Markets, Contracts, or Integration?
The Adoption, Diffusion, and Evolution of Organizational Form

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Abstract: The rise of contract farming and vertical integration is one of the most important changes in modern agriculture. Yet the adoption and diffusion of these new forms of organization has varied widely across regions, commodities, or farm types, however. Transaction cost theories and the like are not fully effective at explaining the variation of adoption rates of different organizational forms, in part because of their inherent static nature. In order to explain the adoption, diffusion and evolution of organizational form, a more dynamic framework is required. This paper lays out such a framework for understanding the evolution of organizational practices in U.S. agriculture by drawing on existing theories of economic organization, the diffusion of technological innovation, and organizational complementarities. Using recent trends as stylized facts we argue that the agrifood sector is characterized by strong complementarities among its constituent features and that these complementarities help explain the stylized facts. We also discuss several testable hypotheses concerning changes in organizational form in agriculture.

Keywords: contracting, vertical integration, organizational innovation, diffusion

JEL: L14, L22, Q13, O33

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1. Introduction

The US agricultural sector is characterized by a wide array of organizational arrangements. The past two decades witnessed a tremendous increase in the shares of many products produced or marketed under contract. Contracts now govern 36 percent of the value of all agricultural production, up from 12 percent in 1969 (MacDonald et al., 2004). The adoption of contracting has not proceeded evenly across commodities, however. Between 1991 and 2001 the value of rice production under contract increased from 20 percent to 39 percent. For cotton the increase was 31 percent to 52 percent; for hogs, 30 percent to 61 percent; and for tobacco, less than 1 percent to 48 percent. For livestock commodities such as milk, hogs, and broilers, and for crops such as sugar beets, fruit, and tomatoes, contracts are the primary means of handling production and sales. Moreover, data on contracts tell only part of the story. For instance, Grimes et al. (2004) report the percent of hogs sold on the negotiated cash market fell from 62 percent in 1994 to 12 percent in 2004, suggesting an increase in vertical integration to accompany the increase in contracting for hogs. Vertical integration is also common in the production of poultry, turkey, and particularly eggs.

Besides these differences across commodities, we also observe differences in the adoption and diffusion of contracting and other organizational arrangements across regions. The value share of product under contract varies from a low of 25 percent in the USDA’s Northern Great Plains region to over 68 percent in the Southern Seaboard region. Furthermore, the use of marketing versus production contracts varies across regions and over time. Similarly, the degree of vertical integration differs across regions for particular commodities such as hogs and sugar beets.

These patterns represent puzzles for our theoretical understanding of economic organization. Existing theories that do well at explaining differences in organizational form across different products or commodities, such as transaction cost theories incorporating asset specificity, quality measurement, and production risk, do not do well
at accounting for geographical differences in adoption rates or the speed at which organizational change occurs. The problem with the existing literature is that it tends to focus on the discrete choice of one organizational form (e.g. spot-market exchange) versus another (e.g. vertical integration) in a static equilibrium context. However, as we argue below, this type of analysis precludes an examination of the often more important question of whether the choice of organizational form fits with all other features and characteristics of environment with which the organizational forms must interact that do not remain static, suggesting a more dynamic “systems effect” approach to understanding the choice of organizational form (Milgrom and Roberts, 1995). This is why, at present, we know little about how organizational forms evolve and what factors affect the adoption and diffusion of new organizational forms.

This paper addresses this gap in the organizational economics literature by examining the choice of organizational form as it fits within a system of organizational, operational, and structural features. We first summarize the pattern of organizational adoption rates across agricultural products and producing regions over time. We then draw on existing theories of economic organization, the diffusion of technological innovation, and organizational complementarities to outline an approach to understanding the evolution of organizational practices in US agriculture. Using the observed trends as stylized facts, we then discuss several testable hypotheses concerning changes in organizational form in agriculture.

2. The Vertical Coordination of Agricultural Production: A Bird’s-Eye View

The rise of contract farming and vertically integrated forms of production is undoubtedly one of the most important changes in late twentieth-century US agriculture. As noted above, the value of production under contract has risen dramatically in recent years, roughly tripling over the last three decades, though exact numbers vary by source
(MacDonald et al, 2004). Some details are less widely publicized, however. First, use of contracting is concentrated among large and commercial farms. In 2001, only about 11 percent of US farms used contracts of any type, while 42 percent of all commercial farms used them. The number of farms using contracts, and the value of production under contract, rises monotonically with firm size (a pattern that has remained roughly consistent throughout the 1990s, the period for which detailed data are available). Even if there were no within-farm changes in the organization of production, we would expect an increase in contracting to accompany the generally observed increase in average farm size.

Second, the use of contracting varies widely across regions. The value of production under contract is substantially higher in the USDA’s Heartland and Southern Seaboard, and Mississippi Portal Regions than the national averages. Reimund, Martin, and Moore (1981) and MacDonald et al. (2004) suggest that contracting initially spreads among producers within a particular region before spreading to other regions. Data on changes in contracting practices across regions are spotty, however. MacDonald et al. (2004), base their story on the USDA’s Agricultural Resource Management Survey (ARMS), but the survey was first deployed only in 1991 and does not examine all commodities with equal depth in all years.

Third, the use of contracts and other forms of vertical coordination differs substantially among commodities. Contracts now govern about half of livestock production but only one-fourth of crop production. Livestock producers use both

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1 Data on agricultural contracting are available from the Census of Agriculture, the Agricultural Resource Management Survey (ARMS), and other government and trade association reports. The appendix, “Data on Agricultural Contracts,” in MacDonald et al. (2004) explains these sources in detail.

2 Similar variety is found in European agriculture. Vertical integration or tight vertical control led by large retailers is largely developed among northern members of E.U. (U.K., Germany, and the Scandinavian countries). Complex contractual arrangements among hundreds or even thousands of participants are common in France, Italy, the Netherlands, and to a lesser degree Spain, particularly for developing and marketing products of “Protected Designations of Origin” and “Protected Geographical Indications” as well as organic products. Small independent producers that are less coordinated and tend to focus on local or regional markets are common in Southern Europe (Greece, Portugal, and parts of Spain, Italy and France) (Raynaud, Sauvée, and Valceschini, 2002; Ménard and Klein, 2004)
marketing and production contracts, while crop production rarely involves production contracts (MacDonald et al, 2004). Within livestock, contracts govern about 20 percent of the value of cattle production, while contracts or vertical integration account for about 75 percent of the hog market, 90 percent of the turkey market, 90 percent of the egg market, and virtually all of the broiler market (Martinez, 1999, 2002; Roy, 1963). Often we observe variety among types of contracts even for a single commodity within a given region. 

More importantly, the speed at which contracts and vertical integration were adopted vary widely across farm type, regions, and commodities. In some sectors, new organizational practices diffused very rapidly. The broiler industry was one of the earliest US agricultural sectors to move from spot-market production to more tightly vertically coordinated forms of organization. In 1950 only 5 percent of broiler production was under contract or processor ownership; by 1955, 88 percent was under production contract and 2 percent was vertically integrated (Roy, 1963). Since the 1950s, 85 to 90 percent of production has remained under production contracts, with most of the rest produced under vertical integration (Martinez, 1999, 2002). The typical production contract has not changed much over the last half-century, with the processor providing baby chicks, feed, veterinary services, and managerial expertise to growers, who supply labor and chicken houses and are paid for each chicken produced (Martin, 1999). Spot-market procurement is similarly rare in turkey and egg production, though vertical integration plays a larger role in those sectors.

In the hog market, the adoption of contracts and vertical integration was more recent and not quite as rapid. In 1993, 87 percent of hogs were acquired on the spot market, 11 percent through marketing contracts, and 2 percent through vertical integration (Hayenga

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3 An extensive study of over 20,000 contracts in the poultry industry in France showed a differentiation among three types of contracts—“fixed-price,” “buy-and-sell,” and “putting-out” contracts—that clearly related to the degree of specific investments (Ménard, 1996).

4 Knoeber (1989) argues that grower ownership of production facilities serves as a performance bond; high-quality growers can signal their ability through their willingness to invest in costly, specialized equipment.
et al., 1996). By 2000, the figures were about 25 percent for spot markets, about 50 percent for marketing contracts, and about 25 percent for vertical integration (Lawrence and Grimes, 2001). Spot-market purchases fell further to 17 percent in 2002 (Grimes and Meyer, 2002).

By contrast, in crop production, the use of contracts and vertical integration has increased only gradually over the last few decades (MacDonald et al., 2004), although there are two notable exceptions. Tobacco saw a dramatic rise in contracting, increasing from 9 percent to 81 percent between 2000 and 2001, while contracting in peanuts declined from 48 percent to 21 percent between 1992 and 2001. Yet crop production is subject to many of the same technological and market changes (genetic modification, consumer demands for quality and traceability) that are thought to have driven organizational change in livestock production. Existing literature says little about these differences in the adoption and diffusion of more tightly coordinated vertical modes of production.

3. Why Do Contracting Practices Differ?

As this brief overview demonstrates, the adoption of contracts and vertical integration has not proceeded evenly across commodities or regions, and diffusion rates also vary within commodity groups and within regions. How can we explain these different rates of adoption and diffusion? One approach is an equilibrium explanation in which agents are modeled as always choosing optimal organizational practices, yet these optima vary cross-sectionally and over time due to exogenous changes in resources or technology. An alternative approach — albeit one with which economists are generally less comfortable — is a disequilibrium explanation involving experimentation and learning. In this type of explanation organizational adaptation and diffusion can be slow and uneven, depending on individual, firm, and market characteristics. Consider each type of explanation in turn.
Equilibrium Explanations

Surprisingly, the best-known theories of vertical coordination, such as the transaction cost explanation associated with Coase (1937), Klein, Crawford, and Alchian (1978), and Williamson (1979, 1985), say little about organizational change. Instead, these theories are usually framed in comparative-statics terms. Transaction cost economics (TCE), for example, explains the efficient form or organization in terms of underlying transactional characteristics such as asset specificity, uncertainty, and frequency. Investment in relationship-specific investments exposes parties to certain risks; when circumstances change, their trading partners may try to expropriate the rents accruing to the specific assets by renegotiating the terms of trade. Contracts and vertical integration are a means of protecting these rents. To explain variation in contracting practices across markets or over time, one would look for corresponding variation in the appropriate underlying characteristics.

The theory is fleshed out by specifying which organizational forms (or “governance structures,” in Williamson’s terminology) go with which transactions. Transactions differ in the degree to which relationship specific assets are involved, the amount of uncertainty about the future and about other parties’ actions, the frequency with which the transaction occurs, and so on. Each matters for the preferred institution of governance, although the first—asset specificity—is particularly important. Williamson (1985, p. 55) defines asset specificity as “durable investments that are undertaken in support of particular transactions, the opportunity cost of which investments is much lower in best alternative uses or by alternative users should the original transaction be prematurely terminated.” This could describe a variety of relationship specific investments, including both specialized physical and human capital, location-specific assets (“site specificity”), and equipment or inputs that must be used in a specific temporal sequence (“temporal specificity”).
TCE has many obvious applications to agricultural production.\(^5\) Martinez (1999, 2002) and Martinez and Zering (2004) use TCE to explain contractual practices in poultry, eggs, and hogs. The poultry and egg sectors experienced rapid technological change in the decades immediately following World War II, as specialized production facilities replaced the general-purpose farm equipment used previously. The switch to these more mechanized modes of production led to increased use specificity (assets specialized to particular uses), and consolidation driven by scale economies along with perishability led increased user specificity (asset specialized to particular trading partners). Similar changes occurred in hog production, though the timing came later and with greater variation across regions. Because hogs can be transported greater distances without losing value and can be slaughtered at different ages, site and temporal specificities are less important in the pork industry where (less tightly coordinated) marketing contracts, rather than vertical integration or production contracts, appear sufficient to mitigate opportunism.

This type of explanation suffers from several drawbacks, however. First, if specificity is the main driver of organizational change, then what explains the cross-sectional and time-series variation in the exogenous technological or demand shocks underlying the hypothesized changes in asset specificity? To explain the contracting patterns described in the previous section, a more dynamic theory of the diffusion of technology is required. In Martinez’s (1999, 2002) analysis of hog production, for example, the adoption of marketing contracts and vertical integration tracks closely the adoption of newer, specialized production technologies (including genetic information), which constitute forms of asset specificity, and increases in processor concentration, which make producers more dependent on particular processors (what Williamson describes as small-numbers bargaining conditions). However, technology, industry structure, and.

\(^5\) Indeed, some of the earliest modern studies on economic organization focused on agricultural contracting such as cropsharing (Stiglitz, 1974), land tenancy arrangements (Rounasset and Uy, 1980; Alston and Higgs, 1982; Alston, Datta and Nugent, 1984; Datta, O’Hara, and Nugent, 1986), and markets for commodities like honey (Cheung, 1973) and fresh fish (Wilson, 1980; Acheson, 1985).
organizational form are endogenous; specialized technologies may only emerge after the appropriate governance structures have been devised and deployed. The fact that the particular underlying characteristics change as organizational form changes does not, by itself, provide us with a causal explanation for organizational change.

Second, the variation in transactional attributes we observe does not always closely fit known patterns of vertical coordination. For instance, site and temporal specificities apply to other commodities, such as dairy products, that have not experienced rapid adoptions of contracting.

Third, and perhaps most generally, all such equilibrium explanations implicitly assume that the competitive selection process works well, so that inefficient modes of organization are selected out. Indeed, some version of the “survivor principle” underlies much of the empirical work in organizational economics. Yet, as Lien and Klein (2005) point out, the survivor principle is controversial; it requires sufficient variation among the initial population of behaviors or characteristics and an effective feedback mechanism linking market selection to environmental characteristics. These kinds of criticisms are rarely addressed in the empirical literature.\(^6\) Despite an extensive literature in evolutionary game theory (Banerjee and Weibull, 1996; Fudenberg and Levine, 1999), there is little consensus about how selection mechanisms work, and to what extent they can be relied upon in empirical studies of efficient behavior.\(^7\) Of course, the survivor

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\(^6\) An exception is Williamson (1988: 174), who acknowledges that the process of transaction cost economizing is not automatic. The claim that transactions and governance structures are efficiently aligned, he says, “seems plausible, especially if the relevant outcomes are those that appear over intervals of five and ten years rather than in the very near term. This intuition would nevertheless benefit from a more fully developed theory of the selection process.”

\(^7\) Lien and Klein (2005) test the survivor principle in the context of corporate diversification, finding that survivor-based measures of relatedness are good predictors of firm’s decisions to diversify or retrench. Some newer papers in the empirical TCE literature do not assume the survivor principle, but rather employ a two-stage procedure in which in which the relationship between transactional characteristics and governance structure is endogenously chosen in the first stage, then used to explain performance in the second stage. Silverman, Nickerson and Freeman (1997) and Nickerson and Silverman (2003), for example, show that transaction cost efficiency is positively correlated with firm survival in the for hire trucking industry, while Bigelow (2004) and Argyres and Bigelow (2004) examine outsourcing
principle is particularly questionable in agriculture, where price supports and other subsidy programs tend to cushion the impact of inefficient behaviors or characteristics.

Other equilibrium explanations for changes in the organization of agricultural production appeal to corresponding changes in market structure or consumer preferences. Practitioners often cite the rise of large, consolidated retailers and recent increases in processor concentration as the drivers behind increased reliance on contracting. Powerful downstream participants use their market power to force producers to accept contracts or buyouts. One problem with such explanations, besides their ad hoc nature, is that the underlying structural changes may themselves be endogenous; or, rather, organizational form and market structure may be determined simultaneously by variables omitted from these kinds of stories. Martinez and Zering (2004) note the role of increased consumer demand for quality differentiation and standardization across markets. The increased demand for lean pork, for example, raises measurement costs (in Barzel’s sense), for which marketing contracts can be an effective solution. The challenge here is to explain why preferences have changed for some commodities but not others.

arrangements in the U.S. automobile industry and find that transactions that are appropriately aligned tend to last longer than inappropriately organized ones.

8 We do not say much about changes in risk preferences because, following Allen and Lueck (2003), we question the role of risk in explaining the specific features of agricultural contracting. Allen and Lueck show, for example, that riskier crops are more likely to be associated with fixed-rent contracts, rather than share contracts, contrary to the predictions of standard agency models. Moreover, individuals often act simultaneously as principal in one transaction and agent in another, making it unlikely that contracting arises in response to differences in individuals’ tolerances for risk. Allen and Lueck suggest instead that contracts serve primarily to reduce measurement costs and mitigate moral hazard problems arising from the unique characteristics of land. For a contrary perspective, arguing that studies of risk and transaction costs in agriculture do not adequately control for endogenous matching between principals and agents with unobserved idiosyncratic characteristics, see Ackerberg and Botticini (2002).

9 See Mazé (2002) and Raynaud et al. (2002) for discussions of contracting trends in Europe, where quality control plays a particularly strong role. They show, for example, that contracts involve an increasing number of detailed clauses regarding quality and the control and monitoring processes that render inputs traceable, all of which require increasingly tight control of the supply chain. On the other hand, the need for flexibility—for instance, matching producers’ livestock to the ever changing quality needs of packers—sometimes leads to an increase in informal, relational contracting, rather than explicit agreements.
Disequilibrium Explanations

As noted above, economists have devoted less attention to theories of economic change than to static models of economic efficiency. One important exception is the literature on the adoption and diffusion of new technologies. It is widely recognized that diffusion rates vary considerably. Rosenberg (1972) observes that “in the history of diffusion of many innovations, one cannot help being struck by two characteristics of the diffusion process: its apparent overall slowness on the one hand, and the wide variations in the rates of acceptance of different inventions, on the other.” As modeled, for example, by Hall and Khan (2003), an individual producer’s decision to adopt a new technology depends on the ratio of short-term transition costs (particularly learning) and the long-term benefits of using the superior method of production. When these future benefits are uncertain, and agents have different expectations about them, there is an option value to deferring the decision to adopt. Increased uncertainty and heterogeneity of expectations thus explains the variation in adoption rates across technologies and markets.

Technological innovation can diffuse slowly and unevenly for other reasons. First, there is a need for complementary organizational structures. Chandler (1962, 1977) shows how the rise of large, vertically integrated industrial enterprises during the early twentieth century gave manufacturers the ability and incentives to develop and deploy new technologies. More recently, new information-management technologies (supply-chain management and distribution systems) have given power to large retailers, whose procurement systems drive the entire vertical process of production. Second, complementary marketing and branding strategies must be developed. Of course, as pointed out above, technology and organization may be simultaneously determined, leaving us without a causal explanation for the observed variation in organizational form. Moreover, these complementary factors are themselves endogenous.

To what extent do theories of the diffusion of technological innovation apply to organizational innovation? Chandler’s work on the emergence of the multidivisional or
“M-form” corporation appeals to similar notions of adaptation and imitation. Early adopters reaped innovation rents, which were reduced as the M-form model spread throughout the corporate sector. Henriksen and Hviid (2004) show that the switch from paying by quantity to paying for quality (in this case, for milk) was quite slow. Zylbersztajn and Lima Nogueira (2002) adopt the framework of the traditional logistic “S”-curve of technological diffusion (see Griliches, 1957) to examine the diffusion of two different governance forms in the Brazilian poultry industry based on differences in asset specificity, and argue greater asset specificity is associated with a faster rate of change to and a greater penetration of contractual versus market coordination of production.

The rate at which technological or organizational innovations spread throughout an economy depends on information (market participants must be familiar with the new methods or processes), switching costs, strategic considerations, and the strength of market feedback mechanisms. The literature on network effects suggests that positive feedback between producers and consumers can lead to “tipping points” during which a new technology or practice suddenly and rapidly displaces an older one (Shapiro and Varian, 1998).10 MacDonald et al. (2004, p. 14) suggest that the rapid adoption of contracting and vertical integration in tobacco and hogs may result from such tipping points in marketing systems. It is unclear, however, what would be driving the network effects in this case. Does the value of contract farming for a particular producer or processor depend on the number of other farmers or producers using contracts? If producers rely on informal exchanges of knowledge with other producers and input suppliers, then the existence of contracting in a particular geographic area could make producers in that area less reluctant to try it. This suggests that diversified agricultural regions, where markets for multiple commodities coexist, are more likely to adopt

10 The best-known example, popularized by David (1985), is the adoption of the QWERTY keyboard. Others include the VHS video recording technology, the MS-DOS operating system, and the Internet Explorer browser. These and other examples are challenged by Liebowitz and Margolis (1999).
contracting than a region specializing in a particular commodity without a history of contracting.

Mayer and Argyres’s (2004) study of contractual practices among repeat players over time suggests that adoption of efficient contractual practices is slow and gradual for another reason: the process of learning and discovery is itself slow and gradual. Contrary to TCE’s notion of “farsighted contracting,” in which parties anticipate potential hazards and design contracts to mitigate them, the firms studied by Mayer and Argyres did not generally correct for contractual problems until they experienced them. If hazards occur randomly, and result in learning for the parties experiencing them, then the evolution of contractual form should be slow and uneven.

The Role of Organizational and Technological Complementarities

As mentioned above, technological or organizational complementarities can have an important effect on diffusion rates. Complements are simply factors that go together. For example, central processing units (CPUs), memory boards, and hard drives are complements because they are mutually required in the production of computer. An increase in the production of CPUs and memory board should be correlated with an increase in the number of hard drives produced. The more tightly variables are within a system move together, the stronger is the degree of complementarity. Williamson (1991, p. 271) hints at the notion of complementarities in the context of organizational change by noting that surviving organizational forms are those in which a “syndrome of attributes” coexist and support one another.

There is a growing body of theoretical work on complementarities within organizational systems. Holmstrom and Milgrom (1994) develop a multi-task agency model in which high performance incentives, worker ownership of assets, and worker freedom from direct managerial control are complementary instruments for motivating workers. They show that weak performance incentives, firm ownership of assets, and
significant restrictions of worker activity are typical characteristics of employment, while strong output-based incentives, worker ownership of productive assets, and worker freedom are characteristic of independent contracting. Milgrom and Roberts (1995) argue, similarly, that the “fit” between firm strategy, structure, and production and managerial processes helps to explain firm performance. For example, mass production is most effective when combined with long production runs, an emphasis on volume, mass marketing, infrequent product changes, the use of specialized rather than flexible machinery and jobs skills, sequential product development, hierarchal planning and control, and vertical integration. Organizations that mass produce but have short production runs, make-to-order inventories, and that emphasize cost and quality will be less effective than companies that adopt the complementary practices and structures. Case studies from sectors ranging from steel (Inchiowski, Shaw, and Prennushi, 1997) to information technology (Bresnahan, Brynjolfsson, and Hitt, 2002) confirm the importance of complementarities to organizational performance.

Most important for our purposes, the existence of complementarities helps account for the extent and effectiveness of organizational change. Milgrom and Roberts (1995, pp. 190-91) note that their analysis of complementarities within organizations provides a reason why change in a system marked by strong and widespread complementarities may be difficult and why centrally directed change may be important for altering systems. Changing only a few of the system elements at a time to their optimal values may not come at all close to achieving all the benefits that are available through a fully coordinated move, and may even have negative payoffs. Of course, if those making the choices fail to recognize all the dimensions across which the complementarities operate, then they may fail to make the full range of necessary adaptations, with unfortunate results. At the same time, coordinating the general direction of a move may substantially ease the coordination problem while still retaining most of the potential benefits of change. Moreover, the systematic errors associated with centrally directed change are less costly than similarly large but uncoordinated errors of independently operating unit.
When a system is characterized by strong complementarities, change requires simultaneous, coordinated changes among all complementary features within the system. By contrast, when complementarities within a system are weak — for example, when production and organization are “modular” (Henderson and Clark, 1990; Langlois, 2002) — then any features of the system could be changed relatively easily. Organizational change will thus tend to be slow and uneven when complementarities are strong and other relevant factors are slow to change.

The notion of complementarities is important for understanding the uneven pattern of adoption and diffusion rates of contracting and other organizational forms within the agrifood sector. As we explain below, agricultural production is characterized by strong complementarities. Sectors such as poultry and hogs that underwent relatively rapid rates of organizational change, for example, did so in part because complementary variables within those sectors also changed to correspond with the production contracting system. Sectors and regions that have been slow to adapt, by contrast, have not experienced complementary changes of key variables.

The following section identifies key complementary factors in food and agricultural production. Our objective is to show that the choice of organizational arrangement in agriculture — spot market transaction, marketing contract, production contract, and vertical integration — is closely tied to complementary variables within the entire agrifood value-added system. Thus, unlike the literature that explores complementarities within distinct organizational units, such as firms, we postulate that there are strong complementarities existing within the entire value-added food chain and that these complementarities explain the pattern of organizational structures described above.

**Complementarities in the Agrifood Sector**

To understand the nature of complementarities within the agrifood system we first present a brief and highly stylized representation of the flow of food from sources to
consumer. We then present what we believe are important complementary variables within the agrifood system. Finally, we show how these variables interact to explain many of the observed organizational variations in organizational choice in agriculture.

The agriculture system is a complex and highly structured system, as shown in the schematic representation of the agrifood chain in Figure 1. Agricultural producers take raw inputs, such as farm supplies, seeds, feed and machinery, and produce raw agricultural products, such as grains, oilseeds crops, vegetables, poultry, livestock and dairy products. These raw products are marketed either through brokers or directly to food processors, who transform raw agricultural products to finished foodstuffs or feedstock. Processors then market their food products to wholesalers and retailers, such as grocery stores and restaurants, where they are finally consumed by consumers.

[Figure 1 about here]

Given the complex nature of the agriculture sector and increasing demand for differentiated and specialized end products, which require greater coordination across levels of the value chain, it is reasonable expect that complementarity would play a significant role in affecting organizational structures between and across levels of production. Although we are primarily interested in the organizational structure of the producer-processor stage, concepts of complementarity require us to consider how this stage fits into the overall value chain for different agricultural products in addition to the nature of the characteristics of the producer and processors themselves.

For instance, demand for GM-free food products offers potential premiums to industry participants that can effectively develop segregated identity-preserving supply systems, but both the premiums and the organizational structure of the segregation systems will depend on the agricultural product (i.e., whether GM is even an issue) and its end use. If the adoption of production contracts in grains and oilseeds is driven by demand for GM segregation, we would expect more contracting in soybeans and corn than in wheat, for instance. Because a vast majority of corn in the US is ultimately
consumed by animals rather than people, we might also expect different rates of GM-based contracting among soybeans and corn.

The nature of the assembly and processing infrastructure in a given region may also affect the introduction and rate of adoption of GM-based contracting. Maltsbarger and Kalaitzandonakes (2000) and Barnes (2004) demonstrate that the costs of identity preserved segregation at the elevator and seed plant levels, respectively, is highly sensitive to the configuration of storage bin assets. Thus, one would expect the volume and premiums offered for contract opportunities would vary across regions based on existing infrastructure. Since volume and premiums are the primary source of value to producers, we would therefore also expect the rate of adoption (or the success of contract programs) to be correlated with market infrastructure as well as the availability of on-farm storage.

While the case of non-GM contracting in soybeans presents a consumer-driven change that works its way back through the supply chain, financing in hog and poultry production may provide an input-driven set of changes in organization. Production contracts in poultry and hogs typically require producers to provide specifically-designed production facilities (buildings) that often require financing for the producer. While these production facilities are long-lived, Knoeber (1989, p. 276) notes that none of the contracts in his study “appear to be designed to last for the likely economic life of the housing facilities provided by a grower, and even longer term contracts provide for early termination by the company (or the grower).” Banks lending to producers have pushed integrators for longer-term contracts as a condition for providing capital for building production facilities. Integrators have, in some cases, also provided financing to producers. Thus, one might expect access to financial capital to be a factor in determining the proliferation of contract production as well as the nature of the relationship between producer and integrator. Because the need for external financing at the farm level depends on the nature of the facilities required for a particular production process, this
factor may also affect agricultural sectors differently. Moreover, since producers have traditionally relied more on rural commercial banks for financing (Keeton, 1996) and given consolidation in the banking industry and entry of larger banks into rural markets (Gilbert and Belongia, 1988), access to credit may also vary regionally as well as across agricultural products.

These two cases represent very different issues facing varying sectors of the agrifood system, but they illustrate the importance of complementary resources for affecting the introduction, adoption and diffusion of different forms of organization. In short, there are several variables originating at many levels of the agrifood chain that may affect the propensity to introduce and the rate of adoption of different forms of contracting or other organizational forms.

Moreover, complementary factors need not be limited to technological or tangible factors in the production process. Producers’ attitudes toward alternate organizational forms as well as differences in producers characteristics and human capital may also affect producers’ willingness to try new organizational arrangements. The density of production practices, both among producers and among processors, may affect information flows and learning among industry participants, thereby affecting the rate of adoption geographically or across members in a particular industry. The diversity of farming practices across regions may also affect the spill-over of contract experiences in one agricultural product to contracting practices in another.

Obviously, the list of potential complementary factors is large. Our challenge is to begin distilling the factors into manageable sets and identifying how those particular factors are likely to apply across agricultural products, producers, and regions. Table 1 presents a partial list of variables that might be complementarities within the agrifood chain. Because we are interested in the adoption and diffusion of organizational form occurring between producer and processor, we concentrate our populated list of complementary variables at those stages.
**Implications and Discussion**

We argue that the adoption, diffusion, and evolution of organizational forms is affected by the nature and strength of complementarities in the incumbent structure of the industry.

Systems characterized by strong complementarities will likely see slow or uneven adoption and diffusion rates of organizational form when other characteristic features of the system are also slow to change or when they change unevenly over time or in different geographic regions within the same industry. By contrast, adoption, diffusion and evolution of organizational form is likely to be rapid in strong complementarity systems when the complementary characteristics of the system change in consort.

Furthermore, because strong complementarities reduce the effectiveness or value of incremental changes at local or individual levels, more dramatic sector-level changes will be expected as market forces push the supply chain past the tipping point where large-scale changes are economically justified (in terms of switching costs, scale economies, etc.). Hence, in the context of the adoption and diffusion literature, we expect sectors characterized by strong complementarity to have a relatively steep adoption curve once a new form is embraced, but a long tail preceding adoption. Conversely, we expect sectors characterized by weak complementarity to have flatter, and perhaps less comprehensive adoption curves (i.e., ones that plateau at lower overall adoption rates).

Given differences in key factors across products and geographic regions, we expect the degree of complementarity—and its resulting implications for organizational change—should similarly vary across these dimensions, especially if exogenous shocks to the system are localized. Given an exogenous shock, regions with more flexible asset structures (human and physical) and complementing factors may adopt more dramatic
changes in organizational form (i.e., moving to vertical integration versus moving to contracting) than regions with more rigid asset structures and over a shorter time period.

Of course, our hypothesized listing of complementary features of the agrifood sector might be incomplete. Moreover, it also might differ for different sectors within agriculture. Further research is necessary to examine the regional rates of adoption of alternate organizational forms in livestock, poultry, grains, and vegetables, and the correlation of adoption rates with key factors identified above. One approach would be to examine changes in response both to fiscal stimuli such as market prices or financial crises and to changes in technologies and consumer demands such as demand for GM-free food products. Such empirical investigation is the next step of this on-going stream of research.
References


Table 1: Complementary Variables within the Agrifood Value Chain

<table>
<thead>
<tr>
<th>Variable/characteristic</th>
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<tbody>
<tr>
<td><strong>Farm producer stage</strong></td>
</tr>
<tr>
<td>Genetic characteristics and genetic diversity of farm inputs (such as seeds, breeding stock, etc).</td>
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<tr>
<td>Ownership of genetic characteristics (intellectual property rights).</td>
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<tr>
<td>Nature of machinery and production technology at farm/producer level.</td>
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<tr>
<td>Capital/labor ratio of farming operation.</td>
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<tr>
<td>Size/scale of farming operation.</td>
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<tr>
<td>Use of artificial chemicals as fertilizers, herbicides, pesticides.</td>
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<tr>
<td>Diversity of farm operation (including number of crops and/or livestocks farmed)</td>
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<tr>
<td>Financial capital borrowing constraints/requirements for farm inputs.</td>
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<tr>
<td>Infrastructure of bankers, credit agencies, legal system to support lending practices.</td>
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<tr>
<td>Indigenous knowledge of farming practices, as well as supplier and marketing networks.</td>
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<tr>
<td>Size of market for finished raw products, including number of and distance to marketing outlets.</td>
</tr>
<tr>
<td>Density of producers and processors/marketing outlets/contractors in geographic region.</td>
</tr>
<tr>
<td>Degree of traceability from raw to finished food products within the value-added chain.</td>
</tr>
<tr>
<td>Nature of organizational/contracting structure between farm producer and processor.</td>
</tr>
<tr>
<td>Knowledge of alternative organizational structures.</td>
</tr>
</tbody>
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| **Processor/producer Stage** |
| Desired quality characteristics of raw farm products. |
| Production requirements/technologies of processors. |
| Configuration of production assets relative to particular products. |
| Concentration of processors at processor/production stage. |
| Nature of organizational/contracting structure between processor and wholesaler/retailer. |

| **Wholesaler/retailer stage** |
| Size of grocery retailer/concentration in wholesale/retail industry. |
| Consumer/buyer demand for quality, price and other final product characteristics. |
Figure 1: The Agrifood Chain

Schematic representation of the agrifood chain, showing the flow of flood from source to consumer. From Kohls and Uhl (2002, p. 5).