HOW THE U.S. FARM FIRM HAS EVOLVED: A CONCEPTUAL FRAMEWORK

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Abstract:

Farm organization literature often focuses on the farm firm as a simple entity, where ownership and control is largely combined, a large amount of contractual relationships are informal, and optimal organizational choice can be examined using comparative static analysis. In this paper, we suggest a framework in which we distinguish how some U.S. farm firms have evolved to be a different organizational form in the 20th century. These differences include more separation of ownership and control, more formality, and more complexity. Farm firm evolution involves more complexity because of the interdependency of farm firms to improve performance and the addition of property rights to the farm manager to reduce transaction costs. Because of the assumptions on farm firm simplicity (lack of interdependency), and limiting discussion of optimal farm organization choice to the land and employment transaction, the current frameworks in the literature may fail to understand the evolution of farm organization. We develop a conceptual framework that incorporates the important dimensions to understand farm firm evolution.

INTRODUCTION

The organizational structure of the farm firm and how that structure has evolved have long been an interest to scholars (e.g. Barry, Sonka, and Lilliji, 1992; Raup, 1973; Dasgupta, Knight, and Love, 1999; Brem, 2002) and policy makers (e.g. Bahls, 1997; Vogel, 2004; Wittmaack, 2006; O'Donoghue et al, 2011). An important research focus has been on understanding and explaining the dichotomy of family farms versus a corporate farm structure (e.g. Gorton and Davidova, 2004; Blank, 1999). Another focus of research has been on the co-existance of crop share, wage, and cash rent contracts (Allen and Lueck, 1992; 1993;See Dasgupta et al., (1999) and Otsuka and Hayami, (1988) for a review).

Though the existing literature has contributed to our understanding of farm firm organization, the existing literature has not been fully effective in explaining the evolution of the farm firm for two reasons. First, studies typically have focused on one aspect or dimension of evolution of farm firm organization, such as the degree of separation of ownership control. The literature often frames the problem of separation of ownership and control to understand optimal farm organization choice using a principle-agent framework with uncertain output production due to random factors such as weather. Second, studies often limit discussion of separation of ownership and control in farm organization to contracts of land and employment. Different incentive effects often describe examinations of optimal degree of separation of ownership and control and joint

wealth maximization of wage, share, cash, or farmer owned farm types—where degree of separation of ownership and control decreases from the former to the latter. The framework has been extended, or adapted, and examined using comparative statics analysis. The purpose is to explain an optimal contract choice equilibrium or equilibrium where there is a coexistence of an optimal contract choice because of offsetting efficiencies. Others have used signaling and matching of land and labor contracts to explain differences in optimal contract equilibriums.

In this paper, we argue that farm firm evolution may be better understood by examining farm transactions governance along multiple dimensions. The multiple dimension framework we propose allows for a more holistic, dynamic framework than existing literature. In particular, we identify the optimal farm organizational problem as not just a principle-agent problem for land or farm labor resources. We include other transactions to optimal farm organization choice, and discuss how these other transactions may create additional Nash equilibriums because of the interdependencies of farm firms, and farm firm agents, actions to performance. We discuss observed solutions (institutions) that have evolved in the 20th century to those transaction cost problems in U.S. farm production. We provide a framework to illustrate how these institutions distinguish the farm optimal contract choice, including land and labor resources, as more complex than what the current literature addresses. When farm firm optimal organization choice includes more transactions than just land and labor resources, and these transactions often involve interdependencies, or more principle-agent relationships, the choice of optimal farm firm becomes more complex. In complex settings, determining

long-term stable optimal contract equilibriums, using comparative statics, may be misguided. Transaction costs not related to labor or land resources may be more important in determining farm performance, thus may trump determination of the optimal contract for labor and land resources. Additionally, property right allocations in other transactions may affect farm manager behavior in land and labor transactions. Extending the optimal farm firm choice to include implications of organizational complexity on performance illustrates how optimal contract choice and performance is not a choice of any one landowner or tenant farmer, necessarily. Further, when complexity increases faster than selection, finding optimal farm firm choice becomes more difficult and adaptation for optimality may fail.

We develop a conceptual framework that distinguishes how the farm firm has evolved on the three dimensions we suggest are important to understanding farm firm evolution: 1) separation of ownership and control, 2) formality, and 3) complexity. The unit of analysis, and unit of adaptation, in the evolution framework is the description (formal, informal, and vaguely defined) and possession of property rights (Barzel, 1997) at the nexus of contracts in the farm firm. We describe the nexus of contracts, and analyze changes at the nexus of contracts, by examining property rights of the farm manager whom is the central farm agent entering into incomplete contracts. We suggest that farm firm evolution can be more appropriately described by property rights the farm management possesses, or has possessed, and not by ambiguous classifications of farm organization type, such as: small family, partnership, or corporate. The motivation is to understand past and future evolution of the farm firm.

The framework we develop is unique in that it combines theories of the firm, and a fledgling theory of the family firm (see Chrisman, Chua, and Sharma, 2005), with implications of organizational complexity (Kaufmann, 1993; Kaufmann and Weinberger, 1989; Weinberger, 1991; Levinthal, 1997) to firm fitness and survival. Most current studies have focused on only two dimensions in the literature: separation of ownership and control and the formality of contracts (i.e. informal institutions and vaguely defined property rights). Fewer studies have emphasized complexity (Anderson, 1999), with equal significance, as the farm firm evolves in the separation of ownership and control or formality dimensions. Predictions or conclusions about organizational stability, dominance, or uniqueness may be misguided in the long-term, because organizational complexity is not incorporated into the analysis.

Understanding the past evolution of the farm firm, and the current nature of the farm firm, better informs farm firm stakeholders, policy makers, and legal/financial advisors on the evolutionary pressures and factors that determine farm firm organization. Choice of actions by stakeholders may change if they understand the long-term implications of property right distributions to farm firm competitiveness or fully understand the factors that contribute to the stability of the current farm firm.

LITERATURE REVIEW:

Separation of Ownership and Control

Separation of ownership and control is largely drawn from Jensen and Meckling (1976) and Fama and Jensen (1983). Theory distinguishes firm types by the possession of

risk bearing and control rights. Comparison are made between agents acting on behalf of the firm that possess both the risk-bearing and residual rights (combined ownership and control), or agents acting on behalf of the firm possess only the control rights (separated ownership and control). Examinations of current farm firm organization and the similarities and differences to the large modern corporations are a recurrent theme. Similarities are that agriculture production can assume the same advantages that large corporations exhibit when farms separate ownership and control, such as: risk sharing, asset specific investment, investing according to the market value rule, and labor specialization, but farms can also exhibit the same agency costs that disadvantage large corporations.

The degree of separation of ownership and control is the most talked about dimension in farm firm literature (e.g. Allen and Lueck, 1998). Typically, the focus has been on what type of ownership structure dominates farm organization. How agency costs are economized is a central focus in explaining survivability of separated ownership and control relationships (Fama and Jensen, 1983) and the stability of family- firms (Chrisman, Chua, and Sharma, 2005). Allen and Lueck (1998) use the logic of controlling agency costs to explain the persistence of family farm ownership (Allen and Lueck, 1998) given agriculture production is influenced by nature that limits specialization gains and exacerbates agency costs. James (1999) suggests the reason that a majority of family firms exist in the economy may be two-fold: the ability to control agency costs and the ability to have an extended horizons compared to that of separated ownership and control firms. Others have raised questions concerning whether the

family-firms do control agency costs, as the literature suggests, and if they do not create transaction cost problems of their own (Schulze et al., 2001). In the agricultural cooperative literature, Cook and Chaddad (2004) have used the concept of separation of ownership and control to distinguish types of agriculture cooperative organization. The literature is extensive in exploring different allocations of ownership rights (e.g. Aghion and Bolton, 1992; Hart and Moore, 1986) and emergence of a dominant type in differing sectors (e.g. Hansmann, 1988). However, there has been less attention paid to the evolution of ownership rights distributions in a more dynamic framework. Farm organization literature has often focused on the long-term coexistence of competing forms of organizations (i.e. share and cash wage contracts, or cooperative arrangements and hierarchical structures compared to spot cash markets) or an emergence of dominant type given exogenous factors.

Formality

Incomplete contracts can be defined formally or can be informal. Typically, formal and informal elements of incomplete contracts both exist. Formal contracts allocate residual rights and control rights in a way that is more easily enforceable. Informal contracts embody all the norms and conventions that typically govern unspecified rights. Informal contracts are more difficult to enforce, socially or through a court of law, and may lead to transaction costs from vaguely defined property rights. Vaguely defined property rights may lead to inferior organization performance (Milgrom and Roberts, 1990) due to inability to protect value in an undefined collective asset (Ostrom, 1990). Hence, the common notion is that a likely evolutionary track regarding

informal and formal would occur as a contract moves from informal to more formal in nature, or an evolution to more complete contracting. There are considerable costs to developing complete contracts, however, particularly in complex enterprises with uncertainty (i.e. Coase, 1960). Moreover, there is reasonable question whether a third party enforcer would properly understand the contract terms if there were a more formal complete contract. Hence, the incomplete contracting literature has recognized that the vast amounts of contracts are left intentionally incomplete (Tirole, 2003; Che and Hausch, 1998). Bernheim and Whiston (1998) have suggested a possible strategic benefit to leaving contracts incomplete and Anderson and Hill (1983) explain that defining property rights may not always be efficient. Examined in the agriculture cooperative literature has been the informal incomplete contracting has led to vaguely defined property rights that inhibit agriculture cooperative performance, thus an emergence of new forms (Cook 1995; Cook and Illiopolous, 1999). James and Sykuta (2005) suggest agricultural cooperatives contain a higher degree of trust that may enable sufficient performance despite vaguely defined rights that would expectedly reduce performance. Many have examined the increased adoption of more formally defined production contracts in the livestock industry (MacDonald et al., 2004; Martinez, 2002; Boehlje, 1999; Barkema et al., 1991; Ahearn, Yee, and Huffman; 2002; Lajili et al.; 1997). Allen and Lueck (1992) have analyzed the simple, incomplete, contracts in crop land rental agreements, and contend despite their incompleteness have been sufficient in governing agriculture land transactions. Other examinations of the degree of formal contracts in family-firms and family-farm firms has been whether formal succession plans have been established that enable efficient long-term investments that may be complicated by

horizon problems and entrenchment that exist in family-firms (e.g. Mishra, El-Osta, and Shaik, 2010; Pitts et al., 2009).

Understanding evolutionary changes in incomplete contracting is the degree property rights are formally defined, informal, and vague. Particularly, how-- informal versus more formal-- contracts are able to adapt to unforeseen contingencies and at what cost? Leading to a valid explanation or refutation to why contracts are commonly thought to evolve to contracts that are more complete, or a stronger understanding to why contracts are persistently incomplete.

Complexity

Fama and Jensen (1983) define complexity as the extent there is specific knowledge that is costly to transfer. Another aspect of complexity is the degree that the numerous interrelated parts have a hierarchical structure (Simon, 1962). Fama and Jensen (1983) contend: as complexity increases, separated ownership and control firms are more likely to survive. Segal (1999) explains how complexity causes more incomplete contracting. Ostrom (1999) posits that polycentric organizations perform better in complex environments. In the agriculture literature, evidence indicates that current farm structure is more complex and a greater percentage of output is produced by farms that involve more owners and decision makers and "an expanding web of interactions between farm households and the surrounding non-farm community" (MacDonald, Hoppe, and Banker, 2004). Zahniser et al. (2002) suggest the evolution in business arrangements in farm production has increased the complexity: "farmers have adapted

their business arrangements to respond to changing economic conditions and to better pursue their personal, household, and business goals…the business structure of farming is far more complex now than in the past". Hoppe et al. (2001) succinctly explain why the complex business arrangements of farms requires a broader focus on farm organization than just farm organization type (i.e. small family, partnership, corporation): "The complexity of today's farm business structure suggests that a farm's form of business organization alone is not sufficient to assess the extent of business linkages or the degree to which production or market integration may exist".

Various models for understanding the evolution of complex networks exist in physical and biological sciences (Dorogovtsev and Mendes; 2002) and have been adapted to the social sciences (e.g. Hite and Hesterly, 2001; Jackson and Watts; 2002). Kauffman and Levin (1987) and Kauffman (1996) use the "NK" model (Kauffman and Weinberger, 1989; Weinberger, 1991) to address some of the intriguing implications regarding complexity on evolution of organization. Questions that alter the fundamental tenants of evolution or "Economic Darwinism" — that mutation ("tinkering") and natural selection will enable more efficient and dominant forms to develop. The "NK" model is useful in incorporating path dependent concepts, local and global adaptations (Levinthal, 1997; 1991), explaining long-term equilibriums of organizational diversity, and giving insight to future organizational changes to improve fitness overtime. Though "Economic Darwinism" is a common notion, less is known about the mechanisms of organizational selection and tinkering; particularly, when the organization develops interdependencies that increase complexity.

Evolution of complex organisms focuses on the interdependent sub parts that can improve evolutionary performance or fitness overtime. In a social contracting context: survivability of the organization is dependent on efficient coordination of interacting, interdependent agents through informal and formal contracts. In a complex nexus of contracts, sufficient coordination and authority, would limit large negative effects from competing, conflicting interests, that could have a significant negative effect on performance of all agents in the nexus of contracts. In a non-complex nexus of contracts, an action by an agent will have an insignificant effect on the performance of another agent in the nexus of contracts. Thus, in a non-complex setting, there would be little incentive to engage in developing various rights allocations to improve overall performance. What is interesting is that in very complex organisms, equilibrium states are very fragile, where small perturbations in the environment can significantly unravel the organization. In non-complex organization, perturbations in the environment may cause a small brief unraveling, but a return to the initial state will occur. Hence, it is thought that most robustly stable organizations exhibit some mixed complexity (Kauffman, 1996; Levinthal, 1997; 1991), because they only contain moderate fragility but are on the edge of more complex coordination where stable competitive advantaged can be sustained . It is on the "edge of chaos", where some combination of rules can unlock a more complex, superior performing organizational structure. Depending on the ability of other agents to imitate, or replicate, the more complex superior design, may lead to long-standing superior performance equilibriums (Rivkin, 2000).

Why the current literature on farm organization evolution is deficient:

The most deficient aspect of models on optimal farm organization choice is the interdependency of farm performance that exists outside the land and labor transactions. Transactions outside the land and labor transactions may have property right allocations that interact with the choice functions analyzed in the land and labor transaction, or cause feedback effects. The inefficient sharecropping framework implicitly assumes all other transactions are efficient using market mechanisms, or do not include them in understanding the optimal agriculture contract. For example, the Allen and Lueck (1998) model does not incorporate the effects to value of quantity of production if quasi-rent from production can be appropriated by other entities in the supply chain (e.g. Harl, 2000). Including this dynamic would change the farm principal's performance function to be dependent on not only effort and actions on her own farm, but also effort and actions of principals and agents in other farms and farm related entities. As a result, a farm principals' optimal contract choice is not limited to the discrete optimal contract choice of the land and labor transaction. Thus, the optimal land and labor optimal contract choice may not be selected, even if agency costs exist and are not offset from gains to specialization.

The determination of property rights distribution that best achieves the optimally organized farm can be more complex than the existing literature assumes. That is because the optimal farm organization choice may not be the choice of a single manager or owner of land, nor may farm managers know the current equilibrium is the optimal because of delayed feedback on payoffs or bounded rationality on contribution of each part in the

system (e.g. Diehl and Sterman, 1995). The optimal equilibrium may only be revealed through numerous trial and error experiments with other stakeholders in the farm firm.

We suggest that a focus on intra-farm agency costs as a primary motivation to understand farm firm organization may be misguided. Our reasoning is that optimal organizational choice may not be dependent on economizing or eliminating intra-farm agency costs alone, rather identifying contractual arrangements that are able to coordinate beneficial inter-farm action while economizing on resulting transaction costs sufficiently. If benefits from inter-farm coordination are sufficient, and such benefits can best be achieved by a corporate type contractual agreement, then stable corporate farm firms are certainly possible. This possibility can occur regardless of random shocks by nature that may exacerbate agency costs or limit specialization gains—particularly if the principal(s) reserves property rights that induce the agent to maximize the principals' interest (Braverman and Stiglitz, 1982).

If we examine the property rights, and changes in property rights, at the nexus of contracts, using only the dimension of separation of ownership and control and formality, we may make misguided conclusions about organization existence and stability. For example, if we were to observe that the nexus of contracts of two farm firms is similarly combined ownership and control and informal, we may struggle in determining why there would be a large performance difference from property rights. We may only understand the large differences if we include and emphasize complexity of property rights to performance as much as the other dimensions. Moreover, we may misunderstand a motivation to alter property rights at the nexus of contracts, or motivations of some farms

to pursue more integrated business arrangements, without the complexity dimension. The example we offer is if we compare collective farms and small family farms. These farms may be considered to both exist in the same dimension of combined ownership and control and informal/ill defined. Collective farms, however, would be far more complex than family farms in the number of property rights, and how interdependent the farm managers' right allocations are to farm performance. Only when we include the complexity dimension, can we make great distinction between performance levels, desires for evolution, and stability between the two (See Figure 1.1).

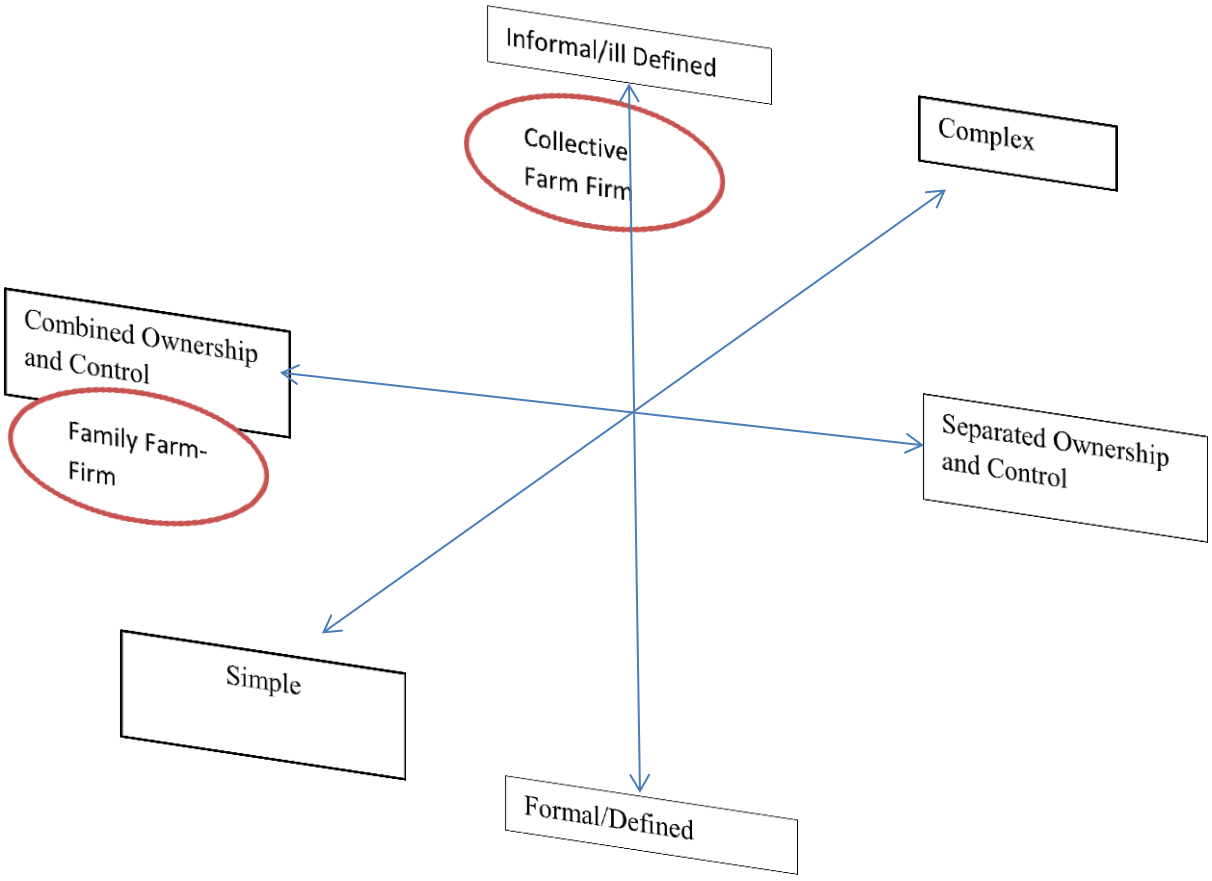


Figure 1.1. Distinguishing farm firms on three dimensions

We suggest the interdependency of farms has resulted in the large, rich, history of farm firm evolution. We track these changes by studying the alteration of property rights at the nexus of the farm firm to obtain collective action gains, minimize agency costs, and encourage optimal organization structure. Specifically, we illustrate property right changes that have occurred to some farm managers in the 20th century in U.S. farm production.

WHAT IS THE FARM FIRM?

Consistent with Fama and Jensen (1983) we define a firm as a nexus of incomplete contracts that govern a set of production processes. The farm we define as the nexus of residual and control rights associated with resources used in the production (i.e. planting, growing, and harvesting of crops and/or the breeding, husbandry, and feeding of livestock) and marketing/consumption of crops and livestock. An incomplete contract is where actions cannot be stated for all possible contingencies (Brickly, Smith, and Zimmerman, 1996)—thus an emerging rationale for ownership (Hart, 1988). Our interest in this paper is not in the typical Transaction Cost Economics discussion (TCE) of whether transactions should be governed under a market, hybrid, or firm (e.g. Williamson, 1979; 1991). Rather, we take as given, that incomplete contracts and ownership have supplanted market mechanisms, in a significant way, for multiple transactions in farm production. We illustrate typical transactions that would fall within how we define the farm firm in Figure 1.2. Figure 1.2 does not represent the extent or bounds of the farm firm, however. We also acknowledge that some transactions may also

be governed using a classical contract and/or market mechanism, though there are also well documented cases of incomplete contracts, presently and in the past, which govern these same transactions surrounding the nexus of contracts that constitute the farm firm. It is in the general evolution of these incomplete contracts that we focus on in the remaining portion of this chapter.

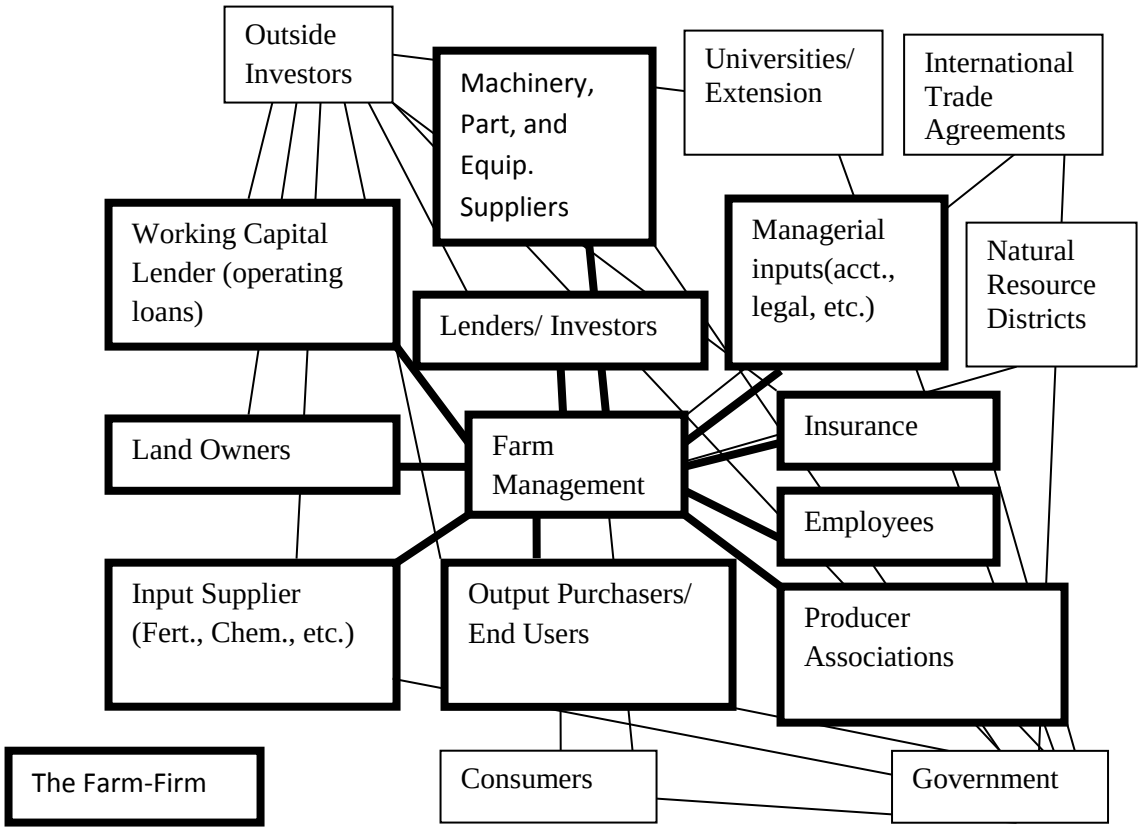


Figure 1.2. Example of a nexus of incomplete contracts that make up the Farm Firm

HOW FARM MANAGERS' PROPERTY RIGHTS EVOLVED IN THE 20TH CENTURY

We illustrate the evolution of a farm manager's property rights through a hypothetical U.S. farm firm during the 20th century. The evolution of property rights we describe occur because of the adoption of incomplete contracts and the subsequent tinkering of incomplete contracts in the 20th century. Not all farms evolved to the same degree of separation of ownership and control, nor tinkered with the contracts to reduce vaguely defined property rights. Thus, there are differences in the degree of separation of ownership and control, and formality, among the farm population that we can measure and examine efficiency differences. We use symbols to represent bundles of property rights; because property rights can be vaguely defined, unknown, or would require great length in describing. It is in the evolution of property rights allocations, their effect on farm firm performance, and property right stability that we are interested.

A fairly accurate representation of a pre-20th century U.S. farm firm resembled a central nexus of incomplete contracts (farm management) where most, if not all, of the finite ownership rights (both control and residual) to the resources that produce crops and livestock, and the subsequent production from those resources, was possessed by a farm manager. In these farms, the farm firm manager, ostensibly, owned the land, did the work, built the machines used in the production, produced and distributed fertilizer from livestock manure or ash, mitigated risk with strategies such as diversity of production, saved part of their own production or herd to expand production in future periods, and consumed the produce for an indefinite period of time (Figure 3 shows an illustration

where the complete set of ownership rights, we'll label "C" where C={all control rights} and "R" where R={all residual rights}, are maintained by the farm management) (See Cochrane, 1993; Hambidge, 1941). Any surplus farm production was traded using spot markets and price mechanisms. Thus, we will label this type of nexus of contracts as a Stage 1 Farm firm (See Figure 1.3). Granted, some farms prior to the 20th century had already evolved to more separated ownership and control organizations, such as farms that were involved in early agriculture cooperatives, used share contracts, were members of an early mutual insurance company, or farms that were associated with the Grange movement (Lawless, 2002; Schnieberg et al., 2008). However, as concluded in the report by the Commission for Country Life in 1909 on the problems with farm and rural prosperity, mutual farm organization was generally deficient and 'farmers stood alone against organized interests' (p.19) in the early part of the 20th century.

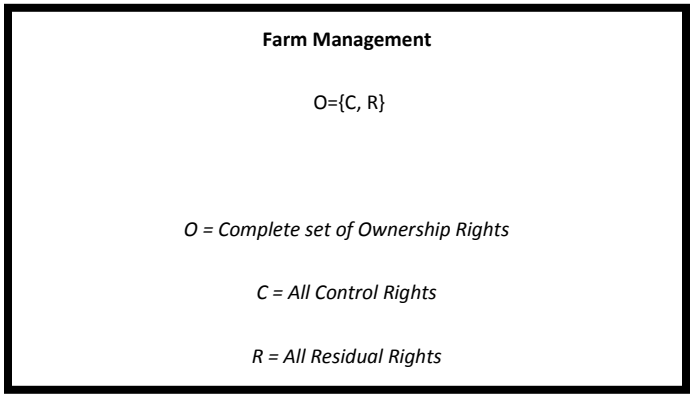


Figure 1.3. Stage 1 Farm Firm

EVOLUTION IN SEPARATION OWNERSHIP AND CONTROL

Changes in policies, technological developments in farm mechanization, and improving knowledge about the nature of the farm business compelled farm managers to

more separate ownership and control rights in order to improve performance. Farms in the early 20th century had already begun to separate ownership and control using increased rates of tenancy, both cash and share, to improve capital-labor ratios through specialization and mechanization (Winters, 1974). Winters (1977) suggests that tenancy, share or cash, was a response to more intensive agriculture and specialization in Iowa, and resulted in the increased rates of tenancy by the end of the 19th century. U.S. Agriculture Census data illustrates that the percentage of farms that classified themselves as a share tenancy, and part ownership farms, continued to increase in the U.S. into the early 20th century. Share tenancy, itself, peaked in the 1930 Agriculture Census as a tenure type (See Figure 1.4). The percentage of farm acres under share tenancy governance also showed a similar peak in 1930 and a steady decline after (See Figure 1.5).

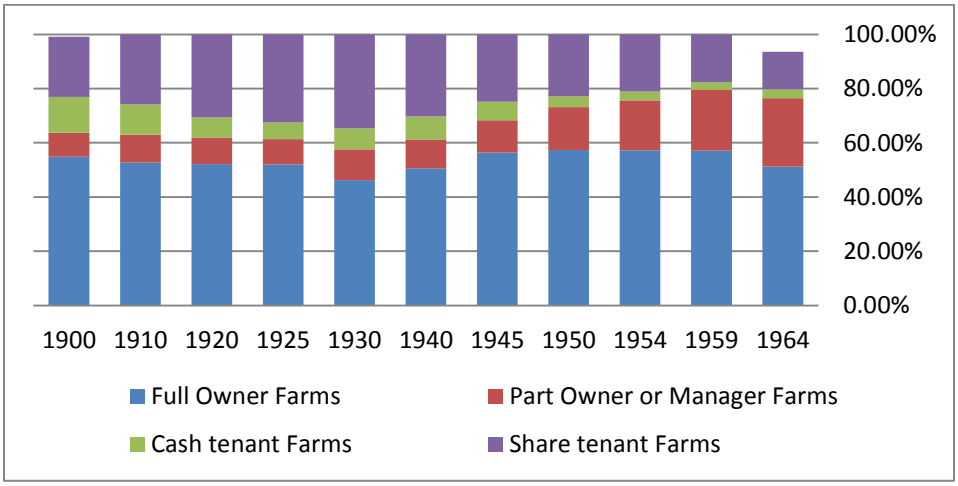


Figure 1.4. Percentage of farms by tenure type (U.S. Agriculture Census survey)

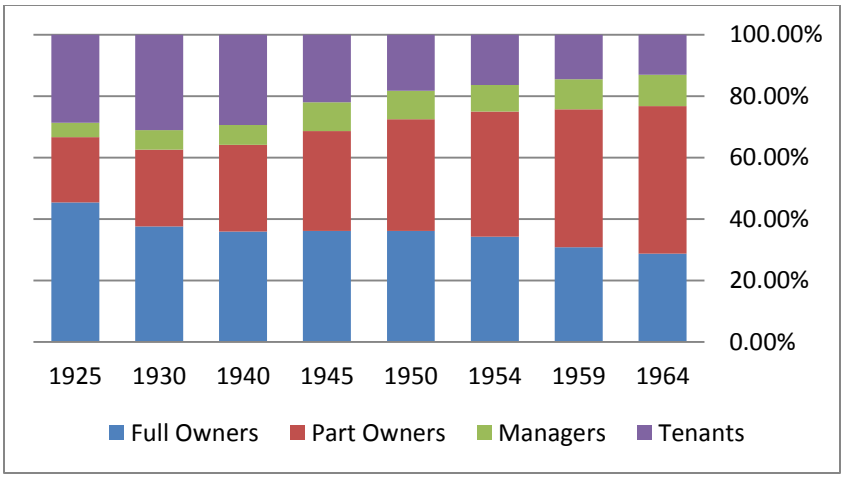


Figure 1.5. Percentage of farm acres by tenure type (U.S. Agriculture Census Survey)

The increased adoption of share contracts created an evolution to more separated ownership and control for a portion of farms in the U.S. We can illustrate the separation of ownership and control from an adoption of the incomplete share contract by tracking the residual and control property rights that are allocated between the landlord and the farmer management. In a share contract, the landlord reserves a portion of the control rights (e.g. right to sell the land, right to access the land, some may have reserved the right to determine crop choice (See Winters, 1974), and portion of the residual rights (e.g. 1/3 share of produce) to the original "land owner". We assume that no specification on duration of the share contract exists, making the contractual relationship incomplete in at least this aspect. A portion of the control rights (α where α={right to utilize the land for farm production}) within the complete set of control rights (C) are distributed to the farm management to operate the farm, and a portion of the residual rights (β, for example, β ={ 2/3 share of production}) are also distributed for the management of the farm.

In addition to the increase in share crop adoption during the early 20th century, there was also a larger movement to develop and join agriculture cooperatives. Cooperatives were exempted from the constraints of the Sherman Anti-trust Act of 1890, by the passage of the Capper Volstead Act in 1922. Cooperative development was encouraged by the Cooperative Extension Service, a partnership of Land Grant Universities and the USDA, outlined in the Smith-Lever Act of 1914. These early 20th century institutional changes led to a large increase in the number of marketing and supply cooperatives that early 20th century farm managers were members. Interest in being a member of an agriculture cooperative was largely a response to the perceived monopolistic behavior of investor owned entities in the supply chain (see Figure 1.6). The numbers of farmer cooperatives declined into the latter half of the 20th century, due to exit and consolidation. However, the amount of sales attributed to cooperatives continued to increase throughout the 20th century (gross sales for both marketing and supply cooperatives were .4 billion dollars in 1913 and steadily increased to 142.4 billion by 2007).

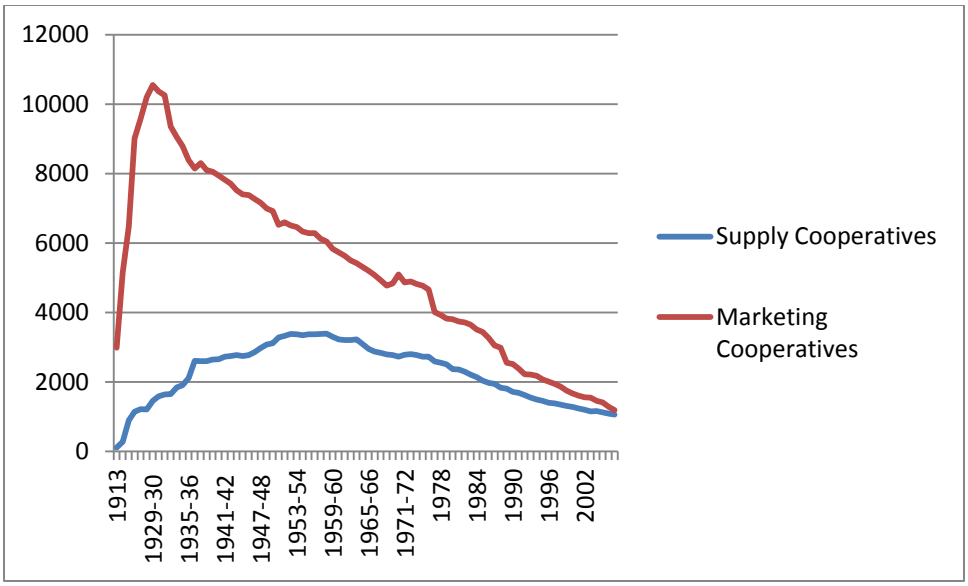


Figure 1.6. Number of Cooperatives in U.S. since 1913 (U.S.D.A. Rural Development)

Property right changes occurred to farm managers who changed delivery of their produce from a spot market with an investor owned firm, or private firm, to delivering their annual share (β) of the produce to an agriculture-marketing cooperative, for example. Deliveries of produce to an agriculture-marketing cooperative is often processed and bulked together with neighboring farm managers produce and traded for currency. In a cooperative exchange for the produce, the farm management reserves the right of a residual return of a specific amount (δ where δ={rights to specific return price given quantity and quality}), and a specified right to an unknown amount of additional return (η where η ={e.g. rights to patronage}). The farm management also reserves limited control rights (π) to oversee the cooperative management during the bulking, processing, and marketing. These control rights often include the right to vote on bylaws, vote on board of director representation, and rights to obtain financial information on the

performance of the agriculture cooperative in the bulking, processing and marketing of their production. The farm management distributes to the agriculture cooperative management their control rights (μ) to the produce and their control rights to the assets used in bulking, processing, and marketing, and a fixed salary and performance incentives for adding exceptional value (ρ). An illustration of ownership rights distribution of our stage 1 farm firm after they adopted the share contract and engaged in an agriculture-marketing cooperative could be construed as figure 1.7, we will label this a Stage 2 farm firm. Naturally, the exact finite amount of ownership rights that is distributed is hard to establish, primarily because the complete set of rights are often unknown or undefined. We will reserve those issues for further discussion in the next sections.

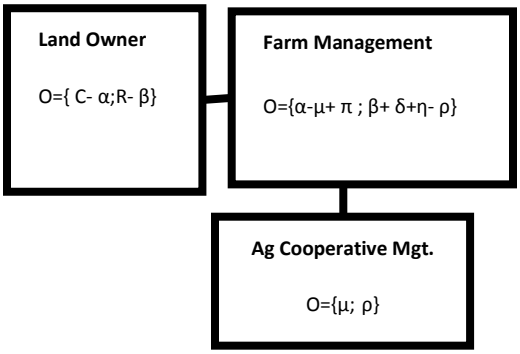


Figure 1.7. Stage 2 Farm Firm

In addition to agriculture cooperatives, further separation of ownership and control of farm manager property rights occurred with development of producer associations and mandated check-offs. Different dates of association development, and implementation of the check-offs, occurred across regions and commodities. For

example, the National Association of Wheat Growers began in 1950, and a voluntary assessment, or check-off, for Kansas wheat was implemented by state statute in 1957. The Kansas wheat assessment was controlled by a Kansas wheat commission. Another example is the National Live Stock Growers Association that began as early as 1898, which later developed into the National Cattlemen's Beef Association. Beef check-offs began in some states in the 1950s, but later evolved into a national Beef Promotion and Research Act in 1985 that mandated national beef check-offs with continued state beef association control over collection and distributions of funds. Many more commodity associations, and their related commodity boards that managed check-off funds, begin to develop in the latter half of the 20^{th} century. Producer elected boards and association representatives generally possesses the bulk of control rights to check-off funds. Most check-off funds are used to obtain asset specific information from commodity related research and to transmit asset specific information on the commodity attributes (advertising) to improve product demand.

Changes in property rights at the farm manager level, with the development of growers association and mandated check-offs, can be illustrated by an increase separation of residual rights to production (λ={ rights to check-off}). In return for the check-off dollars, the farm management does reserve some control rights to oversee association representatives or commodity board representatives. The farm manager also may have control rights to propose and approve tasks for the association to pursue (τ). The farm management grants the association control rights (θ) in promoting their produce and pursuing policies and research opportunities that would be beneficial to the farm

management performance. Examples of control rights the association may have would be rights to represent the farm managements' interest in international trade agreements, government farm policy, and to discuss research collaboration with Universities. To ensure all farmer managers participate in the association, and do not free ride on the benefits from a portion of farmers allocating check-off funds, a common rule is that all farm manager residual returns are automatically deducted for all produce with a check-off program that is traded for currency within a regional area. If check-off funds are not deducted, the buyer and seller will be assessed a civil penalty (φ).

Ownership and control rights of some farm managers separate further during the 20th century with the development of institutions to facilitate risk sharing. An early 20th century form of risk sharing was the rapid increase of mutual property and casualty insurance companies. Hansmann (1985) posits asymmetric information and limited competition gave rise to local mutual insurance companies from more efficient risk sharing compared to stock insurance companies (See also Smith and Sturtzer, 1990; 1995; Born et al., 1995). Some have suggested, local farm mutual insurance companies allowed for better monitoring of moral hazard by farm manager policyholders and better monitoring of mutual insurance management who had control rights over pooled resources and underwriting gains. Examples of farmer mutual insurance firms that began at the beginning of the early 20th century include Farm Bureau Mutual Insurance Companies (1930s), State Farm (1922), Farmers Mutual Insurance Company of Kansas (1896), Farmers Mutual Hail Company of Iowa (1893), etc. These companies offered risk-sharing policies to reduce random losses in value to farm vehicles, machinery,

buildings, and protect farm assets from liability claims. A few early mutual insurance companies provided crop insurance, but were overwhelmed with claims during years of widespread production problems; as a result, self-organization of crop insurance generally failed absent of government-backed programs (Glauber et al., 2002). Some mutual insurance companies also required that the farm manager participate (membership dues) in farm lobby organizations, similar in task to grower associations who had lobbying functions. The mutual insurance benefits, from lower premiums and reduced moral hazard, then acted as a selective incentive to reduce free riding in larger collective action problems, like lobbying for beneficial farm policies (Olson, 1985).

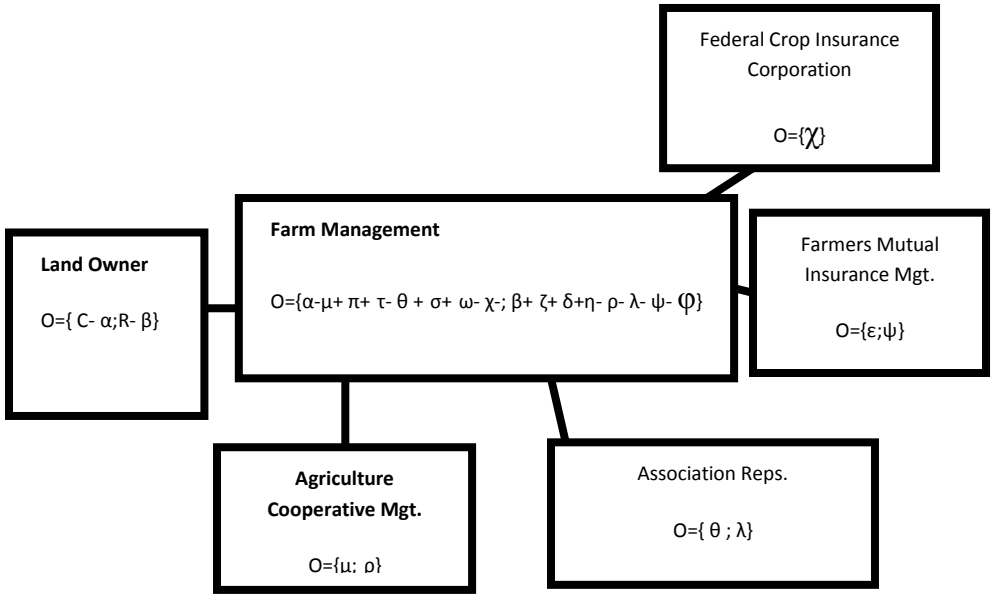
Changes to farm managers' property rights occurred if they determined their risk would be reduced-- therefore their performance improved-- if they collaborated in a mutual insurance agreement with other farm management. The contractual agreement would pool a small portion of their residual return (ψ) with other farm management residual returns. The farm management would reserve some control rights to oversee the mutual insurance management and reserve their right to redeem some of the pooled resources at a pre-specified date in the form of dividends or reduced premiums on future insurance policies (σ). The mutual insurance management will be conveyed control rights (ε) to manage the pooled residual returns, along with rights to stipulate policies about actions and decisions that increase risk and the right to monitor farm management action to ensure compliance. We illustrate the insurance and association contractual arrangements in Figure 1.8; we will label Stage 3 Farm Firm.

Other changes to property rights of the farm manger to facilitate risk sharing occurred with the increased adoption of federally subsidized crop insurance policies in the latter part of the 20th century. Federal crop insurance was enacted as a small pilot project in 1938, but did not achieve wide participation by farm managers until the adoption of the Federal Crop Insurance Act in 1980, which authorized subsidies to encourage more widespread farm manager participation, particularly among lower risk farms (Glauber et al., 2002). For a short-term period, participation in federal crop insurance was mandated if the producer received additional direct government farm payments, but participation in federal crop insurance was not mandated after the '1996 Farm Bill'. The factors found to increase adoption of federal crop insurance policies include the increased degree of separation of ownership and control and larger farm size (Sherrick et al., 2004).

In the Federal Crop Insurance Act, a farm manager was granted the rights to federally subsidized crop insurance premiums (ζ). In exchange for the subsidized premiums, the Federal Crop Insurance Corporation (FCIC), who oversees the administration of the act, reserves the power to approve premium rates and approve crop insurance policies that maintain a specified loss ratio. The farm manager grants the FCIC control rights to crop production information and other information that can 'improve actuarial soundness' (χ)[1]. Farm managers are also granted limited control rights over the FCIC in (1) four appointed board members from different producer regions and farm types, and (2) a requirement of the FCIC 'in the administration [of the Federal Crop

[1] Agriculture Adjustment Act of 1938 & Federal Crop Insurance Act § 7 U.S.C. 1506, p.82.

Insurance Act] to the maximum extent possible, establish or use committees or producer associations'(ω)[2]. In the event of a loss, the farm manager retains the right to indemnities (ζ), unless the farm manager acts with neglect, lack of effort on reseeding, or does not 'follow good farming practices' (χ)[3].



[2] Agriculture Adjustment Act of 1938 & Federal Crop Insurance Act § 7 U.S.C. 1507, p.84.
[3] Agriculture Adjustment Act of 1938 & Federal Crop Insurance Act § 7 U.S.C. 1508, p.86.

C= Control rights to farm resources not allocated

R= Residual rights to farm resources not allocated or possessed by other agents in nexus of contracts

α= control right to utilize farm land for farm production

β= residual right to share of residual return for farm production (i.e. 2/3 share of produce)

λ= residual rights to check-off

η =residual rights to patronage

π= control rights farmer reserves to oversee cooperative management (i.e. voting rights, membership rights, board of directors representation)

δ= residual rights to specific return price given quantity and quality of produce (β)

τ= control rights to oversee association representatives and rights to approve tasks association representative to pursue

θ= control rights association representatives have to promote or utilize checkoff funds to promote farm products, advise policy makers on policy and international trade agreements, and pursue research opportunities with Universities.

μ= control right to produce and processing assets given to cooperative management to bulk/ process and trade for currency

φ= right of government enforcement agency to make claim on farm management residual returns if found to shirk on check-off (λ) (i.e. civil penalty)

ψ= residual return given to farmers mutual insurance management for insurance coverage

σ= control rights to mutual insurance firm that farmer retains to oversee mutual insurance management (member voting rights), residual rights to unallocated indemnities if mutual insurance firm is profitable (i.e. dividend, lower premium the following year, etc.)

ε= control rights given to mutual insurance management to ensure farmers compliance of insurance policies and manage pooled residual returns for indemnities and administrative expenses.

χ = control rights to crop production and financial information that can improve actuarial soundness of federal crop insurance programs, and control rights to production practices to comply and be eligible for crop insurance benefits.

ζ= residual rights to indemnities in the case of a crop loss, and the rights to federally subsidized premiums for crop insurance.

Figure 1.8. Stage 3 Farm Firm

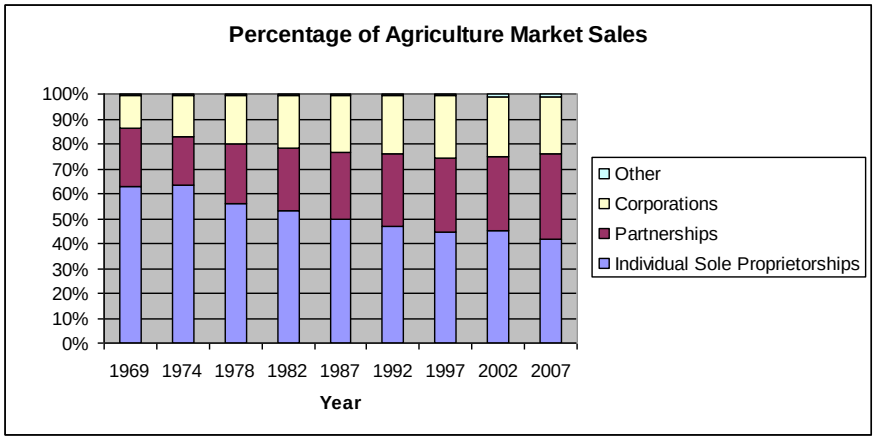
For the sake of brevity, we will not examine all the changes in the farm managers' ownership and control rights in every possible link in the nexus of incomplete contracts of the farm firm. However, other contract relationships evolved in the 20th century, which further altered the set of ownership and control rights of the farm manager. Examples include the establishment of the rural electric cooperatives, stewardship agreements with seed manufacturers, organizations to manage collective natural resources (e.g. irrigation districts), contracts with non-owner employees, international trade agreements, and the Farm Credit System to name a few. Our focus here was not to describe the complete property rights changes of the farm firm. Rather, we wanted to illustrate how on the one dimension of separation of ownership and control, our proposed U.S. farm firm evolved from a more combined ownership and control firm in Stage 1, to a significantly less combined ownership and control firm in Stage 3 (Farm Management ownership rights in stage 1$\{C;R\} \neq$ Ownership rights stage 3 $\{\alpha-\mu+\pi+\tau-\theta+\sigma-\chi\,;\,\beta+\delta+\eta-\rho-\lambda-\psi-\varphi+\zeta\}$). The evolution was described by the adoption of simple-- though reasonably accurate and common—incomplete contractual agreements during the 20th century. We suggest that some farm firms generally have evolved to have less combined ownership and control than they historically did. Where the degree separation of ownership and control can be measured by estimating the farm managements' missing elements of the set of ownership rights in Stage 3 to the ownership rights in Stage 1. Certain elements of the Stage 3 ownership rights will not have existed in the set of ownership rights at Stage 1, for example control rights to monitor the agriculture cooperative management and residual rights to patronage were not available to the farm management in stage 1, thus these are

additional elements to the set. However, from the set of the original farm managers ownership in stage 1, we hypothesize there will be missing elements at stage 3 (e.g. missing ownership rights to farm management at Stage 3={C- α, μ, θ, ε, χ; R- β, ρ, λ, ψ, φ}). The missing elements were distributed to other agents. The number of missing elements in the original set can represent the degree that the farm firm has evolved to have less combined ownership and control. The motivation to evolve was a result of farm managers trying to improve performance, thus survivability. The mechanism was through adoption of incomplete contractual agreements that explicitly or implicitly distributed ownership rights. The actual degree of evolution, and the exact current make up of a representative farm firm, we will leave for future research. We acknowledge that different forms of contractual agreements currently exist, or have further evolved (e.g. See Chaddad and Cook, 2004 on demutualization), and are far more intricate than what we described here.

EVOLUTION IN THE FORMALITY OF CONTRACTS

Not only did farm managers' property rights evolve in separation of ownership and control, but the property rights also evolved in the degree of formality. An example of changes in formality of property rights could be a change in the share contract, adopted in stage 2 farm firm, to a more formalized family corporation. In a portion of the share contract agreements that existed in early U.S. agriculture census surveys, there existed kinship relationships between different generations (e.g. father as a landlord and son as a sharecrop tenant). Changes in strategies to arrange multiple owner farms began occurring in the mid-20th century with more formalize arrangements between multiple

farm owners and managers. Changes in the tax code in the 1950s allowed for Corporations and "S" Corporations to become a more desirable organizational arrangement for multiple owner and larger farms (Raup, 1973), particularly when there is an emphasis on reducing liability, reducing estate taxes, and achieving efficient horizon investment (e.g. Harl, 1984; Boehlje and Eisgruber, 1972). An impetus in changes in organizational strategies could be in reducing vaguely defined rights, and/or formalizing tacit understandings, regarding continuation of the existing share contract agreement across generations that may create 'dialectical tensions' (Pitts et al., 2009). Issues may arise because the landlord may have multiple children that, presumably, would be granted an equal share of the fee simple ownership rights to the capital used in production. Or issues could be related to entrenchment concerns with the older landlord/ manager, which create complex, competing desires on allocation of farm resources and investment to preserve future farm residual returns at efficient, extended horizon levels. Vaguely defined property rights may alter farm managers' current investment without a long-term commitment and deter extended horizon investment, thus altering the performance of the farm firm in the long-run (see Harl, 1984). More formalizing and defining vaguely defined property rights can achieve increased short-term investment and facilitate efficient extended horizon investment. By the latter part of the 20th century, multiple-owner farm organization types, with more formal property right allocations, governed over 50% of farm sales (See figure 1.8).



C

Figure 1.8. Percentage of Agriculture Market Sales by Organization type (United States Agriculture Census)

We illustrate the farm manager property rights as formal (F), informal but enforceable (I), and vaguely defined (V) in the stage 2 farm firm from before (See Figure 1.6). To illustrate the evolution of formality of property rights, the set of property rights from before are identified in subsets as either Informal (a, e), formal (b, f), or vaguely defined (d,g).

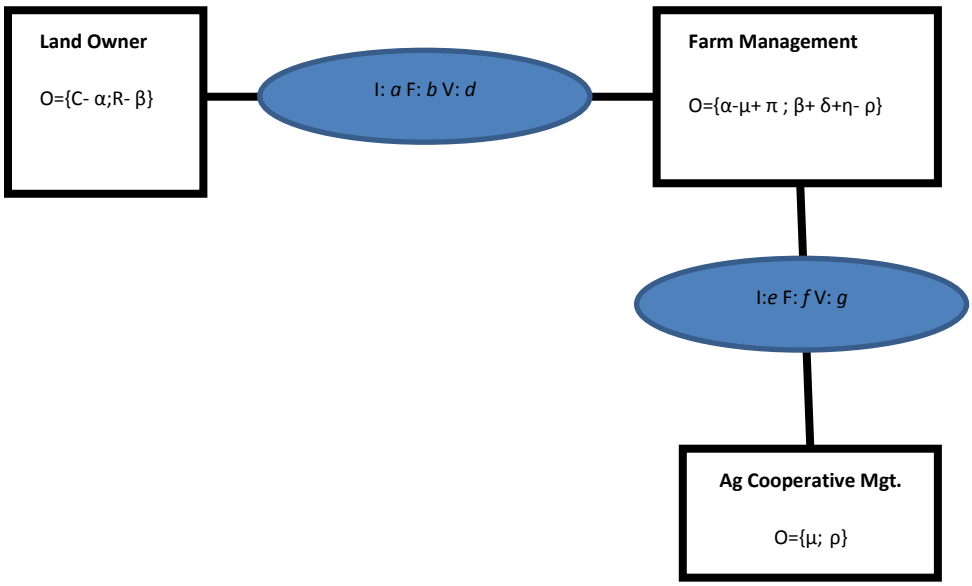


Figure 1.9. Stage 2 Farm Firm with informal, formal, and vaguely defined rights

When a landowner decides to transfer their ownership rights into a closed corporation, they would transfer the landowner rights, reserved under the share agreement, to a corporation with a name "Land Owner Inc.". The corporate contractual agreement separates the long-term ownership rights from the life cycle of the landowner, thereby reducing vaguely defined property rights. The rights that were vaguely defined are reduced by the corporate contractual agreement by increasing either the subset of formal {F}, or an informal {I} property rights by some unknown amount ($h+i$, where h is the increase in formal rights and i is the increase in informal rights) that were created by issues of generational transfers. We will assume, the improved informal enforcement could be the result that the corporate contractual agreements have many implicit understandings of property rights that have been enforceable in preceding cases by a court of law (I: a+i). We will also assume the corporate contractual agreement would stipulate management of the farm firm to be within the family, determined by majority voting of the shareholders, and control rights and residual rights to the management would operate as they did before under the share crop agreement. As a result, we have a more formally defined incomplete contract than the share contract under the ownership of a landlord that we had before i.e.(b+h). But now the control rights and residual rights of the land-owner {C- α ;R- β} would be distributed in proportion to the investors with outstanding shares of the corporation. We will assume the distribution would be to an outside Land Owner Inc. shareholder and the farm management in equal proportion. Depending on the dilution and concentration of these shares can affect the level of control

the owners can have on the management (See Bahls, 1994 for a discussion on family farm minority ownership issues). To illustrate dilution and proportion of share we'll use parameter "*n" for* number of shares, and parameter *"o"* for number of shares owned, where shareholder rights will be some proportion of *o/n*({C- α ;R- β}. For simplicity, we will ignore issues of transfer of control rights and residual rights to an owner with majority voting shares at this time. In addition, we will assume that a corporate contractual agreement reduces vaguely defined property rights, without introducing any vaguely defined rights of its own. This may be an erroneous assumption, but for purposes of understanding the evolution of farm managers' property rights will be maintained.

A second example of the evolution in formality of farm managers' property rights in the 20th was the transition from a traditional cooperative model to a New Generation Cooperative (NGC) model. Cooperative failure rates were often high after the initial increase in the early 20th century. Factors that were frequently cited for cooperative failure were lack of business volume and insufficient equity arising from "free rider" type behavior and poor cooperative member commitment (Sexton and Iskow, 1988; Staatz, 1987). In the latter part of the 20th century, tinkering with the incomplete contracts, to reduce vaguely defined property rights of traditional agriculture cooperative incomplete contracts, assisted in the reemergence of cooperatives; and allowed some traditional cooperative forms to transition to better performing and more sustainable entities from the original justification for agriculture cooperative to defend against opportunistic oligopolies (Cook, 1995). Surviving agriculture cooperatives found organizational justification, through asset specific investment, asset specific product attributes, risk

sharing, reputation effects, and extended horizon investment, compared to investor owned firms (Cook, 1995) that could not replicate the agriculture cooperative strategy by a change in opportunistic behavior. Important attributes of an NGC were more defined membership rights on patronage of the cooperative and residual rights of the farm manager in the agriculture cooperative, and these enterprises were often engaged in a value-added, offensive strategy (Cook and Iliopoulos, 1999; Coltrain et al., 2000). The new contractual agreement more formally define the residual rights and control rights of the farm-manager owners and agriculture cooperative management. Common in the NGC agreements were that farm managers were conveyed rights to transfer their unallocated equity rights at their discretion (ϒ), but not redeem at an undefined time as they had before (υ). To give the transferrable rights more value, the agriculture cooperative benefits were restricted from non-members, thus reducing "free-riding". In return, the agriculture cooperative management was granted control rights to a formally specified quantity of patronage by the farm manager, or the farm-manager faces penalties and fines (κ). The NGC contract more formalizes the ownership rights (j) and reduces vaguely defined property rights by some unknown amount (k).

In both the adoption of the corporation and the adoption of a NGC form of agriculture cooperative organization, the original contracts contained vaguely defined rights long-term and were incomplete regarding objectives and contingencies. The vaguely defined property rights affected the current and future performance of the farm firm, thus stakeholders became motivated to tinker with property rights allocations at a subsequent date in order to improve performance by more defining, informally or

formally, vaguely defined property rights. Changes in the formality of the contracts also caused changes in the separation of ownership and control for the farm manager, which we illustrate in Figure 1.10 and we refer to as the Stage 4 farm firm.

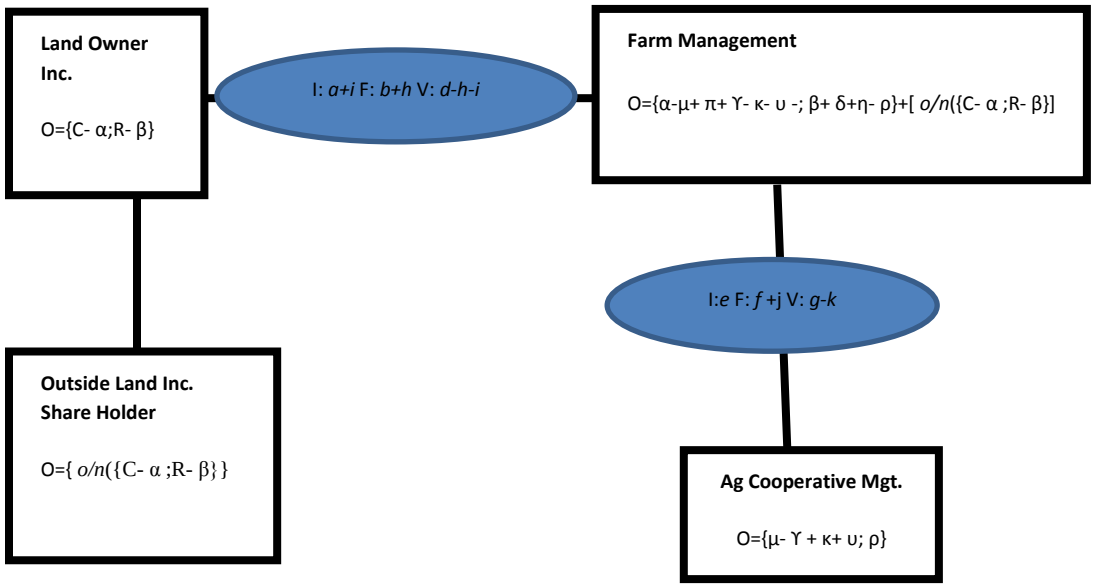


Figure 1.10. Stage 4 farm firm

A third example in the evolution of formality of contracts is the more recent adoption of formal production and marketing contracts by farm managers in the latter part of the 20th century. The increase use of production and marketing contracts allowed efficiencies to be gained from risk sharing, identifying niche markets and capturing premiums, controlling farm manager inputs, and better coordination of farm manager production and delivery (e.g. MacDonald et al., 2004; Martinez, 2002; Boehlje, 1999; Barkema et al. , 1991; Ahearn, Yee, and Huffman; 2002; Lajili et al. ; 1997). Production and marketing contracts more formally stipulate control of inputs in production, methods of production, and market periods. Contracting increased beginning mid-20th century,

from governing 12 percent of farm production in 1969 (MacDonald et al., 2004) to around 40 percent of farm production at the end of the 20th century (O'Donoghue et al., 2011). Production contracts are characterized as the contractor (processor, marketer, or end user) of the produce owning the production from the beginning stages of production and the farm manager being paid a fee. The farm manager fee can be fixed or can include some combination of a fixed fee with performance incentives. A marketing contract is characterized as the farm manager still maintains most of the ownership rights to the production, but has granted some control rights to a processor, marketer, or end user, through a more formalized price, quality, and delivery period prior to the harvesting or finishing of the produce.

Evolution in complexity:

To model the implications of complexity on organizational adaptation and diversity, we use Kauffman's "NK" model (Kauffman and Weinberger, 1989; Weinberger, 1991) where N is the number of components (e.g. gene types) and K is the number of interdependencies (e.g. epistasis of the gene types) to fitness. In our NK model of the farm firm, we would exhibit complexity by the number of property rights that are interdependent to produce a fitness score. For example, imagine all the property rights can be listed for our farm firm resources, where there are N rights. We can examine different farm firm types and evolution of different farm types by coding each right the farm firm management has at the nexus of contracts. Say, for example, there are only four rights (e.g. right to produce on land, right to residual returns, right to sell land, right to sell produce, etc.). We will code the rights that the farm management has the rights as 1

and that they don't have the rights as 0 (coding could be more intricate to identify as an informal, formal, or vaguely defined right). In the case of only four rights, and the farm management has all the rights, then the farm firm would be described as [1,1,1,1]. With only four rights, and two possible codes, (i.e. have the rights or do not have the rights) there could be 16 possible types of farm firms (2^N). Each type of farm firm would have a fitness score, where there would be 16 fitness scores, one for each type of farm firm where fitness performance is ranked from best to worst. The type of farm firm with the highest fitness score will be the most robust. As Kaufmann (1996) describes, finding an organization type with the optimal fitness score would be easy if there are not any interdependencies. In our case, if the rights are interdependent, where K is the number of interdependencies, then it becomes exponentially more difficult to evolve gradually to a farm firm type with the highest fitness score. The reason is experimental variations (tinkering), or error variations, of altering one right while holding the others constant will not necessarily lead an organization from a less fit form to a more fit form. The farm firm can be stuck on a local optimum and never gravitate towards a global optimum, or the general population of farm firms can tinker with the contracts until they gravitate away from an optimal form never to return. Only through experiment of every type of farm firm will an accurate depiction of optimal fitness be revealed. When there are only four rights and two choices, the experimental task would not be daunting. However, when there are more rights (as N increases), and the rights are formally, informally, or vaguely defined, then the search for optimal fitness through experiment of every possible type becomes more costly, particularly as K (number of interdependencies) increases as well. Nevertheless, the framework suggests we could theoretically describe every possible

property right to the farm firm network and plot whether the person or entity at the nexus of contract has the right or does not. Every property rights type would have a corresponding fitness score that ranks the robustness of that organization type to survive. As complexity increases, neighboring organization points will most likely have vastly different fitness scores. In the simple dimension, neighboring organizations will more likely have similar fitness scores.

To describe the evolution of complexity in our framework, using NK interdependency, we will use truncated illustration of the farm firm from before. Consider the performance fitness of a farm firm management that distributed its right to produce (μ) to the agriculture cooperative management, in exchange for a right to patronage from a cooperative (η), and received the right to oversight of the cooperative management (π,) where farm firm of this type can be described as: […μ, η ,π…]=[….0,1,1…]). Imagine the effect on fitness performance if the farm firm did not receive the right to oversee the agriculture cooperative management, where the farm firm would be […0,1,0…]. Such a farm firm, presumably, would suffer poorer performance, possibly even poorer performance than if the farm firm management did not distribute their annual right to the produce (μ) where the farm firm would be[…1,0,0…]. However, if the producer has the right to oversight (π) , then not having the right to annual produce (μ), but a right to patronage (η) would improve fitness, where farm firm is […0,1,1…] . In this example, these three rights (μ, η ,π) all are interdependent (K=N-1=2) in explaining fitness performance of the farm firm. Consider another example, the adoption of the share contract at the Stage 2 farm firm. In this example, the farm firm management does not

have rights to all the residual benefits of the produce (R), rather a share portion of produce (β). The farm firm management does have rights to some of the control rights (α), but not all control rights (C), like the right to sell the land for example. The fitness score would expectedly be lower for a farm firm of this type where […R- β, β, C- α, α …]=[…0,1,0,1…]compared to a farm firm type where the farm management had all the rights ([…1,1,1,1…]), because there would presumably be less incentive for the farm manager to maximize production given their partial share (see Marshall, 1920; See Dasgupta et al., (1999) and Otsuka and Hayami, (1988) for a review of inefficiency of crop share contracts). Notice, also, that farm firm adopting a share contract would be a similar property right allocation at the nexus of contracts for a farm manager of a collective farm. Thus, the fitness score could possibly be better in the farm firm variant with the share contract […0,1,0,1…]due to a fifth interdependent right held by the farm firm management or farm owners. Let us say, the fifth right is an informal right to inheritance of the missing residual and control rights upon death of the land owner due to precedence of inheritance to kin (where inheritance is F and farm firm variants are: […R- β, β, C- α, α ,F …][4]), and this includes the right to sell the land. In such a case, the separation of residual rights and control rights did not have the expected negative effect on fitness, or inefficient allocation of resources, because of the redundancy of another right in the N code of rights (i.e. where farm firm is [...0,1,0,1,1…] and has at least K=4 interdependencies). Now imagine that farm firm fitness is dependent on just having the right to inheritance (F) and some control rights (α) (i.e. family management is most

[4]Family rights can be rights besides rights to inheritance, such as the informal right to free room and board in the family house.

efficient form of organization, due to low agency costs and extended horizons, then the number of interdependencies is less, where K=1. Here farm firm combination [...0,1,0,1,1…] performs nearly equal to other neighboring variants farm firms (e.g. [...0,0,0,1,1…], [...1,1,1,1,1…], [...1,0,1,1,1…], [...0,0,1,1,1…], [...1,0,0,1,1…]) when K=1, and family inheritance (F), and some control rights (α), are the important property rights to performance. The performance landscape is highest where farm management possesses some control rights (α) and rights to inheritance (F). Farm firm variants that do not possess the inheritance (F) and control rights (α) are all less fit forms, regardless of other property right changes (i.e. Fitness Performance {[...0,0,0,1,1…], [...1,1,1,1,1…], [...1,0,1,1,1…], [...0,0,1,1,1…], [...1,0,0,1,1…] }≥ Fitness Performance {[...0,0,0,0,0…], [...1,1,1,0,0…], [...1,0,1,0,0…], [...0,0,1,0,0…], [...1,0,0,0,0…]})[5]. As a result, farm firm evolution (i.e. adaptations) will occur near farm firm variants where farm management possesses both the inheritance (F) and control rights (α).

There could be additional property rights that negate the expected negative performance of the farm firm when there is increased separation of ownership and control besides family inheritance rights (F). These property rights can be associated with the institutional environment or selective incentives of collective action in the agricultural cooperative. For example, a share crop relationship where the agent farmer does not have the right to declare bankruptcy, but the landlord has a right to bonded labor if agent farm

[5] We suggest that positive effects to fitness due to "family-ness" are a "silencing trait" to misallocated or vaguely defined rights, or an institutional redundancy to incentive mechanisms. Thus, organization types that presumably would be inefficient tend to persist despite the perceived inadequacies in economizing on transaction costs that are theoretically expected to be detrimental to their fitness long-term. This also suggests that family firms may vary in property rights types, but their fitness performance may not change dramatically. For example, all possible organization types that include the family-firm property right will have similar fitness performance or a more 'smooth fitness performance' (Levinthal, 1997).

manager shirks on an operating loan from landlord, may not have the expected negative performance from the adoption of the share contract. In addition, a cooperative may incentivize borrowing (through higher loans or subsidized loans) of capital inputs to the sharecrop famer in exchange for the share farmer's annual right to produce (μ). The effect would be that the tenant farmer would increase their effort, despite not having all residual rights (i.e. R-β) to production, or control rights (C-α) to the land, under a share contract, given the agent's lower income level (Braverman and Stiglitz, 1982). Thus, the expected negative effect to farm firm performance from agency costs associated with the share contract would not only be reduced, but farm firm performance may also be improved from obtaining collective action gains, if other farm managers also participate by giving their right to produce to the cooperative. However, the increased borrowing from the cooperative may also cause the tenant farmer to decrease their risk taking given their lower income from borrowing more (Braverman and Stiglitz, 1982). Thus, it may be beneficial to farm firm performance to re-induce risk taking by developing property rights and selective incentives that encourage farm firm risk sharing. This may be through the farmers' mutual insurance contract or a federal crop insurance program we discussed before, which then would add additional property rights to the farm firm variants. However, the increase in income from successful collective action in the agriculture cooperative, and inducing risk-taking through a mutual insurance contract, may cause the farmer to decrease his effort and negatively affect performance of the farm firm from the share contract through a feedback loop, regardless of the increased borrowing. Although, the sharecrop farmer may only possess vague redeemable rights to the increased income from efficient collective action in the agriculture cooperative.

Thus, the feedback effect on effort, from added income, may be tempered. As we illustrate, determining the performance of a farm firm with an interlinked share contract, cooperative contract, and farmer mutual insurance contract became more difficult to determine because of the increasing complexity. Not only were property rights to the farm firm added, besides the property rights associated with the share contract, the added property rights, also, were interdependent on farm firm performance and may interact with the performance of the property right allocation in a share contract.

If the farm firm performance is just dependent on both the allocation of cooperative property rights, and rights to the land and inheritance, then regardless of whether the land contracts can be solved simply through family property rights, the farm firm evolved to be more complex than it originally was prior to the adoption of the cooperative contract. Where the farm firm is now: […μ, η ,π, R- β, β, C- α, α ,F …] with K>1. With just 8 bundles of rights, and if the rights the farm management possesses can be formal (1), informal (2), vaguely defined (3), or don't possess (0), there can be a possible 65,536 types of farm firms ($4^N=4^8$). If these bundles are all interdependent, where K=N-1, then the number of possible local optimum farm firms is estimated to average 7,281 (4^N /N+1) (Kauffman and Weinberger, 1989). If each bundle of right represents five property rights that can take 4 forms, then the number of possible farm firms quickly jumps to 1.2 septillion ($4^N=4^{40}$) and local optimums, with K=N-1, may average 29.4 sextillion. If K=1, then there is only one optimum and a smooth landscape ("a Fujiyama adaptive landscape"), if 1< K<N-1 then the number of local optimums increase and the landscape becomes rugged ("badlands adaptive landscape"). Depending

on the starting position of a stage 1 farm firm can determine how quickly the farm firm reaches a local optimum, and the distance to the global optimum, or next local optimum, through adaptive walks. These adaptive walks would be changes to farm mangers' property right allocations. Some farm firm types can probably be discarded as less fit forms, such as a farm firm where all the rights are vaguely defined, or the farm management does not possess any rights. However, when interdependencies increase, and the number of rights increase, the property rights that achieves the global optimum can be difficult to find with certainty, even if we can discard a great deal of farm firm variants as implausible. Furthermore, if complexity is increasing at a greater rate than selection, then the ability to improve fitness becomes more difficult and "complexity catastrophe" may result (i.e. McKelvey, 1999).

Implications of Conceptual Framework:

If we examine the successive stages of our farm firm evolution before, we will note that number of rights associated with farm assets and resources increased as our farm firm evolved. Additional rights were residual rights to cooperative returns, rights to unallocated indemnities from the mutual insurance firm, control rights to oversee cooperative management, association representatives, etc. We will also note that interdependency of the number of rights to those assets increased as well due to the adoption of these contracts. As a result, the degree of complexity also increased. The expected evolutionary track is for the nexus of contracts to become more complex. In our framework, interdependency of the property rights was a byproduct of our hypothetical contractual arrangements that benefited the individual agents. For example, in our Stage 4

farm firm, farm management performance is now dependent on rights allocations and subsequent actions taken by agriculture cooperative management, producer association representatives, desires of land owner incorporated shareholders, farmers mutual insurance managers, federal crop insurance managers and government subsidization, and other farm managers involved in these organizations, given their rights. The arrangement of rights to control actions that are beneficial to competing interests creates interdependencies of those rights allocations. A high degree of interdependency would likely find random fitness as individual rights allocations are altered in the nexus of contracts. A weak degree of interdependency would find low correlations of rights changes to fitness in the nexus of contracts. Many interdependencies increase complexity, and raise the costs to development of a long-term optimal rights allocation. Hence, a robustly stable system of rights allocation is likely to develop that is Pareto inferior. A Pareto superior equilibrium would be more fragile to undesired mutations and outside perturbations given the existing property rights allocations. The evolution to more robustly stable complex organization will occur as agents continue to informally, or formally, redistribute and recombine property rights. The motivation is to find allocations that improve coordination and mitigate the harmful effects of undesired alterations.

We contend that surviving farm-firms that are simple, and have very little interdependencies, have dramatically decreased in market share. Our hypothesis is that current farm firms, with larger market share, are more complex and have been sustained by altering the N code of property rights, despite interdependencies, that have revealed

fitter forms of organization. We contend that even fitter forms of farm firm organization potentially exists, but the potential to inadequately determine the proper arrangement of rights expose the farm firm to un-economized transaction costs that would severely affect fitness. As the farm firm evolves, misaligned property rights allocations will likely become more catastrophic because of greater interdependency and complexity.

Some criticism of the complex adaptive system model centers on an unsound social definition of organization fitness. Our suggestion of fitness, in the context of this framework, is a rights allocation distribution that sufficiently brings utility to the agents in the systems. This utility extends both to the direct stakeholders and indirect stakeholders in the nexus of contracts. Since this framework focuses on contractual agreements that allocate property rights, the contractual agreements must by definition be agreeable by at least two agents. That is not to suggest that there may not be a better system of agreements, but given the existing environment, agents find the current system brings sufficient utility. Motivation for changes to the contractual agreements will result when agents feel the current agreements do not bring maximum utility and continuation of the current system will lead to further disutility, or actions by other agents reduce the expected utility in the current contractual agreements. Persistent, sub optimal, property allocations can occur in more complex arrangements because superior equilibriums would require extensive tinkering of property rights across different contractual transactions, and may lead to even worse performance if the property rights allocations has small misallocations.

Limitation of the Framework:

We acknowledge that by limiting our focus to the evolution of incomplete contracts, we miss another evolutionary track that can occur. That is to market type governance. A fourth dimension in our framework would be evolution to markets, or classical contracting that utilizes a price mechanism. Though, farms that exhibit high combined ownership and control are likely to have more market governance transactions, particularly as farm size and production increase. This is because surplus production and inputs needed to produce surplus production are likely traded using spot market governance mechanisms. These transactions would focus on transfers of rights and not extended distributions or allocations of rights. To maintain the simplicity of the framework, we limit any discussion to incomplete contracting, in a "firm" type sense.

Summary of the framework:

The framework we develop illustrates how our model farm firm has evolved from a combined ownership and control, informal, and non-complex nexus of contracts to something that is more separated ownership and control, more formally defined, and has an increased degree of complexity than it initially did. The degree of evolution in our three dimensional framework only matters in the relation to what the existing literature conveys about understanding the firm, from either a family-firm position, or the theory of the firm position. We suggest the evolution of the farm firm has made it distinctly different in these dimensions than what the current literature on the theory of the firm, or literature on the Family Firm, examines (See Figure 2.7 and Table 2.1).

Further, we suggest that every type of farm firm is related to a fitness performance level. The performance level is different from other performance measures often used in trying to examine differences in farm-firm makeup, primarily because the fitness performance we refer is a measure of the stability of the nexus of contracts. This is distinct in that performance can be enhanced to one person or entity in the nexus of contracts at the expense of another entity or person—say if the current contractual agreements favors one at the expense of another. In such a case, the nexus of contracts suffers inferior fitness performance longer-term because the entity or person who is adversely affected will be motivated to alter the existing nexus of contract design. Thus, the survivability of an inferior design is unlikely long-term, unless superior design changes require large mutations (where a long string of rights allocations are altered) that cannot be altered at low cost.

Table 2.1. How the farm firm has evolved to be distingushible from the literature on multiple dimensions

Dimensions	State of Family-Firm	Theory of the Firm	Theory of Farm Firm
Ownership and Control	Combined	Separated	Combined and Separated
Residual Rights	Family Managers	Investors	Farm- Managers and Family Investors
Control Rights	Family Managers	Management	Family Managers, investors, hired employees, cooperative managers, association representatives
Complexity	Simple	Complex	Mixed-Complexity
Correlation of Fitness performance to small changes in property right allocations	Low	High	Medium
Extension of Interdependency	Confined to family Managers	Extensive; investors, employees, management, strategic partners, customers, government	Family Managers, Family Investors, Employees, Cooperative Partners, Association Representatives, Other Farm-firms
Adaptation for Superior Fitness	Small Changes, Local changes	Global, large changes	Uncertain
Degree of Informality	Mostly Informal	Formal and defined but Incomplete	Uncertain
Organizational Diversity	Mono-culture	Poly-culture	Mixed

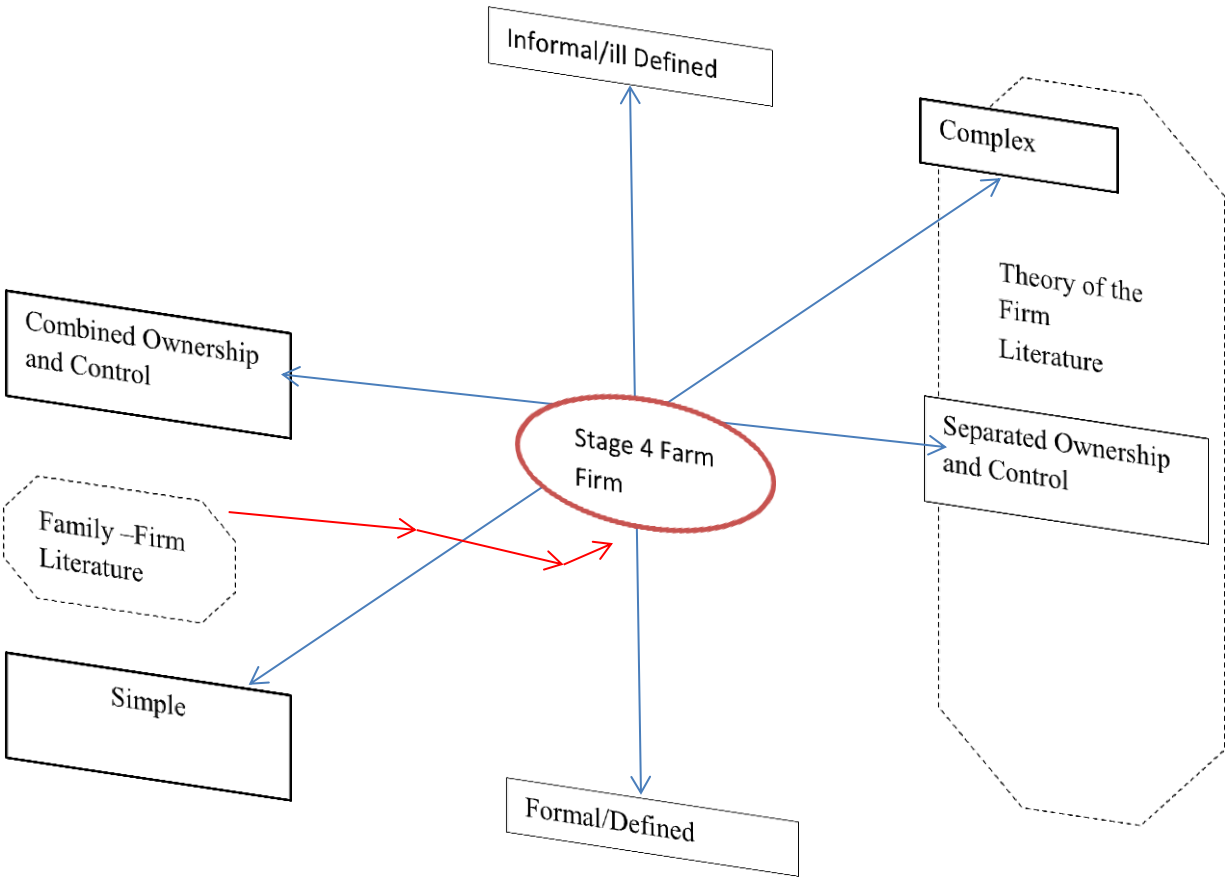


Figure 2.7. Illustration of the Evolutionary track of the Farm firm relative to the literature on family firms and the theory of the firm

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