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THE USE OF SIMULATION IN EVALUATING INTERNATIONAL COMPETITIVENESS IN BROILER PRODUCTION

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ABSTRACT

With the ongoing U.S.-Canada Free Trade Agreement and the recently approved North American Free Trade Agreement, there is a need to evaluate the competitiveness of Canadian broiler farms with U.S. broiler farms under the free trade environment. This study uses a comprehensive, farm-level, capital budgeting, Monte Carlo simulation model, CHICKSIM III, to analyze the production and financial performance of representative broiler farms for both countries under various free trade scenarios. Results show how differences in industry and cost structures of the broiler industry in both countries affect the ability of the Canadian broiler growers to compete with U.S. farms in an unrestricted market environment.

1 INTRODUCTION

Since its enactment on January 1, 1989, the U.S.-Canada Free Trade Agreement (FTA) has supported the continued increase in agricultural trade activities between the two countries. It was also a major component in the negotiations to create the North American Free Trade Agreement (NAFTA) among the United States, Canada, and Mexico. Currently, the U.S. provides over 60 % of Canada's agricultural imports and purchases over a third of Canada's agricultural exports. With the expansion of chicken import quotas as outlined in article 706 of the FTA, there has been an increase in the trade volume of chicken imports.

In U.S. and Canada, government programs in agriculture are designed to support farmers' incomes and well-being, protect the self-sufficiency of each country's food production, and promote a competitive agricultural trade export activity. Furthermore, in both the U.S. and Canadian poultry industries, there is a departure from the free market system. However, the government programs for poultry production in these two countries are strikingly different in their structure and policies. These differences can affect trade between the two countries under the free trade agreement.

1.1 Comparison of U.S. and Canadian Broiler Industry

The U.S. broiler industry is highly concentrated and vertically integrated while the Canadian counterpart can be described as the horizontal integration of producers via a supply system. In U.S., a vertically integrated broiler company controls the entire production and marketing process, except for the broiler growout stage which is controlled by the integrators through a production contract with producers. The top ten companies control 60 % of the market (Thornton, 1993). In contrast, the Canadian broiler industry consists of relatively small independent producers involved in all phases of broiler production. Production quotas and price levels are controlled by the national and provincial marketing boards.

The U.S. integrator covers the major components of the variable production costs, guarantees the marketing outlet, provides various production efficiency bonuses, and offers new housing incentives. This allows the grower to avoid risks normally faced by an independent producer. In return, the grower invests in broiler housing and related equipment, provides labor and daily management, and operates within the production objectives set by the integrator. Unlike producers of other agricultural products, broiler producers do not receive direct government support except for the export enhancement program.

In Canada, production and prices are governed directly by the national and provincial marketing boards whose activities include updating the full-cost formula price regularly, distributing the national quota among provinces and individual producers, and penalizing broiler producers with substantial levies for over-quota production (Coffin *et al.*, 1989). Import restrictions ensure production that is matched to expected domestic demand and thereby insulate the formula price from the impacts of foreign competition (Zachariah *et al.*, 1989). A more detailed comparison of the U.S. and Canadian broiler systems can be found in Gempesaw *et al.* (1994).

Both countries have numerous programs to shield domestic markets from foreign imports and to support the income of farmers. The U.S. government has tariffs and export subsidies affecting broiler industry in addition to regulations on standard size, quality, labeling,,food safety, and packaging. Canada primarily relies on price, production and, import controls as policy instruments to manage broiler supply and trade. Other complementary policies are import quotas, health regulations, and processing requirements which provide trading controls. The sharp divergence in industry structure, government programs, and trade controls have resulted in substantially higher domestic Canadian broiler prices than comparable domestic U.S. prices.

The current U.S. and Canadian trade policies have resulted in relatively low levels of trade in poultry products. To achieve a further increase in broiler trade between the U.S. and Canada, both countries will have to agree to remove some of the trade barriers. Under current conditions, Canadian producers are more heavily supported by government policy than are U.S. producers. Because Canada broiler meat is generally more expensive than U.S. broiler meat, the Canadian broiler industry would be negatively affected by increased U.S. imports supply. Unrestricted import access and Canadian chicken supply management are therefore incompatible (Normille and Goodloe, 1988) and the structure of the Canadian broiler industry would need to be drastically altered if trade barriers were removed for Canada to be competitive with U.S.

2 OBJECTIVES OF THE STUDY

As the trade barriers between U.S. and Canada are reduced, the degree to which Canadian broiler producers will be affected by freer trade will be an issue in the continuing trade talks. To evaluate the competitiveness of the Canadian broiler industry, this study will analyze how the cost and returns of the Canadian broiler enterprise will be affected by unrestricted trade. The first objective is to compare and evaluate the costs and returns of representative U.S. and Canadian broiler farms. The second objective is to illustrate the use of Monte Carlo techniques in evaluating international competitiveness in broiler production.

3 METHODOLOGY

CHICKSIM III (AQUASIM) is a comprehensive, farm-level, dynamic, and stochastic capital budgeting computer simulation model. In this study, CHICKSIM III will be used to evaluate the costs and returns of four U.S. and three Canadian representative farms. However, only results for one representative farm from each country will be presented in this paper. In addition to the accounting subroutines from FLIPSIM V (Richardson and Nixon, 1986), other subroutines were written to model the production and financial performance of vertically or horizontally integrated agricultural enterprises with multiple inputs and outputs (Gempesaw, Munasinghe, and Richardson, 1988). The model simulates the effects of changes in production, financial, and policy variables on the broiler grower's profitability.

CHICKSIM III is a dynamic Monte Carlo model which simulates the broiler farm operations by using the ending financial position of the previous year as the beginning position for the following year. The stochastic nature of the model comes from drawing random mortality rates, individual variable costs, feed efficiency levels, output levels, and prices. The user has the option of using several probability distributions such as the triangular, beta, lognormal, normal, and empirical distributions for each key variable in drawing the stochastic values. The model is capable of simulating a broiler enterprise with 1 to 50 broiler houses and up to seven placements (flocks) per house/year over a ten-year planning horizon.

CHICKSIM III has been used in several studies which have evaluated the profitability of U.S. broiler growout firms (Gempesaw and Bhargava, 1990; Gempesaw, Bacon, and Richardson, 1989). In addition, it has also been extensively applied to analyze the profitability of alternative technologies (biotechnology), new products (aquaculture), and alternative agricultural policies (dairy). CHICKSIM III can model enterprises that produce outputs to be used as inputs in the next stage of operations. The model permits the simulation of multiple output/input enterprises (e.g., joint production of poultry and grains). It has the capability of simultaneously modelling products with different time periods. The analyst can also select output and price relationships such that a randomly selected high output quantity will be correlated with a randomly selected low output price and vice-versa. Since mortality rates can be estimated on a monthly basis, annual variable costs can be estimated using pre-mortality stocks, average monthly bird population, and/or post-mortality monthly population. The estimation of the production costs can be evaluated on a per-head or per weight basis and the allocation of costs can be distributed over time. For example, harvesting costs will only be incurred when they are needed.

The model provides detailed results regarding the economic and financial viability of the representative farms. The farms are simulated over a ten-year planning horizon with a maximum of 300 iterations. At the end of each iteration, values for each of the key production and financial variables are calculated. If the farm experiences a negative cash flow during the planning horizon, deficits are automatically covered by the model through a loan secured by existing equity, if available. If the farm takes this option but still cannot cover the cash flow deficit, the farm is declared insolvent and the model stops and prints the statistical results. The complete model results include a ten-year projection of the income statement, balance sheet, and cash flow statement, as well as descriptive statistical measures and cumulative probability distribution functions of the key output variables and probabilities of economic success and survival. In addition, the model also prints randomly derived output quantities and prices, variable costs, mortality rates, and other random variables per broiler flock.

Recent additions in the model include the use of biophysical variables in production estimation. With this option, the model will describe not only the economic performance of the farm but also the effect of the biological processes which influence the production cycle. Factors such as rainfall, temperature, fertilizer type, farming methods, and other variables can be incorporated in the simulation model. Options for the use of different equations such as linear, quadratic, square-root, and non-linear von Liebig formulas (Paris, 1994) in the computation of yield are also available in the model.

4 DATA ASSUMPTIONS

Data requirements for the U.S. farms were collected from various sources. Personal interviews were conducted with broiler growers, input-supplying companies, bank loan officers, and poultry extension agents. Four representative farms were constructed for Delmarva (Delaware, Maryland, and Virginia), Alabama, Arkansas, and Georgia which account for over half of total U.S. broiler production (Lasley et al., 1988).

All farms were assumed to have three negative-pressure type broiler houses with six flocks per year and 4 hectares of land. The representative farms began their operations with $5,000 in cash and were required to maintain $2,500 in cash reserves. The projected increases in variable costs were set between 3 to 5 % annually (WEFA Group, 1992). A complete description of the U.S. representative farms is provided in Gempesaw and Bhargava (1990).

Three broiler growout farms were developed representing Ontario, Quebec, and British Columbia. These three provinces account for over 75 % of total broiler production in Canada (Canadian Chicken Marketing Agency, 1992). The representative farms were assumed to have two broiler houses with an average capacity of 18,000 birds per house. The farms operated on a 4-hectare farmland with an initial base of five placements per year. Table 1 compares the characteristics of the U.S. farm (Delmarva) and the Canadian farm (Ontario).

Table 1: Production and Financial Characteristics of Representative Broiler Farms in U.S. (Delmarva) and Canada (Ontario)

Characteristics	U.S. Delmarva	Canada Ontario
No. of Houses	3.0	2.0
Ave. Capacity/House (000 birds)	24.0	18.0
Farmland Owned (hectares)	4.0	4.0
Number of Flocks/Year	6.0	6.0
Debt/Asset Ratio	0.5	0.5
Total Assets (000)	US$378.8	Can$672.1
Cash Reserves (000)	US$5.0	Can$5.0
Age of Operator	45.0	45.0
Off-Farm Income (000)	US$20.0	Can$20.0
Wage Rate (per hour)	US$4.50	Can$11.3
Ave. Mortality Rate (%)	3.0	3.0
Ave. Initial Bird Prices	152.0*	116.0**
Ave. Bird Weight	4.8 lbs	1.8 kg
Interest Rates:		
Long Term (%)	8.0	8.0
Intermediate Term (%)	7.0	7.0
Operating Loans (%)	6.0	6.0

* Per thousand birds (US$)
** Per kilogram (Canadian cents)

The estimated variable costs were based on cost of production updates per province provided by the

Canadian Chicken Marketing Agency (1992a). Increases in variable costs over the planning horizon were taken from Agriculture Canada forecasts and averaged between 2 to 4 % per annum (Agriculture Canada, 1992). Data on fixed cost items were also provided by the Canadian Chicken Marketing Agency based on the 1991 model farm costs for new construction. A complete discussion of the cost components for the Canadian farms is presented in Gempesaw *et al.* (1994).

5 COMPARISON OF PRODUCTION COSTS

In order to evaluate the competitiveness of Canadian broiler farms operating with unrestricted import access (i.e. no import quotas or tariff protection), it is necessary to compare production costs with U.S. farms. Direct comparison is not possible since there are differences in the industry structure of the two countries (e.g., U.S. growers do not pay for feed, chick costs, catching, and part of energy cost). Therefore, the comparison of production costs will be undertaken using the present Canadian broiler industry structure. This means that cost items which are normally not shouldered by the U.S. grower under the vertically integrated system will be estimated indirectly from secondary sources. For example, feed costs will be computed using prevailing feed prices and feed conversion rates. Personal interviews were also conducted with selected poultry integrators in Delmarva to verify the estimated production costs. Furthermore, for brevity's sake, only the production costs for Ontario and the Delmarva region will be included for comparison. To facilitate the cost comparison, an exchange rate of 1.24 was used in converting U.S. costs to Canadian dollars. The fixed and variable costs for the Ontario and Delmarva farms are shown in Table 2.

Based on the fixed cost data, the Delmarva representative farm pays about $(Can) 150,000 less than the fixed costs being paid by the representative Canadian farm. The total cost per house for the Ontario farm was almost $(Can)320,000 while the Delmarva cost per house was estimated to be less than $(Can) 170,000. The variable production costs were also estimated for the Ontario farm and the Delmarva farm. As expected, the largest component of variable cost was feed cost which includes mill delivery cost and medication costs. The Ontario farm spent 46.49¢(Can) for its feed cost while the Delmarva farm spent about 3 ¢ (Can) less. There are three variable cost items for which the Ontario farm spent considerably more than the Delmarva farm, namely, the chick cost, energy cost, and maintenance cost. Compared to the costs incurred by the Delmarva farm, the Ontario farm pays almost two times more for the chick cost and energy cost and almost three times more for the maintenance cost. Overall, the total variable costs of the Ontario representative farm were at least 30 ¢(Can) per kg higher than the Delmarva farm.

Table 2: Comparison of Production Costs: Delmarva and Canadian Representative Farms

Cost Item	Ontario	Delmarva
Fixed Costs ($Can per house)		
Broiler Housing	199,412.50	93,000.00
Barn/Yard Equipment	73,989.00	43,400.00
Tractors/Truck/Others	44,177.00	29,760.00
Total Fixed Costs	317,578.50	166,160.00
Variable Costs (¢Can per kg.)		
Feed Cost	46.49 (46.3%)	43.32(61.9%)
Chick Cost	27.72 (27.6%)	9.95 (14.2%)
Labor Cost	13.11 (13.0%)	9.96 (14.3%)
Maintenance Cost	2.91 (2.9%)	0.76 (1.1%)
Energy Cost	5.28 (5.3%)	1.79 (2.6%)
Catching Cost	2.47 (2.5%)	3.06 (4.1%)
Miscellaneous Cost	2.36 (2.4%)	1.06 (1.5%)
Total Variable Costs	100.34	69.90

6 MODEL VALIDATION

Model validation is a procedure in which the analyst evaluates the degree to which the model satisfies the objectives of the study and accurately represents the system in the real world. Model validation in this study was conducted as follows. First, the representative broiler farms were developed using various data sources as previously described. Second, the representative farms were simulated using both the deterministic and stochastic options. Third, the simulated deterministic and stochastic values were then compared with the actual data on hand. Fourth, particularly in the case of the U.S. farms, the simulation results were shared with broiler growers, extension personnel, and representatives of poultry integrators for comments. The statistical comparison of simulated and actual values were very close indicating that the model has the capability of replicating broiler farm performance. In addition, the feedback from producers has been positive regarding the estimated economic performance of the representative farms.

7 EVALUATION CRITERIA

The simulation model provides considerable detailed results regarding the financial performance of the representative broiler farms. For purposes of this study, five output variables were selected to evaluate the results of the policy impact scenarios. First, the net present value (NPV) is defined as the discounted earning stream plus the change in equity over time using a 5 % discount rate. The net present value is a dynamic measure of the representative farm's profitability over time. A net present value greater than zero indicates positive returns to the producer's equity investment. Second, the internal rate of return (IRR) is defined as the discount rate that would equate the net present value of the farm's earning stream to zero. The farm's earning stream includes the annual cash returns (less off-farm income and outside investments) and the change in net worth over the planning horizon. Third, the net cash farm income (NCFI) is computed as the cash revenue minus cash farm expenses (production expenses, labor costs, property taxes, and interest expense). The net cash farm income provides a direct indicator of the farm's profitability before noncash adjustments are made. Fourth, the probability of survival is defined as the probability that the representative farm will remain solvent over the ten-year planning horizon. The criterion for remaining solvent specifies that the farm enterprise has to maintain at least a 20 % equity to asset ratio over the planning horizon. Fifth, the probability of economic success is defined as the probability that the broiler farm will have a positive NPV using a 5 % discount rate.

8 RESULTS

For purposes of comparison, the results for Delmarva and Ontario will be presented in this section. Among the U.S. representative farms, Delmarva has the lowest IRR while Ontario has the highest IRR among the Canadian representative farms. The discussion of the simulation results will be divided into two categories. The first category deals with the economic performance of U.S. and Canadian broiler farms assuming they have only been in operation for one year. The second category deals with the financial performance of the representative Canadian farm assuming it has been in operation for at least 10 years. For this case, it was assumed that the ongoing Canadian broiler farm have fully paid for the land and half of the cost of the broiler housing and equipment. It was also assumed that these producers start with a .25 debt/asset ratio and that the truck, tractor, and other equipment were at least 5 years old and required to be replaced during the planning horizon.

8.1 Impact Scenarios

In order to evaluate the competitiveness of Canadian broiler grower farms, several production and policy impact scenarios were developed. These scenarios were meant to capture the possible impacts on Canadian broiler growout farms given unrestricted import access and vertical integration assumptions. The base scenario assumes that the characteristics of the Canadian representative farms are as shown in Table 1. Expected output price increases of about 2 to 3 % annually over the planning horizon were taken from forecasts provided by Agriculture Canada Medium Term Outlook (1992).

The simulation results for the base scenario are presented in Table 3 for both new and ongoing operations of the Ontario farm. Due to high output prices and import controls, the Ontario representative farm was able to generate positive financial returns and the probabilities of survival and economic success are both high. The returns are even higher for the ongoing operations which assume that the farm has been running for at least ten years.

Table 4 shows the performance of a representative Delmarva farm with new operations. It has high probabilities of survival and economic success, similar to the Ontario broiler farm. Comparing the new operations for Ontario and Delmarva, the IRR measures are similar and are both above the minimum requirement of 5 %.

Compared to the other U.S. representative farms, Delmarva has the lowest IRR due to the higher costs of capital investment and production in the area brought about by urbanization pressures and colder climate conditions. On the other hand, the Ontario farm has the highest IRR among the Canadian farms at 8.81 %. The internal rates of return for the Canadian farms are generally lower than their U.S. counterparts primarily because of higher capital investment requirements. However, as shown in Table 3, the Ontario farm is competitive if it has been in operation for at least 10 years. The IRR jumped to an average of 11.18 % and the net cash farm incomes increased by around \$(Can) 6,000 per year.

A cursory review of the simulation results presented in Tables 3 and 4 may lead one to conclude that Canadian farms may actually be competitive with U.S. broiler growout farms. However, these results are primarily driven by the supply management policies in effect in Canada along with the presence of import controls. As previously noted by Normille and Goodloe (1988), the producer subsidy equivalents (PSE) for poultry in the U.S. was around 8.3 % while the comparable statistic for Canadian poultry was twice as much (16.3 %). A PSE is an estimate of the revenue required to compensate growers if existing government programs were eliminated. The large PSE for Canadian poultry illustrates the significant degree of protection provided to Canadian producers. The production quotas and import controls result in chicken prices in Canada which are substantially higher than chicken prices in the U.S.

Table 3. Summary of Key Output Variables for the Representative Broiler Farm in Ontario: Base Scenario

Financial Variable	New Operations	Ongoing Operations
Net Present Value ($Can)		
Mean	236,724	388,466
Coefficient of Variation	42.50	27.91
Minimum	117,027	228,434
Maximum	381,930	472,586
Internal Rate of Return (%)		
Mean	8.81	11.18
Coefficient of Variation	17.02	13.12
Minimum	7.16	9.27
Maximum	10.88	13.07
Annual Net Cash Farm Income ($Can)		
Mean	56,206	62,346
Coefficient of Variation	25.32	20.40
Minimum	38,693	47,271
Maximum	76,143	79,546
Probability of Survival	100	100
Probability of Economic Success	100	100

To further evaluate the competitiveness of the Canadian broiler growers, several impact scenarios were developed to characterize several possible unrestricted import access environments. From the base scenario, some production and financial characteristics were changed to make the following scenarios. The second scenario assumes that unrestricted trade exists between U.S. and Canada. In response, the latter changes its broiler industry structure to a vertically integrated one and adjusts its costs to be more in line with the U.S. farms. The third scenario increases the production capacity of the Canadian farm from the original capacity of two houses with five flocks to a new capacity of three houses and six flocks, similar to the U.S. farms. Scenarios 4 (with original capacity) and 5 (with new capacity) compute for the output price which will allow the Canadian farm to maintain a rate of return of at least 10% which the Canadian government defines as the reasonable rate of return. Lastly, in scenarios 6 (with original capacity) and 7 (with new capacity), the Canadian government reduces the required of return to at least 8 % and the output prices are again computed. Scenario 7 is simulated for both new and ongoing farm operations.

Table 4. Summary of Key Output Variables for the Representative Broiler Farm in Delmarva

Financial Variable	New Operations
Net Present Value ($)	
Mean	137,563
Coefficient of Variation	7.34
Minimum	121,331
Maximum	146,179
Internal Rate of Return (%)	
Mean	8.66
Coefficient of Variation	3.87
Minimum	8.30
Maximum	9.06
Annual Net Cash Farm Income ($)	
Mean	32,114
Coefficient of Variation	4.97
Minimum	29,586
Maximum	33,623
Probability of Survival	100
Probability of Economic Success	100

Results from the second and third scenarios reveal that the Canadian broiler farms cannot compete with the U.S. broiler farms given unrestricted trade conditions and even with bigger production capacities. Based on the original production capacity, the Ontario farm has to charge 30 ¢ (Can) per kilogram to achieve the desired rate of return of at least 10% and 22 ¢ (Can) per kilogram for a return of at least 8 %. With a bigger production capacity, the required output prices are lower. For an IRR of at least 10 %, the Ontario farm's price is 23 ¢ (Can) per kilogram; for an IRR of at least 8 %, the required price is 26 ¢ (Can) per kilogram. Lastly, if the Ontario farm in the seventh scenario with the bigger capacity were assumed to be operating already for at least 10 years, the output price needed to achieve an IRR of at least 8 % is 20¢ (Can) per kilogram.

9 CONCLUSION

The expected benefits from free trade are lower consumer prices, increase in poultry production efficiency, and access to a bigger market. On the other hand, free trade may also have adverse effects especially on the country which may not have the competitive advantage. The simulation results have several implications for the Canadian broiler industry. First, the present supply management policy of the Canadian government has been successful in providing reasonable rates of returns for the Canadian broiler farms and supporting their continues existence. Farms that have been operating for more than ten years have substantially higher returns than new farms. This means that it would be difficult for new farmers to enter the industry or for existing farmers to expand their operations since the returns from new farms and expansions are relatively lower than the returns from existing farms.

Second, the results indicate the difficulty the Canadian broiler farms will face if the trade barriers were eliminated. They cannot compete with U.S. broiler farms because of higher production costs. Even assuming that the Canadian broiler industry will change its structure to be more similar to the U.S. structure, the Canadian farmers will still charge a higher output price at 20 ¢ (Can) per kilogram. The prevailing U.S. prices are approximately 3.8 to 4.2 ¢ (US) per pound or 11 ¢ (Can) per kilogram.

Third, the U.S. producers can transport their chicken products from the Northeast to Ontario with very little additional cost. According to U.S. broiler producers, the additional transportation cost is estimated to be about 4.4¢(US) per kilogram or almost 6 ¢ (Can) per kilogram. With the additional transportation cost, the Delmarva price will increase to 17 ¢ (can) per kilogram. Therefore, the Ontario farm may be more competitive with its output price of 20 ¢ (Can) per kilogram, although it is still higher by 3 ¢(Can) per kilogram.

With unrestricted trade between U.S. and Canada, the broiler producers from U.S. will find it more profitable to send poultry to Canada than shipping poultry to Southeast Asia. However, in order for Canada to compete with U.S., there has to be a change in Canada's supply management policy. Canadian poultry producers may adopt the vertical integration scheme used by U.S. producers. Simulation results, however, show that it would be still difficult for Canadian producers to be competitive even under this industry structure. Therefore, policy makers should also consider the negative effects of the free trade agreement and balance these with the expected benefits.

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