thus infer information about local spot market conditions from the spread between the futures price and spot market price in the previous period. Because small and midsize family farms only have "half the equation", buyers are able to exploit their informational advantage by asymmetrically adjusting spot market prices in response to positive and negative spreads between the futures price and spot market price. The analysis found support for this hypothesis, as spot market prices were adjusted more fully in response to negative spreads as compared to positive spreads. This finding suggests that negative spreads play a more significant role in the price adjustment process in agriculture, which is in contrast to the spot markets examined in previous studies (Scott, 2018; Seifert et al., 2004) that typically command a premium (i.e., positive spread) for added flexibility.

While buyers can exploit their relative informational advantage by asymmetrically adjusting spot market prices in response to differences, the futures price limits the extent to which they can do so because of the "law of one price" (e.g., Protopapadakis & Stoll, 1983). If buyers disregard futures prices, they risk setting their spot market bid too high – and transferring some of their margins to farmers – or setting their bid too low and failing to procure the commodity (Huber & Spinler, 2014) The futures price thus puts a "limit" on the extent of the asymmetry as buyers are be compelled to offer prices that concur with the information conveyed by the futures markets. In this sense, the findings suggest that futures markets play an important role in mitigating the effect of information asymmetry in buyer-supplier exchange. This expands understanding of the role of futures markets in supply chain operations beyond risk management (e.g., Kouvelis et al., 2018; Zsidisin et al., 2016) and contracting (e.g., Goel & Tanrisever, 2017; Li et al., 2018) to include their role as a price discovery mechanism and information conduit.

More broadly, this study illustrates how information asymmetry affects the market mechanism (Williamson, 1991) through the asymmetric adjustment of prices. The market – in it various forms – plays an important coordinating role in a number of industries critical to supply chain management, such as agriculture (MacDonald, 2015), truckload freight (e.g., Caplice, 2007) and ocean bulk shipping (e.g., Adland & Alizadeh, 2018), but extant research has focused more extensively on 'hybrids and hierarchies' (Williamson, 1991). Moreover, given the dominant focus on downstream echelons (e.g., distributors, wholesalers, and retailers), collaboration (Cao & Zhang, 2011), contracting (e.g., Sluis & Giovanni, 2016), and information-sharing practices (e.g., Sahin & Robinson, 2002) are often recommended to mitigate information asymmetry in buyer-supplier exchange. In contrast, this study revealed how small and midsize family farms use an alternative mechanism (i.e., the futures market) to reduce the information asymmetry they face

relative to large buyers in local spot markets. In doing so, I respond to calls for incorporating "the structure and institutional features of specific marketing chains" (Meyer & von Cramon-Taubadel, 2004 p.605) to better understand how and why asymmetric price adjustment occurs and to calls from supply chain scholars to increase the practical relevance of our theorizing by ensuring that the underlying mechanisms align with industry conditions (e.g., Calantone et al., 2017).

Implications for Practice and Public Policy

By identifying and empirically estimating asymmetries in the price adjustment process, this study offers quantitative, industry-specific insights that can be used by small and midsize family farms and procurement managers. Small and midsize family farms can use these insights to forecast spot market prices, which can then be used as an input in short-term operations decisions throughout the year. One important insight is that the informational value that futures markets provide varies depending on market conditions, particularly related to positive and negative spreads between futures prices and spot market prices. The structure of the rice supply chain prevents complete adjustment of spot market prices to correct for these spreads, as powerful buyers dictate the price in local spot markets and incorporate negative spreads more fully. Because futures prices are only "half the equation", small and midsize family farms need to be careful of the extent to which they infer information about local conditions from these spreads. Likewise, procurement managers can also use the findings from this study to time their purchasing activities in local spot markets in ways that expand their margins. For example, this study suggests that it takes approximately three weeks for spot market prices to fully adjust to futures price increase whereas it takes slightly longer – approximately four weeks – for spot market prices to fully adjust futures price decreases. Thus, by buying sooner in periods of rising futures prices and later in periods of falling futures prices, procurement managers can achieve a cost advantage.

For exchange executives and regulators, this study reiterates the importance of policies and contract specifications that foster the futures market's role as a price discovery mechanism and limit the effects of factors that are unrelated to supply and demand. Ensuring the proper functioning of the futures market is particularly important for small and midsize family farms in the U.S. rice industry, who face significant information asymmetries due to the nature of buyer-supplier exchange and the private information gap plaguing the industry (e.g., Food and Agriculture Organization, 2004; McKenzie & Darby, 2017). To supplement the price information provided by futures markets, some industry experts have advocated for more extensive reporting of inventory levels to "ensure that all decision-makers have access to relevant information" (U.S. International Trading Commission, 2015 p.84) – like in the *Stocks of Grains* reports published by the Chicago Mercantile Exchange – and "the creation of price-reporting systems in order to bring more transparency to market transactions" (p.85).

Price reporting is voluntary for most commodities but has been mandated for some due to issues with the price discovery process. For example, in hog and cattle markets, Congress passed the Livestock Mandatory Price Reporting Act of 1999 "to facilitate price discovery, make the market open, and provide all market participants with market information that can be easily understood" (MacDonald et al., 2004 p.59). While well-intentioned, the legislation was controversial because of the concentration of buyers in downstream markets; only a few companies handled most livestock purchases, and they did not want their spot market prices – competitive information – known to others (MacDonald et al., 2004). The Agricultural Marketing Service responded by developing confidentiality guidelines, which specified that at least three entities needed to provide price data and no single entity could provide more than 70 percent of the data (MacDonald et al., 2004). The findings suggest that such confidentiality guidelines may be

necessary to facilitate the development of price-reporting systems in the U.S. rice industry given the concentration of buyers.

For the U.S. Department of Agriculture, the findings suggest that it may be time to reevaluate existing crop insurance and revenue protection policies, which use futures prices as the "trigger" for insurance indemnities paid to farmers (U.S. Department of Agriculture, 2018). The analysis revealed that, although the two are correlated, price movements in futures markets and price movements in spot markets deviate from one another—particularly in the short-term (e.g., see Figure 3). Because small and midsize family farms rely more heavily on spot markets and often do not have the resources or expertise to dedicate to hedging with futures markets (e.g., Schnitkey & Coppess, 2018), current insurance indemnity payments may not fully compensate farmers. This is particularly the case during periods of increasing prices or positive spreads (i.e., when the spot market price is greater than the futures price) because buyers do not adjust spot market prices as fully during these periods. The findings suggest that price decreases and negative spreads (i.e., when the spot market price is less than the futures prices) are passed on more fully, so farmers "disproportionately suffer the losses of lower prices relative to the gains of higher prices" (Shrinivas and Gomez, 2016 p.435). Understanding these asymmetries can thus help policymakers determine benchmarks that are more localized and more representative of the price risks small and midsize family farms face in their daily operations.

Limitations and Directions for Future Research

This study has several limitations that offer fruitful avenues for future inquiry. First, the U.S. rice industry was the empirical context for this study. While focusing on the U.S. rice industry aligned with the purposes and assumptions of this study, it limits the generalizability of the findings to other industries. For example, further inquiry is needed to understand which external

sources of information are used by SMEs to overcome information asymmetries in industries where futures markets do not exist.

Second, my theorizing and analysis was based on three assumptions regarding the nature of buyer-supplier exchange in the spot market. While these were in line with extant research (e.g., Ma et al., 2019; Meyer & von Cramon Taubadel, 2004) and corroborated with industry feedback, the nature of the proprietary data set did not allow for formal measurement of information asymmetry and power asymmetry in each spot market transaction. Empirically examining the direct and/or moderating effects of information asymmetry and power asymmetry on the price adjustment process is a fruitful avenue for future research to better understand the exchange factors influencing spot market prices. Additional industry idiosyncrasies, such as barriers to entry due to the labor-intensive nature of both rice production and rice milling, low futures market liquidity, and government regulations and price supports, may also be contributing to asymmetries in the price adjustment process and would also be interesting to examine should such data become available.

Lastly, buyer-supplier exchanges characterized by size and information asymmetries may also be characterized by relational capital asymmetry – an imbalance in buyers and suppliers' perceived levels of trust and reciprocity (Thomas & Esper, 2010; Villena & Craighead, 2017) – or power asymmetry (e.g., Touboulic et al., 2014). It would thus be interesting for future research to explore if and to what extent power asymmetry and/or relational asymmetry moderate(s) or directly influence(s) the market mechanism through the asymmetric adjustment of prices.

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V. Conclusion

The purpose of this dissertation was to examine how institutions influence exchange in the farm-supply chain interface. Essay 1 used a qualitative approach to identify the individual and institutional actors influencing farmers' operations decision-making. Field interviews revealed that farmers approach buyer-supplier exchange differently and tend to rely more heavily on market mechanisms to coordinate activities with buyers and inform their decision-making. Essay 2 builds on this finding to examine the institutional factors influencing exchange in the spot market, which accounts for a significant proportion of the value of agricultural commodity production. A proprietary data set and time series econometrics were used to investigate how spot market exchanges between farmers and buyers are influenced by the futures market—a longstanding institution in the agriculture industry. The findings indicate that farmers and buyers use the information conveyed by the futures market as they negotiate prices in the spot market, which is in line with the predictions of Austrian economics. Essay 3 builds on this finding to further explore how the futures market influences spot market exchanges by examining how information asymmetry affects the price adjustment process. A proprietary dataset and nonlinear time series econometrics were used to test the hypotheses; in line with economic theory, the findings suggest that buyers exploit their informational advantage by adjusting spot market prices asymmetrically. Taken together, the three essays demonstrate how institutions influence decision-making and exchange in the agricultural supply chain. More broadly, the three essays demonstrate (1) the role of the market as a coordination mechanism and (2) the dynamic influence of institutions, and, as detailed below, offer important implications for research, practice, and public policy.

Coordination – the matching of supply and demand – is foundational to effective supply chain management (Esper et al., 2010; Fugate et al., 2006; Mentzer et al., 2001), and extant supply chain research has focused extensively on how 'hybrids and hierarchies' are used to coordinate the

activities of buyers and suppliers (e.g., Sahin and Robinson, 2002; Cao and Zhang, 2011; Sluis and Giovanni, 2016). This dissertation extends this body of work by demonstrating the role of the market as a coordination mechanism. In his seminal piece, Williamson (1991) noted that markets are a "marvel" in terms of adaptation (p.279) because they allow actors to respond autonomously to changes, whereas hybrids are "arguably the most susceptible" to disturbances (p.291) because they require coordinated responses. Indeed, actors engaged in market exchange are relatively clear about how they transact, and their activities are linked through price negotiations (Cai et al., 2017; Kim and Choi, 2015). Ironically, however, the coordinating role of the market – and price more specifically – has received less empirical inquiry in supply chain management given the emphasis on relational exchange (e.g., Davis-Sramek et al., 2007). This dissertation sheds initial light on how markets coordinate the activities of farmers and buyers over time through the adjustment of prices, but additional research is needed to understand how the market – in its various forms – coordinates exchange across other echelons of the supply chain, as well as its implications for supply chain performance. For example, as Kim and Choi (2015 p.61) pose in their typology of buyer-supplier exchange: "Could arms-length relationships actually be beneficial and, if so, when?"

Amidst an increasingly dynamic global macroenvironment, supply chain thought leaders have called for more research that examines how institutions influence supply chain operations (e.g., Fugate et al., 2019). The focus of recent studies has been the moderating effect of institutions in emerging economies, such as China or India, because of the "deleterious" nature of the institutional environment (Zhou et al., 2016). In contrast, institutions in developed economies, such as the United States and Europe, are assumed to be stable, so they are treated as a "control" or assumed away because of their purportedly static and unchanging influence. However, the effect

of institutions – even in the most developed economies – is not homogenous across firms, even within the same industry, or across time (Blake and Moschieri, 2016; Hassan et al., 2017). Indeed, a fundamental tenet of Neo-Institutional Economics is the dynamic nature of the actor-institution relationship (North, 1994), so it is important to understand "how heterogeneity unfolds across different tiers of the supply chain" (Bhakoo and Choi, 2013 p.436). By examining the farm echelon, which is characterized by individuals or small groups of individuals making decisions, this dissertation demonstrates the multilevel and dynamic role of institutions. In doing so, this dissertation reiterates the importance of understanding the effect of institutions *external* to the supply chain, such as government, regulatory agencies, and futures markets. A natural extension thus would be to explore the institutions operating in other echelons and contexts, such as non-governmental organizations (Johnson et al., 2018).

More broadly, this dissertation extends the current conception of institutions beyond their role as contingency factors to include their direct influence on interfirm exchange. Underlying Neo-Institutional Economics is the idea that 'institutions matter' because they determine transaction costs and the value of engaging in exchange (North, 1990; Williamson, 1991). Further, institutions play a critical informational role—that is, the "ability to coordinate different expectations through time" (Foss and Garzarelli, 2007 p.795). By examining how actors use futures market information to inform their exchanges in local spot markets, this dissertation provides preliminary insight into this informational role and into how institutions influence buyer-supplier exchange. In doing so, this dissertation enriches the buyer-supplier exchange literature and demonstrates the importance of integrating macro-level institutional perspectives with micro-level exchange perspectives.

While this dissertation focused on how institutions influence transactional exchange, markets often exist alongside 'hybrids and hierarchies' (Williamson, 1991). For example, markets and contracts are used concurrently in the truckload transportation industry (Scott, 2019), and markets coexist with vertical integration in livestock and poultry industries (MacDonald et al., 2004). Further, although markets continue to govern most transactions for agricultural products (MacDonald, 2015), the use of markets varies across commodities. For example, markets account for a large share of the production of major field crops, such as corn, cotton, rice, soybeans, and wheat, but a smaller share of the production of specialty crops, poultry, and livestock (MacDonald, 2015). As field crops become less commoditized in response to consumer demands for particular product attributes (e.g., organic, non-GMO, free-range), food safety, and traceability (Wowak et al., 2016), as well as farmers' desires to differentiate their products to earn higher returns (MacDonald et al., 2004), there may be a shift towards relational exchange and more integrated forms of organization such as contracts and strategic partnerships (e.g., Williamson, 1981). Further empirical inquiry is needed to examine if and to what extent institutions like the futures market influence 'hybrid and hierarchy' forms of exchange. For example, with the recent launch of the freight futures market, industry experts have touted the potential risk management benefits, but questions remain regarding how informative the freight futures price will be for contracts and spot market exchange (Hampstead, 2018).

For practice and public policy, this dissertation provides guidance on the coordination challenges and information asymmetries currently plaguing the agricultural supply chain. While information-sharing practices are often recommended as "generic cure[s]" for such problems (Sahin and Robinson, 2002 p.510), the three essays illustrated that small and midsize family farms continue to rely on information from the futures market and U.S. Department of Agriculture. Given

resource constraints and lack of visibility in the supply chain, small and midsize family farms use this low-cost, publicly available information to inform their exchanges with buyers in local spot markets. The information, however, is imperfect, and, as illustrated in Essay 3, buyers exploit these imperfections by adjusting spot market prices asymmetrically to expand their margins. The informational value that futures markets provide thus varies depending on market conditions. For small and midsize family farms, this warrants caution regarding the extent to which they use futures market information to inform their operations decision-making because such information is only "half the equation". For exchange executives and regulators, this reiterates the importance of policies and contract specifications that foster the futures market's role as a price discovery mechanism and limit the effect of factors unrelated to supply and demand. Lastly, for policymakers, this suggests that there may be an opportunity for the U.S. Department of Agriculture to supplement the information provided by futures markets. However, as illustrated in Essay 1, the historically significant role of the public sector in agriculture may discourage farmers' engagement with the supply chain, so the provision of additional information should be examined in light of the effects on farmers' profitability and welfare, as well as the implications for food waste and loss in the agricultural supply chain.

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VI. Appendices

Appendix A: Institutional Review Board Protocol Approval

Office of Research Compliance
Institutional Review Board

June 5, 2017

MEMORANDUM

TO:	Jessica Darby Brian Fugate Jeff Murray
FROM:	Ro Windwalker IRB Coordinator
RE:	New Protocol Approval
IRB Protocol #:	17-05-727
Protocol Title:	*Cultural and Economic Perspectives in the Agricultural Supply Chain*
Review Type:	☒ EXEMPT ☐ EXPEDITED ☐ FULL IRB
Approved Project Period:	Start Date: 06/02/2017 Expiration Date: 06/01/2018

Your protocol has been approved by the IRB. Protocols are approved for a maximum period of one year. If you wish to continue the project past the approved project period (see above), you must submit a request, using the form *Continuing Review for IRB Approved Projects*, prior to the expiration date. This form is available from the IRB Coordinator or on the Research Compliance website (https://vpred.uark.edu/units/rscp/index.php). As a courtesy, you will be sent a reminder two months in advance of that date. However, failure to receive a reminder does not negate your obligation to make the request in sufficient time for review and approval. Federal regulations prohibit retroactive approval of continuation. Failure to receive approval to continue the project prior to the expiration date will result in Termination of the protocol approval. The IRB Coordinator can give you guidance on submission times.

This protocol has been approved for 30 participants. If you wish to make *any* modifications in the approved protocol, including enrolling more than this number, you must seek approval *prior to* implementing those changes. All modifications should be requested in writing (email is acceptable) and must provide sufficient detail to assess the impact of the change.

If you have questions or need any assistance from the IRB, please contact me at 109 MLKG Building, 5-2208, or irb@uark.edu.

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Appendix B: Institutional Review Board Exempt Project Continuation Approval

Office of Research Compliance
Institutional Review Board

July 16, 2018

MEMORANDUM

TO:	Jessica Darby Brian Fugate Jeff Murray
FROM:	Ro Windwalker IRB Coordinator
RE:	EXEMPT PROJECT CONTINUATION
IRB Protocol #:	17-05-727
Protocol Title:	*Cultural and Economic Perspectives in the Agricultural Supply Chain*
Review Type:	☒ EXEMPT
New Approval Date:	07/16/2018

Your request to extend the referenced protocol has been approved by the IRB. We will no longer be requiring continuing reviews for exempt protocols.

If you wish to make any modifications in the approved protocol that may affect the level of risk to your participants, you must seek approval *prior to* implementing those changes. All modifications should be requested in writing (email is acceptable) and must provide sufficient detail to assess the impact of the change.

If you have questions or need any assistance from the IRB, please contact me at 109 MLKG Building, 5-2208, or irb@uark.edu.