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Bovine growth hormone

An Examination of the Likely Impact of the Withdrawal of Bovine Growth Promotants on the U.S. Beef Industry*

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Abstract

The paper examines the probable impact on prices, quantities, and profits in the U.S. beef industry in the event of a voluntary ban on hormone use by beef producers.

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Developments in biological science have led to the creation of several growth-promoting compounds for livestock-sector use. Recent examples include bovine somatatropin (BST) and porcine somatatropin (PST). More established compounds include the anabolic implants being used in the beef industry. It is not immediately obvious that producers as a whole benefit from these developments, as evidenced by the opposition of some dairy farmers to the introduction of BST. Economists have begun to analyze the possible impacts of several of these newer compounds on the respective industries. These studies are somewhat hampered by a lack of data on the likely adoption rates, commercial costs, and increases in productivity that will occur under field conditions.

One possible outcome of growth-promotant use is that the producers who adopt early will benefit but that, when most producers adopt, prices will fall as the additional production makes its way to markets in which demand is inelastic. To the extent that this treadmill theory is valid, it might be optimal for producers as a whole to request legislation to ban the use of growth-promoting compounds. Should a ban occur, consumers would lose only to the extent that higher food prices exceed the lower tax revenues required to maintain producer income. It is also interesting to speculate about the distribution of the benefits and costs of these compounds along the production chain. For example, the welfare of corn and feeder cattle producers need not be positively correlated with the welfare of producers of fat cattle.

This paper examines how the U.S. beef industry would respond to the withdrawal of established growth promotants. By choosing a technology that has already been introduced, we remove the usual uncertainty regarding impacts, costs, and adoption rates. In addition, the analysis has some policy implications in that developments in both international and domestic markets might someday force U.S. producers to consider such a ban.

The first section of this paper discusses recent developments in international and domestic markets that might cause interest in imposing a ban on growth-promoting compounds. The second section reviews a recent publication of the Food Safety and Inspection Service (FSIS) on the economic impact of these compounds. This publication contains all the scientific data required for the subsequent analysis. In the third section, we discuss technical problems involved in the analysis, including the dynamic adjustment paths of both consumers and producers and the assumptions regarding the way feedlot owners might respond. The fourth section reviews the model. The fifth presents the results and discusses the sensitivity of the results to some of the more important parameters of the model. Finally, we summarize the important results and attempt to extend the lessons learned from a simulated elimination of existing growth-promoting compounds to the current debate regarding BST and PST.

Domestic and International Status of Anabolic Compounds

On November 11, 1985, the European Community (EC) banned the use of growth-promoting hormones. The ban was slow to be implemented because of legal and practical restraints. As of the summer of 1989, the ban was in effect in all twelve EC member countries. European beef producers have been surprisingly cooperative in reducing hormone use but are adamantly opposed to competing with beef producers who have access to hormones (Hayes). In addition, some European consumer groups have opposed the importation of hormone-treated meat. On January 1, 1989, the EC banned the import of U.S. beef and beef by-products (Hayes). This ban created tensions between the United States and the EC and has resulted in the imposition of countervailing duties on EC exports of tomato paste and other agricultural products. To avoid escalation of the dispute, EC negotiators have agreed to allow imports of U.S. beef produced in feedlots that do not use hormones. The United States, however, has lost its export markets for beef by-products.

A secondary side effect of the EC ban is that other beef-exporting countries have agreed to ban hormone use to maintain their lucrative EC markets. Thus, the United States might find itself alone among beef-exporting countries that allow hormone use. Although Japanese and South Korean producers use growth-promoting products, the situation could arise whereby one or both countries would use the hormone issue to impose a new tariff barrier against U.S. beef products. The U.S. beef industry might respond by voluntarily abstaining from hormone use in an attempt to maintain its export markets.

A second possibility is that U.S. consumer opinion might turn against beef that has been implanted with hormones. The power of negative media attention has been made clear for Alar use in apples, the purported poisoning of Chilean grapes, and salmonella contamination of English eggs. In each instance, one negative report has resulted in a large decrease in demand for the particular product. The conditions that led to these consumer reactions now exist for hormone implants. Although the body of scientific evidence overwhelmingly endorses the safety of these products, the products have negative connotations among some consumers. Also, it is possible for individual producers to abuse the public trust by allowing recently implanted animals to be slaughtered, and this practice is difficult to monitor. Should either of these scenarios occur, producers would almost certainly incur large short-term losses, and interest would inevitably turn to the benefits and costs of banning hormone implants.

Review of the FSIS Report on Hormone Use

In October 1987, the FSIS released "Economic Impact of the European Economic Community's Ban on Anabolic Implants," a lengthy report containing fascinating information on all aspects of hormone use. Of particular relevance is the use of growth models to estimate the effects of anabolic growth promotants on the growth rate and feed conversion efficiency of implanted steers and heifers. The results indicate that implanted animals weigh more at a particular age or, equivalently, reach a particular weight at a younger age than do unimplanted animals. The implants also reduce the amount of food nutrients required to reach a particular weight. These two effects occur because (1) hormones increase the efficiency with which animals use feed, (2) implanted animals produce more lean beef and less fat, and (3) implanted animals use less feed for maintenance in their shorter life spans.

The relevant results of the FSIS study are summarized in Table 1. Four feeding regimes are analyzed. The first regime assumes that producers continue to implant steers as is currently done. This base case is then compared with three alternative feedlot responses to the ban. As shown in Table 1, the first alternative assumes that unimplanted steers are fed to the same slaughter weight, the second alternative assumes that they are fed to the same yield grade, and the third alternative assumes that they are slaughtered at the same age as implanted steers are slaughtered. The principal impact of the hormones is to increase an animal's growth rate by 12 percent and the efficiency with which the animal converts feed by 9 percent. In all three response alternatives, the quantity of retail beef produced per animal decreases significantly. This decrease results because hormones increase the lean-to-fat ratio, thereby increasing the retail weight, and because implanted animals weigh more at a given age than do unimplanted animals.

The authors of the FSIS report did consider the impact of this reduced supply on retail prices by using a calculated price flexibility of -0.7. The impact of this positive price increase on producer profits offsets some of the decreased growth rates. Interestingly, in the scenario in which animals are fed to the same yield grade, the lower production costs coupled with the higher retail prices actually increase the profitability of

Table 1. Estimated production costs and product value differences between a steer continuously implanted with an anabolic agent and an unimplanted steer entering a feedlot at the same weight for the same slaughter weight, body composition, and feed days

Variable	Steer continuously implanted with an anabolic agent Base case	Steer never implanted, enters feedlot at weight of continuously implanted steer Steer never implanted finished to continuously implanted steer slaughter weight Alternative A	Steer never implanted finished to choice and yield grade 3 carcass composition Alternative B	Steer never implanted finished to same days on feed as continuously implanted steer Alternative C
Average liveweight out (lbs)	1,111	1,111	967	1,063
Average liveweight in (lbs)	670	670	670	670
Net liveweight gain (lbs)	441	441	297	393
Increase (decrease) in liveweight vs implanted steer	0	0	(144)	(48)
Days on feed	146	163	110	146
Lbs of gain per day	3.02	2.70	2.70	2.70
Lbs of as-fed feed per lb of gain	8.96	10.63	9.54	10.11
Lbs of as-fed feed consumed per day per steer	27.07	28.70	25.76	27.30
Total lbs of as-fed feed consumed per steer	3,952	4,678	2,834	3,986
Anabolic agent growth promotion effect	12%	0%	0%	0%
Anabolic agent feed efficiency effect	9%	0%	0%	0%
Interest charge per head per day (carrying charge)	$0.177	$0.177	$0.177	$0.177
Interest on feed per head per day	$0.027	$0.027	$0.027	$0.027
Total interest costs per head per day	$0.204	$0.204	$0.204	$0.204
Feed costs per ton with markup	$115.66	$115.66	$115.66	$115.66
Feed cost per pound with markup	$0.058	$0.0578	$0.0578	0.0578
Costs per anabolic implant	$1.00	$0.00	$0.00	$0.00
Average number of implants	1.26	0.00	0.00	0.00
Costs per cwt for feeder steer	$65.54	$65.54	$65.54	$65.54
Total costs of feeder steer	$439.12	$439.12	$439.12	$439.12
Total interest costs per steer	$29.78	$33.25	$22.44	$29.78
Total feed cost with markup less interest per steer	$228.00	$270.00	$164.00	$230.00
Total feed costs with markup and total interest	$257.78	$303.25	$186.44	$259.78
Costs of anabolic implants per steer	$1.26	$0.00	$0.00	$0.00
Total costs of production per steer	$698.16	$742.37	$625.56	$698.90
Cost of production increase (decrease) vs implanted steer	$0.00	$44.21	($72.60)	$0.74
Percent of dressed weight to liveweight	62.5%	62.5%	62.5%	62.5%
Percent of retail weight to liveweight	73.91%	66.75%	73.88%	69.08%
Liveweight per steer (lbs)	1,111	1,111	967	1,063
Liveweight increase (decrease) vs implanted steer	0	0	(144)	(48)
Percentage liveweight increase (decrease) vs implanted steer	0	0	-13%	-4%
Dressed weight per steer (lbs)	694	694	604	664
Net dressed weight increase (decrease) vs implanted steer	0	0	(90)	(30)
Percent net dressed weight increase (decrease) vs implanted steer	0%	0%	-13%	-4%
Retail weight per steer (lbs)	513	464	447	459
Retail weight increase (decrease) vs implanted steer	0	(50)	(67)	(54)
Percent retail weight increase (decrease) vs implanted steer	0%	-10%	-13%	-11%
Average retail dollar value - choice	$2.37	$2.37	$2.37	$2.37
Retail produce price/supply relationship	(1.41)	(1.41)	(1.41)	(1.41)
Adjusted retail dollar value - choice	$2.37	$2.54	$2.59	$2.55
Adjusted retail dollar value - choice	$2.37	$2.54	$2.59	$2.55
Adjusted retail product value per steer	$1,216	$1,177	$1,156	$1,170
Net adjusted retail product value increase (decrease) vs implanted steer	$0.00	($39.04)	($59.84)	($46.01)

SOURCE: FSIS.

fattening. The authors were somewhat dissatisfied with the calculation of, use of, and results from this price flexibility. The authors' dissatisfaction is justified. As they point out, their price flexibility calculation is ad hoc and ignores cross-commodity effects. Also, pork and poultry consumption would eventually increase to compensate for the increase in beef prices, and beef production would presumably respond to the higher prices. Consequently, the rest of the report depends on models in which no retail price increase occurs.

The answers to the questions posed in the introduction of this paper depend on the dynamics of livestock supply and demand. The focus of the FSIS report was on the international implications of the EC ban and not on the domestic response to such a ban; consequently, the authors of the FSIS report ignore many of the issues that need to be addressed to examine the dynamics of such a ban. The rest of this paper focuses on these issues.

Consumer and Producer Adjustments to a Hormone Ban

Current regulations prohibit the Food and Drug Administration from banning hormones in the absence of scientific evidence demonstrating harmful effects (Hayes). Given the vast scientific literature available on the safety of these products, a ban is unlikely. Such a ban would be most probable if producers perceived it to be in their interests. If the consumer scare was severe enough, producers might be forced to voluntarily comply with the demands of retail outlets and packinghouses. Under these circumstances, consumers would have expressed a willingness to purchase hormone-free beef at premium prices. Therefore, we assume that the parameters of the demand function for hormone-free beef are identical to those estimated for hormone-treated beef. Also, we can concentrate exclusively on producer welfare, arguing that a hormone ban could not occur unless it was perceived to benefit the average consumer. In the simulations that follow, we do, however, examine the sensitivity of the results to the calculated price flexibility of demand.

Some uncertainty exists about how beef producers would respond to a ban. The FSIS report documents three alternative scenarios. These scenarios assume that producers maintain the same weight, yield grade, or days on feed. Of these scenarios, the third seems most unrealistic. Profit-conscious beef producers select the animals to sell for slaughter based on the criteria that yield the highest return on inputs. These criteria include the weight and expected yield grade of the animals--the characteristics that influence the price that producers receive. The number of days on feed will obviously influence both these characteristics, but we know of no evidence to indicate that producers use days on feed in their decisions in a manner that is exogenous to the animals' weights and expected yield grades. Therefore, we ignore this scenario.

For the remaining two scenarios, we must decide how the ban will be implemented. As the authors of the FSIS report document, such a ban could not be instantaneous. Animals implanted preceding the announcement would continue to move through the system. Also, it would take some time until the producer groups or the government could enforce the ban. In the results that follow, we assume that half of the full impact occurs in the first year and that the rest occurs in the second year. These assumptions are interpolated through the eight quarters of the first two years.

A second difficulty involves the incorporation of efficiency effects into the simulation. The econometric model we use contains only producer response to corn price changes, not to changes in feed-conversion efficiencies. We therefore modeled the efficiency effects as equivalent to changes in corn prices.

Finally, we must decide how to incorporate the feedback effects from the pork and poultry industries. If we incorporate these effects in all the simulations, realism is added at the expense of clarity. One is never sure if prices change because of a direct effect on the beef sector or because of feedback effects from other sectors. Estimating reasonable cross-price terms in the demand system created some difficulties. For example, it seems that chicken and beef are net complements in the long run. In response to these difficulties, we present the simulated interaction effects as part of the sensitivity analysis rather than as the exclusive focus of the results.

Overview of the Econometric Model

A quarterly model of the U.S. livestock sector was used to predict the impact of a hormone ban. This model was estimated econometrically and is fully documented in Grundmeier et al., Jensen et al., and Skold, Grundmeier, and Johnson. The parameters of the model are presented in Tables 2 and 3. Although these results were estimated econometrically, a full discussion and defense would greatly extend the length of this paper. Consequently, it may be appropriate to consider them to be synthetic parameters. The submodels operate as follows.

Beef

Decision points for representative producers in the supply block of the beef model include the breeding-herd inventory, feedlot placement levels, fed cattle marketings, nonfed cattle marketings, and slaughter weight. Expansion or contraction of the cow breeding-herd inventory occurs through cow slaughter or by additions, respectively. The breeding-herd size determines calf-crop size. Calves can move to the breeding herd, to stocker-cattle and nonfed slaughter, or to feedlots for subsequent slaughter. Slaughter from fed and nonfed sources and inventory culling, along with an estimated average carcass weight, determines the industry beef supply.

The beef demand component contains estimated equations for the retail price, farm-retail margin, and closing cold-storage stocks. Price determination occurs at the retail

Table 2. Estimated elasticities for the demand model with homogeneity and symmetry imposed in the long run and homogeneity imposed in the short run (estimation period 1967-86)

	Estimated Elasticities				Lag Adjustment Coefficient
	Beef	Pork	Chicken	Expenditure	
Beef short run	-0.52 (0.08)[a]	0.23 (0.05)	-0.14 (0.05)	0.43 (0.20)	0.33
Beef long run	-0.80 (0.07)	0.30 (0.06)	-0.028 (0.02)	1.06 (0.30)	
Pork short run	0.42 (0.06)	-0.70 (0.05)	-0.06 (0.04)	0.19 (0.17)	0.25
Pork long run	0.62[b]	-0.60 (0.07)	0.13 (0.07)	0.68 (0.23)	
Chicken short run	0.06 (0.08)	0.19 (0.06)	-0.63 (0.06)	0.0004 (0.23)	0.17
Chicken long run	-0.17[b]	0.34[b]	-1.05 (0.06)	1.24 (0.27)	

SOURCE: Grundmeier et al.

[a]Figures in the parentheses indicate standard error.
[b]Elasticity computed from the imposed symmetry restrictions.

Table 3. Constructed supply response elasticities for 1984-86

	Short-Run Elasticities	Long-Run Elasticities[a]
Beef supply	-0.03	0.16
Pork supply	0.02	0.50
Chicken supply	0.10	[b]

SOURCE: Grundmeier et al.

[a]Elasticities represent approximate supply elasticities evaluated at 1984-86 mean values of exogenous variables and generated through dynamic simulation. The short-run elasticity is the change in total supply in the first year. The long-run elasticity was evaluated after each model converged to a new equilibrium.
[b]The chicken supply fully responded after one year.

level, but with direct quantity linkages to farm supply. Beef consumption is estimated by using a demand system that includes pork and chicken. The farm price is determined through an identity, the difference between the retail price and the farm-retail margin. The model is simultaneous for farm and retail prices and recursive in supply.

Pork

The level of pork supply is primarily determined by producers' decisions about breeding-herd size. Producers expand their herds by retaining gilts or by adjusting the culling rate. The breeding-herd size determines the pig crop, which in turn determines subsequent barrow and gilt slaughter. Domestic pork production is derived from the sum of barrow and gilt slaughter and sow slaughter, multiplied by their respective slaughter weights.

The demand block of the pork model has behavioral equations for the retail price of pork, the farm-retail margin, and closing cold-storage stocks. Retail pork demand is estimated within a system of demand equations, including beef and chicken. The farm-level price is linked to the retail price through the margin equation. The quantity linkage uses a fixed coefficient production function.

Poultry

The supply components of the chicken and turkey models are similar. The supply block of the chicken model reflects producer decisions at three key points in the production process: the level of placements into the hatchery supply flock, the number of eggs hatched, and the level of broiler production. Chicken production other than broilers is also estimated by using a partial reduced-form specification. The turkey model contains two behavioral supply equations, for hatching and production, with the rest of the specification determined by biological restrictions.

Price is determined at the retail level in the chicken model. Broiler consumption is estimated in the dynamic demand system that includes beef and pork. The wholesale price of broilers enters the specifications reflecting producer decisions. In the turkey model, price is determined at the wholesale level. The retail and farm-level prices for turkeys are linked to the wholesale price. Ending turkey stocks adjust to economic factors and are important, given the seasonality of demand.

Results

The model was shocked by using the predicted changes in feed efficiency and growth rate from Table 1. The results are presented in Figures 1 through 6.

Scenario 1 represents the situation in which producers fatten unimplanted livestock to the same weight as that of implanted animals. These unimplanted animals would be much fatter than currently implanted animals and might be heavily discounted. This scenario is the most unrealistic of the two. The second scenario assumes that producers fatten livestock to achieve the same yield grades without hormones. This situation would result in much lighter animals. Scenarios 3 and 4 are similar to scenario 2 except that the short-run own-price elasticity of demand is changed from -0.52 to -0.75 in scenario 3 and to -0.25 in scenario 4. Scenario 5 is the same as scenario 3, except that scenario 5 incorporates the feedback effects from the pork and poultry sectors.

Figures 1 and 2 show how the price of slaughter steers and the retail beef price respond to the hormone ban. All five scenarios exhibit a similar response. For two quarters, beef prices remain unchanged as the hormone-treated animals move through the system. Then, as the lighter animals arrive, prices increase dramatically for two quarters. These high prices remain for about one year and eventually fall as the extra animals produced in response to the higher prices arrive. In scenario 1, prices remain significantly above the base, even in the long run, because these animals are so much more expensive to produce. In the other scenarios, prices equilibrate at levels slightly higher than those of the base, again reflecting the reduced efficiency with which these animals use feed.

Figures 3 and 4 show how the per capita beef consumption and U.S. beef cow herd respond to the hormone ban. In scenario 1, slightly fewer cows are needed because of the reduced beef consumption in face of higher beef prices. This result also reflects an industry rigidity imposed on the system through the potentially uneconomic constraint of feeding unimplanted cattle to heavy weights. In the other scenarios, cow numbers increase dramatically, whereas per capita consumption levels initially fall but then bounce back as the market reaches its new equilibrium. Note how the introduction of feedback effects from the pork and poultry models creates dampened cycles around the other scenarios.

Figures 5 and 6 show how profits over variable and fixed costs change for both cow/calf producers and fat beef production. Fixed costs are held constant over time. These profit levels appear large, particularly the second- and third-year figures. It is clear that cow/calf operators would obtain large windfall profits in the first year after the ban. Also, the long-run results reflect increased profits because of an accrual of Ricardian rents to the owners of suitable grazing land for cows. Beef feedlot owners also achieve windfall profits, but in all scenarios except the first these profits are eliminated after three or four years. In the long run, fattening profits are slightly lower than those for the base. This result is attributable to reduced feed efficiencies and slower growth rates forcing the industry to downsize, thereby reducing its ability to cover fixed costs.

Summary and Conclusions

Although many producer groups strongly support the use of anabolic compounds to enhance the performance of the animals they raise, there is no a priori reason to expect livestock producers to lose should such a ban occur. This paper has examined the likely

Figure 1. PRICE OF SLAUGHTER STEERS

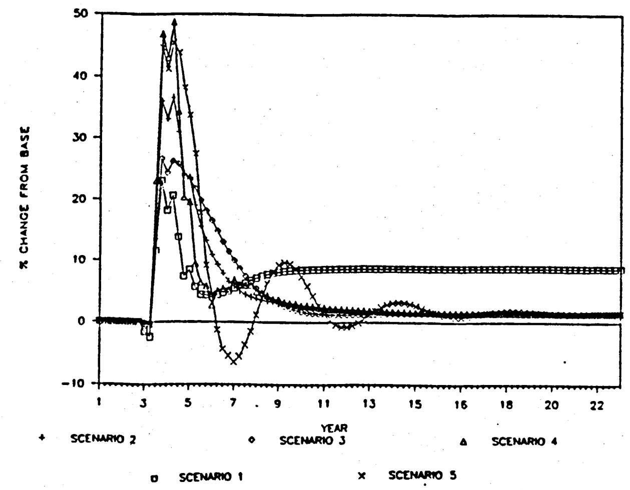


Figure 2. RETAIL PRICE OF BEEF

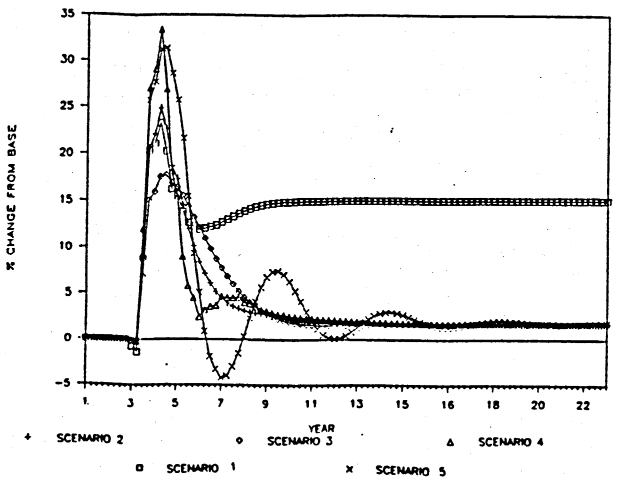


Figure 3. BEEF CONSUMPTION PER CAPITA

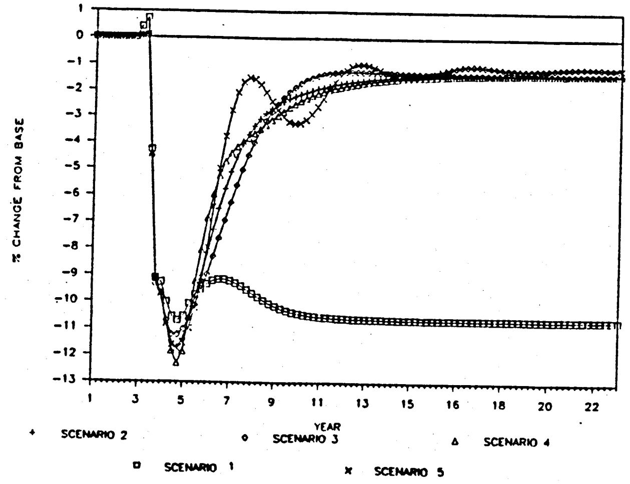


Figure 4. SIZE OF U.S. COW HERD

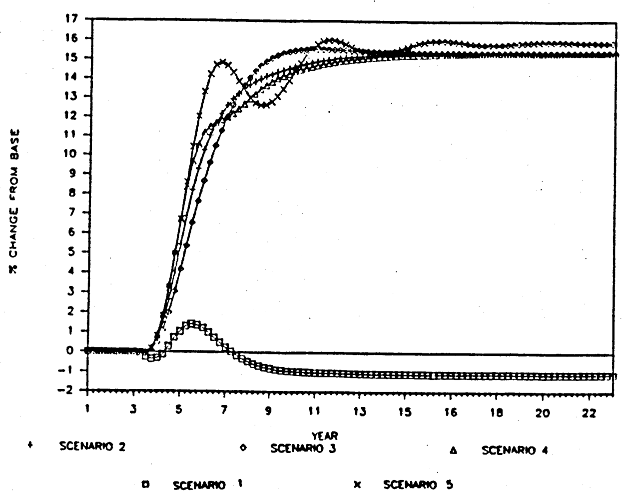


Figure 5. TOTAL PROFIT FROM FATTENING

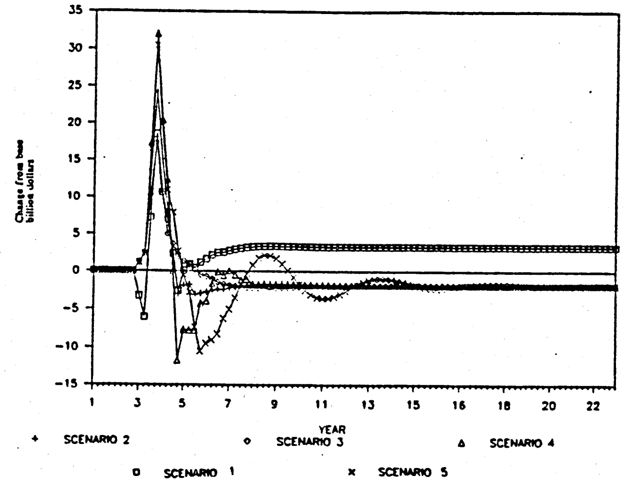
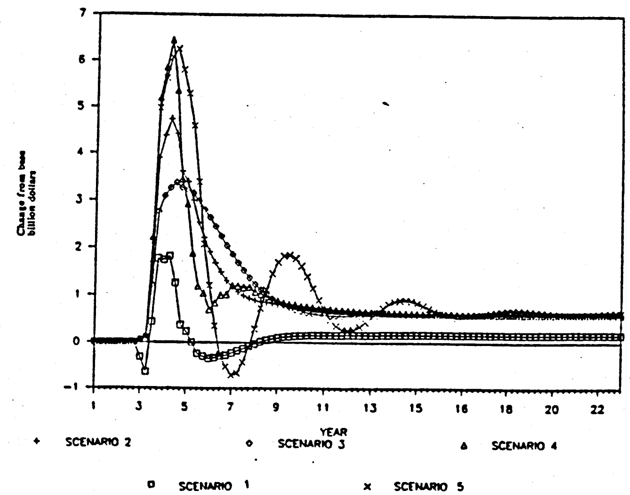


Figure 6. TOTAL PROFIT COW/CALF



impacts of a voluntary withdrawal of these compounds from the production process. The results indicate that feeder cattle producers (and, by analogy, corn producers) would benefit in both the short and long term if such a ban was implemented. In the short run, producer profits increase as more inputs are needed to maintain production. In the long run, the additional demand for feeder cattle and corn will increase the returns to fixed factors in these sectors. Cattle fatteners also reap large windfall profits but in the long run would lose slightly. These long-run losses occur because less beef would be consumed and because feeder cattle producers would receive higher prices for their calves. This reduction in the value added in the fed-beef sector reduces the ability of fed-beef producers to cover their fixed costs. The introduction of feedback effects from the pork and poultry sectors serves to create more interesting dynamics but does not alter the results and conclusions.

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