Consolidation, Concentration, and Competition in the Food System

By James M. MacDonald

There are powerful movements toward consolidation throughout the food system and toward high concentration—with only a few buyers or sellers—in many of its markets. Some consolidation follows from economies of scale and innovation and can therefore be a channel for productivity growth. However, high concentration can, in some circumstances, lead to reduced efficiency, reduced innovation, and slower productivity growth.

I use the term "consolidation" to refer to shifts in production to larger farms and firms; in the context of mature, slow-growing industries, such shifts also imply fewer farms and firms. Agriculture is consolidating, but it is not very concentrated, because there are still many producers of almost all specific commodities. However, farms do face high and growing concentration in many markets with only a few suppliers of inputs or services or only a few buyers of farm products.

Rising concentration across the U.S. economy has become a matter of widespread comment and concern in recent years. Some public policies are directly concerned with concentration, primarily the effect of concentration on competition. However, farm consolidation also affects the design and effectiveness of farm, trade, and environmental policies that are not directly concerned with concentration or consolidation.

James M. MacDonald is chief of the Structure, Technology, and Productivity branch of the U.S. Department of Agriculture's Economic Research Service. The views expressed are those of the author and do not necessarily reflect the views of the U.S. Department of Agriculture or the Economic Research Service. This article is on the bank's website at ***www.KansasCityFed.org.***

In this article, I summarize consolidation and concentration in the food system and distinguish those policies that are directly aimed at the effects of concentration from those aimed at consolidation. I focus first on dairy farming, because it provides a canonical example of dramatic consolidation and of some key points regarding policy, and then expand the story to the rest of U.S. agriculture. Finally, I discuss the food system outside of agriculture, where the policy emphasis shifts more to competition and antitrust policy.

I. The U.S. Dairy Sector as a Striking and Canonical Example

In 1987, 202,068 farms maintained 10.1 million milk cows. By 2012, total milk production had grown by 44 percent while using fewer cows (9.3 million). But 2012 production came from just 64,098 farms—a 70 percent reduction in farms over 25 years.

Those statistics from the U.S. Department of Agriculture (USDA) imply that the average herd size nearly tripled, from 50 to 145 cows. However, using averages actually understates the sector's structural change. Table 1 reports midpoint values for milk cows and other livestock—half of all milk cows are in herds that are no larger than the midpoint, and half are in herds that are at least as large.[1] In 1987, the midpoint was 80 cows—in other words, half of U.S. dairy cows were in herds with at least 80 cows, and half were in herds with no more than 80. The midpoint grew rapidly after 1987, as farms with 2,000 or more cows began to multiply; the midpoint was 140 cows in 1997, 570 cows in 2007, and 900 cows in 2012.

Larger dairy farms generally realize substantial cost advantages over smaller farms (Mosheim and Lovell). Estimates of the cost of milk production from the USDA's Economic Research Service indicate that farms with herds of 2,000 or more cows had, on average, 16 percent lower production costs per hundredweight of production than farms with herds of 1,000–1,999 cows and 37 percent lower production costs than farms with 200–499 cows (MacDonald, Cessna, and Mosheim). The striking changes in herd size were accompanied by regional shifts in production to the West and by expanded reliance on purchased instead of homegrown feed. However, milk production did not see the

Table 1
Consolidation in Livestock Sectors

Commodity	1987	1997	2007	2012
	Sales midpoint: number of head sold or removed in year			
Broilers	300,000	480,000	681,600	680,000
Fed cattle	17,532	38,000	35,000	38,369
Hogs and pigs	1,200	11,000	30,000	40,000
Turkeys	120,000	137,246	157,000	160,000
	Inventory midpoint: number of head in herd/flock			
Beef cows	89	100	110	110
Egg layers	117,839	300,000	872,500	925,975
Milk cows	80	140	570	900

Note: The midpoint is the median of the distribution of animals by farm size: half of all animals are on farms that are at least as large as the midpoint, and half are on farms that are no larger.
Source: Economic Research Service calculations from unpublished census of agriculture records.

wide-ranging organizational changes that occurred in hog production at the same time; mostly, cows moved to much larger herds.

There has been no sustained policy effort to arrest dairy consolidation. This is a striking nondevelopment in light of the industry's dramatic consolidation—and, in particular, the sharp decline in the number of dairy farms.

However, some policy initiatives were aimed at supporting smaller operations. The Northeast Dairy Compact, for example, aimed to set wholesale prices for fluid milk within New England with the intention of protecting the viability of dairy farms—mostly fairly small—in the region. Later, the Milk Income Loss Contract program, initiated in the 2002 farm bill, provided countercyclical payments when farm milk prices fell below target levels. Payments were capped at relatively low levels of production, so the program provided greater support, per pound of milk production, to farms with herds no larger than 130–145 milk cows. Both programs had minor influence on small farm survival; to the extent they encouraged continued production from smaller herds and thereby reduced milk prices, they may have discouraged some large farm entry. However, these effects have been quite small (U.S. Department of Agriculture). In addition, no policy initiatives have aimed at directly slowing the entry and expansion of larger operations.

Consolidation did affect the design of existing policies related to dairy support and international trade. In 1987, dairy policy relied on

price supports both to manage the risks from price fluctuations and to support farmer incomes. However, given the wide range of production costs, large farms could make money, and have strong incentives to expand production and herds, at prices that failed to cover costs for small farms. As consolidation undermined policy, the United States moved away from reliance on price supports, and Congress eventually repealed the price support program in the 2014 farm bill.

The price support program sometimes resulted in U.S. milk prices that exceeded global prices, and dairy trade policy limited dairy product imports in response to those price differences while disposing of excess U.S. production through export subsidies. As production shifted to larger and lower-cost farms, industry average costs of production fell compared with what they would have been without consolidation, and the U.S. dairy industry became internationally competitive.[2] The combination of improved industry competitiveness and changes in trade policy led to sharp increases in U.S. commercial exports of dairy products starting in 2004 (MacDonald, Cessna, and Mosheim; Cessna and others).

In the short run, milk production is highly insensitive to prices; in consequence, modest movements in dairy demand can result in wide milk price fluctuations. The growing export competitiveness of the industry adds to those price risks, as changes in exchange rates or foreign production can affect U.S. milk demand. Moreover, many large dairy farms finance their expansion with bank loans, so that they carry large debt loads and a substantial liquidity risk in periods of low prices. In response, dairy policy has moved toward an emphasis on risk management through insurance-type programs, such as the Margin Protection Program introduced in the 2014 farm bill.[3]

Dairy consolidation has also affected environmental policy. Consolidating production also consolidates manure, which carries environmental risks. Manure storage facilities can fail, and if manure is applied to cropland in amounts that exceed the crops' agronomic capacity to absorb nutrients, nearby groundwater and surface water can be contaminated. Most large-scale dairy farms are classed as concentrated animal feeding operations (CAFOs) under the Clean Water Act and are subject to rules for reporting, storing, and managing manure under the

Act. CAFOs are also subject to state regulation and are frequently the focus of state and local litigation over the siting of new dairy facilities.

In summary, the dairy industry has undergone dramatic consolidation. Although there were no serious attempts to slow consolidation through policy, the industry's rapid consolidation did influence commodity, trade, and environmental policies. This pattern appears elsewhere in agriculture.

II. Consolidation in the Rest of Agriculture

Other livestock sectors have undergone major structural changes (Table 1). The midpoint sizes of hog and egg–laying farms increased dramatically from 1987 to 2012. Over the same period, broilers, turkeys, and fed cattle, which underwent wide-ranging reorganizations in the 1960s and 1970s, continued to shift to larger operations.[4] Note that beef cows (cow-calf operations) are an outlier. The cow-calf sector has seen little significant change in organization, and the pasture and rangeland that supports it has not become more consolidated.

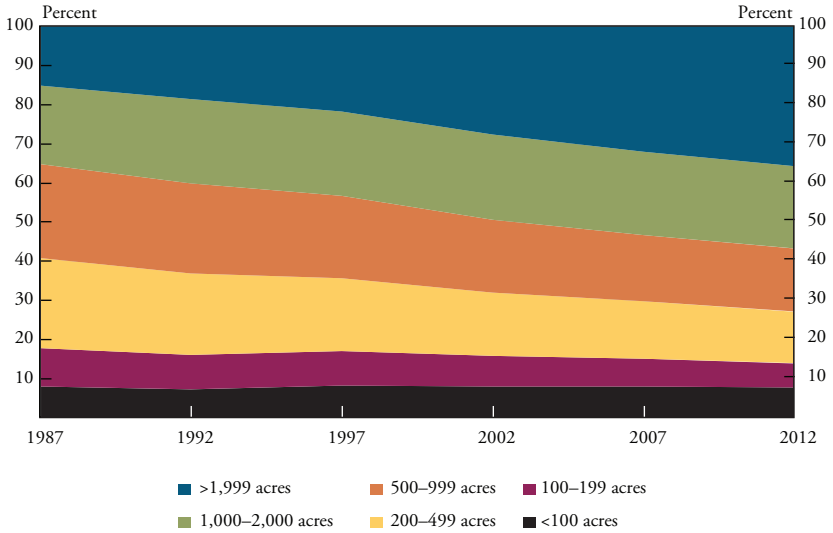
Consolidation in livestock, where it has occurred, has been dramatic and episodic, with major changes occurring in fairly short time periods. Consolidation in crop production has been a bit different. From 1987 to 2012, cropland shifted away from farms with 100–999 acres of cropland, whose aggregate acreage share fell from 57 to 36 percent, and toward farms with at least 2,000 acres, whose acreage share grew from 15 percent to 36 percent (Chart 1).

The cropland midpoint shows the farm size that splits the distribution of acreage: half of all cropland acres are on farms with no more than the midpoint acreage, and half are on farms with no less. That midpoint grew persistently between each census over 1982–2012, and the aggregate increase was substantial, from 589 acres in 1982 to 1,201 acres in 2012 (Chart 2).[5] Similarly, midpoints for major field crops grew substantially and persistently as cropland shifted to larger corn, cotton, rice, soybean, and wheat operations (Chart 3).

In further work, MacDonald, Hoppe and Newton calculate midpoints for harvested acres for 55 crops over 1987–2012: 15 field crops, 20 vegetable and melon crops, and 20 fruit, tree nut, and berry crops. Consolidation in these crops was widespread—midpoints increased for 53 crops. Consolidation was also substantial: the midpoints for 40 of

Chart 1

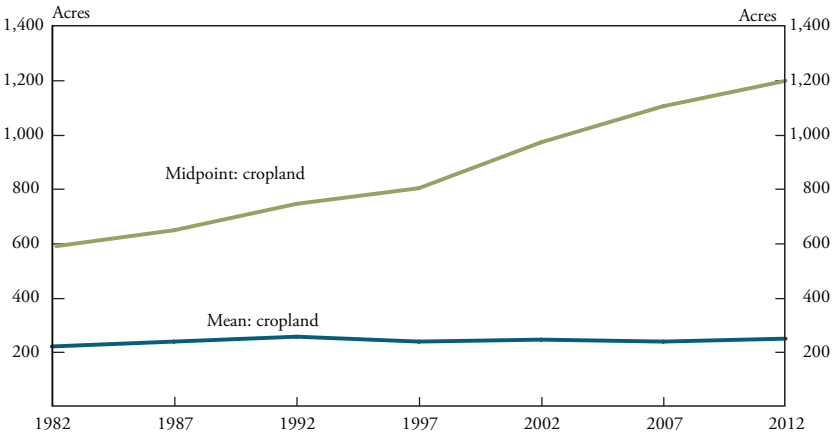
Shifts in Cropland Among Acreage Size Classes, 1987–2012



Source: Economic Research Service calculations from unpublished USDA Census of Agriculture records.

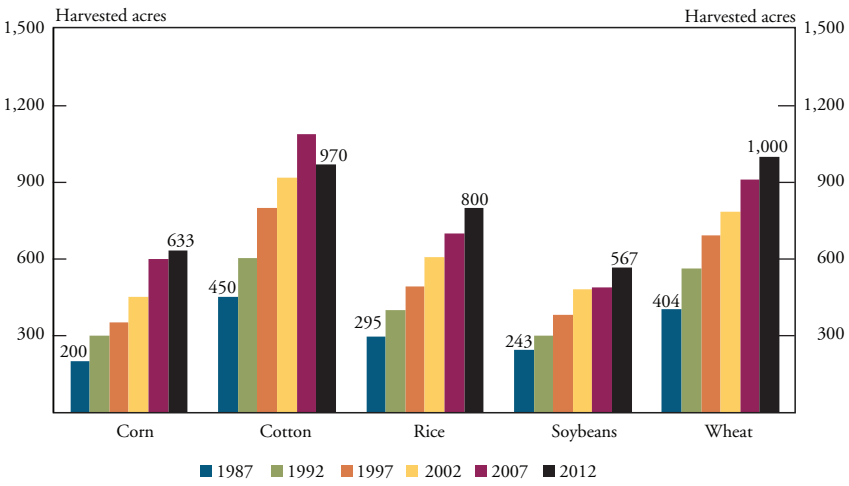
Chart 2

Cropland Is Consolidating



Note: Half of all cropland acres are on farms with at least the midpoint acreage, and half are on farms with no more.
Source: Economic Research Service calculations from National Agricultural Statistics Service, census of agriculture.

Chart 3
Midpoints for Major Field Crops, 1987–2012



Source: Economic Research Service calculations from unpublished census of agriculture records.

55 crops at least doubled, with a median midpoint increase of 133 percent. And consolidation was also persistent, steadily increasing in each five-year census period.

Why has crop acreage and production shifted to larger farms? The broad pattern of consolidation, covering livestock as well as crops not supported by commodity programs, suggests that commodity programs cannot be the major driver.[6] Instead, technology has likely played a major role (MacDonald, Korb, and Hoppe). Specifically, the equipment used in field tasks—for ground preparation, planting, spraying, and harvesting—has become steadily larger and faster, allowing a single farmer or farm family to manage more acres. Several other important "labor-saving" innovations, such as chemical pesticides, herbicide-tolerant seeds, and reduced tillage, have reduced the time needed for farm operations on a given land area, thus increasing the amount of land that a farmer or farm family can manage. Finally, equipment has also become "smarter" by incorporating information technology that allows for autosteering, variable application of nutrients and chemicals, and yield monitoring within fields. This technology carries substantial fixed costs, which may create economies of scale, and is far more likely to be adopted on larger farms (Schimmelpfennig). These examples concern

crops, but technologies that generate scale economies in some processes—and that provide opportunities to regularize production by moving it indoors and substituting capital for labor—also support larger livestock operations (Allen and Lueck).

As in the dairy example, no policies currently aim directly at farm structure, nor do any aim to arrest consolidation, though a few such policies were proposed in the livestock sector. Specifically, proposals made during the 2002 and 2008 farm bill debates would have banned packer ownership of livestock and limited the use of the marketing and production contracts that have been integral to the extensive reorganization and consolidation of hog and poultry production while also governing the sale of most fed cattle. I will not dwell on the details of the proposals, nor on the extensive research surrounding the use of such contracts (see, generally, RTI International), but will simply note that those efforts failed, and that agricultural consolidation proceeded without significant policy constraints.

Why are there no policies regarding structure? Agriculture is a competitive industry. Absent concerns with monopoly power, changes in farm structure are viewed as farmers' responses to changes in technology and to prices for inputs and outputs. Those who respond most effectively will tend to realize lower costs and growing shares of land and production. Structural change then becomes a vehicle for agricultural productivity growth.[7] If structural change exacerbates externalities like water or air pollution, then the policy response has been to deal directly with the externality, rather than with structural change.

In recent years, the locus of direct federal support for agriculture has shifted away from price supports and direct payments and toward risk management under crop insurance, with support in the form of premium subsidies. Consolidation has likely influenced that shift.

Operators of larger farms realize higher household incomes than operators of small and midsize farms. Since commodity program payments reflected acreage and production devoted to certain field crops, consolidation that shifted acreage and production to larger farms also shifted program payments to higher-income households (White and Hoppe). When commodity programs were initiated in the 1930s, one could argue that they served as income support and antipoverty programs, since farm household incomes were well below the averages for

all U.S. households (Gardner). That is a much more difficult argument to make today. Program proponents are now more likely to couch federal commodity and insurance programs as a "safety net" in the event of sharp declines in commodity prices and household incomes. Indeed, the household incomes of the operators of commercial farms do show far more variability over time than household incomes in the broader economy (Key and others).

III. Concentration in Agribusiness

Agribusiness industries that buy from or sell to farmers have become more concentrated (Table 2). Since the late 1970s, most basic commodity processing industries—as well as industries that provide key farm inputs or services such as seeds, machinery, chemicals, or rail freight—have seen large increases in concentration. Livestock slaughter industries consolidated sharply during the 1980s and 1990.

The trend toward higher concentration is not unique to agribusiness, but is apparent across the U.S. economy, a development that has attracted considerable notice in recent years (Council of Economic Advisers; Baker; Peltzman; *The Economist*). High concentration can facilitate the exercise of monopoly power by sellers (or monopsony power in the case of buyers). The classic concern with monopoly power is that it can lead to higher prices (lower in the case of monopsony power) thereby distorting production and consumption decisions and leading to losses in allocative efficiency. However, reduced competition can also lead to lower productive efficiency, reduced innovation, and slower productivity growth in affected industries. Moreover, these costs can be much larger than classic allocative efficiency losses (Holmes and Schmitz; Bloom and others; Lewis). More recently, some have argued that increased concentration plays a role in slowing growth and increasing inequality across the economy (Baker; Autor and others).

These issues are the primary focus of antitrust policy, which in turn focuses on three primary areas of enforcement: collusion, merger policy, and facilitating practices—business practices that might facilitate cooperation among firms or the exercise of monopoly power by individual firms (Posner; Hovenkamp). Collusion primarily concerns explicit agreements among rivals to fix prices or production; such agreements are per se violations of the antitrust laws, and the focus on

Table 2

Four-Firm Concentration Ratios (CR4) in Selected U.S. Agribusinesses

Largest four firms' share of:	Beginning year	Ending year
Manufacturing value of shipments (dollars)	Year=1977	Year=2012
Fluid milk processing	18	46
Flour milling	33	50
Wet corn milling	63	86
Soybean processing	54	79
Rice milling	51	47
Cane sugar refining	63	95
Beet sugar	67	78
Nitrogenous fertilizer manufacturing	34	69
Phosphatic fertilizer manufacturing	35	88
Pesticide manufacturing	44	57
Farm machinery	46	61
	Year=1980	Year=2007
Railroad grain shipments (ton-miles)	53	84
Seed value of shipments (dollars)	Year=2000	Year=2015
Corn seed	60	85
Cotton seed	95	91
Soybean seed	51	76
Livestock procurement (animals)	Year=1980	Year=2012
Steer and heifer slaughter	36	85
Hog slaughter	34	64
	Year=1995	Year=2012
Broiler processing	50	51
Turkey processing	41	53

Sources: U.S. Census Bureau; USDA Agricultural Marketing Service; Farm Journal; USDA Grain Inspection, Packers and Stockyards Administration.

explicit agreement drives an enforcement emphasis on evidence of conspiracies.[8] However, firms may refrain from competing vigorously with one another and may therefore be able to exercise monopoly power without explicit agreement. For this reason, merger policy focuses on identifying and deterring those mergers that might reduce competition, and policy also seeks to identify and deter those practices that might facilitate the exercise of market power by incumbent firms. I will focus on merger policy, because the merger issues that are relevant for concentration also relate to other enforcement.

Concentration and antitrust policy

Merger policy in the United States underwent a significant revision and easing in the 1980s (Posner; Hovenkamp; Peltzman). Two federal antitrust enforcement agencies—the Department of Justice (DOJ) and the Federal Trade Commission (FTC)—provide merger guidelines to acquaint interested parties with the standards currently applied in determining whether a merger would be challenged on antitrust grounds. The initial guidelines, in place from 1968 to 1982, placed heavy emphasis on concentration by specifying the combinations of market shares that would "ordinarily" lead to merger challenges.[9]

This issue—whether concentration is a sufficient indicator of the exercise of market power—received intense scrutiny in economic research in the 1970s and 1980s. "Sufficient" means that increases in concentration beyond some threshold could be expected, with a high degree of confidence, to lead to price changes (increases for monopoly, decreases for monopsony), irrespective of other market factors.[10]

Concentration does appear to be generally correlated with prices; the correlation is quite strong in some markets, indicating a considerable amount of market power, but weak in many cases and nonexistent in some (Bresnahan; Schmalensee; Weiss). The findings for agricultural markets mirror those for the broader economy: concentration matters in general, but the precise effects on prices vary widely and depend on a host of other factors. Some highly concentrated markets even appear to be quite competitive (Sexton; Adjemian and others). In short, empirical evidence does not support the use of concentration as a sufficient indicator of market power, and policy has followed suit.

Subsequent editions of the merger guidelines (most recently, 2010), raised the levels of concentration (and the merging firms'

market shares) that would "likely" lead to challenges and placed greater weight on other market attributes, such as the ease of entry into an industry, the ease with which customers of the merged firms can switch clients, substitute products, and efficiencies realized through a merger (U.S. DOJ and U.S. FTC).

As a specific example, consider a rare case of a highly concentrated agricultural market. Numerous media reports note that two large producers—Grimmway Farms and Bolthouse Farms—account for 80–90 percent of U.S. carrot production. Given this concentration, shouldn't the producers be able to raise product prices well above costs? The sufficiency argument, which emphasizes concentration alone, would say yes, but there are at least three mitigating factors to consider. First, if the producers did succeed in raising prices—which would require cuts in production—would the resulting profit opportunities attract other vegetable growers to carrot production? Second, how easily could major customers (who are primarily large retail chains) switch between carrot rivals or to new suppliers in the event of higher prices? Third, how rapidly would consumers substitute other products for carrots and carrot juice in response to higher prices? Easy entry, easy switching, and close substitutes would constrain the pricing of the leading growers and could leave the incumbents with little or no ability to impose and maintain non-competitive prices, even in a highly concentrated industry.

The easing of merger policy is not the only factor leading to increased concentration. Technology also influences the concentration of several industries, with expanded scale economies—combined with slow demand growth—playing an important role in food processing industries (see, for example, MacDonald and Ollinger), and agglomeration economies playing a role in many modern information technology and communications industries. Nonetheless, merger policy plays a role in increasing industry concentration, and Peltzman provides evidence that it has played an important role.

Effects of increased concentration on economic performance

Has increased agribusiness concentration harmed the sector's performance? Changes in the merger guidelines arose because of a view, supported by considerable empirical evidence, that increased concentration did not necessarily lead to increased monopoly power and the

costs associated with it. This view in turn relies on three principles: 1) the exercise of monopoly power is primarily of concern at high levels of concentration, with only a few firms competing with each other; 2) concentration alone is not a sufficient indicator of monopoly power; and 3) increases in concentration may reflect efficiencies—such as the realization of scale economies or the success of an innovating firm in expanding its sales—and we should therefore weigh the social costs and benefits to restricting concentration. However, these principles do not tell us that current practice is optimal, nor do they suggest the recent emergence of highly concentrated industries is costless.

In an influential recent book, Kwoka argues that actual merger policy has been considerably more tolerant of horizontal mergers (between competitors) than the guidelines would imply for all but the highest levels of concentration. He also finds that approved mergers frequently resulted in price increases, often substantial, as a result of the merger.[11]

Kwoka focuses on mergers that were "close calls"—horizontal mergers between relatively large firms that elicited initial interest and information requests from the agencies. His findings suggest that some mergers, and by extension some of the recent increases in concentration in markets that were already concentrated, led to losses in efficiency and productivity from the exercise of monopoly power. He argues that easing has gone too far and that merger policy should be more restrictive, though he certainly does not call for a return to the 1968 guidelines, nor does he argue for a simple and primary focus on industry concentration.

Kwoka's work focuses on the effect of competition and mergers on prices, which reflects a long tradition in economics (Bresnahan; Weiss; Adjemian and others). However, there is growing interest in the effects of concentration and mergers on innovation, particularly on the investments in research that lead to innovation. In the last two decades, antitrust enforcement agencies have been increasingly likely to cite potential reductions in innovation when they challenge mergers.

These issues carry particular resonance in agribusiness because of the importance of innovation and productivity growth in agriculture and because of the salience of innovation and research in recent agribusiness mergers. Specifically, the DOJ blocked Monsanto's proposed sale of Precision Planting LLC, a maker of high-speed planters, to John Deere, the other major producer. The DOJ argued that intense rivalry

between the two firms had led to improved prices for farmers and to the rapid introduction of innovative new features, and that the merger would reduce incentives to invest in further innovation by removing the threat of rivalry. In addition, while some observers have expressed concerns about the effects of the recent seed/chemical company mergers on prices, the firms are also major sources of research investments and innovation in crop seeds and crop protection chemicals.[12]

Most research and development (R&D) investments are carried out by large firms in industries that are at least moderately concentrated (Aghion and Griffith; Shapiro). Moreover, the links between concentration, R&D investments, and innovation are quite complex, not least because successful innovation can lead to increased concentration as the successful innovator attracts sales away from rivals. However, Shapiro provides a way to think about competition in innovation and applies the idea to merger policy. He distinguishes between the effects of a merger on a firm's *ability* to innovate and its *incentive* to innovate.

A merger may improve firms' ability to innovate when it combines firms with complementary research assets. For example, small pharmaceutical research firms may not have the expertise in clinical testing and regulatory review necessary to bring a new drug to approval and marketing; merging with a larger firm is a common way to combine applied research expertise with expertise in clinical testing and product development.

However, a merger may also reduce a firm's incentive to innovate. A firm with no rival may have limited incentive to invest in R&D, because new products would largely be cannibalizing from their own sales—the expected returns from R&D are lower for these firms than for firms whose successful innovations would pull sales from rivals. As a result, a merger between the two dominant producers of a technology may reduce the combined firm's incentive to innovate, because new products will largely draw sales away from its existing products rather than from rival products (Arrow).[13]

In contrast, a large firm with a dominant market share may still have incentives to invest in innovation if it fears a rival may scoop it with a major new innovation that would undermine its present position (Aghion and Griffith). These incentives are more likely if the firm has rivals in technological innovation and if new technologies can provide major leaps forward. For these reasons, Shapiro argues that

innovation concerns should matter when a merger combines rival innovators from a small existing pool. More broadly, concentration may discourage innovation when firms have no fear that rivals will scoop them, as well as when they are concerned that their own innovation will cut into their existing sales.

IV. Conclusion

Competition matters for economic performance. There is powerful evidence that more competitive industries innovate more, realize more rapid productivity growth, and are more responsive to consumer demands (Baker; Bloom and others; Lewis; Shapiro). However, American industry—including American agribusiness—is becoming more concentrated. Does increased concentration portend declining competition?

Increased concentration does not necessarily imply reduced competition. Competition can itself cause increased concentration; absent the possible reverse causality, the link between concentration and competition is conditional on other key market factors and is more likely to be of concern at high levels of concentration. It is this understanding, widely shared among economists who study the issue, that has led to substantial changes in antitrust and competition policy over the last four decades—and these changes are one source of increased concentration.

However, recognizing that the link between concentration and competition is conditional and complex does not mean accepting current levels of concentration as ideal. Considerable evidence suggests that some industries are not particularly competitive, many of which are also highly concentrated.

Competition policies, including antitrust, are influenced by politics; elections matter, by affecting leadership and enforcement priorities at federal agencies. Ideology also matters: the shifts in merger policy in the 1980s were part of a broad shift toward greater reliance on market outcomes in pursuit of national goals.

But analysis and evidence matters as well. Antitrust policy is strongly influenced by the broadly held views of influential judges, academics, and the antitrust bar, which are in turn influenced by an extensive academic literature combining applied economic and legal theory and empirical analyses. In fact, the major shift in merger policy in the 1980s did not stem from congressional or White House action but was instead

initiated by the DOJ in response to developing views of lawyers and economists (Posner; Hovenkamp). The United States is currently in the midst of another vigorous discussion of concentration, competition, and policy in the economy and agribusiness. In my view, the outcome of that discussion will depend to a great extent on the continued accretion of evidence on the nature of competition and the effects of policy decisions.

Endnotes

[1]The midpoint is *a* median—the median of the distribution of cows by herd size—as distinct from the simple median of the distribution of farms by herd size (such that half of all farms are larger than the simple median, while half are smaller). Midpoints are useful for summarizing highly skewed size distributions: see Lund and Price or MacDonald and others.

[2]MacDonald, Cessna, and Mosheim estimate that consolidation, by shifting production to lower cost operations, reduced average U.S. dairy production costs by 19 percent from 1998 to 2012.

[3]While dairy farmers have been reluctant to purchase anything more than catastrophic coverage under the program, the National Milk Producers Federation aims to adjust the program's parameters in the next farm bill, rather than replace it.

[4]Dairy, egg, and cow-calf operations all produce products from herds or flocks on site, so inventories (herd or flock size) are used to measure size. Broilers, fed cattle, hogs, and turkeys are placed on an operation to be raised under contract and removed at the end of a production stage. In feeding operations, annual "sales and removals" (production) is a better basis for measuring size than inventories.

[5]Note that the mean farm size changed very little (Chart 2). The number of midsize farms (100–999 cropland acres) fell by 45 percent from 1987 to 2012, but the number with 1–9 acres grew substantially, in part because the farm definition (at least $1,000 of actual or potential sales) is not adjusted for inflation. With modest declines in total cropland and in the total number of farms with cropland, the mean size changed little even as land shifted to much larger farms.

[6]Separate analyses have evaluated the role of crop insurance and federal disaster programs in spurring consolidation. By reducing the financial risks faced by farmers, the programs could have induced farmers to invest more time and money into farming activities, and the effects could be stronger among larger operations, thus spurring larger farms and consolidation. Thus far, research finds positive but small impacts of crop insurance on consolidation. For more detailed summary and references, see MacDonald, Korb, and Hoppe.

[7]Consolidation in hog and dairy production were accompanied by spurts of cost reduction and productivity growth (McBride and Key; MacDonald, Cessna, and Mosheim). Shifts of field crop production to larger operations account for about a sixth of observed productivity growth in that sector (Key).

[8]Important examples in agribusiness include the global price-fixing conspiracies in lysine, a feed additive, and vitamins (including those used in animal feed) in the 1990s, and in herbicide ingredients in 2001 (Connor).

[9]For example, in an industry with a four-firm concentration ratio (CR4) exceeding 74, mergers between firms with market shares of at least 4 percent would ordinarily have been challenged, while in less-concentrated markets, an acquisition of a firm with a market share of at least 4 percent by one with at least 10 percent would draw a challenge. Tighter thresholds applied where concentration had been rising.

[10]In a recent article, Pollan succinctly expresses the sufficiency view: "according to one traditional yardstick, an industry is deemed excessively concentrated when the top four companies control more than 40 percent of the market."

[11]See also Ashenfelter, Hosken, and Weinberg, who conclude, on the basis of a review of consummated mergers, "the empirical evidence that mergers can cause economically significant increases in price is overwhelming." Further support can be found in Blonigen and Pierce, who look at changes in pricing and efficiency in a large sample of establishments acquired in the period 1998–2006, when merger policy was relatively lenient. On average, there was no change in productivity following acquisition but a substantial increase in price mark-ups over marginal costs, especially in horizontal mergers. The study did not look separately at acquisitions in concentrated industries or at mergers that were "close calls" for the antitrust agencies.

[12]The proposals include the combination of Dow Chemical and Dupont, which would then spin off the combined agriculture (seeds and crop protection), material science, and specialty chemicals businesses into three separate firms; the acquisition of Syngenta by the state-owned Chinese firm ChemChina; and the acquisition of Monsanto by Bayer. The proposals would reduce the Big Six global seed and agricultural chemical firms to a Big Four.

[13]This relates to a product innovation. Higher market shares provide a stronger incentive for process innovations aimed at reducing the costs of existing products, because a cost reduction will be applied over a larger volume of production.

References

Adjemian, Michael K., B. Wade Brorsen, William Hahn, Tina L. Saitone, and Richard J. Sexton. 2016. "Thinning Markets in U.S. Agriculture: What are the Implications for Producers and Processors?" U.S. Department of Agriculture Economic Research Service, *Economic Information Bulletin*, no. 148, March.

Aghion, Philip, and Rachel Griffith. 2005. *Competition and Growth: Reconciling Theory and Evidence*. Cambridge, MA: The MIT Press.

Allen, Douglas W., and Dean Lueck. 2002. *The Nature of the Farm: Contracts, Risk, and Organization in Agriculture*. Cambridge, MA: The MIT Press.

Arrow, Kenneth. 1962. "Economic Welfare and the Allocation of Resources to Invention." *The Rate and Direction of Economic Inventive Activity: Economic and Social Factors*, Universities-National Bureau Committee for Economic Research and the Committee on Economic Growth of the Social Science Research Council. Princeton: Princeton University Press.

Ashenfelter, Orley, Daniel Hosken, and Matthew Weinberg. 2014. "Did Robert Bork Understate the Competitive Impacts of Mergers? Evidence from Consummated Mergers." *The Journal of Law and Economics* vol. 57, pp. S67–S100.

Autor, David, David Dorn, Lawrence F. Katz, Christina Patterson, and John van Reenen. 2017. "Concentrating on the Fall of the Labor Share." *American Economic Review Papers and Proceedings,* vol. 107, pp. 180–185.

Baker, Jonathan B. 2017. "Market Power in the U.S. Economy Today." Washington Center for Equitable Growth, March.

Blonigen, Bruce A., and Justin R. Pierce. 2016. "Evidence for the Effects of Mergers on Market Power and Efficiency." National Bureau of Economic Research working paper no. 22750, October. Available at https://doi.org/10.3386/w22750

Bloom, Nicholas, Erik Brynjolfsson, Lucia Foster, Ron S. Jarmin, Megha Patnaik, Itay Saporta-Eksten, and John Van Reenen. 2017. "What Drives Differences in Management?" National Bureau of Economic Research working paper no. 23300, March. Available at https://doi.org/10.3386/w23300

Bresnahan, Timothy. 1989. "Empirical Studies of Industries with Market Power," in R. Schmalensee and R.D. Willig, eds., *Handbook of Industrial Organization*. Amsterdam: North Holland.

Cessna, Jerry, Lindsay Kuberka, Christopher G. Davis, and Roger Hoskin. 2016. "Growth of U.S. Dairy Exports." U.S. Department of Agriculture, Economic Research Service*, Livestock, Dairy, and Poultry Outlook Report,* no. LDPM-270-01, November.

Connor, John M., 2007. *Global Price Fixing*. Heidelberg: Springer-Verlag.

Council of Economic Advisers. 2016. "Benefits of Competition and Indicators of Market Power." *Council of Economic Advisers Issue Brief,* April. Available at https://obamawhitehouse.archives.gov/sites/default/files/page/files/20160414_cea_competition_issue_brief.pdf

Gardner, Bruce L. 2002. *American Agriculture in the 20th Century: How It Flourished And What It Cost*. Cambridge, MA: Harvard University Press.

Holmes, Thomas J., and James A. Schmitz. 2010. "Competition and Productivity: A Review of the Evidence." *Annual Review of Economics,* vol. 2, pp. 619–642. Available at https://doi.org/10.1146/annurev.economics.102308.124407

Hovenkamp, Herbert. 2005. *The Antitrust Enterprise: Principle and Execution*. Cambridge, MA: Harvard University Press.

Key, Nigel. 2017. "Farm Size and Productivity Growth in the United States Corn Belt." Paper presented at the Conference on Farm Size and Productivity: A Global Look, Washington, DC, February 2–3.

Key, Nigel, Daniel Prager, and Christopher Burns. 2017. "Farm Household Income Volatility: An Analysis Using Panel Data from a National Survey". U.S. Department of Agriculture, Economic Research Service, *Economic Research Report,* no. 226, February.

Kwoka, John. 2015. *Mergers, Merger Control, and Remedies: A Retrospective Evaluation of U.S. Policy*. Cambridge, MA: The MIT Press.

Lewis, William. 2004. *The Power of Productivity: Wealth, Poverty, and the Threat to Global Stability*. Chicago: University of Chicago Press.

Lund, Philip, and Roger Price. 1998. "The Measurement of Average Farm Size." *Journal of Agricultural Economics*, vol. 49, no. 1, pp. 100–110. Available at https://doi.org/10.1111/j.1477-9552.1998.tb01254.x

MacDonald, James M., Robert Hoppe, and Doris Newton. 2017. "Tracking Consolidation in U.S. Agriculture." Paper presented at the Conference on Farm Size and Productivity: A Global Look, Washington, DC, February 2–3.

MacDonald, James M., Jerry Cessna, and Roberto Mosheim. 2016. "Changing Structure, Financial Risks, and Government Policy for the U.S. Dairy Industry." U.S. Department of Agriculture, Economic Research Service, *Economic Research Report*, no. 205, November.

MacDonald, James M., Penni Korb, and Robert Hoppe. 2013. "Farm Size and the Organization of U.S. Crop Farming." U.S. Department of Agriculture, Economic Research Service, *Economic Research Report* no. 154, August.

MacDonald, James M., and Michael E. Ollinger. 2005. "Technology, Labor Wars, and Producer Dynamics: Explaining Consolidation in Beefpacking." *American Journal of Agricultural Economics,* vol. 87, no. 4, pp. 1020–1033. Available at https://doi.org/10.1111/j.1467-8276.2005.00785.x

McBride, William, and Nigel Key. 2013. "U.S. Hog Production from 1992 to 2009: Technology, Restructuring, and Productivity Growth." U.S. Department of Agriculture, Economic Research Service, *Economic Research Report,* no. 158, October.

Mosheim, Roberto, and C.A. Knox Lovell. 2009. "Scale Economies and Inefficiency of U.S. Dairy Farms." *American Journal of Agricultural Economics*, vol. 91, no. 3, pp. 777–794. Available at https://doi.org/10.1111/j.1467-8276.2009.01269.x

Peltzman, Sam. 2014. "Industrial Concentration Under the Rule of Reason." *Journal of Law and Economics,* vol. 57, no. S3, pp. S101–S120. Available at https://doi.org/10.1086/675719

Pollan, Michael. 2016. "Why Did the Obamas Fail to Take on Corporate Agriculture?" *New York Times Magazine*, October 5.

Posner, Richard A. 2001. *Antitrust Law*. 2nd edition. Chicago: University of Chicago Press.

RTI International. 2007. "GIPSA Livestock and Meat Marketing Study." Prepared for the U.S. Department of Agriculture Grain Inspection, Packers and

Stockyards Administration. Contract No. 53-32KW-4-028. Available at https://www.gipsa.usda.gov/psp/publication/live_meat_market.aspx

Schimmelpfennig, David. 2016. "Farm Profits and the Adoption of Precision Agriculture." U.S. Department of Agriculture, Economic Research Service, *Economic Research Report*, no. 217, October.

Schmalensee, Richard. 1989. "Inter-industry Studies of Structure and Performance," in R. Schmalensee and R.D. Willig, eds., *Handbook of Industrial Organization*, vol. 2. Amsterdam: North-Holland.

Sexton, Richard J. 2013. "Market Power, Misconceptions, and Modern Agricultural Markets." *American Journal of Agricultural Economics*, vol. 95, no. 2, pp. 209–219. Available at http://dx.doi.org/10.1093/ajae/aas102

Shapiro, Carl. 2012. "Competition and Innovation: Did Arrow Hit the Bull's Eye?" in Josh Lerner and Scott Stern, eds., *The Rate and Direction of Inventive Activity Revisited*. Chicago: University of Chicago Press.

The Economist. 2016. "A Lapse in Concentration." *The Economist,* September 29.

U.S. Department of Agriculture. 2017. "Economic Effects of U.S. Dairy Policy and Alternative Approaches to Milk Pricing." U.S. Department of Agriculture, Economic Research Service, *Administrative Publication,* no. 076, May.

U.S. Department of Justice and U.S. Federal Trade Commission. 2010. *Horizontal Merger Guidelines*. Available at http://www.justice.gov/atr/horizontal-merger-guidelines-08192010

Weiss, Leonard W. 1989. *Concentration and Price*. Cambridge, MA: The MIT Press.

White, Kirk, and Robert Hoppe. 2012. "Changing Farm Structure and the Distribution of Farm Payments and Federal Crop Insurance." U.S. Department of Agriculture, Economic Research Service, *Economic Information Bulletin*, no. 91, February.