The Economic Impact of Beta Agonist Removal from Beef Production

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Abstract

Beta agonists are feed additives that increase the efficiency of feed conversion in feedlot cattle. Their use has recently generated significant discussion. We have developed an equilibrium displacement model that examines the impact of their removal from the market on production and prices of beef at the farm, wholesale, and retail levels. After their removal beef prices are increased in the retail, wholesale, feedlot, and cow/calf segments. Quantity of beef available decreases initially and in the long-term in the retail, wholesale, and feedlot segments, but increases in the long-term. Quantity produced increases in the short and long term for the cow/calf segment.

Key Words: Beta Agonist, Beef, Equilibrium Displacement Model (EDM), Zilmax, Optaflexx

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Introduction

Beta agonist, feed additives used to increase beef production efficiency, have come under increasing scrutiny over the past year. Beta agonists (ractopamine hydrochloride and zilpateraol hydrochloride) allow feed to be converted more efficiently generating more lean muscle mass and less fat, resulting in increased meat production. Of the two products, Zilmax® (zilpaterol hydrochloride) has been found to increase average daily gain (ADG; lbs/day) and hot carcass weight (HCW) more than Optaflexx® (ractopamine hydrochloride; Avendano-Reyes, 2006). While approved for use by the international standards body, Codex Alimentarius, Russia has banned imports of beef that cannot be certified as having been produced without beta agonists. Currently, Russia accounts for approximately 7% of U.S. beef exports. Additionally, Tyson stated in August 2013 that they will no longer purchase cattle fed Zilmax® (effective in early September 2013). Tyson's decision was based on animal welfare concerns as feeding Zilmax® may increase non-ambulatory or lame cattle. After Tyson's announcement Merck removed Zilmax® from the market to allow additional research into the animal welfare impacts of Zilmax.

The objective of this paper is to determine price and quantity effects on livestock and meat markets due to removal of both beta agonist feed additives (RH and ZH) from the U.S. beef production process. In this analysis beta agonist feed additives are assumed to be used in the pork industry.

Literature Review

Schroeder and Tonsor (2011) reported the economic impacts of Zilmax® adoption in the cattle and beef industry. They determined the overall market impacts and distribution of impacts across industry sectors using an equilibrium displacement model (EDM). This EDM model divided the beef industry into four sectors: 1) retail (consumer), 2) wholesale (processor/packer), 3) slaughter (cattle in feedlots), and 4) farm (feeder cattle from cow-calf producers). They also included dynamics of the pork and poultry markets to capture interactions between retail meat substitutions for beef. Schroeder and Tonsor estimated a net return for cattle fed Zilmax® of $24.24/head for steers and $15.69 for heifers in 2009. Net return benefits for packers slaughtering Zilmax-fed cattle were estimated to be $32.92/head for steers and $29.57/head for heifers. Schroeder and Tonsor's long-term market effects analysis revealed the ultimate beneficiaries to be the cow-calf producers and consumers as the benefit from feedlots and packers are transmitted through the rest of the market system. Cow-calf producers receive higher prices for their cattle and consumers observe lower prices for beef at retail stores.

Avendano-Reyes et al. (2006) evaluated the effects of two beta agonists on finishing performance, carcass characteristics and meat quality of feedlot steers (45 crossbred Charolais and 9 Brangus). Three treatments were administered: 1) control (no supplement added), 2) zilpaterol hydrochloride (ZH; 60 mg/steer/day), and 3) ractopamine hydrochloride (RH; 300 mg/steer/day), with beta agonists added to the diets for the final 33 days of the experiment. Steers fed ZH and RH had 26% and 24% greater ADG versus the control steers, respectively. Steers fed RH had a lower dry matter intake (DMI; lbs/day) than control steers, but DMI did not differ between ZH and control steers. ZH and RH use also influenced hot carcass weight (HCW), increasing HCW by 7% and 5%, as compared to control steers, respectively. Avendano-

Reyes et al. concluded that ZH and RH supplementation improved feedlot performance of steers based on average daily gain (ADG) values and the efficiency of gain. Additionally, HCW and dressing were also increased by beta agonist supplementation.

In 2007, Quinn et al. reported the effects of RH on live performance, carcass characteristics, and meat quality of finishing crossbred heifers (n = 302). Heifers were implanted with Revalor[2]-H and received treatments of 200 mg/head/day of RH or no RH supplement (control) 28 days prior to slaughter. Heifers receiving RH had an improved feed efficiency for the 28 day feeding period prior to slaughter. Similar measurements were obtained for the two treatments for dressing percent; HCW; marbling score; fat thickness; ribeye area; kidney, pelvic and heart fat; and USDA yield and quality grades. They reported no difference in Warner-Bratzler shear force between the two treatments. The authors concluded that Optaflexx® added to the diets of finishing beef heifers improved gain efficiency during the 28 day feeding period with no effect on carcass quality or meat characteristics.

Baxa et al. (2010) investigated the effects of ZH administration in combination with a steroidal implant, Revalor-S, on steer performance and the mRNA abundance for β_1-AR; β_2-AR; calpastatin; and myosin heavy chain (MHC) types I, IIA, and IIX in 2,279 English x Continental yearling steers. A 2 x 2 factorial design was used for four treatments evaluating ZH fed for the last 30 days on feed with a 3 day withdrawal and a terminal implant of Revalor-S (RS). The treatments were as follows, 1) no RS or ZH, 2) only ZH, 3) only RS, and 4) RS and ZH (RS+ZH). The RS treatment increased ADG and the gain to feed ratio (G:F) and increased DMI by 2.2%. ZH increased ADG, G:F, HCW, dressing percentage, and longissimus muscle (LM) area while decreasing 12th-rib fat depth and marbling scores. With ZH, there was no effect on DMI. Cattle receiving both RS and ZH had the greatest increase in ADG and G:F.

According to the authors the effects of hormonal implant and beta agonist appeared to be additive when compared with the individual treatments of ZH or RS. It was noted, however, that in each of these treatments carcass quality (marbling) decreased.

Data and Methods

Price and quantity effects are estimated for the retail, wholesale, slaughter, and farm level markets for beef. An EDM is used to estimate the market effects of beta agonist removal. Annual average 2012 U.S. price and quantity data from the USDA, compiled by the Livestock Marketing Information Center, for each of the various market segments is employed in the model. Live animal and carcass composition changes are based on the work of Avendano-Reyes et al. (2006) and Baxa et al. (2010) are used in the model. The EDM is composed of four sectors in the beef industry: 1) retail (consumer), 2) wholesale (processor/packer), 3) slaughter (cattle feeding in feedlots), and 4) farm (feeder cattle from cow-calf producers). Pork and poultry markets are also included allowing interactions between retail markets to be captured. International trade is also explicitly included in the model at the wholesale level for beef and pork. This framework is consistent with existing research and most closely follows the work of Schroeder and Tonsor (2011).

In the EDM, change in profitability due to the removal of beta agonists must be specified at the slaughter (feedlot) level. Change in profitability value is derived from an enterprise budget for a typical large-scale U.S. cattle feedlot (40,000 head capacity). Variables in a feedlot budget that would change with the removal of beta agonists include, but would not be limited to: days on feed (DOF), DMI, and ADG. These variables are used in the enterprise budget to determine feed costs, final weight of the animal, and other variable costs, as well as total revenues and expenses. Each of the feedlot budget variables specified above is related to the growth of the animal, which is altered by beta agonists. To estimate the changes in these variables a production growth model will be used to compare the two scenarios, one in which no beta agonists are used (baseline scenario) and the second where a beta agonist is used (beta agonist scenario). The growth model will approximate the changes in the animal's growth curve. These processes are summarized in Figure 1.

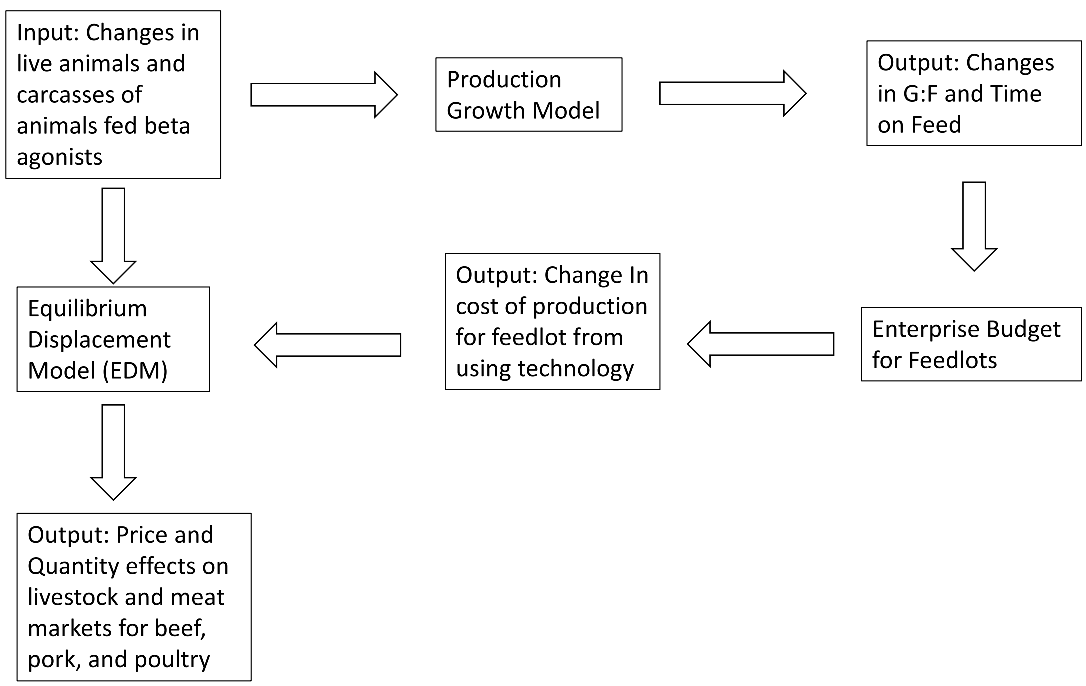

Figure 1. Flow diagram of information and models used in estimating the price and quantity effects of beta agonist removal in livestock

The production growth model uses information and data from the Nutrient Requirements of Beef Cattle model (NRC, 2000). DMI and ADG were calculated using the equations in the NRC for both scenarios. The NRC does not currently include a factor for beta agonist use. Thus, a factor similar to the implant factor was created using data from the literature (Avendano-Reyes et al., 2006; Baxa et al., 2010; Quinn et al., 2007) and incorporated into the NRC equations. This factor was only used in the beta agonist scenario. Cattle in both scenarios were considered to have implants. The calculated DMI and ADG for each scenario was then used in the feedlot enterprise budget.

Two enterprise budgets were constructed, one for each scenario, to determine the difference in profitability. For each scenario the cattle were assumed to start on feed at 750 pounds. The ADG prediction for no beta agonist was used in both scenarios. This ADG was used for the entire DOF for the baseline scenario and for all but the last 30 DOF in the beta agonist scenario. During the last 30 DOF the beta agonist scenario used the aforementioned adjusted NRC prediction equation to calculate ADG. ADG and DOF were used to calculate the final live weights of the cattle.

The 2012 U.S. average price for feeder cattle was used to calculate the purchasing cost along with the cattle's arrivalweight. Yardage, vet, and other variable costs were based on the University of Wisconsin Cooperative Extension's feedlot enterprise budget. The beta agonist cost was calculated based on a weighted average of Zilmax® and Optaflexx® prices. Beta agonist cost was only included in the beta agonist scenario. Feed cost was estimated using 2012 U.S. commodity ingredient prices, DOF, and DMI approximated for each scenario in the NRC. Costs were added together on a $/head basis to obtain total expenses ($/hd). Total revenues ($/hd) and total expenses ($/hd) were then used to calculate Net Cash Income (NCI; $/hd). The difference in profitability between the two scenarios was then used in the EDM.

The change in profitability of the packer/processor is calculated using the reported processing and slaughter cost from the United States Department of Agriculture (USDA) Beef Carcass Price Equivalent Index Value report and the final carcass weights of the cattle in each scenario. Slaughter and processing costs per head are converted to a per hundredweight basis.

Difference in slaughter and processing costs per hundredweight between the two scenarios is then used as the change in profitability for the packer/processor in the EDM.

Results and Discussion

The estimated ADG, based on the NRC equations, for the baseline scenario was 3.57 lbs/day and 4.00 lbs/day for the beta agonist scenario. DMI was estimated at 16.84 lbs/day for the baseline scenario and 16.56 lbs/day in the beta agonist scenario.

Final weights of 1,250 lbs and 1,338 lbs were estimated for the baseline and beta agonist scenarios, respectively. Dressing percentages for the two scenarios, based upon Avendano-Reyes et al. (2006) and Baxa et al. (2010), were used to calculate carcass weights of 775 lbs and 841 lbs for the baseline and beta agonist scenarios, respectively. Multiplying by the 2012 negotiated grid average price of $191.88/cwt results in total returns of $1,486.35/hd for the baseline and $1,614.58/hd for the beta agonist scenario. Using beta agonists resulted in a $128.23/hd increase in revenue.

Purchasing cost for the animal was $1,115/hd and variable costs were $53/hd in both scenarios. Yardage cost was $0.49/hd/day and feed costs were $0.18/lb. Total expenses summed to $1,675.17/hd for the baseline scenario and $1,760.93/hd for the beta agonist scenario. Expenses increased by $85.76/hd when beta agonists were employed. Combining revenues and expenses the NCI was -$188.82/hd for the baseline and -$146.35/hd for the beta agonist scenario. The decrease in profitability from not using a beta agonist is $42.47/hd. Table 1 contains animal information as well as the enterprise budget for the two scenarios.

Table 1. Animal Information and Enterprise Budget for Baseline and Beta Agonist Scenarios

Animal Information	Baseline Scenario	Beta Agonist Scenario
Initial Body Weight (lbs)	750.00	750.00
Final Body Weight (lbs)	1,250.00	1,337.67
Day Beta Agonist Started		131.00
No Beta Agonist ADG (lbs)	3.57	3.57
Weight at Start of Beta Agonist (lbs)		1,217.67
Beta Agonist ADG (lbs)		4.00
Total DOF	141.00	161.00
No Beta Agonist DMI (lbs/d)	16.84	16.84
Beta Agonist DMI (lbs/d)		16.56
Yardage Expense ($/day)	0.49	0.49
Feed Cost ($/lb)	0.18	0.18
Total Weight Gain in Feedyard (lbs)	500.00	587.67
Dressing Percentages (%)	0.62	0.63
Final Carcass Weight (cwt)	7.75	8.41
2012 Average Grid Price ($/cwt)	191.88	191.88
Returns ($/hd)		
Total Returns	1,486.35	1,614.58
Beta Agonist Scenario Increase in Revenue Over Baseline		128.23
Expenses ($/hd)		
Purchasing Expense	1,115.38	1,115.38
Beta Agonist Expense		15.42
Feed Expense	437.71	498.24
Yardage Expense	69.09	78.89
Vet Expense	3.00	3.00
Other Variable Expenses	50.00	50.00
Total Expenses	1,675.17	1,760.93
Beta Agonist Scenario Increase in Expense Over Baseline		(85.76)
NCI ($/hd)	(188.82)	(146.35)
Beta Agonist Scenario Increase in Profitability Over Baseline		42.47

The $42.47/hd reduction in profitability was used as the exogenous shock to the EDM. This exogenous shock induced many endogenous shifts in the EDM. Changes in livestock and meat prices and quantities from the complete removal of beta agonists in beef are intuitive.

Table 2 contains the estimated percentage changes in each model output variable. The removal of beta agonist products causes a decrease in the quantity of beef produced in feedlots and available for sale in the wholesale and retail markets. In the long run, quantity demanded increases at the farm level (1.17%) and the price increases accordingly (6.86%). Price also increases at all other market levels for beef (1.71-9.62%). Impacts are more substantial in the first few years when the supply short run supply response is relatively more inelastic. As supplies have more time to adjust the impacts are mitigated. For instance, the farm level price increases by 8.84% in year two, but only 0.11% by year eight. Over the eight year model prices and quantities oscillate until changes in prices and quantities become infinitesimally small. At this new level, prices have increased in all market levels compared to the initial time period. Quantity demanded decreases in every level, except for the farm level. Quantity demanded increases at the farm level by 1.17%.

Table 2. Percentage Change in Endogenous Variables of the EDM

Endogenous Variables	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Overall % Change
Retail Beef Quantity	-3.42%	3.10%	-2.02%	1.45%	-0.65%	0.44%	-0.35%	0.25%	-1.34%
Retail Pork Quantity	0.00%	10.72%	-10.76%	3.73%	-0.63%	0.03%	-0.01%	0.01%	1.88%
Retail Poultry Quantity	1.01%	-3.03%	2.72%	-0.86%	0.23%	-0.10%	0.08%	-0.05%	-0.10%
Wholesale Beef Quantity	-3.42%	1.82%	-1.29%	1.00%	-0.77%	0.52%	-0.42%	0.29%	-2.32%
Wholesale Pork Quantity	0.00%	11.15%	-4.32%	2.19%	-0.61%	0.04%	-0.01%	0.01%	8.04%
Imported Wholesale Beef Quantity	-3.42%	1.82%	-1.29%	1.00%	-0.77%	0.52%	-0.42%	0.29%	-2.32%
Imported Wholesale Pork Quantity	0.00%	11.15%	-4.32%	2.19%	-0.61%	0.04%	-0.01%	0.01%	8.04%
Exported Wholesale Beef Quantity	-3.42%	1.82%	-1.29%	1.00%	-0.77%	0.52%	-0.42%	0.29%	-2.32%
Exported Wholesale Pork Quantity	0.00%	11.15%	-4.32%	2.19%	-0.61%	0.04%	-0.01%	0.01%	8.04%
Slaughter Cattle Quantity	-5.44%	2.01%	-1.42%	1.10%	-0.84%	0.58%	-0.46%	0.32%	-4.25%
Slaughter Hog Quantity	0.00%	11.58%	-4.49%	2.27%	-0.63%	0.04%	-0.01%	0.01%	8.34%
Feeder Cattle Quantity	0.00%	1.87%	-1.32%	1.03%	-0.79%	0.54%	-0.43%	0.30%	1.17%
Retail Beef Price	4.31%	-4.04%	2.68%	-1.32%	0.58%	-0.39%	0.31%	-0.22%	1.71%
Retail Pork Price	0.07%	-15.15%	15.17%	-3.89%	0.66%	-0.04%	0.02%	-0.01%	-5.41%
Retail Poultry Price	-0.69%	2.06%	-1.84%	0.86%	-0.23%	0.10%	-0.08%	0.05%	0.18%
Wholesale Beef Price	5.80%	-3.09%	2.18%	-1.07%	0.82%	-0.56%	0.45%	-0.31%	4.05%
Wholesale Pork Price	0.00%	-15.57%	6.04%	-2.19%	0.61%	-0.04%	0.01%	-0.01%	-11.93%
Imported Wholesale Beef Price	5.82%	-3.10%	2.19%	-1.07%	0.82%	-0.56%	0.45%	-0.31%	4.06%
Imported Wholesale Pork Price	0.00%	-16.20%	6.28%	-2.19%	0.61%	-0.04%	0.01%	-0.01%	-12.38%
Exported Wholesale Beef Price	7.10%	-3.78%	2.67%	-0.33%	0.26%	-0.17%	0.14%	-0.10%	5.57%
Exported Wholesale Pork Price	0.00%	-13.14%	5.10%	-2.19%	0.61%	-0.04%	0.01%	-0.01%	-10.20%
Slaughter Cattle Price	12.88%	-4.75%	3.36%	-2.08%	1.59%	-1.09%	0.87%	-0.61%	9.62%
Slaughter Hog Price	0.00%	27.18%	-10.54%	5.34%	-0.35%	0.02%	-0.01%	0.01%	19.44%
Feeder Cattle Price	0.00%	8.84%	-6.25%	4.86%	-0.28%	0.19%	-0.15%	0.11%	6.86%

Overall, consumers, beef packers, and feedlots are made worse off by the increase in prices and decreases in quantity of beef. Only producers at the farm level are made better off by the higher prices.. The higher prices are estimated to result in higher feeder cattle prices as the higher fed cattle prices offset reduced profitability from loss of the beta agonist technology.

Relatively, quantity demanded increases at each market level for pork. Pork also becomes relatively cheaper at the retail and wholesale levels compared to beef. Price increases at the slaughter level in pork due to the increased demand for pork. Initially, pork quantity increases by about 11% in each market segment, leveling off to about 8% in the slaughter and wholesale markets and 2% in the retail market. The poultry industry sees only slight changes in prices and quantities. In the first year price and quantity each change by less than 1%. In the long run quantity decreases by 0.10% and price increases by 0.18%. The pork industry is the biggest winner from the removal of beta agonist products in beef production.

Conclusions

Removing beta agonist technologies from beef production induces several changes in the beef, pork, and poultry markets. Removing beta agonist products from beef causes cattle's ADG to decrease and their DMI to increase. Additionally, it also decreases the dressing percentage of the cattle. These physiological changes lead to decreases in profitability for both feedlots and packer/processors in the beef industry.

The reduction in saleable pounds of beef increases the price of beef in every market segment. Quantity demanded of feeder calves also increases. Price and quantity changes are more significant at the outset of beta agonist removal, but decrease over time. The pork industry also gains from the removal of beta agonists in beef.

Beef consumers lose due to the increased price and reduced quantity they face. Packer/processors and feedlots also suffer from the reduced quantities available and increased prices. Feeder cattle producers benefit from the increased price they receive for their cattle. Pork consumers and producers also benefit, consumers from lower prices and producers from increased demand. It is unknown whether Zilmax® will return to the market if beta agonist products will continue to be restricted or removed. Regardless, the removal of any or all beta agonist products from beef or pork production will certainly effect the beef, pork, and poultry industries at all market segments.

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