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The Economic Impact of Beta Agonist Removal from Beef Production

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24 **Abstract**

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

33

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

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39
40 **Introduction**

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

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

58

59 **Literature Review**

60 Schroeder and Tonsor (2011) reported the economic impacts of Zilmax® adoption in the
61 cattle and beef industry. They determined the overall market impacts and distribution of impacts
62 across industry sectors using an equilibrium displacement model (EDM). This EDM model
63 divided the beef industry into four sectors: 1) retail (consumer), 2) wholesale (processor/packer),
64 3) slaughter (cattle in feedlots), and 4) farm (feeder cattle from cow-calf producers). They also
65 included dynamics of the pork and poultry markets to capture interactions between retail meat
66 substitutions for beef. Schroeder and Tonsor estimated a net return for cattle fed Zilmax® of
67 \$24.24/head for steers and \$15.69 for heifers in 2009. Net return benefits for packers
68 slaughtering Zilmax-fed cattle were estimated to be \$32.92/head for steers and \$29.57/head for
69 heifers. Schroeder and Tonsor's long-term market effects analysis revealed the ultimate
70 beneficiaries to be the cow-calf producers and consumers as the benefit from feedlots and
71 packers are transmitted through the rest of the market system. Cow-calf producers receive
72 higher prices for their cattle and consumers observe lower prices for beef at retail stores.

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

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

85 In 2007, Quinn et al. reported the effects of RH on live performance, carcass
86 characteristics, and meat quality of finishing crossbred heifers (n = 302). Heifers were implanted
87 with Revalor²-H and received treatments of 200 mg/head/day of RH or no RH supplement
88 (control) 28 days prior to slaughter. Heifers receiving RH had an improved feed efficiency for
89 the 28 day feeding period prior to slaughter. Similar measurements were obtained for the two
90 treatments for dressing percent; HCW; marbling score; fat thickness; ribeye area; kidney, pelvic
91 and heart fat; and USDA yield and quality grades. They reported no difference in Warner-
92 Bratzler shear force between the two treatments. The authors concluded that Optaflexx® added
93 to the diets of finishing beef heifers improved gain efficiency during the 28 day feeding period
94 with no effect on carcass quality or meat characteristics.

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

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

108

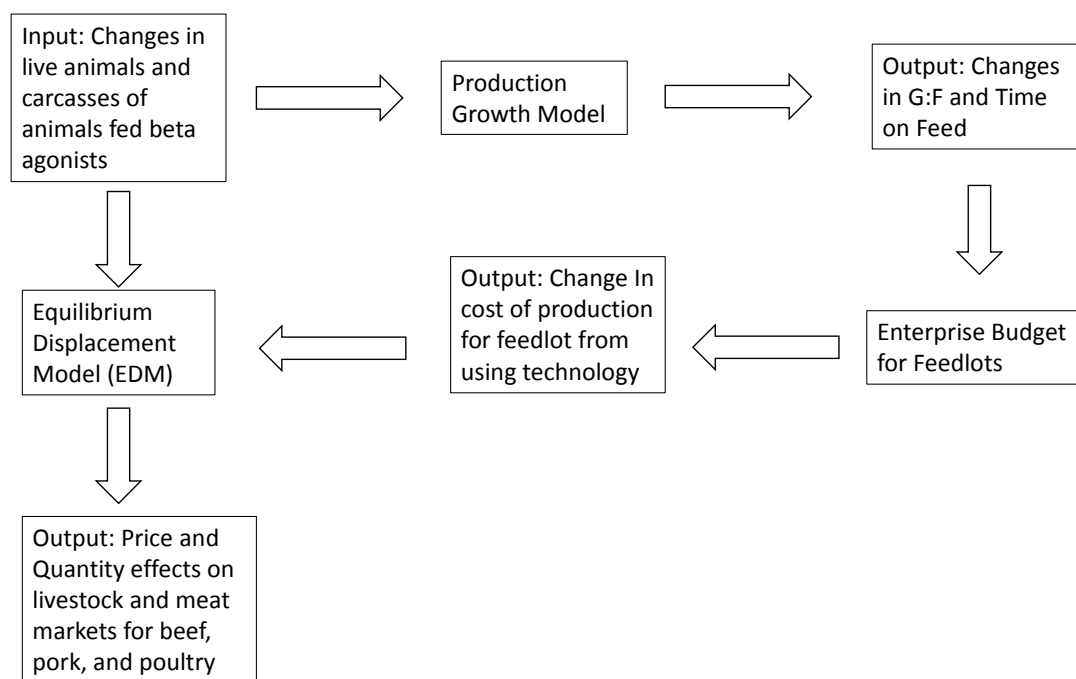
109 **Data and Methods**

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

122 In the EDM, change in profitability due to the removal of beta agonists must be specified
123 at the slaughter (feedlot) level. Change in profitability value is derived from an enterprise budget
124 for a typical large-scale U.S. cattle feedlot (40,000 head capacity). Variables in a feedlot budget
125 that would change with the removal of beta agonists include, but would not be limited to: days
126 on feed (DOF), DMI, and ADG. These variables are used in the enterprise budget to determine
127 feed costs, final weight of the animal, and other variable costs, as well as total revenues and

128 expenses. Each of the feedlot budget variables specified above is related to the growth of the
 129 animal, which is altered by beta agonists. To estimate the changes in these variables a
 130 production growth model will be used to compare the two scenarios, one in which no beta
 131 agonists are used (baseline scenario) and the second where a beta agonist is used (beta agonist
 132 scenario). The growth model will approximate the changes in the animal's growth curve. These
 133 processes are summarized in Figure 1.

134



135

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

138

139 The production growth model uses information and data from the Nutrient Requirements
 140 of Beef Cattle model (NRC, 2000). DMI and ADG were calculated using the equations in the
 141 NRC for both scenarios. The NRC does not currently include a factor for beta agonist use.
 142 Thus, a factor similar to the implant factor was created using data from the literature (Avendano-
 143 Reyes et al., 2006; Baxa et al., 2010; Quinn et al., 2007) and incorporated into the NRC

144 equations. This factor was only used in the beta agonist scenario. Cattle in both scenarios were
145 considered to have implants. The calculated DMI and ADG for each scenario was then used in
146 the feedlot enterprise budget.

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

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

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

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

169

170 **Results and Discussion**

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

174 Final weights of 1,250 lbs and 1,338 lbs were estimated for the baseline and beta agonist
175 scenarios, respectively. Dressing percentages for the two scenarios, based upon Avendano-
176 Reyes et al. (2006) and Baxa et al. (2010), were used to calculate carcass weights of 775 lbs and
177 841 lbs for the baseline and beta agonist scenarios, respectively. Multiplying by the 2012
178 negotiated grid average price of \$191.88/cwt results in total returns of \$1,486.35/hd for the
179 baseline and \$1,614.58/hd for the beta agonist scenario. Using beta agonists resulted in a
180 \$128.23/hd increase in revenue.

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

188

189 **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)

NCI (\$/hd)	(188.82)	(146.35)
Beta Agonist Scenario Increase in Profitability Over Baseline		42.47

190

191

192 The \$42.47/hd reduction in profitability was used as the exogenous shock to the EDM.

193 This exogenous shock induced many endogenous shifts in the EDM. Changes in livestock and

194 meat prices and quantities from the complete removal of beta agonists in beef are intuitive.

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

207

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%

208

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

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

221

222 **Conclusions**

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

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

232 Beef consumers lose due to the increased price and reduced quantity they face.
233 Packer/processors and feedlots also suffer from the reduced quantities available and increased
234 prices. Feeder cattle producers benefit from the increased price they receive for their cattle.
235 Pork consumers and producers also benefit, consumers from lower prices and producers from
236 increased demand. It is unknown whether Zilmax® will return to the market if beta agonist
237 products will continue to be restricted or removed. Regardless, the removal of any or all beta
238 agonist products from beef or pork production will certainly effect the beef, pork, and poultry
239 industries at all market segments.
240

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