Journal of Agricultural and Applied Economics, 37,2(August 2005):347–364

Industrialization and Contracting in U.S. Agriculture

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This paper examines the industrialization process of U.S. agriculture by examining the trends in the number of farms, the concentration of production during the last decade, and the dynamics of farm survivability, entry, and exit underlying aggregate statistics. We next examine vertical coordination as part of the industrialization process and highlight contracting in the poultry industry. The analysis provides evidence that production is continuing to be concentrated on a smaller number of farms at a relatively rapid rate, in spite of the stability in the number of farms. Although contracting clearly dominates the broiler industry, it is less prevalent in egg and turkey production, where other forms of vertical coordination are likely established.

Key Words: broilers, contracting, eggs, industrialization, poultry, structural change, turkeys, vertical integration

JEL Classification: D23, D40, L11, L14, L22, L23, Q12

The industrialization of U.S. agriculture has been documented for some time (e.g., Drabenstott). The industrialization has been, at least in part, motivated by more specific demands of consumers requiring a tighter supply chain to adequately respond. Major features of this tighter supply chain include greater concentration of production on a decreasing number of farms, more vertical coordination in the system, and significant concentration downstream from the farm. While the total number of farms has been remarkably stable for decades, this has been true because of the sustainability of very small farms. The endurance and growth of small farms result from the investment opportunities and the amenities they provide to their owners and communities, and are distinct from the industrialization process.

The increasing concentration of production in an industry is a longstanding public policy interest because it is not obvious whether this concentration is the desirable result of cost efficiencies in production or the undesirable result of market power on the part of various players in the supply chain (Williamson). Traditionally, concentration in production is a concern when a very few firms, e.g., four, control a significant share of the market. For this reason, most empirical applications on market power in U.S. agriculture are focused on meatpacking and, for example, the role of captive supplies (Azzam; Azzam and Anderson) because the processing sector of the supply chain is significantly more concentrated than is the farm production sector.

A related public policy issue is raised with respect to one approach to more vertical coordination in the supply chain, namely, contracting between farmers and downstream processors. For example, Perry, Banker, and Green reported that, for broilers which are largely produced under production contracts,

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the top 10 processing firms controlled two thirds of broiler processing in 1997. Empirical applications, where contractors operate in a concentrated processing industry while farmers operate in a sector with many other producers, include the analysis of the effects of individual clauses in contracts. (For example, Xia and Sexton analyze top-of-the-market pricing in cattle to evaluate whether the clause is due to efforts by contractors to exploit market power or to capture efficiencies.) The farm production component of the supply chain is not a highly concentrated industry in a traditional industrial organization sense; in fact, it is still used as a textbook example of a perfectly competitive industry. However, because of the institutional context of farm policy, there is a longstanding interest in family farms and an interest in tracking how farm production is concentrated among farm firms. Hence, *concentration* is a relative term and can take on different meanings, depending on which sector of the supply chain is of interest.

Questions relevant to the issue of the industrialization process in agriculture are: Why do farmers choose to contract? Why is certain commodity production concentrated in select states? And, why do processors locate in select states? Although these questions are generally addressed independently, they are likely interrelated. For example, if markets are incomplete locally, contracting may be the only option available to a farmer in that locale. Applied economic literature has largely explained the observed farmer adoption of contracting *ex post*. The principal-agent model is the most common economic framework employed to consider why individual farmers contract. This framework can address the two most commonly cited reasons for parties entering into contracts, namely risk management and minimization of production and/or transaction costs. Empirical research is mixed on which is most important.[1] McBride and Key analyzed the choice of hog farms to contract or not contract and found important increases in productivity resulted from contracting in the hog sector, compared to independent production. Some of the literature is focused on how specific terms of contracts affect their performance. In studies of the poultry industry, Knoeber and Knoeber and Thurman found that the terms of broiler contracts could be explained largely by the incentives to produce more efficiently. Growers are often rewarded based on relative performance, i.e., relative to other growers. In an aggregate analysis of how contracting has affected productivity of the U.S. farm sector since 1978, Ahearn, Yee, and Huffman found that the use of production contracting had a small but positive influence on the productivity of the sector.

Cost minimization and efficiency gains are the basis of a region's competitiveness in agricultural production. Traditional farm production economics focuses on the role of farm input prices, technology, and availability of fixed factors (including climate) in contributing to a region's ability to compete successfully. In an industrialized agriculture, nontraditional factors, such as site-specific factors affecting costs, deserve greater emphasis in explaining regional production trends and competitiveness. One obvious reason for this relates to the costs associated with the regulatory environment, especially for animal agriculture. In addition, in an industrialized agriculture producers are more likely to face incomplete markets because production of bulk commodities is replaced by production of specific products. These specific products often require specialized processing or storage and handling facilities in the local area. This is especially true for animal agriculture. Downstream processors choose their sites based on a number of processing cost minimization factors and thereby, to a large extent, affect where farm production will occur. In the case where production is vertically integrated with processing, on-farm cost minimization in the production of the raw agricultural product may be a relatively minor factor in determining the overall competitiveness of a vertically

[1] In the case of land contracts, Allen and Lueck (1995 and 1999) argue that risk management is not an important factor in explaining choice of land contracts. They find that several transaction costs (e.g., enforcement costs) are the more important factors.

integrated firm because farm production may be a small share of total costs.

The looming public policy questions regarding the effects of the industrialization process on the competitiveness and efficiency of the industry will likely never be definitively answered. However, we believe a better understanding of what is underlying the aggregate statistics can improve our understanding of the changes taking place in an industrializing agriculture. The general objective of this paper is to expand the current understanding of the structural changes which have occurred in recent decades and are often captured by the term "industrialization of agriculture." First, we review the basic structure of agricultural operations in the U.S. in terms of the number and size of farms. Secondly, we examine the dynamics of this change by measuring exits, entrants, and survivors over time. Finally, most of our attention in this paper is focused on a more specific organizational change in the structure of agriculture, namely, the use of agricultural contracts. One of the earliest uses of contracting in U.S. agriculture involves broilers in the southern region, so we include an examination of the trends in the production of poultry products, including broilers, eggs, and turkeys. In the end, by uncovering the dynamics and diversity underlying the aggregate statistics on farm structure, our paper raises as many questions as it answers. We believe the answers to some of these questions lie in the issues addressed by the other papers in this session relating to the regulatory environment, the shifts in plant location, and industry responses to consumer-oriented issues, like traceability.

Structure of U.S. Agriculture

Because the aggregate amount of agricultural land was relatively fixed during the 20th century, the change in the number of farms is closely correlated with the change in the size of farms. The long-term trends have been for the number of farms to decline and for the average acres operated per farm to increase over time. More recently, in the past two decades, both the number of farms and the average farm size in acres have been relatively stable. However, an average measure of farm size masks diversity in farm size. Most of today's farms are small farms by some definition, and many are classified as retirement and lifestyle farms (Hoppe et al.). Since the 1978 Census of Agriculture, the total number of farms has remained about 2 million, declining only slightly in the five agricultural censuses since 1978. The number of large farms (>1,000 acres) and the smallest farms (<50 acres) has increased, but the number of mid-sized farms has declined. However, the size distribution and the trends in size class vary considerably by state. In general, the most rapid growth in large farms in recent times tended to occur in the most rural states.

When comparing farms by size over diverse regions, we prefer to use a measure of size based on gross sales. Generally, structural change occurs slowly over time and is only evident in aggregate statistics over a long time series. However, shifts in the size distribution of farms—and especially the distribution of product—are clearly evident in aggregated data even over a period as short as a decade. Table 1 presents the distribution of farms and the value of all agricultural product by size of farm from 1991–2003 for the United States. through price increases, even if physical outputs remain unchanged. We accordingly adjusted farm sales for price changes using the Producer Price Index for farm products (which is also the USDA/NASS index of prices received by farmers), and sales values are thus expressed in constant (2003) dollars.

At the beginning of the period, 94% of farms were considered small and they accounted for 43% of product. A decade later, about the same share of farms was small, but they accounted for only 28% of product. Table 1 also presents this same structural information for four major regions of the United States. Like the Northeast, the South has a higher share of small farms. Tennessee and Kentucky, in particular, have a small-farm structure. Consistent with the small-farm structure, farm households in the South are more dependent on their off-farm income sources than is the average U.S. farm house-

Table 1. Size Distribution of Farms and Production Value, Constant 2003 Dollars, by Year, by Region

Item	1991–1993	1994–1995	1996–1997	1998–2000	2001–2002	2003
				%		
United States						
Share of farms:						
$249,999 or less	93.9	93.4	92.9	92.3	92.1	92.6
$250,000 to $499,999	4.0	3.9	4.2	4.3	4.3	4.0
$500,000 to $999,999	1.5	1.6	1.9	2.2	2.2	2.1
$1,000,000 or more	0.7	1.0	1.0	1.3	1.3	1.3
Share of production:						
$249,999 or less	42.5	39.5	37.4	30.5	28.0	28.4
$250,000 to $499,999	17.8	16.2	17.6	15.6	15.2	14.8
$500,000 to $999,999	13.0	13.4	15.2	15.5	15.8	14.9
$1,000,000 or more	26.8	30.8	29.7	38.4	41.0	41.9
Northeast						
Share of farms:						
$249,999 or less	94.5	93.5	92.6	92.8	92.6	94.6
$250,000 to $499,999	3.3	3.9	4.0	4.2	4.3	2.5
$500,000 to $999,999	1.7	1.8	2.4	1.9	1.9	1.9
$1,000,000 or more	0.5	0.8	1.0	1.0	1.2	1.0
Share of production:						
$249,999 or less	50.8	45.2	48.3	34.2	33.3	40.6
$250,000 to $499,999	17.6	17.0	15.1	15.8	16.8	11.5
$500,000 to $999,999	17.8	17.2	17.3	14.7	14.5	15.8
$1,000,000 or more	13.7	20.6	19.3	35.3	35.4	32.2
South						
Share of farms:						
$249,999 or less	95.5	95.3	95.2	94.9	94.9	95.0
$250,000 to $499,999	2.8	2.5	2.6	2.5	2.5	2.4
$500,000 to $999,999	1.2	1.3	1.4	1.7	1.6	1.6
$1,000,000 or more	0.5	0.9	0.7	1.0	1.0	1.0
Share of production:						
$249,999 or less	40.5	34.7	34.6	31.5	27.8	25.7
$250,000 to $499,999	18.6	14.3	17.2	15.1	14.3	13.3
$500,000 to $999,999	15.1	14.5	18.2	19.8	18.6	17.0
$1,000,000 or more	25.8	36.4	30.0	33.5	39.3	44.1
Midwest						
Share of farms:						
$249,999 or less	93.1	92.5	91.6	90.0	89.9	90.4
$250,000 to $499,999	5.1	5.1	5.7	6.4	6.4	6.1
$500,000 to $999,999	1.3	1.7	1.9	2.5	2.7	2.5
$1,000,000 or more	0.5	0.6	0.7	1.0	1.1	1.1
Share of production:						
$249,999 or less	52.8	52.6	47.5	36.6	36.9	34.3
$250,000 to $499,999	20.3	21.0	21.7	19.5	20.5	19.0
$500,000 to $999,999	10.6	13.0	12.6	15.1	16.5	15.1
$1,000,000 or more	16.3	13.4	18.2	28.8	26.2	31.6

Table 1. Continued

Item	1991–1993	1994–1995	1996–1997	1998–2000	2001–2002	2003
			%			
West						
Share of farms:						
$249,999 or less	91.1	90.2	88.8	90.6	89.5	90.5
$250,000 to $499,999	4.4	4.7	4.9	3.9	4.4	4.0
$500,000 to $999,999	2.5	2.4	3.5	2.7	3.0	2.6
$1,000,000 or more	2.0	2.7	2.8	2.8	3.0	2.9
Share of production:						
$249,999 or less	24.0	22.3	19.3	17.7	14.8	17.8
$250,000 to $499,999	12.3	10.7	11.4	9.3	8.4	9.7
$500,000 to $999,999	13.5	11.8	16.2	12.0	12.5	11.9
$1,000,000 or more	50.2	55.3	53.1	60.9	64.3	60.6

Source: USDA Farm Costs and Returns Survey (1991–95); USDA Agricultural Resource Management Survey (1996–2001).

hold. Many southern states have the highest rates of farmers working 200 or more days off the farm, according to recent Census figures. Although the distribution of farms by size classes is similar between the South and the Northeast, the concentration of product is not. The small farms of the South produce a much smaller share of the total product than do those in the Northeast because of the large share of product in the South concentrated on the very largest farms with sales of $1 million or more. The West has more of its product concentrated on the farms with sales of $1 million or more than does the South, but this region has twice the share of its farms in this largest size class, compared to the South.

Dynamics of Structural Change

For all industries, a high rate of entry is an indicator that anti-competitive barriers to entry are likely not significant. However, agriculture is characterized by some uniqueness that sets it apart from other industries, and these characteristics likely affect entry and exit rates. First of all, most farms are family farms, and their changing structure is reflective of the family life cycle. Most farms are also the residences of their operators, giving the farm business a greater resilience than that of most other nonfarm firms. Finally, the most significant input in farming is land and the total land in agriculture is relatively stable over time.[2] Much of the land operated by the farms that exit agriculture is subsequently purchased or rented by existing farms to expand their operation.

As mentioned above, the number of farms has declined very slowly over the last two decades. However, the relatively slow rate of decline in the number of farms over time masks significant exit and entry. For example, during the 24-year period of 1978–2002, the annual rate of decline in the number of farms was 0.25%, but in the 4–5 years between any two censuses, the annual exit rate has been much higher. The high exit rate has been counteracted by an almost equally high rate of entry, leading to the slow decrease in farm numbers evident from aggregate statistics. For any year, the population of farms can be classified as survivors, meaning the farm was enumerated in a previous census, or the farm can be classified as a new entrant, meaning the farm was not on the census rolls in the previous census. Exitors in a given census are simply those farms that were enumerated in the previous

[2] There is considerable shifting of land. Land moves to and from agricultural and nonagricultural uses, for example, between agricultural and forest uses. Land also shifts among agricultural uses, such as pasture and cropland.

Table 2. Average per Farm Sales for Farm Survivors, Exitors, and New Entrants, by Farm Specialties, during Census Periods, 1978–1997

	1978–1982			1982–1987		
NAICS Type	Survived	Exit	Entry	Survived	Exit	Entry
Wheat	50,341	21,734	36,832	37,443	35,785	30,472
Rice	158,383	84,798	117,491	107,055	126,702	102,540
Corn	63,662	23,253	41,187	50,433	42,728	36,711
Soybeans	35,095	20,749	24,746	36,446	25,705	28,174
Cotton	149,414	65,858	110,488	126,273	128,863	141,081
Tobacco	21,090	11,568	15,250	17,642	16,069	12,795
Sugar	369,019	82,394	169,856	317,482	225,047	232,162
Vegetables and melons	142,898	62,341	80,540	141,236	97,244	119,645
Berry crops	67,714	26,681	58,011	85,955	45,449	71,128
Grapes	112,431	54,158	96,116	90,321	109,641	87,673
Tree nuts	47,110	22,199	41,216	53,031	43,283	56,258
Citrus fruit	100,830	37,191	61,367	120,603	67,318	87,430
Tree fruit	78,718	43,177	58,258	82,568	56,221	62,553
Nursery	145,105	43,711	66,574	175,743	76,195	107,406
Crops covered	594,119	75,803	135,474	505,142	331,926	551,944
Cattle feedlot	192,071	131,733	142,615	205,126	153,404	218,076
Beef cattle, not feedlot	17,677	14,036	14,360	20,510	14,419	19,552
Hogs	71,566	23,242	41,666	83,390	44,470	54,991
Sheep and goats	22,080	15,463	12,044	22,549	13,408	13,861
Dairy	100,883	57,896	95,714	112,002	91,033	107,743
Broilers, chicken meat	189,410	105,485	167,026	247,590	151,861	248,720
Chicken eggs	229,311	110,062	140,028	274,371	152,521	247,331
Turkey meat and eggs	476,593	353,157	474,525	562,681	390,336	504,364
Hatcheries	1,617,433	660,228	1,193,747	2,555,324	980,566	1,695,386
Horses	17,286	8,148	8,835	10,848	9,925	7,427
Aquaculture	a	a	a	180,453	a	96,100
All farm types	59,618	29,400	41,343	58,916	42,924	50,291

Source: Tabulations from USDA, NASS Census of Agriculture Longitudinal file.
Notes: Sales in 1997 dollars using the Producer Price Index for Farm Products. Exit sales are calculated from the beginning of the period, while sales for survivors and entrants are taken from the end of the period. a: Data on aquaculture farms were not available in 1978.

census but not in the current census. Exits, entrants, and surviving farm rates vary by inter-census-time period.[3] In 1997, 62% of the farms that existed in 1992 were still in existence, and 38% of the 1992 farms had exited.[4] However, roughly the same number of farms entered farming during the period as exited, yielding the small observed decline in the number of farms. Exits, entrants, and surviving farm rates vary by size of farm, type of commodity specialization, and location.

During a recent period, 1992–1997, the farms in the Southern states were more likely to be classified as new entrants (and therefore less likely to be survivors) than were all U.S. farms. Thirty-nine percent of U.S. farms in 1997 were classified as new entrants during this five year period. The following Southern states had higher shares of new entrants than the nation as a whole during this same period: Alabama, Arkansas, Florida, Georgia, Louisi-

[3] The intent in the development of the 1978–1997 file was to track farming operations with the same Census File Number (CFN). Hence, if a child took over an operation from a parent and submitted a census form with the same (CFN), the farm would be considered a surviving farm.

[4] Although the 2002 Census data are publicly available, these data have not yet been added to the public use file which links farms across the Censuses. Hence, dynamics are discussed for the period 1978–1997.

Table 2. (Extended)

1987–1992			1992–1997		
Survived	Exit	Entry	Survived	Exit	Entry
61,191	26,474	49,148	83,785	46,168	63,983
153,010	92,761	128,677	271,616	124,627	237,565
87,031	31,973	59,945	130,192	59,086	94,425
44,432	24,665	31,469	81,041	31,501	56,522
210,428	111,836	192,862	316,325	179,715	275,805
31,573	11,995	19,589	47,012	20,492	35,647
407,946	212,072	279,300	584,389	365,615	375,617
217,132	109,412	151,977	354,121	161,476	233,633
124,233	60,191	84,091	177,115	89,319	160,045
157,314	80,061	166,155	280,358	170,082	357,996
71,124	48,185	78,414	123,861	70,148	130,665
155,872	80,116	105,523	171,922	124,111	181,509
127,535	57,087	83,949	167,514	97,247	146,455
247,782	89,844	92,977	304,387	109,904	134,646
1,048,682	394,588	417,995	1,183,765	328,987	360,911
340,259	178,615	310,827	464,942	284,545	430,597
28,348	16,990	22,796	28,899	23,909	22,068
116,054	49,702	73,103	284,255	73,266	321,209
23,282	11,766	12,941	27,452	16,732	14,044
162,359	99,170	152,418	234,485	154,326	259,577
392,768	191,880	373,632	665,401	300,464	652,474
378,026	210,016	253,603	574,690	285,121	363,878
747,583	523,658	715,216	1,020,222	648,342	887,239
3,560,064	1,336,446	1,888,369	4,771,689	1,752,751	2,674,223
10,505	5,863	5,483	15,155	6,175	9,629
250,810	86,852	140,612	326,303	149,795	215,274
85,395	41,997	63,514	115,382	62,630	85,398

ana, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, and Texas. Small farms are more likely to exit than are large farms, and since small farms are more prevalent in urbanized areas, exit rates in urbanized areas are greater than in more rural areas. Aside from new entrants and exits, another dimension to the dynamics of farm structure is the change in farm size of existing farms. In fact, the majority of surviving farms change size from census to census. Over the 1978–1997 time period, we found that small farms were generally more likely to get smaller and large farms were more likely to get larger.

Table 2 provides the average farm sales of surviving farms, exitors, and new entrants for the four census sub-periods between 1978–1997, by type of commodity specialization. First of all, the table provides information on how average farm sales vary considerably across farm specializations. Poultry hatcheries, for example, are by far the largest operations. The surviving hatcheries had sales more than 40 times the average for all surviving U.S. farms in the latest census period. It is also interesting to note the differences in per-farm sales for farms that are entering the sector compared to the farms that had survived. Across all farm types, survivors are generally larger, i.e., have higher farm sales than either exitors or new entrants. New entrants generally have larger per-farm sales than exitors, consistent with a gradual evolution to a larger farm structure. There are exceptions to these general trends, though. For example, entering turkey operations in the beginning period

Table 3. Share of Farms Using Contracts and Value of Production, by Year and Region

Item	1991–1993	1994–1995	1996–1997	1998–2000	2001–2002	2003
			%			
United States						
Share of farms with contracts:						
Any contracts	10.1	13.0	12.1	10.6	11.2	9.6
Marketing contracts	8.2	10.8	10.2	8.4	9.0	7.8
Production contracts	2.1	2.4	2.2	2.5	2.6	2.1
Share of value of production under contract:						
Any contracts	28.9	34.2	32.1	37.3	37.8	39.6
Marketing contracts	17.0	21.2	21.5	20.4	19.7	22.2
Production contracts	11.8	13.0	10.6	16.9	18.0	17.4
Northeast						
Share of farms with contracts:						
Any contracts	9.9	15.7	19.8	16.6	17.0	14.0
Marketing contracts	8.2	13.8	16.6	14.1	14.1	11.1
Production contracts	1.9	2.0	3.5	2.8	3.5	3.3
Share of value of production under contract:						
Any contracts	25.1	38.6	46.3	52.8	49.6	43.4
Marketing contracts	15.5	29.7	36.5	38.2	31.3	35.5
Production contracts	9.7	8.9	9.8	14.5	18.4	8.0
South						
Share of farms with contracts:						
Any contracts	6.6	7.5	6.7	6.2	8.8	7.7
Marketing contracts	3.9	4.9	4.3	3.6	5.6	5.1
Production contracts	2.8	2.7	2.4	2.7	3.3	2.7
Share of value of production under contract:						
Any contracts	36.2	44.8	39.3	43.5	51.7	51.0
Marketing contracts	11.0	12.9	14.8	14.9	11.5	15.6
Production contracts	25.2	31.9	24.5	28.6	40.2	35.4
Midwest						
Share of farms with contracts:						
Any contracts	10.4	16.0	13.4	11.0	11.1	9.3
Marketing contracts	8.8	14.1	12.1	8.8	9.4	8.1
Production contracts	1.9	2.5	1.8	2.8	2.3	1.7
Share of value of production under contract:						
Any contracts	15.2	16.8	17.7	26.0	23.2	27.0
Marketing contracts	7.4	12.4	10.9	9.3	10.5	11.9
Production contracts	7.8	4.4	6.8	16.7	12.7	15.1
West						
Share of farms with contracts:						
Any contracts	19.9	18.8	23.1	19.2	16.2	13.6
Marketing contracts	19.3	17.7	21.7	18.3	15.7	13.3
Production contracts	0.9	1.4	1.8	1.1	0.7	0.6

Table 3. Continued

Item	1991–1993	1994–1995	1996–1997	1998–2000	2001–2002	2003
			%			
Share of value of production under contract:						
Any contracts	46.1	48.7	46.0	45.7	42.4	47.7
Marketing contracts	41.7	43.3	43.3	40.1	37.2	45.5
Production contracts	4.4	*5.4	2.6	*5.5	*5.3	2.2

Source: Tabulations from USDA, ERS, 2005b; USDA Farm Costs and Returns Survey (1991–95); USDA Agricultural Resource Management Survey (1996–2001).

(1978–1982) were just as large as surviving operations. And, during the financial stress of the early 1980s, we note that for some farm types the per-farm sales of exitors were actually greater than the per-farm sales of the surviving farms (for rice, cotton, and grape specialists) and the per-farm sales of new entrants (for wheat, rice, corn, tobacco, and grape specialists). Recall that the stress of the early 1980s was felt especially strongly by producers who had high debt levels and suffered when asset values declined in some areas, especially in the Midwest cash grain areas. Still the per-farm sales of new entrants were relatively high during the early part of the 1980s, and for some specialties (cotton, fruit and tree nuts, crops grown under cover, feedlots, and broilers) equaled or exceeded the established farms in those specialties. During the relatively prosperous 1992–1997 period for U.S. agriculture, new entrants in the specialties of grapes, tree nuts, citrus, hogs, and dairy all had higher per-farm sales than the existing farms in those specialties.

Contracting

Adoption of contracting, as a means of defining roles and responsibilities in the business environment, can result in efficiencies in production of food products to the benefit of many in the supply chain. Two broad categories of contracts are marketing and production contracts. Production contracts identify specific responsibilities of the parties for production practices and for determining the mechanism for payment and delivery of product. The farmer (contractee) typically does not own the commodity being produced, while the contractor typically specifies production practices and provides some/all inputs. Marketing contracts play a narrower role in the supply chain. They typically specify a pricing mechanism, and usually a quantity and quality of product to be delivered under that pricing scheme, under agreements in place before the completion of the production cycle. The farmer generally owns the commodity, supplies the inputs and retains all responsibilities for production management choices.

In 2003, 40% of all U.S. agricultural product was produced with either a marketing and/or production contract. That is up from 29% in 1991, and only 12% in 1969. Across all commodities, large farms are more likely to use contracting than are small or midsized farms. Hence, a larger share of product is under contract than the share of farmers who use contracts. Only about 10% of farms used contracts in 2003. The incidence of contracting varies considerably by commodity (MacDonald et al.). The South has the smallest share of its farmers using contracts (8%), but it leads the nation in the share of product under contract (51%) (Table 3). This is because small farms (<$250,000 in sales) in the South are less likely than small farms in the other major regions to use contracting, but large farms (>$500,000 in sales) in the South are more likely to use contracting.

Nationwide, contracted product is more likely to be under a marketing contract rather than a production contract (56% compared to 44% in 2003). However, in the South, production contracts dominate contracting arrange-

ments in agriculture. In contrast, marketing contracts dominate arrangements in the West and Northeast. In the West, only 6% of farms with sales over $1 million have production contracts, but 64% of farms in the South with sales over $1 million have them. Production contracts cover the value of product for a large share of the product of these very largest farms (>$1 million in gross sales) in both the Midwest and the South. However, in the Midwest, a large share of the volume of production is covered by a production contract at all sizes of farms, unlike in the South where production contracting is concentrated on larger operations (sales of $250,000 or more).

Production Contracts

From a production management perspective, production contracts are distinctively different and more comprehensive than marketing contracts. Farmers with production contracts are often bound by the contract to follow prescribed management approaches. Production contracts can ease the adoption of new production technologies, such as advances in genetics and feed formulations. Production contracts may also require farmers to invest in specific assets. Because of the significant management input of the contractor in the production management of the farm, some courts have recently questioned whether farmers with production contracts should legally be considered as employees of the contractor firm (Hipp and Goodwin). On the other hand, the existence of tournament (i.e., relative performance) contracts underscores the view that contractors recognize the importance of the human capital input of the farmer in production quantity and/or quality.

Most of the agricultural production produced under a production contract comes from the Southeast, the Central states, and California. Production contracting, largely as a result of poultry and hog contracting, now accounts for the majority of all the agricultural production of Alabama, Delaware, Georgia, and North Carolina (USDA, ERS 2005c).[5] In 2002, 20,778 farms had a production contract for broilers (or other chicken meat), 3,408 had a contract for eggs, and 2,102 had a contract for turkeys. Debates concerning contracting frequently turn to discussion of the poultry industry. Contracting is often credited for the poultry subsector's record levels of output, since it was first established in the 1950s in the broiler industry because it allowed for easy, widespread adoption of the technological innovations of the time. The annual rate of growth in poultry output during the 1948–1960 period was a very high 6.52% (USDA, ERS 2005a). Output has continued to grow at above average levels since 1960 (Figure 1). While total U.S. agricultural output grew at a healthy 1.65% annually from 1960–2002, poultry and egg production grew at an annual rate of 3.11% (compared to meat animals at 0.81%, dairy at 0.80%, and all crops at 1.71%).

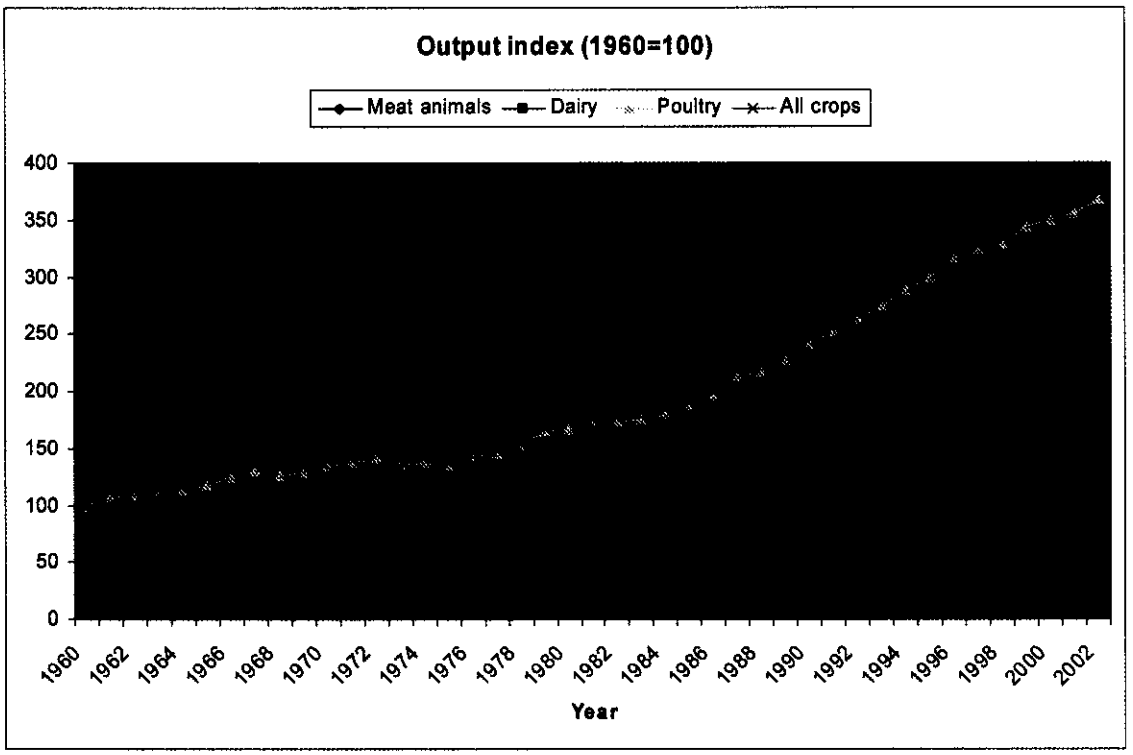
The Case of Poultry

Most of the agricultural contracting literature is commodity-specific, hence, there is not sufficient empirical information yet available on contracting to understand what forces are unique to production and marketing of a single commodity and what forces are more general in nature. We chose to focus on poultry because it has a long history in production contracting; a sparse historical data base exists and it is often used in discussions of industrialization. (For additional information on structural change in the poultry industry see Reimund, Martin, and Moore and Perry, Banker, and Green.)

In spite of the long history of production contracting in poultry, we also chose to focus on poultry for two reasons. First of all, we are interested in why the traditional economic arguments for contracting—whether they be focused on efficiencies or market power—apply differentially among seemingly similar poultry products. Secondly, tensions between poultry growers and contractors have long been evident (Bjerklie).

This tension exists in spite of the relatively high farm and household income of the farm

[5] Arkansas' share is now nearly half of its total product, 48.6% in the 2002 Census.



Source: Tabulations from USDA, ERS, 2005a.

Figure 1. Index of agricultural output, selected commodities, 1960–2002

households that specialize in poultry production, according to aggregate statistics. Both the most recent Census data and the Agricultural Resource Management Survey (ARMS) data show that farms that specialize in poultry have farm incomes at least four times as great as the average income of all farms, and, according to ARMS data, their household incomes (including off-farm income) are above the average income of all farm households. Consistent with these data is the higher survivability rates that poultry farms have experienced during the 1978–1997 period, relative to most other specialties. The source of the tension may lie in terms of the contracts that are not necessarily reflected in the cash returns but relate to the management of risk (Ahearn, Banker, and MacDonald). For example, in 2001, the average contract length was 13 months, but more than one third of contracts were flock-to-flock. This short-term production commitment on the part of the contractor was in spite of the commonly (84%) required long-term investment in assets. In practice, contractual relationships are often renewed and the average duration that farmers report contracting with the same firm has been long-term, averaging nine years (Perry, Banker, and Green). Most producers are also responsible for manure disposal and the associated legal liabilities. The majority of poultry producers (77%) have reported that they did not have access to any open markets for their chickens.

To a large extent, lack of data has been a deterrent to addressing contracting issues. The databases to address contracting issues in poultry are relatively incomplete for a variety of reasons. First of all, as is true with all production contracts, information is incomplete on the costs and returns of the contractor. What we know about contractor costs and returns is either reported by the farmer on farmer surveys or is provided in a highly aggregated, selective, and nonstatistical manner by

contractors. Secondly, the poultry farmer survey data are often very thin because rarely are surveys designed to represent poultry farmers. Rather, they are designed to represent farmers in general, and there happen to be poultry producers in the sample. Contracts vary considerably—for example, by the production practices and inputs required and the required attributes of the product—and so the data collection burden is intensified.[6] The Census of Agriculture has excellent representation, but the information has historically been very limited and the data have only been available in an aggregated form. However, the 2002 Census included some additional information on production contracting, and we accessed the individual records. This allowed us to explore structural differences among poultry types, albeit in a largely descriptive manner.[7]

We examined contract and noncontract production for three 5-digit North American Industry Classification System (NAICS) poultry products, using individual farm records from the 2002 Census of Agriculture: broilers (and other meat chickens, code 11232), eggs (code 11231), and turkeys (code 11233). Our sample includes only those farms that specialize in production of these poultry products according to NAICS types. We decided to focus on NAICS poultry farms because of the commonness of small quantities of poultry on farms in the U.S. For example, while 98.6% of the product comes from the farms that specialize in poultry production, only 51% of farms with poultry specialize in poultry. Half of the remaining 1.4% of the value of poultry products comes from farms that specialize in hogs and pigs, and the rest from general crop and/or livestock farms. We find it useful to examine poultry production at the state-level because of distinct differences along state lines. Table 4 provides some highlights from the state-level analysis of poultry production in 2002. Since farmers with production contracts are paid a fee for their services and their capital inputs, in Table 5, we have also examined the fees per unit of output for three poultry products by size of farm. In this case, we have only included the specialized farms which produced only one commodity under a production contract. This is because the census form asks the farmer to report a single dollar amount for the whole farm.

Most (98%) of all broilers were produced under a production contract in 2002, and hence, all the leading states are dominated by production contracting.[8] Three quarters of all U.S. states had some level of broiler production in 2002.[9] The leading states in terms of broiler production in 2002 were Georgia, Arkansas, and Alabama. These three states accounted for 41% of U.S. production. The next three leading states were Mississippi, North Carolina, and Texas, accounting for an additional 24% of U.S. production. The size of the operations in the leading broiler states are generally above average in size (except AR and NC), but they do not have the largest broiler farms. The state with the largest average broiler production per farm in 2002 was California. The average volume of birds per farm in California was more than six times the national average! The state with the second largest per-farm production was Texas, with 1.5 times the national average. As mentioned, only 2% of broiler production is not produced under a production contract, and most of that is concentrated on very large operations. In fact, out of the 1,006 broiler farms producing without a contract, the 14 largest farms (with more than $2 million in poultry sales) accounted for 93% of all broilers not produced under a production contract. This raises the question about how those farms market their product

[6] See Ahearn, Banker, and MacDonald for analysis of the variation in contract terms for various marketing and production contracts and for an analysis of the factors affecting the contract price or fee.

[7] Information on marketing contracts is not collected on the Census of Agriculture.

[8] Six states had broiler production without contracting, but the production levels were very small. New York had more noncontract production than contract production of broilers, but still the quantities were small, i.e., less than 0.03% of the U.S. total.

[9] Our analysis considers only the 48 contiguous states. We use the term broiler production to capture the Census of Agriculture category which includes "broilers, fryers, and other chickens raised for meat production, including capons and roasters" (USDA, NASS).

Table 4. Importance and Extent of Contracting for Broiler, Egg, and Turkey Farms, 2002

State	Broilers and Other Meat Chickens				Layers for Chicken Eggs					
	Share of U.S. Total	Share of State Total under Contract	Birds per Farm under Contract	Birds per Farm Not under Contract	Share of U.S. Total	Share of State Total under Contract	Layers per Farm under Contract	Layers per Farm Not under Contract	Share of U.S. Total	Share of State Total under Contract
Alabama	12%	100%	420,015	73	4%	86%	16,426	3,442	0%	0%
Arkansas	14%	100%	345,442	20	4%	86%	13,328	2,976	11%	99%
California	3%	72%	3,111,168	1,517,592	5%	3%	39,832	27,215	6%	55%
Colorado	0%	0%	na	120	1%	0%	na	14,404	2%	na
Delaware	3%	100%	317,031	na	0%	28%	19,236	57,638	na	na
Florida	1%	100%	384,476	22	2%	45%	43,795	9,617	0%	0%
Georgia	15%	100%	476,070	422,162	8%	88%	29,902	5,675	0%	0%
Indiana	0%	97%	313,473	51,436	5%	24%	64,555	39,834	4%	88%
Iowa	0%	98%	181,280	2,253	9%	14%	68,148	98,078	3%	18%
Kentucky	3%	100%	526,635	94	1%	74%	18,569	1,947	0%	0%
Louisiana	3%	100%	450,869	12,535	1%	56%	23,004	3,298	na	na
Maryland	3%	100%	364,751	na	1%	30%	30,403	15,494	0%	100%
Michigan	0%	99%	316,304	450	2%	9%	50,978	14,839	0%	0%
Minnesota	0%	100%	289,802	408	3%	31%	52,999	18,164	17%	18%
Mississippi	9%	100%	416,756	88,623	1%	78%	15,659	2,736	na	na
Missouri	3%	88%	551,615	983,871	1%	42%	21,293	3,875	7%	73%
Nebraska	0%	99%	465,929	1,878	3%	31%	148,382	77,630	2%	0%
New York	0%	38%	104,466	52,750	2%	1%	2,686	14,359	0%	0%
North Carolina	9%	100%	303,999	3,000	4%	80%	16,793	3,824	16%	94%
Ohio	0%	100%	143,036	131	12%	40%	108,444	38,634	2%	79%
Oklahoma	3%	98%	351,284	215,033	2%	61%	13,605	3,186	0%	100%
Pennsylvania	1%	99%	274,002	29,196	7%	50%	53,132	13,353	3%	67%
South Carolina	2%	100%	520,165	9,126	2%	72%	55,539	8,346	7%	92%
Tennessee	2%	99%	298,838	76,453	0%	90%	13,984	204	0%	0%
Texas	6%	92%	618,137	686,107	5%	35%	20,542	6,161	2%	82%
Virginia	3%	100%	375,921	30,773	1%	54%	13,886	4,087	7%	99%
West Virginia	1%	100%	595,198	na	1%	100%	13,699	4	2%	100%
U.S.	100%	98%	405,194	163,752	100%	41%	25,790	11,727	100%	64%

Source: Tabulations from USDA, NASS 2002 Census of Agriculture.
Note: na is not available.

Table 5. Fees Received by Producers with Production Contracts per Unit of Output, by Size of Farm, 2002.[a]

Value of Poultry and Eggs	Fee per Broiler	Fee per Dozen Eggs	Fee per Turkey
<$250,000	$0.25	$0.26	$1.52
$250,000–$999,999	$0.25	$0.21	$1.32
$1 million–$1,999,999	$0.22	$0.14	$1.06
$2 million or more	$0.21	$0.08	$0.94

Source: Tabulations based on 2002 Census of Agriculture.
[a] For specialized farms (according to the NAICS) which only produced one commodity under a production contract.

and, for example, whether they have marketing contracts or are vertically integrated. Unfortunately, that is not known from Census data. The newly collected 2002 Census data show that fees paid to broiler growers decrease as the size of the farms increase (Table 5). There are many possible explanations for why this is so, and data simply do not exist to unravel the underlying reason. The fee structure in production contracts is variable across commodities. Oftentimes, broiler producers are in tournaments where they are paid a flat fee per bird and then an additional incentive bonus, depending on efficiency factors of the farm relative to other producers in the tournament. For example, the higher fee per broiler that the smaller farms receive may mean they receive more in incentive bonuses, or it may mean that they provide more of the production inputs than do larger farms, or even that they are producing broilers with more valuable attributes than larger farms.

In contrast to broilers, most egg production in the U.S. does not occur under a production contract and is not largely concentrated in the Southern region. In 2002, every state had some egg production, but the top five producing states (Ohio, Iowa, Pennsylvania, Georgia, and Indiana) accounted for 41% of the total.[10] The next seven largest egg-producing states (Alabama, Arkansas, California, Minnesota, Nebraska, North Carolina, and Texas) accounted for an additional 29%. There is a regional effect for contracting in egg production. Most egg-producing states in the Southeast have eggs produced largely under production contracts, in contrast to egg production outside the region. For example, Ohio is the largest egg-producing state and 60% of its production is noncontract, while Iowa is the second largest and 86% of its production is noncontract. There are 231 egg farms that do not have a production contract but have more than $2 million in poultry sales. Again, the Census of Agriculture does not provide information on how the eggs are marketed if they are not under a production contract. As we did with broilers, we found the same negative relationship between producer fees per unit of output and size of farm. However, in this case, the differences across farm sizes were much greater. Farms with less than $250,000 in poultry and egg production received $0.26 per dozen, compared to $0.08 per dozen for the largest farms of more than $2 million in poultry and egg production (Table 5). Again, the underlying reasons for this relationship cannot be explored in greater detail due to data limitations, and would require analyzing a representative sample of confidential contracts and contract outcomes.

Although not as extensive as for broilers, the majority of turkey production in 2002 was under a production contract. Minnesota is the leading turkey-producing state, however, and most of its production is noncontract. It is likely that the regulatory environment in Minnesota is a factor in the low level of contracting in the state (e.g., see Livestock Advisory Taskforce). The next largest turkey-producing state in 2002 was North Carolina, which was dominated by production contracting.[11] Across commodities, farms with production contracts generally have a significantly greater volume of the commodity than farms without production contracts. That is certainly the case for

[10] We measure farm size for egg farms based on the number of layers since Census only reports quantity of eggs produced for those farms that produced without production contracts.

[11] North Carolina actually had more turkey-producing farms than any other state.

broilers and eggs. However, in the case of turkeys, the average number of turkeys per farm is very similar for contracting and noncontracting turkey operations. For example, in 2002, the average number of birds per farm for turkey farms with production contracts was 88,941, compared to 81,394 for farms without contracts for their birds. In the two largest turkey-producing states, Minnesota and North Carolina, noncontract operations were larger on average than the contract operations. In the other states where per-farm production is greatest (at least twice the national average), there is significant noncontract production of turkeys. These are the states of California, Nebraska, and Colorado. As with the other two poultry products, the fees turkey producers received per bird declined as farm production of poultry products increased.

The Census does not provide clear information about how commodities are marketed if they are not produced under a production contract—i.e., under a marketing contract, through open market/direct sales, or transferred internally (if the farm is vertically integrated). However, we did consider two related organizational issues: the prevalence of marketing contracts (using ARMS data) and the legal organization of farms that don't engage in production contracting (using Census data). Based on the ARMS data, we know that among farms that specialize in poultry products (five-digit NAICS are not possible with ARMS data), marketing contracts are not common. About 2–6% of all production by poultry farms was under a marketing contract in recent years. This compares to about 80% of the total product of poultry farms produced under a production contract. Marketing contracts are more common among very large poultry farms (>$1 million in sales) in the Midwest and especially the West, but production contracting nonetheless dominates production of poultry farms in all farm sizes and all regions.

We also examined the type of legal organization of large farms that do not have production contracts. We would expect some poultry farms, especially the very large operations, that do not have production contracts to be vertically integrated with downstream processors. In that case, they would likely be legally organized as corporations. In fact, most of the birds not produced using production contracts in 2002 were produced on very large farms organized as corporations. For broilers, about 165 million birds were not produced under a production contract. Most of that production (100 million birds) took place on 10 large corporate farms in California, Texas, and Oklahoma (Table 6). It is also true for layers and turkeys not produced under production contracts that the farms are significantly larger than contract farms. Most noncontract production for layers and turkeys occurs on corporate farms, with the exception of layers in Ohio and California, where the majority of noncontract production takes place on farms that are either sole proprietorships or partnerships.

The extent and variation of poultry and egg contracting by state raises questions about the importance of the regulatory environment for where processors locate and how they organize. For example, Texas is a leading producer of both broilers and eggs, and, in contrast to broilers, egg production is largely noncontract. Georgia and Alabama are also significant broiler and egg producers but the production of both commodities is dominated by production contracts. Two other Southern states, Arkansas and North Carolina, are major producers of all three poultry products we examined and are clearly dominated by production contracting for these commodities. The state regulatory environment can shift the legal liability for environmental management, determine how contract disputes are resolved and contracts terminated, as well as offer various tax concessions to processors. In addition, some substate local political jurisdictions control zoning that can be a significant factor in the plant location decision.

Conclusions and Research Questions

Indicators of industrialization in agriculture have only grown stronger since Mark Drabenstott's paper on the subject presented here a decade ago. Only 1.6% of farms accounted for half of the agricultural product in 2002. Nearly 40% of the total product is produced under

Table 6. Legal Form of Organization of Poultry Farms Producing without a Production Contract, 2002.

	All Farms without Production Contracts		Corporate Farms without Production Contracts		Noncorporate Farms without Production Contracts	
	Farms	Total Birds	Farms	Birds per Farm	Farms	Birds per Farm
Broilers						
U.S.	1,006	164,734,118	17	8,016,641	989	28,768
CA	82	71,326,834	6	9,122,489	76	218,315
TX & OK	81	47,095,352	4	11,625,000	77	7,732
Layers						
U.S.	9,929	116,421,460	373	185,599	9,556	4,939
IA	160	15,692,490	29	360,522	131	39,980
OH	379	14,642,360	16	250,493	363	29,296
CA	340	9,253,168	21	191,006	319	16,433
Turkeys						
U.S.	1,170	95,150,131	230	262,730	940	36,939
MN	183	37,058,741	83	354,314	100	76,506
CA	44	7,726,323	17	250,615	27	128,366

Source: Tabulations from 2002 Census of Agriculture.

either a marketing or production contract. It is likely that a significant share of the remaining product is produced under some other type of vertical coordination arrangement. The unique picture provided by the Census longitudinal file shows that the sector is a very dynamic one. Although the number of farms declined at a very slow 0.25% annual rate over the past couple of decades, that masks the high rates of both exit and entry. For example, only 62% of the farms that existed in 1992 were still in existence by the time of the 1997 census. We also know that large farms have tended to get larger and small farms are more likely to grow smaller.

In this paper we attempted to elaborate on what is known about industrialization by focusing on the subsector that has been the industrialization poster child, the poultry specialties. While the analysis provides some clear results, we also acknowledge that we offer more questions than answers. We only hope that our explorations have sharpened the research questions and the data needs for future research. In particular:

- Ninety-eight percent of all broiler production is produced under contract, as are 41% of eggs and 64% of turkeys. What commodity, industry, and regulatory environmental factors have resulted in these differences in the adoption of contracting across poultry products?
- The extent of contracting not only varies across poultry products, but, within a poultry product, varies considerably by state. In addition, some states produce large quantities of all poultry products, while other states specialize. How important are state regulatory and other institutional factors in explaining these differences across states?
- At the U.S. level, specialized poultry farms with contracts are generally larger than those without contracts. Broiler contract farms have 2.5 times the volume of noncontract operations; egg contract farms have 2.2 times the volume, but contract turkey operations are less than 10% larger than noncontract operations. What is the role of scale economies in these differences?

- The vast majority of noncontract poultry farms are sole proprietorship or partnership farms, but most of the product from noncontract farms comes from a few extremely large corporate farms. Are the large noncontract farms vertically integrated? If so, why does the extent of vertical integration differ across poultry commodities?
- There is a clear relationship between size of farm and the fees producers receive per unit of output under production contracts for broilers, eggs, and turkeys. The smaller the production level, the larger the per unit fee they receive. Why is that? Are the smaller farms more efficient producers and receive more in incentive bonuses? Do they contribute more of other production inputs or produce a more valuable product for which they are compensated?

In 2002, 90% of the product was produced on 15% of farms. For economists who focus on these approximately 312,000 farms responsible for the bulk of agricultural products, theories that focus on the organization of the supply chain, rather than on traditional microproduction economics, are likely to prove useful in understanding structural changes in the sector. Of course, any analysis is limited by available data. The analysis in this paper is based on the premier U.S. national agricultural data bases: Ten years of data from USDA's Agricultural Resource Management Survey, the Census longitudinal file for 1978–1997, and the new 2002 Census data on contracting (USDA, ERS 2005b; USDA, NASS). However, it should be clear from the analysis that the data for studying an industrialized agriculture are seriously lacking. Some relatively simple solutions to improving our current data involve asking farmers about their vertical ties downstream and upstream. It is also feasible to improve our data collection on the product attributes specified in contracts, and we have already begun to improve our data collection on specific terms of contracts that are critical to explaining the variation in net returns of contracts (Ahearn, Banker, and MacDonald). However, marginal improvement to the current data collection system (of farmer surveys and censuses) does not have the potential to yield detailed information about vertical coordination. New approaches—for example, surveys of contractors or case study approaches (Boehlje)—will need to be explored if economists are to maintain their capacity to interpret and forecast the behavior of the parties involved in the continuing evolution of industrialized agriculture.

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