

Livestock - hogs

Econ 235

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- The United States is the third largest producer of hogs in the world, behind China and the EU.
- The supply chain for hogs and pork operates differently than the supply chain for cattle and beef.
- Production cycles in hogs are shorter than in cattle but nonetheless important.
- Like cattle, the characteristics of hogs are difficult to observe on a live animal and the market has come up with solutions for the adverse selection problem it can create.
- I will begin with definitions, review some market data and finally turn to the economics of hog marketing.

- [Information about livestock farming](#) from ISU extension.
- [Hog markets](#) from Mindy Mallory textbook.

Definitions

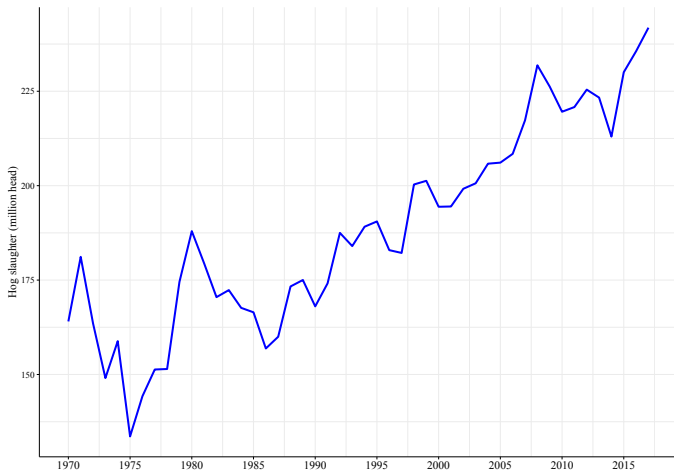
- Hog: Live animal, domesticated pig;
- Pork: Meat from hogs;
- Barrow: Neutered male hog;
- Boar: Uneutered male hog, usually kept for breeding;
- Feeder pig: Young hog, 6-8 weeks old and 40-50lbs in weight;
- Gilt: Female hog that has not yet had a litter;
- Sow: Female hog that has had a litter;
- Market hog: Adult hog for slaughter;
- Piglet: Baby pig;
- Weanling: Weaned pig, typically 2-3 weeks old and 10-15lbs in weight;
- Farrow: Birth of piglets;
- Parity: Number of farrowings or litters from a sow.

- Farrow-to-finish: Production of hogs from birth (farrowing) to finishing (market hogs);
- Farrow-to-wean: Production of hogs from birth to weaning;
- Farrow-to-feeder: Production of hogs from farrow to feeder pigs;
- Wean-to-finish: Production of hogs from weaned pigs to finishing (market hogs);
- Feeder-to-finish: Production of hogs from feeder pigs to finishing (market hogs).

Supply chain (example)

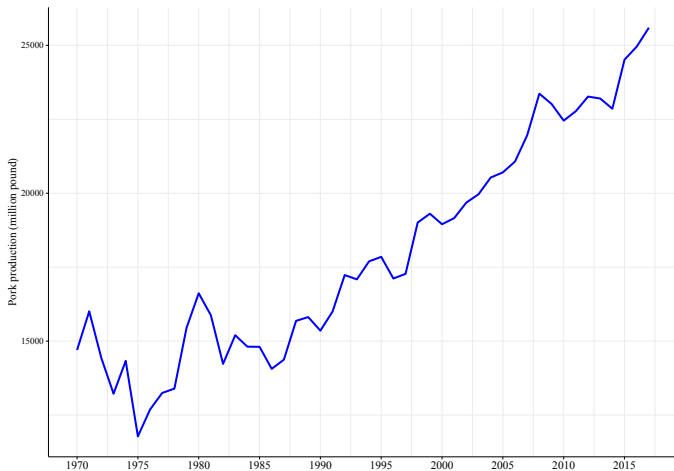
- Farrow-wean:
 - ▶ Sell weaned hogs (2-3 weeks old).
- Wean-to-finish:
 - ▶ Purchase weaned hogs;
 - ▶ Sell market hogs (24-29 weeks old depending on target weight).
- Packing/slaughter plant:
 - ▶ Buy market hogs;
 - ▶ Sell pork cuts.
- Retail/food service:
 - ▶ Buy pork cuts;
 - ▶ Sell beef to consumers.

Commercial hog slaughter



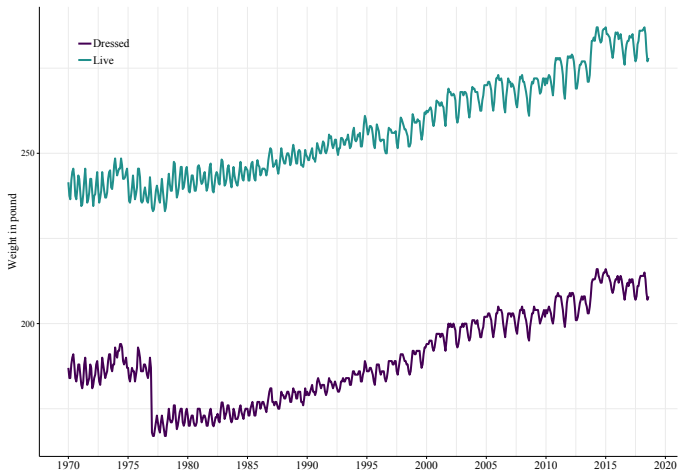
Data source: [USDA - Economic Research Service \(2018a\)](#).

Pork production



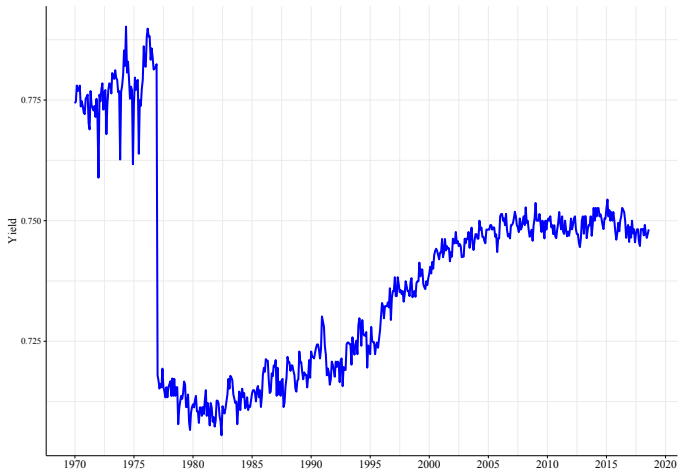
Data source: [USDA - Economic Research Service \(2018a\)](#).

Average live and dressed hog weight in federally inspected facility



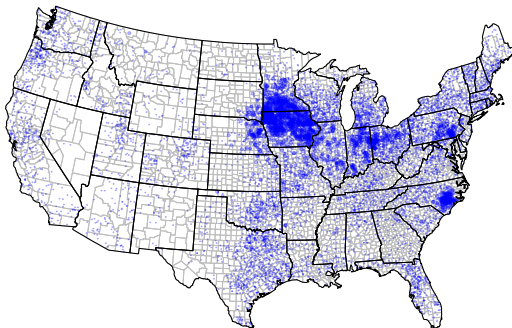
Note: I suspect that the drop in carcass weight in the 1970s is from a modification in the way to measure carcass weight. Data source: [USDA - Economic Research Service \(2018a\)](#).

Average carcass yield (live weight/dressed weight)



Note: I suspect that the drop in carcass weight in the 1970s is from a modification in the way to measure carcass weight. Data source: [USDA - Economic Research Service \(2018a\)](#).

Operations with hog inventory by county (2012 census of agriculture)



This is a density dot map where each dot represents about 5 operations, with larger dots representing groups of larger operations. Data source: [USDA - National Agricultural Statistics Service \(2018\)](#).

Hog inventory by state (March 1, 2018)

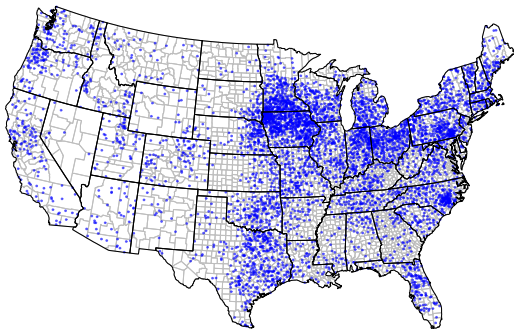
State	Inventory
Illinois	5.3
Indiana	4.0
Iowa	22.5
North Carolina	8.9
Other states	32.1

Note:

Inventory is measured in million heads

Data source: USDA - National Agricultural Statistics Service (2018).

Operations with market hog inventory by county (2012 census of agriculture)



This is a density dot map where each dot represents about 10 operations, irrespective of their sizes. Data source: [USDA - National Agricultural Statistics Service \(2018\)](#).

Market hogs by state (March 1, 2018)

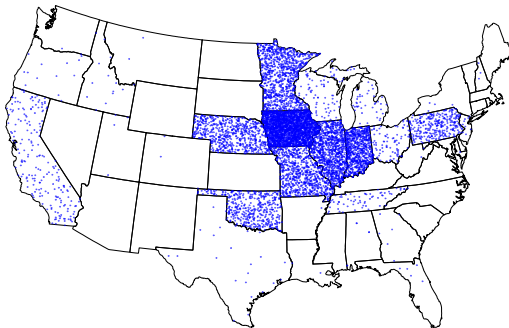
State	Market hogs
Illinois	14.4
Indiana	11.4
Iowa	65.6
North Carolina	24.5
Other states	78.4

Note:

The number of market hogs is measured in million heads

Data source: USDA - National Agricultural Statistics Service (2018).

Hog slaughter by state (2017)



This is a density dot map. A dot does not represent the specific location of hog. Rather, the number of dots within a state that represents the relative hog slaughter by state. Data source: [USDA - National Agricultural Statistics Service \(2018\)](#).

Hog slaughter by state (2017)

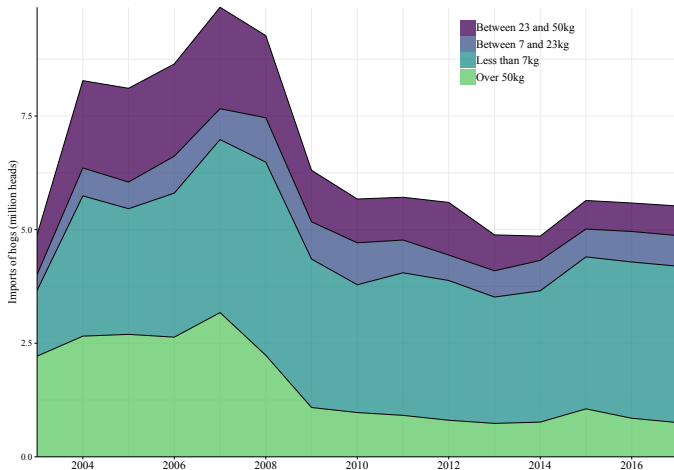
State	Hog slaughter
Illinois	12.2
Indiana	8.9
Iowa	32.9
Missouri	9.3
Other states	35.3

Note:

Hog slaughter is measured in million heads

Data source: USDA - National Agricultural Statistics Service (2018).

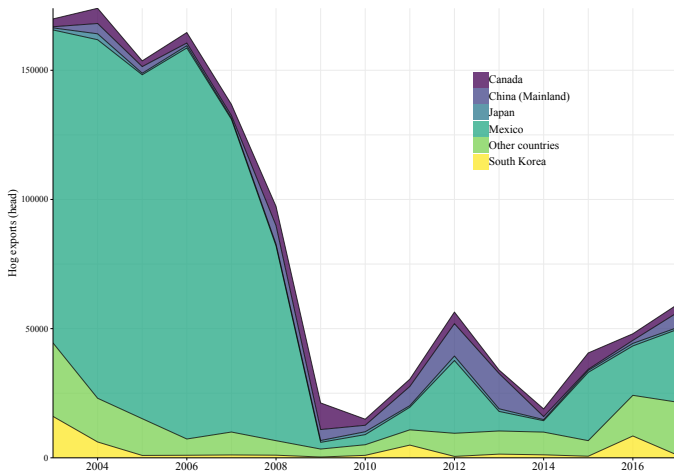
Annual imports of hogs



Data source: [USDA - Economic Research Service \(2018b\)](#).

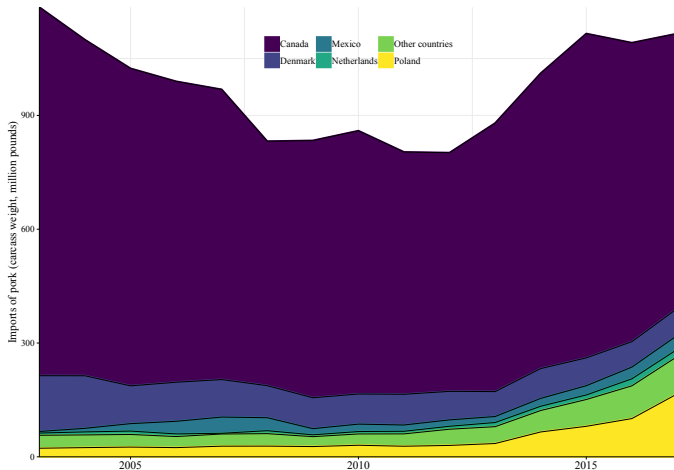
- Virtually all hog imports are from Canada.
- Most of the piglets (less than 7kg) come from Manitoba.
- Farrowing is more efficient (larger litter) in Canada presumably because of colder climate.
- The exchange rate also plays a role.

Annual exports of hogs (all weights)



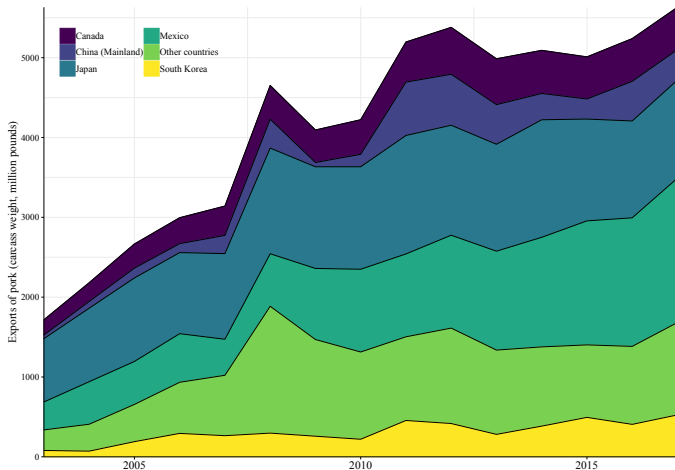
Data source: [USDA - Economic Research Service \(2018b\)](#).

Pork imports (carcass weight, million pounds)



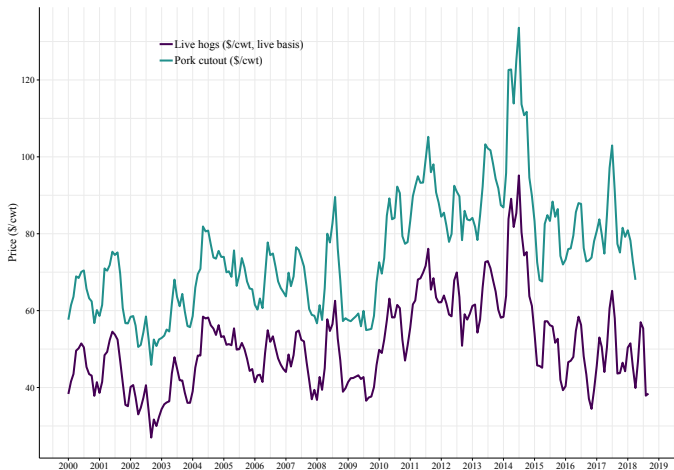
Data source: [USDA - Economic Research Service \(2018a\)](#).

Pork exports (carcass weight, million pounds)



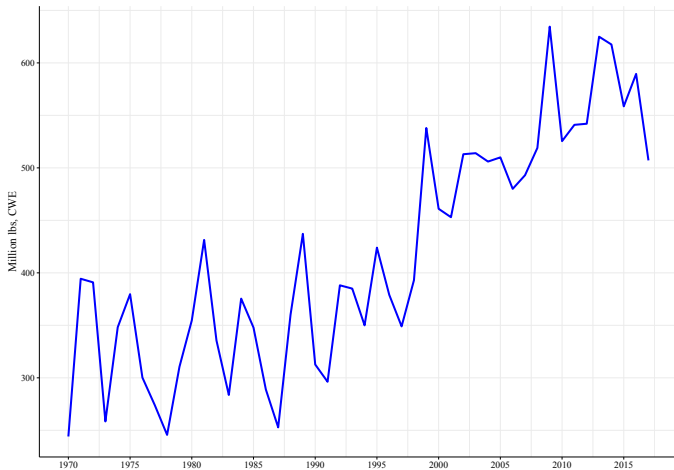
Data source: [USDA - Economic Research Service \(2018a\)](#).

Live hog price and pork cutout prices



Data source: [USDA - Economic Research Service \(2018a\)](#).

Beginning stocks of pork (Million lbs, CWE)



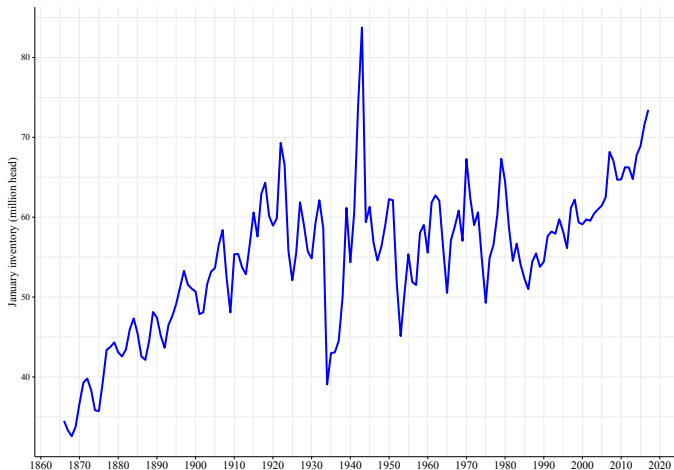
Note: CWE means Carcass Weight Equivalent. Data source: [USDA - Economic Research Service \(2018a\)](#).

- Hog cycles are just like cattle cycles but they occur at a shorter interval because of a faster production dynamics in hogs.
- Hog cycles are expansion and contraction of hog inventories at regular intervals (see hog inventory figure below).
- A cycle lasts from three to five years.
- Cycles occur because of biological nature of hog production:
 - ▶ A sow can be bred for the first time at around 5 to 6 months old.
 - ▶ A sow will have its first litter about 113 days later (3 months, 3 weeks and 3 days).
 - ▶ It takes between 24 to 29 weeks to attain a target slaughter weight.

- Biological lags cause a delayed response between a shock and a response in production.
 - ▶ For example, if the price of feeder hogs increase, farrowing operations increase the size of their breeding herd.
 - ▶ During the time it takes to increase the breeding herd, the price continues to increase.
 - ▶ It takes about a year and a quarter from the time a farrowing operation decides to expand and the time its production actually increases.
 - ▶ Expansion continues until the prices for piglets, feeder pigs, market hogs and pork begins declining from the increased production.
 - ▶ Average parity per sow is about 5.5 litters. This means that a sow is culled at about 2.5 years old.
 - ▶ Producers reduce the size of their herd by not replacing all of their sows.
 - ▶ Hog production then declines and prices start increasing once again, re-starting the cycle.
- Cycles last 3 to 5 years.

- Cycles contribute to periods of prosperity followed by periods of losses to hog farmers.
- See for example historical returns in the hog sector at <http://www2.econ.iastate.edu/estimated-returns/> or at <https://www.ers.usda.gov/data-products/commodity-costs-and-returns/commodity-costs-and-returns/>

US December hog inventory



Note: I suspect that the shocks in the 1930s and 1940s have to do with how the data were collected. Data source: [USDA - National Agricultural Statistics Service \(2018\)](#).

Return to a farrow-to-finish operation in Iowa (\$/head)

Table 1. Estimated returns to farrow to finish pig production in Iowa (\$/head), by sale month 10-year summary

Month sold	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Ava.
January	-\$18.78	-\$6.74	\$17.48	\$7.63	\$10.95	-\$7.56	\$13.15	\$13.28	-\$12.83	\$2.76	\$1.94
February	-10.31	-3.37	15.59	18.04	14.40	-11.60	33.59	-3.12	4.12	22.18	7.95
March	-25.62	-1.83	25.51	15.72	13.43	-25.60	92.35	-3.23	3.66	11.48	10.59
April	-9.54	-2.24	43.36	26.80	2.54	-14.37	81.64	2.84	9.33	-7.38	13.30
May	15.83	-3.45	52.67	23.32	1.38	6.76	74.13	26.25	25.01	17.40	23.93
June	2.40	-6.66	41.22	26.43	33.82	24.29	93.04	23.23	32.92	41.46	31.21
July	4.98	-6.60	41.71	27.22	27.90	24.57	107.25	22.17	19.36	47.62	31.62
August	19.38	-21.23	50.21	33.50	-3.47	22.60	57.45	20.27	0.70	27.54	20.69
September	-5.75	-15.58	47.39	7.64	-37.37	21.90	66.15	12.29	-15.77	-12.68	6.82
October	-17.88	-12.56	17.19	16.20	-19.25	15.63	53.03	13.97	-30.11	-1.18	3.50
November	-28.35	-6.42	-2.26	-0.82	-24.04	9.67	39.31	-14.44	-35.52	-1.38	-6.43
December	-23.35	9.08	3.43	-2.74	-16.19	8.22	31.10	-18.40	-16.03	-4.42	-2.92
Average	-\$8.08	-\$6.47	\$29.46	\$16.58	\$0.34	\$6.21	\$61.85	\$7.93	-\$1.26	\$11.95	\$11.85

	Month sold	Months of		Range	Months
		Profit	Loss		
During the 2008-2017 period, the range in profits was from -\$37.37 to \$107.25.	January	60%	40%	Profit over \$25 =	25.0%
	February	60%	40%	Profit \$20 to \$25 =	7.5%
	March	60%	40%	Profit \$15 to \$20 =	9.2%
	April	60%	40%	Profit \$10 to \$15 =	6.7%
	May	90%	10%	Profit \$5 to \$10 =	5.8%
During this period, 62.5 percent of the months were profitable and 37.5 percent of the months were unprofitable.	June	90%	10%	Profit \$0 to \$5 =	8.3%
	July	90%	10%	Loss \$0 to -\$5 =	10.8%
	August	80%	20%	Loss -\$5 to -\$10 =	6.7%
	September	50%	50%	Loss -\$10 to -\$15 =	5.8%
	October	50%	50%	Loss -\$15 to -\$20 =	6.7%
	November	20%	80%	Loss -\$20 to -\$25 =	2.5%
	December	40%	60%	Loss over -\$25 =	5.0%

The assumptions used in computing the returns are outlined in the Iowa State University Extension and Outreach Estimated Livestock Returns at www.econ.iastate.edu/estimated-returns/.

Source: Schulz (2018).

Marketing methods for hogs

- The same marketing methods for cattle are used in the hog industry.
- However, an important difference is that in addition to the traditional marketing methods, a major part of hog production is under contracts.
- Vertical integration means that *integrators*, or *contractors*, contract production for their hogs to independent growers or are directly involved in upstream production stages.
- Integrators are packing plants.
- *Full integration* means that a packing plants own facilities for growing hogs and thus control the entire supply chain.
- It is not possible to tell how much of the hog production is under vertical control.
- It is also very difficult to tell whether there is a trend toward more vertical integration and more full integration.
- See some explanations at this link:
<http://porkgateway.org/resource/producing-and-marketing-hogs-under-contract/>.

Marketing and production contracts

- See definitions in [this ERS publication](#).
- *Marketing contracts* refer to verbal or written agreements between a contractor and a grower that sets a price (or pricing mechanism) and an outlet for the commodity before harvest or before the commodity is ready to be marketed.
- *Production contracts* specify in detail the production inputs supplied by the contractor (processor, feed mill, other farm operation or business), the quality and quantity of a particular commodity, and the type of compensation to the grower (contractee) for services rendered.
- Marketing contracts are common in grains and cattle industries.
- Marketing contracts are also common in the hog industry.
- There are also production contracts in the hog industry.

Why are there contracts in the hog industry?

- There are contracts in the grain and cattle industry.
 - ▶ The objective of these contracts is usually to manage price risk.
 - ▶ The contracts are typically for a relatively short period of time (i.e. a few months).
- Contracts in hog and poultry, as well as for specialty crops, are different:
 - ▶ They address issues regarding price risk.
 - ▶ They also include provisions regarding the characteristics of a product and farming methods.
 - ▶ The contracts cover longer time periods (several years).
- The extent of vertical integration depends on transaction costs and asset specificity.

Transaction costs and asset specificity

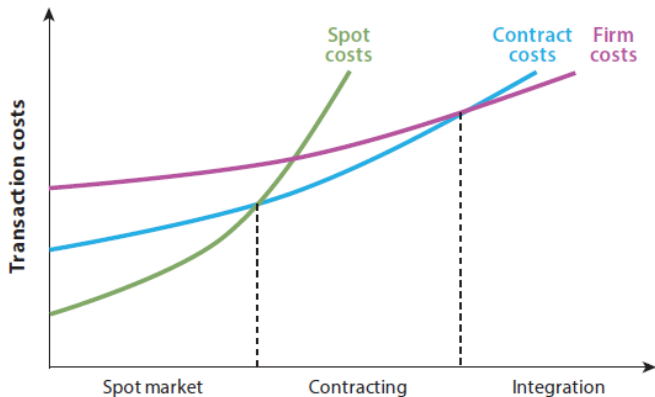
- Some characteristics of a product are difficult (i.e. costly) to observe.
 - ▶ For example, a packer could do extensive tests for antibiotics or other meat quality traits on every carcass but this would be very costly.
 - ▶ Observing/testing the quality of a product is an example of transaction cost that firms might have to incur.
 - ▶ Contract can specify practices that insure the presence or absence of certain characteristics, hence eliminating certain transaction costs.
- A farm would not invest into assets specific to meet the need of a packer unless it is guaranteed that it can have a return on that asset.
 - ▶ A contract can provide a long term incentive to invest in some specific assets.

Transaction costs and asset specificity I

- The figure below shows the relationship between vertical integration, transaction costs and asset specificity.
 - ▶ The horizontal axis is the degree of asset specificity.
 - ▶ The vertical axis is the transaction costs for a product, which may include testing.
- The three cost curves show three types of transactions:
 - 1 Spot market;
 - 2 Contract;
 - 3 Firm, i.e. full integration.
- If transaction costs are low and assets are not specific, the spot market minimizes costs.
 - ▶ This is the example for corn.
- As transaction costs increase and assets are more specific, then contracts minimize costs.
 - ▶ Some marketing contracts
 - ▶ This is the case for a major part of the hog production.

- In the case where transaction costs are high and assets are very specific, then full integration becomes the cost minimizing method.
 - ▶ Production contracts are an example of full integration.
 - ▶ This is the example of some of the hog production and almost all of the poultry and egg industry where packers control the supply chain from feeds up to packing.

Transaction costs and asset specificity



Note: On the horizontal axis is the degree of asset specificity. Source: Crespi and Saitone (2018).

- The hog industry uses the spot market, contracts and full integration:
 - ▶ Spot market is not very common anymore.
 - ▶ Most of the production of hogs is under contract.
 - ▶ There is a good share of the production that is under full integration but that is difficult to evaluate how much.
- Most of the hog production is under some form of vertical integration (production contracts mean full integration).

Advantages to vertical integration in the hog industry

- Vertical integration minimizes transaction costs and incentivizes investments in specific assets.
- Some related advantages to vertical integration in the hog industry.
 - ▶ Smooths out production cycles, especially seasonal production cycles;
 - ▶ This allows to maintain a more uniform production volume throughout the year, reducing packing costs;
 - ▶ Reduces price risks;
 - ▶ Better control of genetics;
 - ▶ Allows for a better control of hog characteristics (e.g. size), reducing packing costs;
 - ▶ Facilitates widespread adoption of latest practices and technologies, hence reducing production costs.

Disadvantages to vertical integration in the hog industry

- There are some disadvantages to vertical integration in the hog industry.
 - ▶ Growers partly loose control of their operation;
 - ▶ Growers may have limited ability to negotiate the terms of production contracts;
 - ▶ Growers retain production risk.
 - ▶ There might be a hold up problem where growers invest in specific assets and at the end of a contract they do not have any other option than to contract again with the same integrator.

- For vertical integration to work, it requires that both the integrators and the growers gain from it.
- Integrators must offer contracts such that some growers will be willing to accept.
- Price for hogs under contract are either negotiated (fixed base price) or determined by formula.
 - ▶ Some contracts will also specify premia for grade and yields.
- Contracts are incomplete, meaning that they cannot account for every possible contingency.
 - ▶ This became evident with the outbreak of PEDv recently.
 - ▶ Producers who received sick pig could not meet production targets.
 - ▶ This became an important legal issue.

Price of weaned and feeder hogs

- Prices for hogs are determined at the intersection of demand and supply.
- An increase in the costs to farrow-to-wean or farrow-to-feeder reduces the supply of weaned pig and feeder pigs.
 - ▶ For example, the outbreak of Porcine Epidemic Diarrhea Virus (PEDV) in 2014 reduced yields in farrowing effectively increasing production costs.
 - ▶ This shifted the supply of weaned pigs and feeder pigs to the left.
- Many factors affect the demand for weaned pigs and feeder pigs:
 - ▶ Feeding costs (e.g. cost and other feeds);
 - ▶ Costs at packing plants (e.g. labor costs);
 - ▶ Domestic consumer demand (e.g. income, price of substitute products, irrational fear);
 - ▶ International consumer demand (e.g. trade agreements, competition from other countries, exchange rate, tariffs).

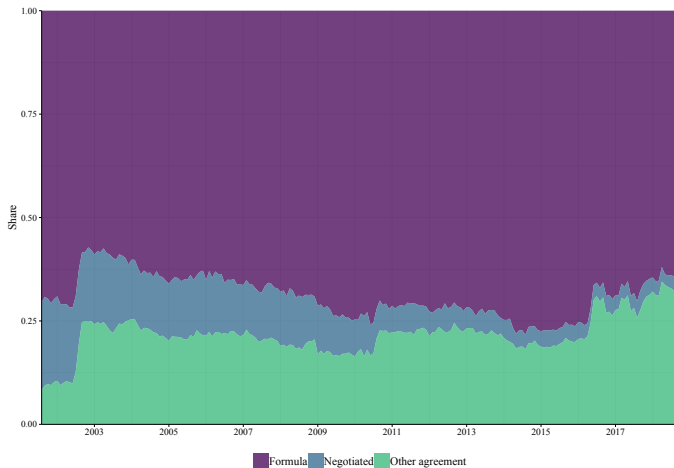
Price of slaughter hogs

- The price of slaughter hogs is determined at the intersection of demand and supply.
- Costs of finishing hogs affect the supply of slaughter hogs:
 - ▶ Includes the cost of younger pigs (weanlings, feeders);
 - ▶ Cost of feed (e.g. corn);
 - ▶ Because PEDV shifted the supply of weanlings and feeders, it also shifted to the left the supply of market hogs.
- Many factors affect the demand for market hogs:
 - ▶ Costs at packing plants (e.g. labor costs);
 - ▶ Domestic consumer demand (e.g. income, price of substitute products);
 - ▶ International consumer demand (e.g. trade agreements, competition from other countries, exchange rate, tariffs).
- Characteristics of a pigs (e.g. breed, weight, color) explain difference in prices across pigs.

Hogs prices

- Throughout the supply chain, the characteristics of hogs affect their prices.
- Quality is difficult to observe but hogs tend to be more homogenous than cattle.
 - ▶ There is more breed variety in cattle (southern versus northern breeds, dairy).
- The methods to price hogs in direct sales or contracts are very similar to those for direct sales for cattle.
 - ▶ For that reason they are not covered here.
- The number of hogs sold on a live weight basis is small.
- There are hogs that are sold between packers:
 - ▶ A packer might have more hog produced in an area than it can processed nearby;
 - ▶ Temporary slow down in packing operations.

Negotiated versus formula - producer sold, carcass basis



- Packers use different matrices to reward the characteristics that they find desirable.
 - ▶ Packers offer different pork products to consumers and hence they look into different quality attributes into hog carcasses.
- The characteristics considered include:
 - ▶ Backfat thickness;
 - ▶ Loineye area;
 - ▶ Loin depth.
- The net price is calculated from a base price to which are added discounts and premia depending on the characteristics of a carcass.

What are the discounts and premia

- The USDA reports price ranges based on measured backfat thickness, loin eye area and loin depth.
- This information is available in report 1m_hg200:
https://www.ams.usda.gov/mnreports/lm_hg200.txt.

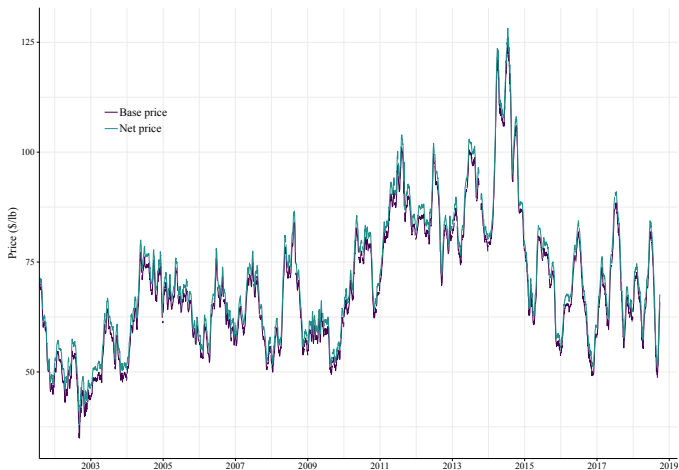
Example matrix from USDA report 1m_hg200

- Below is an example of the range of prices paid for negotiate hog prices for given backfat thickness, loineye area and loin depth.

NATIONAL DAILY DIRECT NEGOTIATED HOG PURCHASE MATRIX
REPRESENTING INDIVIDUAL PACKER CARCASS MERIT BUYING PROGRAMS
based on both Fat and Muscle Measurements for a 200 lb Carcass Basis
LOIN AREA/DEPTH (INCHES)

BF	4.0/ 1.4		5.0/ 1.7		6.0/ 2.0		7.0/ 2.3		8.0/ 2.7	
0.4	61.00	67.57	62.50	68.90	63.50	70.23	64.50	71.56	65.00	73.33
0.5	58.00	67.57	61.00	68.90	63.50	70.23	64.00	71.56	65.00	73.33
0.6	58.00	66.31	61.00	67.64	62.50	68.96	63.50	70.29	64.50	72.06
0.7	58.00	65.04	58.00	66.37	61.00	67.70	63.50	69.03	64.00	70.80
0.8	57.00	63.78	58.00	65.10	61.00	66.43	62.50	67.76	64.00	69.53
0.9	57.00	62.51	58.00	63.84	58.00	65.17	61.00	66.50	62.50	68.27
1.0	55.00	61.25	57.00	62.57	58.00	63.90	61.00	65.23	62.50	67.00
1.1	54.00	59.66	57.00	61.00	58.00	62.32	58.00	63.65	61.50	66.50
1.2	54.00	58.00	55.00	59.09	57.00	61.00	57.50	62.00	59.50	65.00
1.4	49.50	54.50	50.87	58.00	52.20	59.00	53.53	61.00	55.30	62.00

Base price and net price - producer sold



Mandatory price reporting (MPR)

- MPR also applies to the hog industry.

- Crespi, J. M. and Saitone, T. L. (2018). Are cattle markets the last frontier? vertical coordination in animal-based procurement markets. *Annual Review of Resource Economics*, 10(1):null.
- Schulz, L. (2018). Livestock – cost & return. Available at <https://www.extension.iastate.edu/agdm/ldcostsreturns.html>.
- USDA - Economic Research Service (2018a). Livestock & meat domestic data. Available at <https://www.ers.usda.gov/data-products/livestock-meat-domestic-data/>.
- USDA - Economic Research Service (2018b). Livestock and meat international trade data. Available at <https://www.ers.usda.gov/data-products/livestock-and-meat-international-trade-data/>.
- USDA - National Agricultural Statistics Service (2018). Quick stats. Available at <http://quickstats.nass.usda.gov/>.