The influence of growth promoting antibiotics on variability of productivity and economics in U.S. swine finishing.

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Summary
Societal concerns about the efficacy of antibiotics have generated increased scrutiny of antibiotics used for growth promotion. To evaluate potential regulatory changes in the use of growth promoting antibiotics, an understanding of both the risks and benefits generated is needed. Producer benefits may not be limited to average effects seen on performance indicators. The benefits may include reductions in the variability of production. We study the production risk by examining the change in production variability and profits associated with growth promoting antibiotic use. Increasing the number of days antibiotics are fed increases profits per pig and decreases variability of profits.

Antibiotics have been used by U.S. swine producers for growth promotion for decades. Growth promoting antibiotic use became an established practice because of the realized gain in productivity and the associated enhanced profitability for swine producers. Antibiotics have been used extensively by U.S. swine producers, with 78% of swine producers using growth promoting antibiotics in the 1990 and 1995 NAHMS National Swine Survey data (Miller et al., 2003).

However, antibiotic use has come under increased public scrutiny. This increased scrutiny arises because of a fear of the influence of antibiotic use in animals on the antibiotic resistance in human pathogens. While there has been increased resistance, and the development of multi-drug resistant strains during a time of high antibiotic use in animal agriculture, scientists do not currently share a consensus understanding of the ecology of antimicrobial resistance, and the distinct contribution of growth promoting antibiotics to the observed resistance in human pathogens. In this environment, the use of antibiotics for growth promotion is one area that has been increasingly criticized. In addition, a growing body of research has enhanced our understanding of the various mechanisms of antibiotic resistance and resistance transfer between microbes making it even clearer the degree of complexities involved in antibiotic resistance.

Food safety has become an increasingly important topic. Foodborne illness is a common human problem; foods which are contaminated with microbes with antibiotic resistance are of increased concern. Food safety risk models that can link human food safety risks with foods of animal origin are inherently complex (Barber et al., 2003). Again our understanding of the microbial ecology of organisms in the farm-to-fork food production chain has a fair degree of uncertainty.

Simultaneously with the increased isolation of microbes harboring antibiotic resistance, and the increased public awareness of food safety problems, there have been major changes in the basic production practices and the structure of the swine industry. An increasing proportion of U.S. pigs are grown in integrated systems, with controlled pig flow, controlled environment confinement operations, with strict

biosecurity, and lean genetic pigs. Thus, there is reason to question whether growth promoting antibiotics is still cost beneficial. Some studies document on-going productivity gains and improved profitability from growth promoting antibiotic use while other studies fail to document significant differences in various productivity measures (Miller et al., 2003a). Also, there is a need to model the economic tradeoffs between impacts to producers, and consumers involved in an industry (McNamara and Miller, 2002).

In addition to the basic mean effects in productivity gains from antibiotic use, there is the potential for an influence of antibiotic use on production risk. Production risk in this application is defined as differences in variability in output attributable to antibiotic use. Thus, the objective of this study was to identify the economic implications of variability of production output attributable to use of antibiotics for growth promotion.

Material and Methods

Data from the National Animal Health Monitoring System (NAHMS) 2000 swine data were used. These data are from a survey of 2,499 U.S. swine farms conducted in 2000. The final dataset uses data from 315 farms; only a portion of the original farms surveyed completed all of the dataforms necessary to allow them to be included in this study.

Prior to studying the details of production risk, a clear understanding of the mean impacts of antibiotic use on various productivity measures is needed. We model 4 measures of swine finishing productivity: average daily gain (ADG), feed conversion ratio (FCR), mortality rate (MR), and stunted pig rate (SR) (Miller et al., 2003b). The use of feedgrade antibiotics for growth promotion, for disease prevention, and for disease treatment are modeled as separate independent variables in a system of equations using seemingly unrelated regression. We used the Hausman statistic to assess model specification comparing SUR, ordinary least squares (OLS) and 3-stage least squares models.

We model production risk using the ADG estimated equation only. ADG and FCR are probably the most important of the 4 productivity measures to influence farm profitability; antibiotic influence on FCR was not significant. The functional form for the influence of the number of days antibiotics are used for growth promotion (or disease prevention/disease treatment) is identified to be a quadratic.

The market weight of hogs is estimated using the estimated ADG equation. Mean entry weight to the finisher was assumed to be 59 pounds. Mean time spent in pig finishing was 114 days (mean from NAHMS 2000 data). The estimated coefficients were used in conjunction with these data to estimate market weight for every day of possible antibiotic use. The variability in market weight of pigs is estimated by the standard deviation of market weight in each of 11 groups; groups were categorized by number of days growth promoting antibiotics were fed (0, 1-20, 21-40, 41-50, 51-60, 61-70, 71-80, 81-90, 91-100, 101-115, and more than 115 days).

The economic impact for individual producers was estimated using an @Risk spreadsheet. The distribution of live weight for pigs marketed from farms using antibiotics for growth promotion at the full spectrum of possible days (0-120) was used in conjunction with mean U.S. prices for market hogs (USDA) from 1995-1999,

and an assumed pricing grid matrix which results in price penalties for pigs below 231 and above 280 pounds of live weight. Mean costs of production for U.S. swine producers were also used, and assumed costs of antibiotics used for growth promotion. Profit is reported per pig marketed.

Results and Discussion

Approximately 62% of U.S. swine operations in 2000 used at least 1 antibiotic for growth promotion during the grow/finish phase. Antibiotics used for growth promotion enhanced pig productivity (increased ADG, decreased SR; but there was no statistically significant change found in FCR or MR) and producer profits (Miller et al, 2003b). Mean profits per pig increased with increasing days antibiotics were fed; profits per pig marketed reached a maximum when the number of days antibiotics were fed was between 65 and 75 days. The change in profits per pig was about $0.01 per pig marketed in going from 65 to 75 days. Profits decrease by about $0.13 per pig when the number of days antibiotics were fed increased to 85.

Variability of ADG decreased when the number of days antibiotics were fed for growth promotion increased; variability was at a minimum when the number of days antibiotics were fed was 75. Variability of profits was highest for producers using zero antibiotics. The standard deviation of profits was over $1.00 per pig higher for producers who used no antibiotics compared to producers who used antibiotics for almost the entire production period. But generally, profitability and variability of profits were not much different and were optimized (highest profits and lowest variability) when the number of days antibiotics were fed was between 55 and 85.

The economic implications of decreased variability of productivity are complex. The implications of the influence of mean and variance of profits in the context of producer utility allows for an increased understanding of the likely response of producers to various policies that might restrict growth promoting antibiotic use in swine production. Most producers are thought to be risk averse. Thus, production uncertainties influence production decisions. Our results lend support to the hypothesis that growth promoting antibiotics serve as a risk-reducing input (Robison and Barry, 1987). Analyses which do not measure the impact of growth promoting antibiotics on producer risks appear to be biased downwards.

References

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