This Little Piggy Went to Market: Will the New Pork Industry Call the Heartland Home?

By Mark Drabenstott

Throughout the 1990s, the pork industry has been at the forefront of a revolution in the structure of the U.S. food and agricultural sector. In particular, the pork industry has been rapidly moving away from its traditional structure built on hundreds of thousands of small farms selling hogs at local terminal markets to a much more concentrated "supply chain" model. Contracting is one prominent feature of supply chains, and the share of pork production grown under contract or vertical integration has jumped from a few percent in the early 1980s to around a third today. Most analysts agree that the structure of the U.S. pork industry will soon resemble that of the U.S. poultry industry, which moved to a supply chain structure more than three decades ago. In short, the hog industry, once a quintessential "family farm" enterprise, has gone to market—a very big market.

As the pork industry's structure has changed, so has its geography. Raising hogs was once heavily concentrated in the Corn Belt, since corn is the primary feed for hogs. The shift to supply chains, however, has taken the pork industry to many new places. North Carolina and Virginia became major pork states in the 1980s. More recently, the industry has moved aggressively into states in the Great Plains that used to be cattle country, Oklahoma being a good case in point. Pork production there has leaped nearly 900 percent since 1990.

Where the pork industry locates in the future carries big economic implications. At the farm level, hog production generated $13.2 billion in farm revenue in 1998. When processing activities are thrown in, economists estimate that pork is a $28 billion industry that employs roughly 600,000 people (Otto and Lawrence). The Heartland has a major stake in the location outcome. The seven states of the Tenth District now account for nearly a fifth of the nation's hog production.

Yet where this important agricultural industry calls home in the future is far from certain. Recent trends would suggest the Heartland has a strong claim on the new pork industry, offering convenient access to feed and final markets. But where the industry finally settles seems sure to depend on more than just the usual economic factors. The new pork industry is sparking a furious debate throughout the nation on a handful of policies critical to the industry, and the outcome

Mark Drabenstott is a vice president and economist at the Federal Reserve Bank of Kansas City. Michelle Beshear, a research associate at the bank, helped prepare the article. This article can be accessed on the bank's Website at ***www.kc.frb.org****.*

will influence where the industry goes next. Many states are reluctant to embrace the new pork industry because it does bring with it an unpleasant byproduct—an abundance of animal waste. Thus some states are enacting environmental regulations to discourage further expansion.

As the pork industry continues its rapid transition to a supply chain structure, will it also continue its migration to the wide-open spaces of the Heartland? Or, will new economic and policy developments lead some companies to consider moving hog production to a brand new list of destinations?

This article concludes that the recent geographic shift in the U.S. pork industry could foreshadow still more shifts in the future, possibly including moves to Canada, Mexico, or South America. The first section of the paper reviews recent trends in the U.S. pork industry, and shows that the industry is well on its way toward a supply chain structure, much like the U.S. broiler industry. The section also documents the regional shifts in production that have accompanied an evolution to more contract production and bigger farms. The second section analyzes two issues likely to influence the future location of the U.S. pork industry—economic factors and environmental regulations. The final section draws some conclusions about possible future geographic shifts in pork production.

I. THE NEW U.S. PORK INDUSTRY

The pork industry is rapidly reorganizing itself to deliver products that meet the rising expectations of consumers. To provide products that are leaner, more consistent, and more convenient to prepare, the industry has built new alliances with hog breeders and producers to ensure breeding and production decisions that yield a superior product. The result is an industry with a supply chain structure, where hogs are grown under contract or by large integrated firms.

The new pork industry is defined by three characteristics. Perhaps the defining characteristic is a huge jump in the percentage of production grown under contract or outright ownership. The move to a supply chain structure has also led to a much more concentrated industry. Finally, the move to a supply chain structure has also coincided with dramatic geographic shifts in hog production.

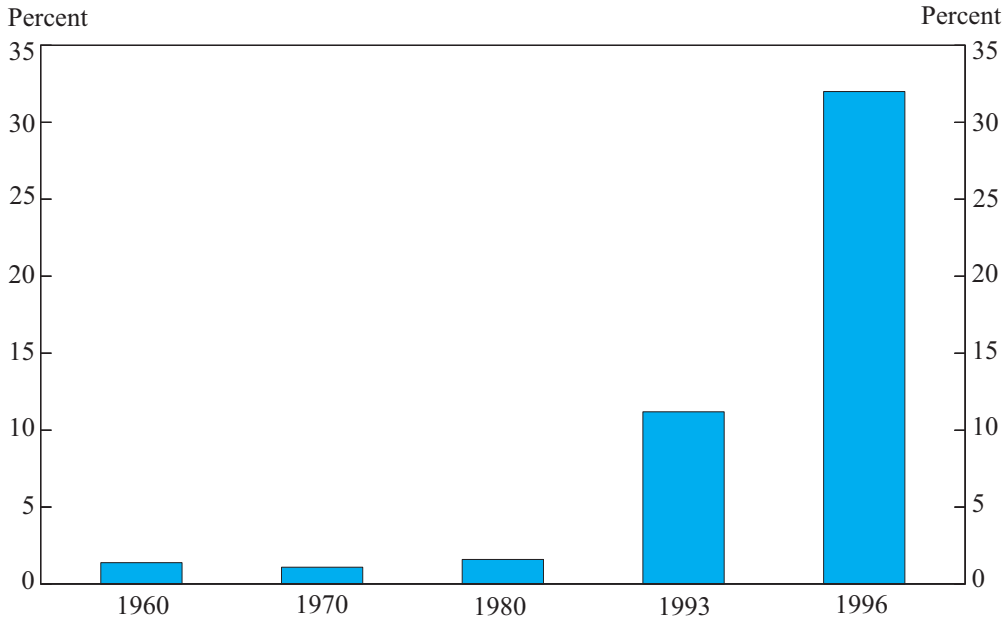
The shift to contract production

In a supply chain structure, all stages of production, processing, and distribution are bound tightly together to ensure reliable, efficient delivery of high-quality products. The glue that binds together neighboring links of the chain ranges from production contracts to outright ownership, or vertical integration. Traditionally, hog production was dominated by a large number of small farms. Hogs were a broadly defined commodity grown on hundreds of thousands of hog farms. These farms produced hogs that were little differentiated in terms of size, genetics, or meat characteristics when hogs were sent to market. Packers essentially bought whatever hogs showed up on a given day.

In many respects, the U.S. pork industry has become the front line in an ongoing revolution in U.S. food and agricultural markets, a revolution marked by the emergence of new supply chains (Barkema, Drabenstott, and Welch). In nearly all cases, the chains result in a shift from commodities to products, and from traditional auction or spot markets to contracts and other forms of direct marketing.

Two powerful forces have driven the changes in the pork industry. On the one hand, producers have been armed with a new generation of pork genetics and production techniques that produce leaner meat more cheaply. For example, scientists have reduced the fat in pork chops by more than a third over the past 20 years. At the same time, the new generation of genetics has com-

Chart 1
HOG PRODUCTION UNDER CONTRACT
OR VERTICAL INTEGRATION



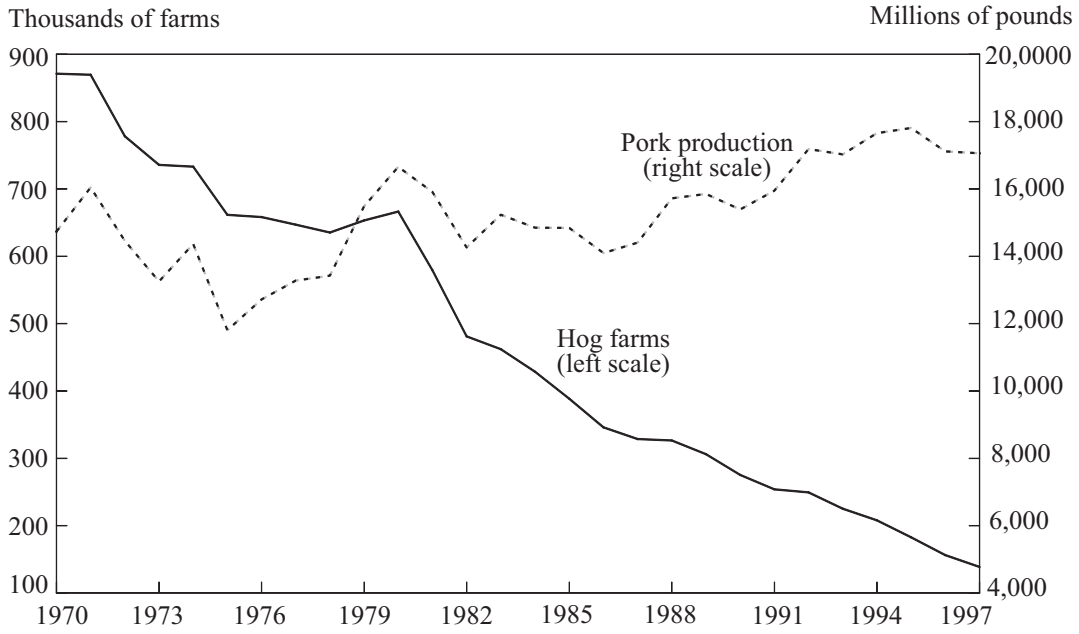
Source: Economic Research Service, U.S. Department of Agriculture.

bined with new confinement production systems that have substantial economies of scale. On the other hand, consumers have demanded meat products with more specific traits, including convenience and nutritional value. Such specificity requires meat products that meet much more exacting standards than in the past.

As a result of these two forces, pork supply chains are forming as the previously separate links of production, processing, distribution, and marketing fuse together. In fully developed supply chains, such as Premium Standard Farms and Smithfield, all phases from the animal genetics to the final packaging are now under common ownership. In other cases, strategic alliances and production contracts bind links of the chain together. In either case, the sharing of strategic information on production, processing, and marketing is an essential part of delivering high-quality products at lowest cost.

One good measure of the development of chains in the U.S. pork industry is the share of total production sold under production contracts or vertical integration. Only a small percentage of pork output was sent to market under production or marketing contracts in the 1970s and 1980s (Chart 1). In the 1990s, this percentage has jumped to an estimated 32 percent. Industry leaders suggest the actual number could be even higher. In any event, market participants expect the share of production under contract or ownership by processors to rise sharply over the next

Chart 2
PORK PRODUCTION AND THE NUMBER OF HOG FARMS IN THE UNITED STATES



Source: Economic Research Service, U.S. Department of Agriculture.

five years. Production by small independent producers for country markets will clearly continue for some time, but this segment of the market seems likely to wane as a share of the overall market. In short, the pork industry gives every indication of heading toward a structure like that of the U.S. broiler industry, where more than 95 percent of production is under contract or vertical ownership.

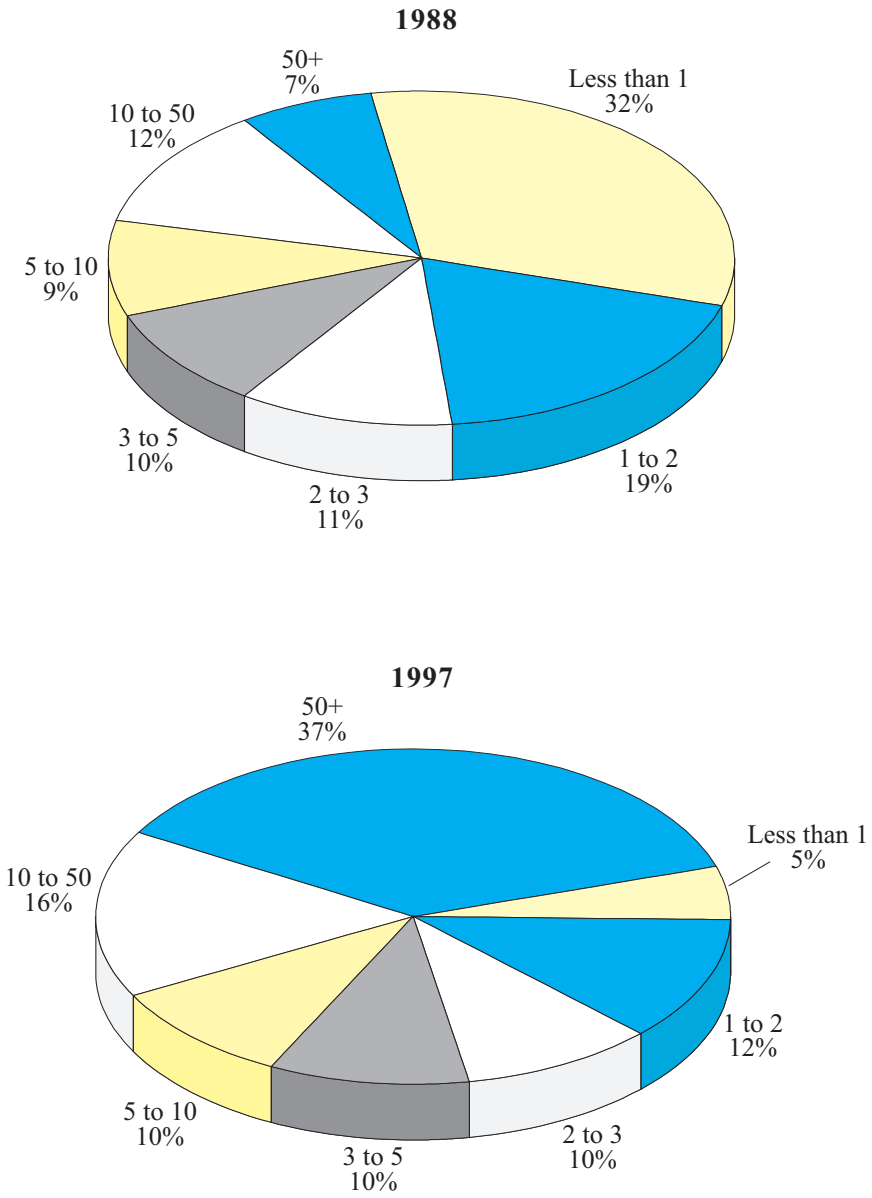
Increasing concentration of production

The shift to pork chains has also coincided with increasing concentration of production. With powerful economies of scale at work in the new pork industry, many small pork farms have simply gone out of business.

The number of hog farms in the United States has fallen precipitously as the pork industry has moved to a chain structure. Hog farms numbered nearly 900,000 in 1970, and were still more than 660,000 in 1980 (Chart 2). Since then, the number of hog farms has dropped to just 139,000. Reflecting the efficiency of the remaining farms, pork production has risen even while the number of farms has dropped sharply.

More revealing than the total number of farms is the growing concentration of pork production. The largest hog farms, those that market more than 50,000 hogs a year, account for 37 percent of total U.S. pork production, yet they represent only 1 percent of all hog farms (Chart 3). A decade ago, this category accounted for just 7 percent of

Chart 3
STRUCTURE OF THE PORK INDUSTRY
Percent of marketings by size of operation
(in thousands)



Source: Lawrence, Grimes and Hayenga, Iowa State University.

production. Farms with between 2,000 and 5,000 head account for another 20 percent of pork output, while those between 1,000 and 2,000 add another 16 percent. Taken together, these three largest categories produce nearly three-quarters of the nation's hogs yet represent less than 9 percent of all hog farms. Ten years ago, this same group produced a bit more than a third of the output.

Geographic shifts in production

Whereas pork production was once concentrated in the Corn Belt states, the move to supply chains has led to dramatic geographic shifts in production. While largely unheralded, the regional shifts have been a critical impact of the move to a supply chain structure in the U.S. pork industry. The regional shifts have occurred in two stages, reflecting two different driving forces.

The first shift resulted from the emergence of large pork firms in the Southeast. Not only was the scale of operations previously unheard of, but so was the location. Historically, hog production was heavily concentrated in the Corn Belt. In 1960, for instance, hog farms were scattered across most states, but nine Corn Belt states accounted for 60 percent of the output (Figure 1). By 1996, production was much more concentrated in a handful of states—in Iowa and North Carolina, in particular. While Iowa had always been a hog producing center, North Carolina's rapid rise as a pork powerhouse was due almost entirely to the emergence of a few big pork supply chains there.

More recently, pork production has begun moving to states that heretofore have been home to neither pork chains nor traditional hog farms. As shown in Figure 2, pork production has grown rapidly in some unlikely places. Oklahoma, for example, has never been a prime pork growing area, in part because it produces few feed grains. Yet pork production in the Sooner state has risen almost 900 percent this decade. Why have large operations moved there? Oklahoma has a lot of open space with a low population density—features that provide much more flexibility in managing animal waste than in places like North Carolina and eastern Corn Belt states where population density is much higher. Moreover, Oklahoma is well-positioned to ship pork products to the West Coast and Asia, markets that have grown rapidly in the 1990s. Similar location arguments apply to southern Utah, a region that has also experienced rapid growth in pork production in recent years.

In summary, the new chain structure in the U.S. pork industry is resulting in dramatic structural and regional shifts in pork production. A rapidly growing portion of production now occurs under contract or some form of business alliance. Production is concentrating in the hands of relatively few large operators. Finally, as the industry's structure has changed, so has its geography. Responding to concerns about the industry's environmental impacts and its access to key markets, pork production has grown rapidly in the Great Plains, in places with little history in pork. Thus far, that relocation has brought a bigger share of the pork industry to the states of the Tenth District.

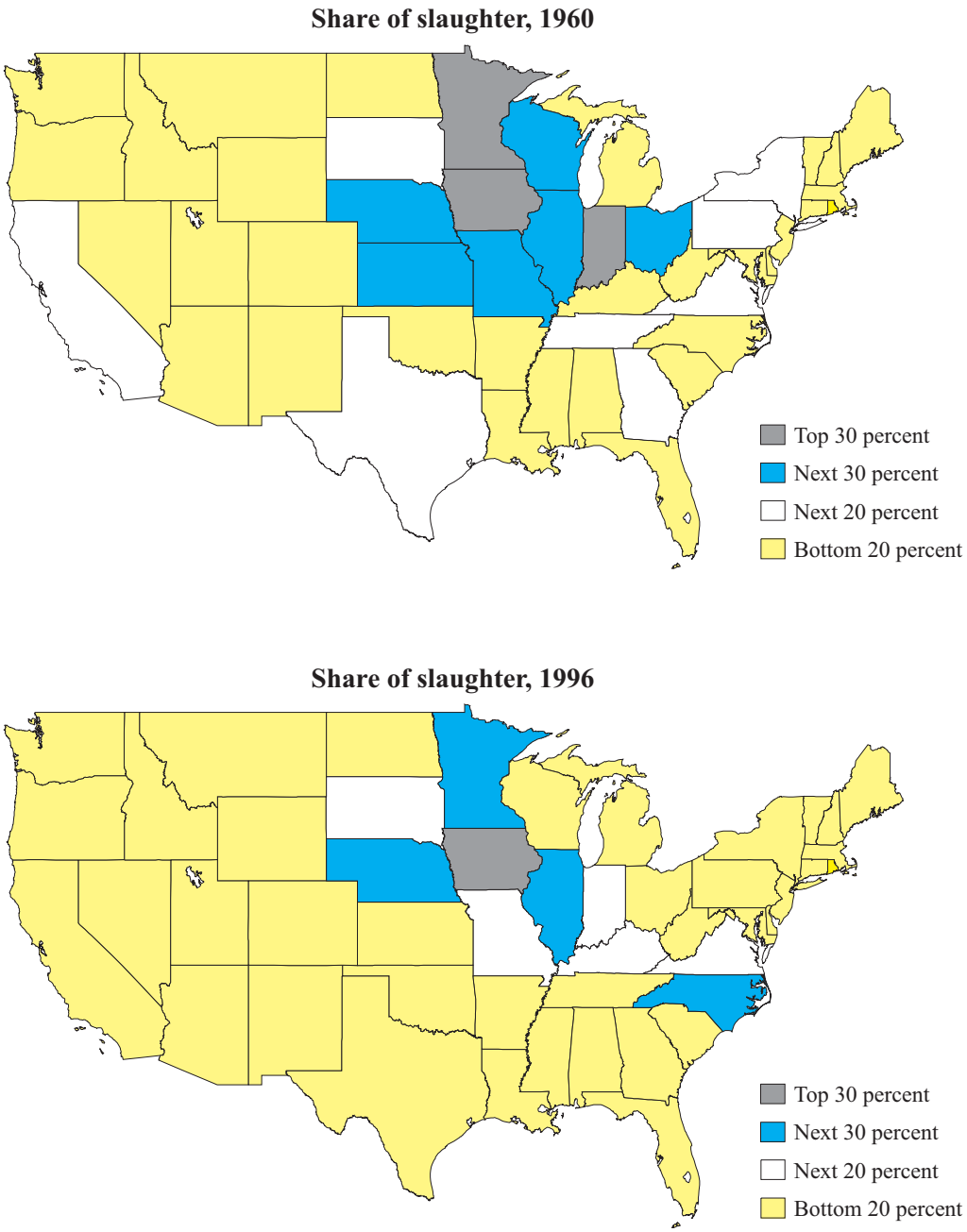
II. WHERE WILL THE NEW PORK INDUSTRY CALL HOME?

With so much turmoil currently in the pork industry, there are many unanswered questions about its future. Perhaps most intriguing is where the new pork industry will settle. Coming at a time when the industry is in the throes of so much change, this question may not have a ready answer. Yet an examination of the economic issues and the regulatory environment suggests further geographic shifts may lie ahead for the pork industry.

Economic issues

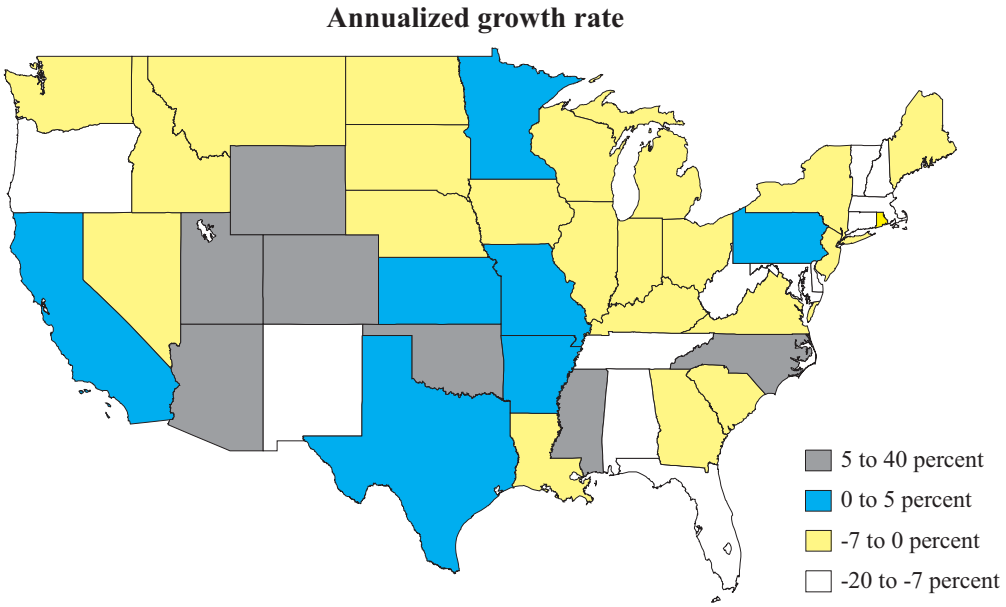
Market economics will ultimately rule the

Figure 1
U.S. HOG SLAUGHTER



Source: U.S. Department of Agriculture.

Figure 2
PIG CROP – 1990 TO 1997
Annual percent change



Source: U.S. Department of Agriculture.

pork industry's location decisions. Two economic issues seem especially important in shaping these decisions. First, the costs of producing pork appear to differ significantly across the many regions of the United States, and range even more widely across key producing nations around the globe. Second, there appear to be large economies of scale at work in the new pork industry, and these must be considered since they influence the location decisions of big operations much more than small-scale farms.

One reason the pork industry has thrived in the United States is the industry's competitive advantage in the world market. The principal source of that advantage stems from the nation's abundant corn crop—the major ingredient in hog feed. As the industry has changed, however, other cost factors have risen in importance in determining competitiveness. The new pork supply chains, for example, use large amounts of capital to finance a new generation of genetics and production facilities. They also rely on efficient transportation systems to supply inputs and move products to retail markets.

A recent study that compared pork production costs throughout the world found that parts of the United States have among the lowest production costs in the world (Martin, Kruja, and Alexiou). As shown in Table 1, pork production costs in the eastern and western Corn Belt regions of the United States compare favorably with most other parts of the world. Still, this study—con-

Table 1

HOG PRODUCTION COSTS BY REGION

Cost per 100 kg in Canadian dollars

Region	Size of operation	
	1,200 sow	3,000 sow
U.S. West Corn Belt	88.67	84.44
U.S. East Corn Belt	89.99	85.27
U.S. South East	98.36	93.78
U.S. Mountain	104.15	99.24
Maritime Provinces	104.26	100.08
Quebec	101.22	96.82
Ontario	87.23	81.93
Eastern Prairie Provinces	74.06	69.78
Western Prairie Provinces	84.08	79.30
Argentina	104.64	101.55
Chile	107.96	105.10
Netherlands	143.24	137.16
Denmark	142.95	136.37

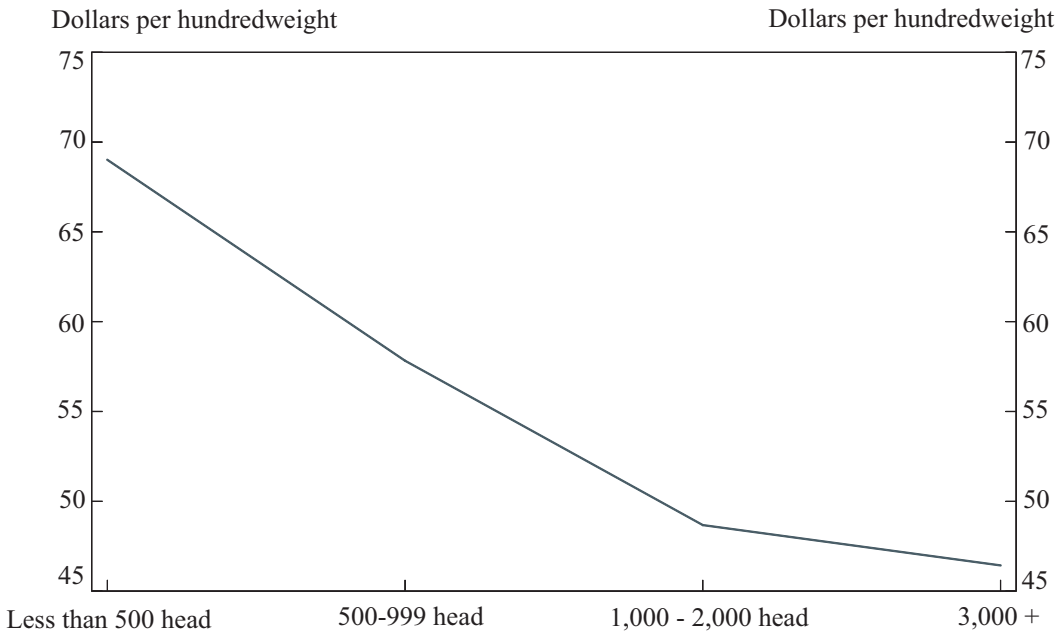
Source: George Morris Centre at University of Guelph: Martin, Kruja, and Alexiou.

ducted by Canadian economists—found that the lowest costs are found in Manitoba and the other Canadian prairie provinces. Within the United States, costs are much lower in the Corn Belt than in the Southeast or Mountain states, regions where the industry has grown rapidly recently.

The low Canadian costs are very important in considering the pork industry's future location because of a significant change in Canada's agricultural policy. In 1996, Canada ended its decades-old policy of subsidizing the cost of transporting grain from the fertile prairie provinces to export terminals serving both European and Asian markets. Since that policy reform, grain prices have fallen in provinces such as Manitoba and Saskatchewan, providing new incentive for Canadian farmers to pursue livestock production as a means of adding more value to their crops. Moreover, provincial governments seem eager to encourage new livestock production as a means of spurring rural economic growth.

Argentina is another country mentioned as a place where pork production could expand substantially. Like Canada, Argentina is a major grain producer with substantial surpluses that could support new livestock feeding. Nevertheless, the costs of producing pork in Argentina appear to be much higher than in either the United States or Canada. Much of the cost premium, however, is due to the unusually high cost of capital in Argentina—a cost that is quickly reflected in pork costs given the capital demands of the largest operations. With lower inflation

Chart 4
AVERAGE HOG PRODUCTION COSTS IN THE UNITED STATES



Source: Economic Research Service, U.S. Department of Agriculture.

and interest rates, Argentine costs could be much more competitive—approximately two-thirds of Argentina's cost disadvantage is due to higher interest costs alone. Although the study did not include Brazil, it has many similarities with Argentina. That is, Brazil produces crops that could sustain livestock expansion, but capital costs there are high.

An initial assessment of costs, therefore, concludes that Corn Belt pork production is highly competitive on world markets, although Canadian costs may be slightly lower. At first glance, regions in the Great Plains and Southwest that have experienced rapid gains in pork production recently appear to have higher costs than the Corn Belt.

A considerable body of evidence points to powerful economies of scale in the new pork industry. A Department of Agriculture survey of hog farms throughout the nation in 1992 found that unit costs of production on farms with 3,000 head are roughly a third less than on farms with less than 500 head (Chart 4). The largest operations, typically organized as part of a supply chain, are able to capture not only the cost advantages of large production units, but also product quality and marketing advantages. Large farms typically have much tighter control over animal genetics, feed regimens, and ultimately the uniformity of the final pork product.

Another study found that costs are much lower on large Corn Belt hog farms than on smaller

Table 2

COST-OF-PRODUCTION COMPARISONS

	1,200 sow high tech	600 Sow high tech	300 sow high tech	150 sow high tech	150 sow low tech
Total costs ($/cwt.)	$ 34.25	$ 35.72	$ 38.63	$ 40.54	$ 47.88

Source: Purdue Cooperative Extension Service.

ones. A team of Purdue University pork specialists estimated that 1,200 sow hog farms had a narrow cost advantage on farms half that size but held as much as a 40 percent cost edge over the smallest operations (Table 2). The smaller enterprises could adopt new production technology to lower their costs, but it seems unlikely that even the best management practices will close the gap with the biggest supply chains.

The rapid growth of the very largest supply chains supports this conclusion. In 1995, the largest 15 U.S. hog producers controlled roughly a sixth of the nation's hog inventory. In just two years, that share had jumped to nearly 23 percent (Table 3). Some industry participants have expressed the view that within the next decade 40 major supply chains will dominate the pork industry.

Environmental regulations

Environmental regulations will be a major influence in the future location of the pork industry if the recent past is any guide. As noted above, the Corn Belt states have the lowest costs, yet in recent years the industry has grown fastest in "unconventional" states like Utah and Oklahoma. While researchers have not formally identified the reasons for this geographic shift, environmental issues almost certainly were a factor in the location decisions.

The large-scale units favored by the new pork supply chains produce vast amounts of animal waste that are highly concentrated geographically. The public is now becoming much more aware of the potential environmental hazards of the waste, and states are enacting new restrictions on pork production facilities. North Carolina and Oklahoma provide good examples. North Carolina was at the heart of the emergence of pork supply chains in the 1980s and 1990s, but the state is also home to more than 6 million people. The rise in pork production has thus brought with it growing controversy over the potential impact of the industry on the environment. Responding to growing public concerns over odor and possible impacts on water quality, North Carolina enacted in 1997 a moratorium on the expansion or start-up of pork facilities with more than 250 hogs. The law also prescribed new setbacks for pork production facilities and directed the state's environmental agency to develop new procedures for addressing farm odor emissions. Summarizing the bill, one publication concluded, "The state's rapidly growing pork industry has been stalemated by a sprawling population" (Marbery).

More recently, the environmental debate has shifted to Oklahoma, a state where the pork industry has grown rapidly in the 1990s. One of the reasons the industry chose Oklahoma was because it had fewer environmental restrictions

Table 3

TOP 15 U.S. HOG PRODUCERS

1997 Rank	Name of operation	Location of operations	No. of sows in 1995	No. of sows in 1996	No. of sows in 1997
1	Murphy Family Farms	NC,MO,OK,IL, UT	227,500	260,300	297,200
2	Carroll's Foods	NC,VA,IA,UT, Mexico	110,000	111,400	144,800
1	Smithfield Foods	NC,VA,UT	95,000	112,000	120,000
2	Cargill	NC, AR, OK	80,000	90,000	115,000
4	Prestage Farms	NC, MS,UT	96,000	102,200	115,000
6	Tyson Foods	AR, NC,MO, OK, AL	107,000	110,000	111,500
7	Premium Standard Farms	MO, TX	96,800	105,000	110,000
8	Seaboard Corporation	KS, CO, OK	50,000	90,000	108,750
9	DeKalb Swine Breeders	KS, OK,IL,TX,IA, CO, NC	72,000	72,000	97,000
10	Iowa Select Farms	IA	42,000	62,000	82,000
11	Goldsboro Hog Farm	NC	52,000	54,000	60,000
12	Heartland Pork Enterprises	IN, IL, IA	18,000	36,400	56,000
13	Continental Grain Company	MO, NC	35,000	52,000	52,000
14	The Hanor Company	NC, WI, OK, IL	12,000	25,000	40,000
15	Land O' Lakes	IA, IL, OK, MO	14,500	19,000	34,000
15	National Farms	NE, CO	34,000	34,000	34,000
	Total		1,141,80	1,335,300	1,577,250
	Percent of U.S.		16.10	20.03	22.60

Source: *Successful Farming*: October 1997.

that affected the hog industry. But that is changing. In June, a new law was enacted that is considered by some in the industry as one of the nation's toughest hog laws. Specifically, the law stipulates a new licensing process for hog facilities, giving landowners within a mile of a hog farm a substantial voice in the granting of permits. The law also sets clear requirements for waste disposal, and mandates professional certification that waste disposal is not affecting the quality of groundwater. Finally, the bill imposes a fee amounting to 32 cents a hog to cover public costs of implementing the new bill.

The new Oklahoma bill highlights the speed with which state hog regulations can change. But it also points out that laws are far from uniform across the nation. Indeed, the nation has

become a patchwork of hog regulations. There is no definitive listing of state environmental regulations affecting the pork industry, a point made by several researchers (Mo and Abdalla; Copeland and Hipp). A sampling of regulations from a handful of states, however, illustrates the wide variation that exists. As shown in Table 4, Iowa requires permits only to construct pork facilities, whereas Missouri also requires an operating permit. Most of the sample states have rigorous setback limits that determine where pork facilities may be located. Utah leaves that decision up to local zoning authorities. North Carolina requires operators to keep records on waste disposal and corresponding soil conditions for the past five years, while Iowa requires waste disposal for three years.

Compounding these differences in regulation are differences in how the regulations are enforced. There is no comparison available on state-by-state differences in enforcement, nor on variation in the overall costs of compliance. Nevertheless, most analysts believe there is substantial variation throughout the nation.

What is clear is that firms in the pork industry are comparing regulatory climates across state lines and even county borders in search of places with fewer regulations. Analysts are divided on how important environmental regulations are in causing geographic shifts in production. A recent study found that pork location decisions this decade have been driven more by economic variables and local factors than by differences in state regulations, although the authors admitted their analysis was hampered by poor data on state programs and stringency of enforcement (Mo and Abdalla). Other studies suggest that environmental programs are a major factor in location decisions.

While empirical research remains inconclusive on the impact of environmental regulations on the industry's location, recent geographic patterns to some extent speak for themselves. The pork industry's two major geographic shifts of the 15 years both were clearly influenced by environmental factors. The first, the emergence of large pork supply chains in North Carolina, happened far from the Corn Belt, where it might have been expected. That was mainly because the innovators who created integrated pork supply chains were from the Southeast. At the time, however, some market observers thought the new pork industry might locate in Virginia. However, the industry's rapid growth was clearly concentrated in North Carolina. One study concluded that tighter environmental regulations in Virginia pushed the industry toward North Carolina (Bacon). The second shift, a move of pork operations to the Great Plains and Southwest, was driven at least in part by the desire to find states where large pork facilities could find more space, fewer people, and perhaps less restrictive regulations.

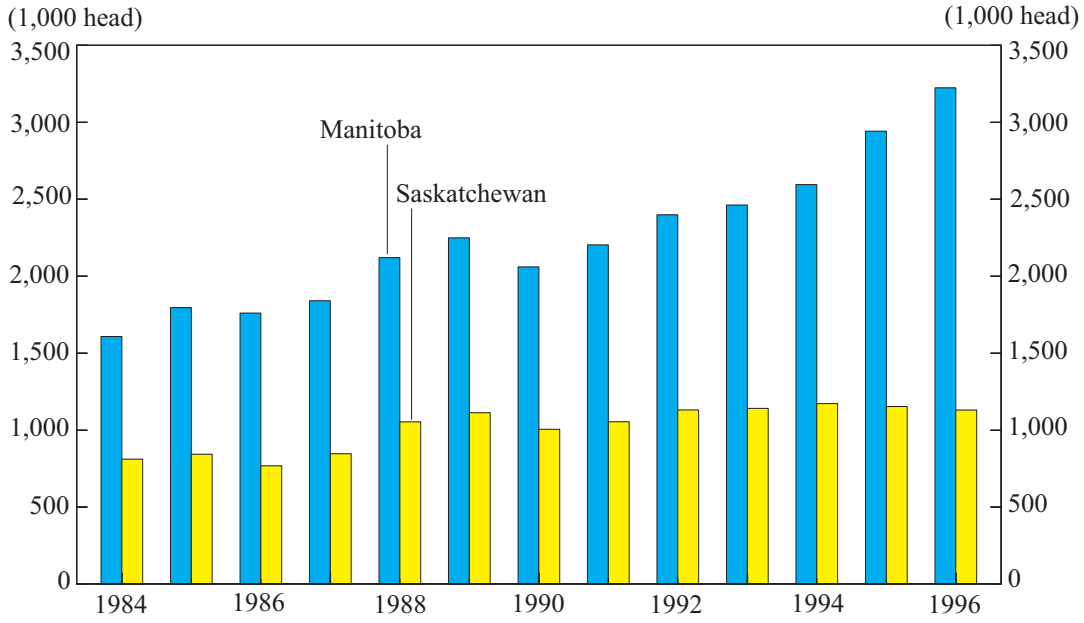
Looking forward, two environmental issues will be important in shaping location decisions. The first is whether a national set of environmental standards is enacted. The Environmental Protection Agency, the U.S. Department of Agriculture, the National Pork Producers Council, environmental groups, and state regulators began a public dialogue in December 1997 to create national environmental regulations for the pork industry. The group hopes to draft guidelines that will provide a "national floor" that all states would be required to adopt. States could opt to write more stringent regulations at their own discretion. The EPA, the regulatory agency that would oversee the national guidelines, has announced it wants proposed rules by December 1999 and final action by December 2001.

National guidelines for the pork industry would appear to provide a much more level playing field on which location decisions will be made. In essence, such a step would push location decisions to the local level. Some communities are eager to embrace the new pork industry,

Table 4
ENVIRONMENTAL REGULATIONS ACROSS SELECTED STATES

	Iowa	North Carolina	Oklahoma	Utah	Missouri
Permits:					
Type required	State Construction	State	State	State	State Construction and Operating
Cost	Based on # of head	$50-200	$15-$225		
Permit required for:	Feeding operations defined under EPA Clean Water Act.	New feedlots or those with > 250 head	CAFO with > 1,00 head	CAFO with > 1,00 head	Class I CAFO
Earthen liners:					
Required	Yes	Yes	Yes	Yes	
Lagoons:					
Days capacity	No	180	Must be able to contain 25 yr/24 hr rainfall event	None	
Size limits		No			
Setbacks:					
Buildings	750-2,250 ft	1,500 ft	1,350 ft	Determined by local boards.	1000 ft
City limits		2,500 ft	3 miles		
Lake, river, streams	200 ft	100 ft			
Well	100-1,00 ft	100 ft	300 ft		300 ft
Property line		500 ft			
Records:					
What type	Waste Application	Waste Application Soil Analysis	Waste Application	Waste Application Soil Analysis	Waste Application
Years	3 years	5 years	3 years		
Inspection:					
Required	Yes	Yes	Yes	Yes	
How often	Periodic	Annually	Annually		
Regulatory authority:	Iowa Department of Natural Resources	Department of Enviromental Quality	None	Department of Enviromental Quality	Department of Agriculture

Chart 5
HOG PRODUCTION IN CANADIAN PROVINCES



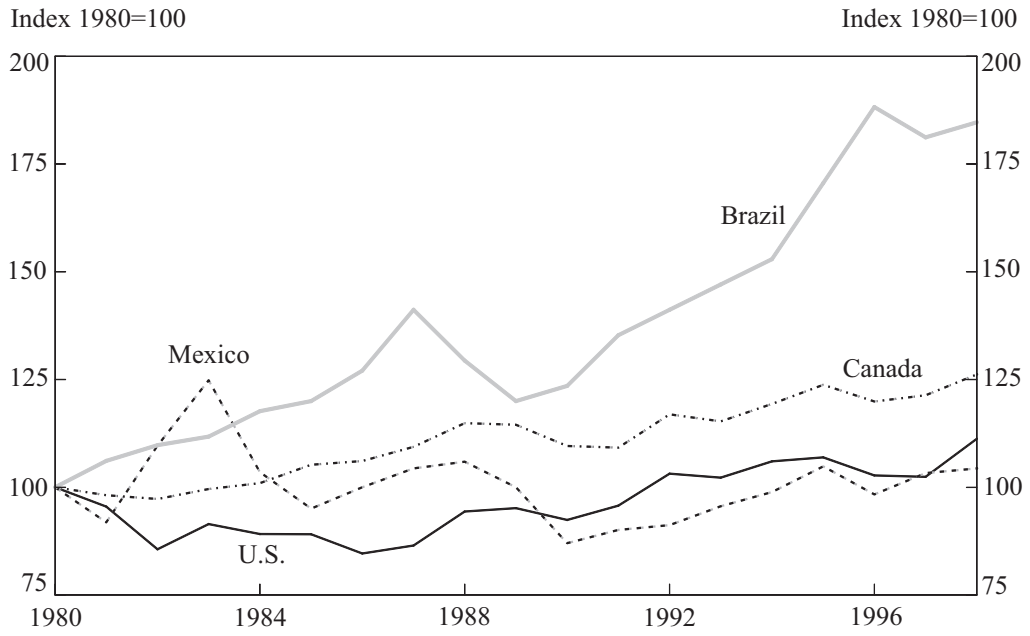
Source: Canadian Pork Council.

while many others are not. Uniform regulations across states will allow the industry to identify these communities readily.

Uniform environmental regulations could also serve to highlight the role of corporate farming laws. Some Midwestern states have laws that prohibit corporations from owning farmland. This tends to curtail pork expansion since large pork farms require land on which to spread animal waste, and in some cases land on which to grow their own corn. How important these laws will be remains to be seen, however, since some states like Missouri have granted exceptions for some pork operations. The one state in the Heartland where the restriction may deter expansion is Nebraska, which has one of the most restrictive statutes concerning the activities of corporate farms.

The other environmental issue that will influence future location decisions is differences in regulation across national borders. No comparison of regulatory regulations in major pork producing nations is currently available. However, the information that can be gleaned points to some significant differences. In Canada, there are only limited federal regulations, with legislative oversight of livestock operations falling to the provincial governments. Many provinces have regulations regarding water quality issues, but most leave the licensing of pork farms to local governments, and these rules range widely in terms of stringency. This is true in Manitoba and Saskatchewan, two provinces with low-cost

Chart 6
HOG PRODUCTION



Source: U.S. Department of Agriculture.

structures and thus likely to see further expansion. One positive factor throughout Canada is that the Canadian pork industry in 1995 endorsed a set of guidelines on environmentally sound production practices (Canadian Pork Council). These guidelines involve issues similar to those involved in the current dialogue between U.S. pork producers and the EPA. With agreement in the industry and effective local control, environmental issues may be less combative in Canada in the period ahead than in the United States.

In Mexico and Latin America, the situation is much less clear. The Mexican government has some regulations that define limits on animal waste disposal near water sources. State and local governments enforce environmental regulations, with wide variations in stringency of enforcement. In Brazil, another country where there is potential to expand pork production, there appear to be few environmental regulations surrounding pork production.

The differences among Canada, Mexico, and the United States are especially germane since enactment of the North American Free Trade Agreement in 1994 eliminated nearly all tariffs on trade in pork products and live hogs. NAFTA eliminated trade considerations from pork firms considering alternative locations in North America. In addition, talks to form a Free Trade Area of the Americas are now beginning, which could remove tariffs as a factor in pork locations by 2005 throughout the Western Hemisphere.

III. THE NEW PORK INDUSTRY'S FUTURE GEOGRAPHY

As shown earlier, the U.S. pork industry has already moved to many new locations in the 1990s. Thus far, these geographic shifts have been favorable to the Heartland region, bringing pork operations to many rural communities eager to find new sources of economic growth. But with powerful forces of change still at work in the pork industry, it seems far from having reached a new operating equilibrium. What do the economic and environment factors discussed above suggest for the future location of the pork industry? Three conclusions have merit.

First, within the United States the Heartland seems likely to capture a bigger share of total production. The recent migration to the Great Plains states and other western states like Utah appears well-rooted. As an example, over the past four years Seaboard Corporation invested $330 million in state-of-the-art production and processing facilities near Guymon, Oklahoma. That operation now has a capacity of 4 million hogs a year. Earlier this year, the company announced plans to construct a twin facility in Great Bend, Kansas.

Pork operations in the Great Plains have strong advantages. They are near abundant corn supplies in the western Corn Belt. What is more, the new farm bill makes it easier for farmers in the Great Plains to switch from wheat production to crops that are better feedstuffs. States in the southern Great Plains are near rapidly growing retail markets in the Southwest and West. They also provide ready rail access to developing export markets in Mexico, and West Coast ports for transshipment to Asia, which promises to be a strong market once near-term economic problems are past. While demand has slumped since economic problems began in Asia last year, the region has proven that it has huge potential as a market for U.S. pork. Between 1990 and 1997, for example, U.S. pork exports to Asia surged from $235 million to $758 million. Finally, pork operations in the Great Plains can be located in areas with some of the lowest density of population in the nation. Further, many communities in the region offer ecosystems with substantial capacity to handle animal waste. Thus, states in the Heartland will probably capture an even bigger share of U.S. pork production and processing, as they already have this decade.

Second, some pork production seems likely to shift from the United States to other countries, although the extent of this shift is extremely difficult to predict in advance. The pork industry is rapidly moving to supply chains, and at least some of these chains will be borderless. That is, the firms will be built on technology and relationships instead of bound by land holdings. Under its traditional small farm structure, the pork industry was tied to the barns and farmyards scattered throughout the nation. But no longer. The largest firms, as many researchers have noted, are mobile and will almost certainly consider transborder alternatives in their search for low costs and higher profits.

Moreover, other countries will offer competitive locations compared with the United States. The Canadian prairie provinces may be the most likely place for the new pork industry to expand. Feed is plentiful, substantial pork infrastructure is already in place, and these locations offer ready access to the U.S. market. The most telling factors, however, may be that these provinces hold even fewer people than states south of the border, and the provinces appear to be encouraging the pork industry to boost rural economic gains. Manitoba and Saskatchewan have already shown substantial ability to gear up their hog production, with Manitoba's pork output roughly doubling over the past 12 years (Chart 5). Most of this expansion occurred prior to the recent Canadian agricultural policy reforms that provided still more incentive to boost livestock production.

One deterrent to Canadian expansion may be packing capacity. Canadian plants tend to be smaller than U.S. plants, with correspondingly higher average costs. Moreover, Canadian labor costs tend to be higher overall than in the United States (Martin and others). But if the history of the cattle industry in the U.S. Great Plains is a guide, big new packing plants can materialize fairly quickly if there are sufficient animal numbers to support them.

Mexico and Brazil will also share in some pork gains. Labor is cheaper than in the United States or Canada, and environmental compliance almost certainly will be both easier and cheaper than in the United States. Brazil has a huge supply of grain to feed a growing pork industry. Mexico does not, but under NAFTA and with improved transportation systems it could import more corn from the United States.

The extent to which some U.S. pork production may shift to these countries is very difficult to predict. Much will depend on how current debates over environmental regulations play out in key states. However, recent production trends in competing countries may provide a glimpse of the potential for expansion in these countries. As shown in Chart 6, since 1980 pork production has generally grown faster in Brazil and Canada than in the United States. Mexico's production has been somewhat more variable. Considering the huge amounts of feed and land available in Canada and Brazil, and the lure of cheap labor and low environmental compliance costs in Mexico, further pork expansion in these countries appears inevitable.

Third, innovations in technology and policy almost certainly will help to retain pork production in the United States and thus discourage the exodus described above. One obvious deterrent to continued pork expansion in many states is the odor associated with concentrated animal production and the corresponding waste. This becomes a bigger issue in states where the rural population density is fairly high. Indiana is a good case in point. Traditionally, Indiana was a leading pork state. But its share of production has shrunk significantly, in part because large-scale pork farms quickly collide with a substantial number of rural homeowners. The same can increasingly be said of North Carolina.

Recognizing how much this problem curtails further pork expansion in many parts of the nation, the pork industry has undertaken a $3.5 million initiative to identify and test ways to reduce or even eliminate odor from animal waste. Moreover, researchers at many land grant universities are now exploring innovations in feed rations and other techniques to reduce odor emissions.

Finally, the policy environment at the federal and national level will be anything but static in the period ahead. The pork industry has clearly demonstrated that it can move in response to differences in regulatory climate, and that will continue to be the case in the future. With the prospect that federal guidelines could emerge, the regulatory field will be more level throughout the nation. That would make pork location decisions a matter of local control, where they probably belong. Still, some states may view the new pork industry as a welcome source of economic growth, especially in rural areas. Thus, some states may well step forward with regulatory regimes more friendly to the pork industry. However, those states are most likely to be found in the Heartland, where rural populations are smaller and where economic alternatives are fewer. In the end, the emerging regulatory environment may only reinforce the economic forces pushing the new pork industry to the Heartland.

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