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Economic impact of a ban on the use of over the counter antibiotics in U.S. swine rations

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Abstract

The U.S. pork industry routinely adds antibiotics to rations of weaned pigs both to prevent illness before symptoms emerge and to increase growth rates. The European Union (EU) is in the process of restricting feed use of antibiotics, and the U.S. is currently reviewing the practice. The strategic issue facing U.S. pork producers is whether another food safety dispute with the EU is worthwhile. This paper evaluates the economic impact of such a ban in the U.S. The analysis uses a set of technical assumptions derived from the experience of a similar ban in Sweden and finds such a ban would increase production costs per head between $5.24 and $6.05; net profit would decline $0.79 per head. On the consumer side, the effects of a ban would raise the retail price of pork by 5 cents per pound.

1. Introduction

U.S. pork producers are currently permitted to use 29 over the counter antibiotics and chemotherapeutics in feed (National Research Council, 1999, Tables 2–6 and 2–7). Of these, five are listed only as growth promotants (bambermycin, efrotomycin, oleandomycin, penicillin, and virginiamycin) while seven are listed both for growth promotion and ‘‘various infections’’ and 17 only for infections. Recommended concentrations in feed vary greatly as well as withdrawal times. These products improve feed conversions and rate of gain, and they reduce morbidity and mortality in growing pigs (Hayes, 1981; Cromwell, 1991). They are also said to increase sow productivity and reduce the incidence of mastitis and agalactia

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(Cromwell, 1991). Antibiotic drugs are currently used in 90% of starter feeds, 75% of grower feeds, more than 50% of finishing feeds, and at least 20% of sow feeds in the U.S. (Dewey, Cox, Straw, Bush, & Hurd, 1999, reporting data from NAHMS).

The use of antibiotics in animal feed has come under review due to concerns that antibiotic resistance developed in food animals might be transferred to humans (for example, see Swann, 1969; NRC, 1980; CAST, 1981; Institute of Medicine, 1989; WHO, 1997; SOU, 1997; NRC, 1999). This literature suggests a tendency for scientists in Europe to favor a ban and for scientists in the United States to oppose such a measure. For a recent example of a representative U.S. position, see NRC (1999). For a recent representation of the European position, see Wegener, Arestrup, Gerner-Smidt, and Bager (1999) or SOU (1997). However, there are also strongly opposing opinions on both sides, in the United States and Europe, which demonstrates a continued intense debate about the antibiotics issue.

One possible reason for the divergence in scientific opinion across the Atlantic is that human resistance to vancomycin has emerged in both the United States and the European Union (EU). The EU had permitted the use of avoparcin, a closely related antibiotic in animal feeds, until 1997. This drug was not permitted for use in animal feeds in the United States. While it would not be the case that vancomycin resistance in humans was related to avoparcin use in animal feeds in the United States, this possibility cannot be ruled out in Europe (see Hayes, 1999).

Current EU regulations state that antimicrobials used in either human or in veterinary therapeutic medicine are prohibited from use as feed-additive growth promoters in livestock (Hayes, 1999). A ban on over the counter feed antibiotics was implemented in Sweden in 1986. Similar bans were enacted in Norway in 1992, for grower-finishing hogs in Finland in 1996, Denmark in 1998, and in Poland and Switzerland in 1999.

In December 1998, the EU Commission and Council of Ministers followed suit by restricting the use of feed additives to only avilamycin, bambermycin, salinomycin, and monensin. Avilamycin is now also under consideration for being banned. The decisions are interimistic and will be reviewed within 2 years. Shortly after the ban was imposed, Pfizer Animal Health and AlPharma, Animal Health Division (1999) sued Denmark and the EU for its ban on feed antibiotics, in particular, virginiamycin and bacitracin. The EU Supreme Court dealt with the issue in June 1999. Pfizer's and AlPharma's claims were dismissed at that time, but a final ruling is not expected until 1 or 2 years from now.

The motivation and funding for this research came from the National Pork Producers Council (NPPC). This organization finds itself at a strategic quandary. The Industry routinely adds antibiotics to rations of weaned pigs both to prevent illness before symptoms emerge, and to increase growth rates. Although this practice is under scrutiny by federal regulators, any restriction on this practice in the United States will depend on evidence showing a link between feed use of antibiotics and antibiotic resistance in humans. This evidence may not ever be forthcoming, and if forthcoming, could take several years to emerge. (See NRC, 1999 for a current description of the scientific evidence in this regard.)

The European community uses an alternative to scientific research known *as the precautionary principle*. This alternative allows regulators to restrict food industries so long as there is a possibility that harm might emerge. As a result the EU is in the process of restricting feed use of antibiotics. The EU is currently in a position to sell pork from untreated animals on world markets. If the EU attempts to restrict imports of pork from countries where the practice persists, the United States will be in a position to file a case at the World Trade Organization (as has happened with artificial growth hormones).

The strategic issue facing United States pork producers is whether another food safety dispute with the EU is worthwhile. If the United States brings the case, the EU may capture the moral high ground because it will be perceived as having higher food safety standards. Any negative perception of United States food safety standards might then harm the reputation of United States pork in markets where U.S. pork is sold. Asia, and specifically Japan, is the largest importing region for U.S. pork at this time. It might also be true that the costs of such a ban will eventually be passed on to pork consumers.

The purpose of this research was to evaluate the impact of such a ban on the United States pork industry and to make the results available to pork producers and to policy makers. The study uses a set of technical changes in the production of hogs that are based in large part on a historical analysis of how the Swedish ban influenced the Swedish pork industry, although there are some basic differences between Sweden's and U.S. production practices. For example, Swedish pig farmers have never weaned pigs before 5 weeks, bedded solid floors are standard, and pen space is considerably larger than in the United States.

2. Sweden's experience

Swedish agricultural production is to a large extent (about 80%) organized in a trade union, The Federation of Swedish Farmers (LRF), which has considerable power to negotiate policies with the government. Sweden entered the EU in 1995 has been the second largest per capita net payer (after Germany) to the EU since 1995. Sweden's pork industry is relatively small compared to Denmark and the United States. Sweden's annual slaughter in 1998 was about 3.5 million hogs (LRF 1998). Production costs are somewhat higher than in Denmark.

Swine health in Sweden is generally good, with complete absence of viral diseases such as TGE, rotavirus, pseudorabies, and PRRS. The prevalence of influenza is very low, and there is virtually no salmonellosis due to decades of strong diagnostic efforts, quarantine, and indemnity procedures. Typically, compared to at least 23 swine pathogens for which there are federally licensed vaccines in the United States, only 7 are licensed in Sweden (Backstrom, 1998). Other contributing factors to the good health might be the generally low swine herd density in the country, low pen space density, geographic location with good breaks between winter and summer seasons, relatively small temperature differences between seasons, and protection from epidemics by surrounding seas.

At the time of the ban on feed grade antibiotics in 1986, the Swedish pork market was heavily regulated. In the early 1970s, strong pressure led to demanding animal welfare regulations. There was a new animal welfare law implemented in 1988. Sweden also implemented several restrictions on feed antibiotics in 1977 in response to the Swann Committee Report of 1969. That report, citing the recent discovery of the transmissable *r*-factor, aimed at restrictions of antibiotics to food animals when such drugs were important to human medicine. As a result, several non-prescription feed grade antibiotics were put under veterinary prescription to obtain better control but also to secure the availability of such drugs when needed for specific disease treatment, somewhat similar to the Animal Medicinal Drug Use Clarification Act (AMDUCA) and Veterinary Feed Directive (VFD) of 1996 in the United States.

Swedish consumer pressure increased sharply in the early 1980s. To restore consumer confidence, and supported by many farmers who had grown increasingly skeptical towards the use of feed antibiotics, the LRF asked for a voluntary ban on such antibiotics in 1985 (Stahle, 1997), which was made law in 1986. At the same time veterinarians' rights to prescribe preventive and therapeutic medications remained intact.

Coinciding with the ban, post-weaning diarrheas initially led to a 1.5% increase of post-weaning piglet mortality and almost 1 week longer time to reach 25 kg feeder pig size (Robertsson & Lundeheim, 1994; Wierup, 1999). There was no effect on the health of sows, nursing piglets, length of lactation, or number of weaned piglets per sow per year (Swedish Agricultural Statistics). Later, economic estimates assumed a slight increase (0.04%) of mortality and 1.5% impact on feed efficiency in finishing hogs. The net increase of consumer costs was estimated to be about $\$0.12 \pm 0.06$/kg retail meat (SEK 8.10/$), half of which was due to the antibiotics ban and half to animal welfare legislation (Jonasson & Andersson, 1996; Stahle, 1998).

Also important are data on the ways that farmers chose to deal with the problems they encountered. Initially, the previously non-prescribed and widely used feed grade olaquindox (Bayonox) continued to be applied to treat scours, now classified as a prescribed therapeutic antibiotic. Later, zinc oxide was found to be effective in reducing piglet mortality and was extensively used until environmental concerns about manure pollution restricted its use from 1997. It is now limited to the first 2 weeks post weaning, and the total use has declined sharply.

Overall, the total use of antibiotics was reduced almost 50% in 1986 (SOU, 1997). Over the next few years, the use again increased about 20% where it leveled off until 1995, after which a new steep reduction began. In 1998, the tonnage (including "potency factors") of animal antibiotics in Sweden was only 30% of the tonnage of active substance used in 1984 (Greko, 1999).[1]

Despite the differences between the U.S. and Swedish conditions, the Swedish experiences afford some unique information. The evidence from Sweden shows clearly that the impact of the ban was smallest in farms that "followed the rules". The impact of the ban was greatest in farms with questionable hygiene practices. For example, farmers who weaned pigs into cold, old, continuous flow buildings (an all too common practice in Sweden at the time) encountered problems with post weaning diarrheas. Also important are data on the ways that farmers chose to deal with the problems they encountered. Almost all of the farmers who survived the initial problems switched to some form of all-in-all-out nursery batch production with less concentration of protein (17% to 18% CP) and concurrent increase of amino acids and enzymes in feed. The Swedish experience shows both negative effects of the way the ban impacted less well-organized producers and positive effects of the substitute measures that were brought into use.

3. Methods and data

The following sections include a short overview of the economic model and discussion of the technical parameters, and cost and price data used to estimate the effect of a ban in the U.S. Three alternative cases are used. A *most-likely case* (case II) uses evidence from the experience in Sweden to describe what is most likely to occur (given the evidence from Sweden and other expert opinion) if the ban were implemented in the U.S. These results are compared with the *bast* case, or results with no change in feed grade antibiotic use. The uncertainty of these estimates is acknowledged with a worst-case (case III) and a *best-case* scenario (case I). These scenarios, or alternatives, are developed by revisiting each of our assumptions and assuming worst (best) case impacts. The best case is found by combining all of the best-case assumptions. The differences between the best and worst cases provide the range for the results.

It is important to recognize that the framework used to evaluate impacts of a ban makes use of existing information on technical and economic relations to predict the impacts. New technologies to supplement the growth effects, changes in underlying economic relationships, or farm structural issues are not addressed explicitly within the model, yet may modify some of the predicted impact. Fixed costs, also, are not tracked fully in the estimates.

The economic model incorporates both biological and economic processes that govern production and consumption (Buhr and Hayenga, 1994). The livestock model structure includes components for pork, beef, and chicken. The processes include binding biological limits (e.g., weight gain rates, length of gestation), lags of variables to capture time periods required in production, and accounting identities to ensure consistency in the stock (e.g., animal inventory) and flow variables (e.g., number of animals slaughtered, pig crop, and mortality). The model also includes technical parameters such as feed efficiency, weight and weight gain, mortality, and sow efficiency.

The model has a simultaneous econometric framework where the market equilibrium price and quantity for pork, beef, and chicken are jointly determined. For this analysis, input markets were assumed to be exogenous. For the pork sector, the model includes information on feed costs, labor costs, other variable costs, and fixed costs. The results include estimates for sow inventory, commercial pork production, retail price and barrow-gilt price, pork per capita consumption, costs per head and changes in profit (defined as farm price less costs). Retail prices and farm prices are related through marketing margins.

The results of the model estimates provide baseline projections. The analysis of the impacts of a ban on feed-grade antibiotics is conducted by comparing the results of the analysis using baseline values, to one that uses assumptions about the requirements and results of changes in raising of hogs under conditions implied by a ban. These comparisons include the previously described three cases, or scenarios.

3.1. Technical assumptions

The technical assumptions are summarized in Table 1. Based on information gathered during a visit to Sweden and Denmark, and from other sources, the basic technical assumptions for the most-likely effects of the ban are as follows. The *age at weaning* increases by 1 week, based on the assumption that the U.S. practice of early weaning (2–3 weeks) is dependent on antibiotics in

Table 1
Technical assumptions for the three cases

	Case		
	I (best)	II (most-likely)	III (worst)
Age at weaning	No increase	+1 week	+1 week
Days from weaning to reach 25 kg	No increase	+5 days	+12 days
Feed efficiency from 50 lb to 250 lb	No change	−1.5%	−1.5%
Piglet mortality	+1.5% pts	+1.5% pts	+4.0% pts
Fattening–finish mortality	No change	+0.04%	No change
Piglets per sow	No change	−4.82%	−3.84%
Veterinary and therapeutic costs (per pig) net of costs for feed grade antibiotics	+$0.25	+$0.25	+$0.25

the starter feed and will have to be delayed 1 week. *Days to reach 25 kg* (~50 lb) increase by 5 days (Robertsson and Lundeheim, 1994). *Feed efficiency for pigs from 50 lb to 250 lb* declines by 1.5%, based on the Swedish assumptions (SOU, 1997) and estimates from discussions in Denmark. *Post-weaning mortality* increases by 1.5% (Robertsson and Lundeheim, 1994), and *mortality for fattening–finishing pigs* increases by 0.04% (assumptions in SOU, 1997). *Piglets per sow decline* by approximately 1 per year (4.82%) due to the increased age at weaning (Holden (1999) and USDA (2001) data).[2] With normal technical change (improvements) in pigs per sow per year, the baseline level in 1999 would again be met after nine quarters. *Veterinary and therapeutic costs*, net after the deduction of the cost for feed additives, increase by $0.25 per pig, based on estimates from Sweden. For the United States, we estimate the net costs to be $0.25 per pig. The above changes were implemented in cases I and II.

3.2. Fixed costs

Because of additional time after weaning and restricted feeding that might be needed in order to reduce nutritional stress, additional space would be required for the nursery and finishing periods for existing production capacity, as is currently the case in northern Europe.[3] Additional troughs would use, in net, about 10% more floor space, and new construction would be required to provide this space. With a one-time capacity today of 40 million hogs, four million additional "spaces" (10% of 40 million) would be required. The new construction would cost $115 per head for nursery space and $165 per head for finishing space, or a total cost to the industry of $1.12 billion (i.e., $(165 + 115) \times 4$ million). In addition, existing feeders would need to be replaced with pre-cast concrete troughs. This would cost $7.50 per space for existing facilities and nothing for new facilities (except the extra space). The total cost would be 40 million times $7.50 = $300 million. Hence, the best estimate in cost of changed space required is about $1.42 billion (Lawrence, 1999; Harmon, 1999; Stoeker, 1999). We also explore the sensitivity of results to the assumption on the need for expanded use of restricted feeding.

The longer weaning times would require new investment to expand sow nursery space. The costs for the additional sow nursery space are $166.39 million.[4]

Fixed costs were depreciated over a 10-year period at an interest rate of 7%.

3.3. Additional costs

Other variable costs include: feed costs from wean to feeder; feed costs for fattening–finishing (estimated in the model); labor cost based on farrow-to-finish hog production for operations of 1,600 head annual sales, North Central Region (USDA); standard veterinary costs (USDA); other variable costs (including fuel, lube, electricity, machinery and building repairs, and miscellaneous) (USDA); and fixed costs (including general farm overhead, taxes and insurance, interest, and capital replacement) (USDA).

The change in feed costs associated with a ban is reflected under the different cases evaluated (see Table 1). Other, additional costs include the added net veterinary treatment costs of $0.25 per pig (after deduction of the present cost for in-feed antibiotics) and the additional fixed cost (both depreciation and interest cost) required (see above).

3.4. Increased variability in pigs and sort loss

Hog producers are penalized for marketing either too-light or too-heavy pigs. Observation in the Sweden and recent experiments in the United States indicate increased variability in ending weight after the removal of antibiotics in feeds. The sort loss enters the calculation of the marketing margin, and reduces the effective price received by farmers. To account for the effect of increased weight variability on price, distributions of market weights for pigs under the baseline and different scenarios were characterized. A normal distribution was assumed for all cases.

For the baseline distribution, the 1998 national average carcass weight for hogs slaughtered under federal inspection was 189.75 lb. Data from the Pork Chain Quality Audit were used to derive the baseline standard deviation. In the Audit data, 8.9% of total pigs were marketed with too-light carcass weight; this percent, and the normality assumption, imply a standard deviation of 14.63.

After a ban, the standard deviation of hog weights increases. Under a mean-preserving change in the distribution, the standard deviation is estimated to increase by 3.775 units, an amount interpolated from experimental results (reported from AlPharma). With the increased dispersion, the share of animals with too light carcass weight (i.e., penalized under sort loss) increased to 14.2%. A price grid for Excel Corporation was used to estimate the sort loss, with estimates of average percent lean of 54.6% and a mean base price of $52.00 per cwt. Under the *most-likely* case, the estimated change in sort loss is $0.341 per cwt ($0.644 per head) or 0.873% of the liveweight price.

4. Results

4.1. Most-likely scenario

The major technical effects of the ban are on feed efficiency and piglet mortality. The changes in feed efficiency lead to changes in feed costs (Table 2).

Table 2
Feed efficiency and average daily gain—most-likely

Weight		Feed efficiency		Average daily gain	
Beginning	Ending	Baseline	Scenario	Baseline	Scenario
50	100	2.35	2.39	1.57	1.55
100	250	3.39	3.44	1.68	1.65

After the ban, piglet mortality is assumed to increase by 1.5% and mortality for fattening–finishing pigs increase by 0.04%. Mortality numbers were spread out by animal type based on their proportion in the inventory, and were adjusted accordingly. As weaning age is extended by 1 week, piglets per sow per year decline by 4.82%.

The results are presented in Table 3. The sow inventory declines by 0.97% in the new equilibrium (after 10 years), as farmers adjust to higher feed costs and the changes in sow productivity and pig mortality. Commercial pork production declines by 3.43% and per capita consumption declines by 3.42%.

The retail price and barrow-gilt price reflect the effects of reduced pork supply in the market. As pork supply decreases, the new retail price equilibrium increases by 2.21%, while the barrow-gilt price increases by 4.62%. The estimated retail price increases 5.2 cents per pound.

Cost per head increases by $6.05 in the first year and by $5.24 at the end of the projection period. This estimate includes the additional fixed costs of $1.41 to $2.79 per head. Profit per head declines by $4.17 in the first year and by $0.79 per head at the end of the projection period, or slightly lower than $0.01 per pound of pork.

Table 3
Most-likely (II) scenario impact from baseline

	Year									
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Percent change from baseline										
Sow stock	−0.16	−0.54	−0.64	−0.70	−0.76	−0.81	−0.87	−0.91	−0.94	−0.97
Farm price	2.24	4.90	5.01	4.91	4.82	4.75	4.70	4.66	4.64	4.62
Consumption	−1.46	−2.92	−3.13	−3.20	−3.25	−3.30	−3.34	−3.37	−3.40	−3.42
Production	−1.46	−2.93	−3.14	−3.21	−3.26	−3.31	−3.35	−3.38	−3.41	−3.43
Retail price	0.99	2.01	2.15	2.16	2.15	2.15	2.15	2.17	2.19	2.21
Pigs/sow	−1.32	−1.18	−1.16	−1.16	−1.15	−1.14	−1.13	−1.12	−1.11	−1.11
Change from baseline										
Cost										
Per head ($)	6.05	6.34	6.21	6.05	5.89	5.75	5.61	5.49	5.36	5.24
Net profit										
Per head ($)	−4.17	−1.82	−1.37	−1.25	−1.20	−1.17	−1.11	−1.02	−0.91	−0.79
Per pound ($)	−0.03	−0.01	−0.01	−0.01	−0.01	−0.01	−0.01	−0.01	−0.01	−0.01
Industry (million $)	−429	−190	−147	−136	−134	−131	−125	−116	−104	−91

These changes over the projection period lead to a decline in the present value of industry profit over 10 years of $1.039 billion. This is calculated as the sum of "forgone" profit over the 10-year period on the hogs marketed, discounted to present at a 7% discount rate.

4.2. *Worst-case (III)*

Case III alters several of the technical assumptions from cases I and II. The data are taken from a comparison between Danish and Swedish production results among the best quartile of swine producers with records on hand (Jonasson & Andersson, 1996). According to that study, piglet mortality was 4% higher, and time to 25 kg weight 11.7 days longer in Swedish production. Mortality of finishers remained unchanged. Feed antibiotics were still permitted in Denmark at that time, and the Danish animal welfare legislation was less stringent than the Swedish (no ban on sow stalls and crates, fewer pen space restrictions). The data have been used in case III to assess differences due to the debated "Swedish model". The results should be viewed with some caution since it is well known that many "non-antibiotic" and "non-animal-welfare" factors (animal genetics, feed composition, feeding technique, management skills, state support, EU CAP, etc.) also differed between the two countries at that time. The Swedish statistics did not include SPF herds, while more than 50% of the Danish herds were SPF.[5]

In case III, pigs per sow per year declined by 3.84% (instead of 4.82%). The additional costs for fixed costs (buildings and space) and additional vet costs were assumed to be the same as the *most-likely case*. The cost components included in the profit estimation, including the sort loss, were the same as *most-likely case*.

The results of the worst-case (case III) model are presented in Table 4. After the adjustments (in equilibrium), sow stock declines by 1.31% due to reduced profits from

Table 4
Worst-case (III) model scenario impact from baseline

	Year									
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Percent change from baseline										
Sow stock	−0.20	−0.68	−0.82	−0.90	−0.99	−1.08	−1.16	−1.23	−1.28	−1.31
Farm price	4.43	8.57	8.53	8.26	8.04	7.88	7.77	7.70	7.65	7.61
Consumption	−2.52	−4.87	−5.16	−5.24	−5.30	−5.36	−5.41	−5.46	−5.49	−5.51
Production	−2.52	−4.89	−5.18	−5.26	−5.32	−5.37	−5.43	−5.47	−5.51	−5.53
Retail price	1.72	3.39	3.58	3.57	3.53	3.51	3.51	3.52	3.55	3.58
Pigs/sow	−1.01	−0.81	−0.76	−0.74	−0.72	−0.69	−0.66	−0.64	−0.62	−0.61
Change from baseline										
Cost										
Per head $	7.92	8.59	8.50	8.33	8.16	8.01	7.87	7.73	7.59	7.45
Net profit										
Per head ($)	−4.82	−1.87	−1.40	−1.33	−1.36	−1.38	−1.36	−1.29	−1.18	−1.05
Per pound ($)	−0.03	−0.01	−0.01	−0.01	−0.01	−0.01	−0.01	−0.01	−0.01	−0.01
Industry (million $)	−488	−188	−142	−138	−142	−146	−144	−137	−126	−113

higher piglet mortality and longer time on feed; commercial pork production declines by 5.53%. Per capita pork consumption declines by 5.51%. With smaller pork supply, the new retail price equilibrium increases by 3.58%, while the barrow-gilt price increases by 7.61%. These price levels are higher than those of the most-likely scenario.

Under this worst-case scenario, total cost per head increased by $7.92 in the first year and by $7.45 at the end of the projection period. Of these costs, the additional fixed cost was $1.42 to $2.80 per head, the same as for the most-likely case on a per head basis. Due to higher costs, though, profit declined by $1.05 per head. Under this worst case, the present value of industry profit over 10 years declined by $1.135 billion. The results are summarized in Table 4.

4.3. Best-case (I) scenario

The best-case scenario includes several assumptions that reduce the anticipated effects of the ban compared to the *most-likely* assumptions. The only effect of the ban on productivity is an increase of piglet mortality by 1.5%. There are no additional feeding days required; piglets per sow per year are unchanged from the baseline; veterinary costs increased by $0.25 per head, as in the other cases. New investment in additional nursery and finishing spaces are still required, but not for farrowing space.

The results of the best-case scenario are presented in Table 5. The decline in sow stock is minimal and declines slowly from 0.06% in the first to fifth year, and ending with 0.11% lower stock in equilibrium, compared to the baseline. Commercial pork production declines by 1.48%, compared to 3.42% in the *most-likely case*. Per capita consumption declines by 1.48%. Retail price increases by 0.95% and farm price increases by 1.89%.

Table 5
Best-case scenario impact from baseline

	Year									
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Percent change from baseline										
Sow stock	−0.03	−0.07	−0.05	−0.03	−0.04	−0.06	−0.07	−0.09	−0.10	−0.11
Farm price	1.34	2.25	2.16	2.05	1.98	1.94	1.92	1.90	1.90	1.89
Consumption	−0.76	−1.41	−1.45	−1.44	−1.44	−1.44	−1.45	−1.46	−1.47	−1.48
Production	−0.76	−1.42	−1.45	−1.44	−1.44	−1.45	−1.46	−1.47	−1.47	−1.48
Retail price	0.51	0.96	0.98	0.96	0.94	0.93	0.93	0.93	0.94	0.95
Pigs/sow	0.01	0.03	0.02	0.02	0.02	0.02	0.03	0.04	0.04	0.04
Change from baseline										
Cost										
Per head $	3.10	3.13	2.97	2.80	2.65	2.52	2.41	2.30	2.20	2.10
Net profit										
Per head ($)	−1.89	−0.83	−0.63	−0.55	−0.50	−0.44	−0.37	−0.28	−0.19	−0.10
Per pound ($)	−0.01	−0.01	−0.00	−0.00	−0.00	−0.00	−0.00	−0.00	−0.00	−0.00
Industry (million $)	−195	−88	−69	−62	−57	−51	−43	−34	−23	−12

Under this case, the total cost per head increases by $3.10 in the first year and $2.10 at the end of the projection period. Of these costs additional fixed costs represent $1.25 to $2.50 per head. Forgone profit per head declines by $0.88 in the first 5 years and $0.28 in the remaining period. The present value of industry profit over 10 years is estimated to decline by $0.429 billion.

4.4. Summary of estimated economic effects on producers

The estimates for the three scenarios show that costs per head would increase by $6.05 to $5.24 per head over the 10-year period estimated under the *most-likely case*, with somewhat lower values for the best case (case I) and higher values for the worst case (case III). The timing of these changes is also illustrated in Figs. 1–3. However, since prices would be higher due to smaller supply (a result of the lower profits), net profit would decline only by $0.79 per head by the end of the period (under the most-likely case), or less than $0.01 per pound of pork in retail weight. The net present value of forgone profit to the industry over 10 years is $1.039 billion (with a range over the scenarios from $1.135 to $0.429 billion).

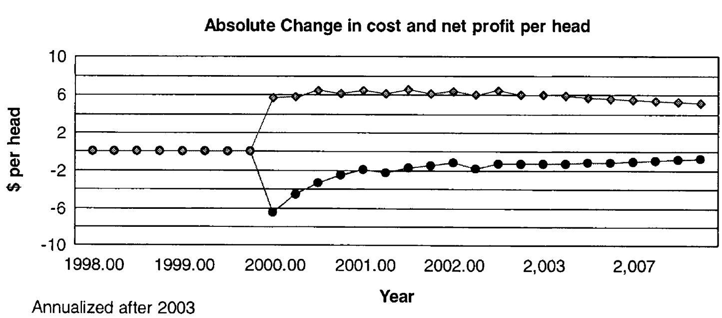

Fig. 1. Most-likely scenario.

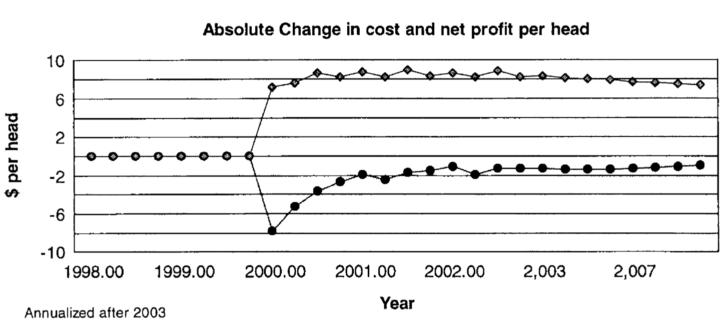

Fig. 2. Worst-case scenario.

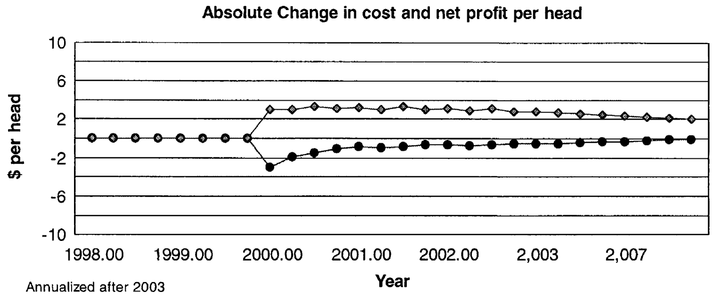

Fig. 3. Best-case scenario.

Table 6
Approximate annual costs to consumers

Items	Units	Scenarios		
		Most-likely	Worst-case	Best-case
Change in retail price	$/lb	0.052	0.084	0.022
Per capita consumption	Retail weight lb	53	53	53
Extra cost per capita	$ Per capita per year	2.75	4.45	1.18
Extra cost per family	$ Per family per year	11.02	17.84	4.73
Extra cost national million	$ Per year	748	1212	322

4.5. Impact of a ban on consumer demand

In the results described above, consumers respond only to changes in the price of pork. Table 6 provides an estimate of the approximate annual costs to consumers, calculated by multiplying the projected change in retail price by the per capita consumption. The estimated increase in retail prices for the most-likely case is 5.2 cents per pound, with an estimated range between 8.4 cents, for the worst case, and 2.2 cents for the best case.

As shown in Table 6, with the increase in retail price of 5 cents in the most-likely case, the effect on the consumers' expenditure on pork per year (calculated for a family of four) is about $11 per year. Over all consumers, the increased costs for pork is estimated to be $748 million per year. These estimates are based on an examination of the effects of a ban on the pork industry. If the ban were applied to all meats, including beef and poultry, the overall increase in costs for consumers would be higher as production for all meats would adjust.

5. Discussion

The results for producers show the technical impacts of a ban on an "average" or "representative" farm. These results mask very wide differences across farms, and the distributional effects are not estimated in the model. Also, one must be cautious about using the Swedish experience as an exact indicator as to what might happen in the United States, although certain general patterns do stand out.

First, if restricted feeding has to be used, almost all U.S. producers will have to make some adjustments. This practice is also common in other European countries that allow the use of feed-grade antibiotics. Most U.S. pork producers allow unrestricted feeding at this stage. It is not clear what would happen to U.S. practices should the use of feed antibiotics be prohibited. One scenario is that U.S. producers would encounter health problems in their stock, such as dysentery, and that they would use restricted feeding to reduce nutritional stress. This is the assumption in our estimates. A second scenario is that the costs of implementing a restricted feeding regime would be less than the expected health benefits and that the U.S. pork industry would continue ad libitum feeding. The results presented for the three cases (I, II, and III) include the costs of adding troughs and space to allow restricted feeding. These costs totaled $960 million in total or approximately $1.20 per hog. If this assumption is incorrect, then these values overstate the effects by this amount. This is obviously an area where additional research is needed.

Also, another cost would be for a change to all-in-all-out production for farms with continuous production systems. It is estimated (Lawrence, 1999) that as much as 20% of U.S. production still originates on farms that have not yet adopted all-in-all-out. The existence of these continuous flow systems is puzzling because the all-in-all-out method more than pays for itself. If these producers plan to remain in business they should adopt the all-in-all-out system regardless of whether the ban is implemented. Therefore, the results presented above do not include the costs of transforming these facilities. It seems likely that many of the remaining continuous flow systems are owned by individuals who are financially marginal, or who plan to stop production in the near future. A likely possibility is that the ban would cause the majority of these producers to exit the industry.

From a purely economic perspective, the closing down of these older farms makes sense. The individuals involved likely have more productive uses for labor and capital, and the efficiency and disease status of the overall U.S. pork industry would improve. However, many of these older operations are owned by small to medium family farms and some exist on farms that would not otherwise justify the full-time input of the producer. The ongoing trend away from this type of production unit has created social tensions and any acceleration of this trend will only increase these tensions.

The impact of the ban will also differ across commercial producers. The Swedish experience suggests that those who follow good hygienic and health practices will see the smallest impact. The largest impact would be expected on densely populated farms in counties with large numbers of hog farms who have older buildings and who do not follow sound management practices. In this context, the on-going elimination of low dosage feed additives in Denmark, with its very high swine population density and large numbers of old barns, may provide a more important source of information on possible impacts in the U.S. than comes directly from the Swedish experience.

Larger, modern three-site confinement systems will likely see the smallest impact. Anecdotal evidence suggests that the impact of the ban on the very largest producers would be minimal. As one reviewer suggested, the larger units may use antibiotics as a risk management tool because the costs of disease spread can be catastrophic in such units. However, many of these producers have created systems where disease and health problems have been greatly reduced and the principal benefit they receive is via the growth promoting effects of the antibiotics. One of these producers suggested that the net benefit of using antibiotics in feed amounted to only $0.50 per animal. These producers would likely improve their competitive position should a ban be implemented. Again, the social impacts of such a trend might be very different than the economic impact. Because high quality management and modern buildings are partial substitutes for antibiotics, a ban would have a disproportionate impact on producers with below average management skills and older buildings.

In the analysis, we did not alter the price of poultry or beef, despite the likelihood that the other animal products would be affected similarly by a ban, nor have we factored in any positive impact of such a ban on consumer willingness to pay for pork produced without the use of feed-grade antibiotics. The logic behind the latter assumption is that consumers who want to pay a premium for this kind of pork will encourage producers to produce antibiotic-free pork for niche markets. Currently, this market segment does exist, but it is small. We did not attempt to make assumptions on changes in consumer preferences from the current situation. Producers in this segment will obviously not see any technical impacts. Any consumers who do not purchase this specialized pork will be worse off once their choice set is restricted and will not likely increase their pork consumption. The well-documented consumer concerns in Europe on these questions have, so far, not been heard as much in the U.S. However, U.S. perceptions on the safety of antibiotics use in feed could change if a controversy emerges.

One very important consumer response may occur in export markets. The U.S. pork industry currently depends on export markets such as Japan to absorb ever-increasing quantities of U.S. pork. The U.S. pork market has therefore become very sensitive to developments in these markets. So far there is very little evidence to suggest that these export customers are concerned about the use of antibiotics among suppliers.[6] However, once the EU or Danish industry can guarantee reliable supplies of "antibiotic free" pork this situation may change.

Possible factors that might lead to such a change would include: (1) A marketing campaign by EU or Danish producers that used the antibiotic issue to disparage U.S. pork; (2) A well-publicized dispute between the EU and United States about the safety of U.S. pork; or, (3) a decision by Japanese society that it does not want to have to compete with low-cost U.S. producers. This latter development might occur if the next round of world trade negotiations forces Japan to further liberalize import barriers against pork. This development would lead to a rapid deterioration in the competitive position of the domestic Japanese industry and might force Japanese policymakers to find a non-tariff barrier to replace the existing protection system. Losses to the U.S. pork industry associated with a loss of an important export customer such as Japan would dwarf the losses associated with the ban described above.

Additional research and prognostication of consumer attitudes on these issues in the United States are perhaps the most important aspect for understanding the future challenges to American pork production from any changes in the use of over the counter antibiotics in swine rations. The development of a niche market for pork produced without the use of feed-grade antibiotics is likely to be difficult in the U.S. due to difficulties of identity preservation in the large scale processing units. This suggests that a ban would be needed at the national level to obtain widely available product produced without the use of over the counter antibiotics in feed. Given changes in pork production underway, and increased competition in international markets, the U.S. pork industry may decide it is opportune it accept a ban for strategic reasons.

Notes

1. It should be noted that the Swedish statistics include all applications of antibiotics (injectibles and non-injectibles) to both companion and food animals. Thus, the statistics on usage of antibiotics are more complex than just the matter of feed antibiotics.
2. The likely positive effects on sow reproduction by increased lactation length (wean to service interval and litter size) have not been included in the assumptions (Marsteller, 1997; Tummaruk, 1999).
3. In this context it is important to mention that Swedish and Danish experts do not link restricted feeding to the ban on feed grade antibiotics. Restricted feeding has always had a place in Scandinavia for reasons other than antibiotics (cost of feed, feed efficiency and improved leanness). However, our estimates are based on discussions and data from animal scientists, agricultural engineers, and other experts.
4. This cost assumes a farrowing sow inventory of 3.47 million, 4% increase in stay in the nursery due to extended weaning age, and $1,200 cost per sow space (Harmon, 1999). This assumes a 7×5 space with gates and passageways but without farrowing crates, a conservative estimate.
5. Jonasson and Andersson (1996) suggested another method of assumptions, that was to apply the Danish rules on antibiotics and welfare to Swedish conditions (an approach that indicated much less differences between results).
6. A reviewer pointed out that some U.S. pork buyers have now begun to collect information on use of antibiotics from producers in Iowa.

Acknowledgments

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