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Brazil's Broiler Industry: Increasing Efficiency and Trade[1]

Constanza Valdes[a]ⓘ, Charlie Hallahan[b], and David Harvey[c]

[a] *Agricultural Economist, International Demand and Trade Branch, Market and Trade Economics Division Economic Research Service, United States Department of Agriculture, 355 E Street SW, Room 5-267A, Washington DC, 20024, USA*

[b] *Operations Research Analyst, Research Support Branch, Information Services Division, Economic Research Service, United States Department of Agriculture, 355 E Street SW, Room 5-266, Washington DC, 20024, USA*

[c] *Agricultural Economist, Animal Products & COP Branch, Market and Trade Economics Division, Economic Research Service, United States Department of Agriculture, 355 E Street SW, Room 5-149A, Washington DC, 20024, USA*

Abstract

Brazil's broiler industry growth over the past fifteen years has led the country to become one of the world's leaders in the industry. Between 1999 and 2014 Brazil's broiler production increased from 5.5 million tons to 12.7 million tons, or 130 percent, propelling the country to become the world's third largest producer after the United States and China. Exports have increased fivefold since 1999 with Brazil, in recent years, overtaking the United States as the world's largest chicken meat exporter. The very rapid and successful vertical integration in the poultry industry in Brazil has led to productivity growth, efficiency gains from vertical coordination, and lower production costs. We examine the costs, returns, and profitability of commercial broiler production in Brazil taking into account the country's regional diversity in production, the size of operations, and the type of technology used.

Keywords: Brazil, broilers, production, technical efficiency, trade

ⓘCorresponding author: Tel: + 1.202.694.5225
Email: C. Valdes: cvaldes@ers.usda.gov
C. Hallahan: hallahan@ers.usda.gov
D. Harvey: djharvey@ers.usda.gov

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Introduction

Over the past 15 years Brazil has evolved into the world's largest exporter of broiler meat, the world's 3rd broiler producer, and an important meat competitor of the United States. In 2000 chicken meat accounted for 42 percent of Brazil's animal protein sector, producing 6 million tons of broiler meat. Chicken meat production increased 5.2 percent per year during 2000-2014 to reach 13 million tons in 2014 (USDA/FASa). Since 2004 (with the exception of 2013 when U.S. broiler exports were larger), Brazil has been ranked as the world's largest broiler exporter, ahead of the United States, the European Union, China, and Thailand. In 2014, Brazilian broiler exports reached over 3.6 million tons, equivalent to 34 percent of the global broiler trade (USDA/FASa). Brazil's domestic chicken meat consumption is also significant, as 72 percent of total production is consumed in the domestic market. Favorable price relationships between chicken meat and competing meats (beef, pork) have contributed to gains in broiler meat competitiveness.

Brazil's broiler industry is characterized by large-scale production, high technology use, and integration contracts covering about 85 percent of broiler production (Caldas 2014). These changes have resulted in further reductions in production costs, greater efficiency, and increased exports. Various factors have contributed to the development of large poultry operations in Brazil including low labor costs, ample feed availability, favorable foreign investment regulations, and a large domestic market. Government policies have also facilitated sector growth with the provision of subsidized credit for production and investment and support to the feed sector (CONAB 2014). A better understanding of Brazil's broiler industry, especially of costs at farm level, of technical performance for broiler production, and of the importance of emerging new poultry production regions in Brazil could provide an indication of the industry's future competitiveness.

Growth and Efficiency in the Broiler Industry

Recent studies on the broiler industry in various countries around the world, including the United States (MacDonald 2014; Miles et al. 2012), Thailand (Areerat et al. 2012), and Nigeria (Bamiro et al. 2009) have sought to identify the factors driving the industry's growth, with a focus on contract growers. These studies examined the relationship between the industry organization and the financial performance of broiler grow-out operations, concluding that, while the system of vertical integration organization had fueled the industry's growth, other factors (i.e., production practices, size of operations, and technology), had been crucial for continuing gains in the industry's productivity and profitability.

Other studies have found that improvements in on-farm production practices (e.g. floor space, feeder space per bird) constitute very significant cost-reducing drivers in per-broiler feed, labor, and housing requirements (Dos Santos et. al. 1998). Expanded production has been found to allow integrators to realize further costs saving through scale economies in larger facilities (Sandi et. al. 2011). More recent studies have focused on improvements in broiler housing as a crucial contribution to bird health and industry productivity. When exposed to heat stress by high temperatures, the bird present decreased feed intake and consequently, a reduction in weight

gain; technologies associated with climate controls and ventilation systems contribute to better bird health, reduced bird mortality, and improved feed conversion (MacDonald 2014).

For the case of Brazil, several studies of the efficiency of the poultry industries have been conducted both at the national level (Siffert and Faveret 1999), and regional levels (Mendes et al. 2014). Both approaches concluded that the adoption of advanced ventilation systems to manage temperatures is the most crucial factor to raising productivity by improving efficiency. Various researchers have analyzed the issue of agricultural productivity improvements measuring agricultural production and farms' efficiency as a means to finding alternative ways to improve the utilization of resources (Kamruzzaman et al. 2007; Coelli et al. 2002), and while most have focused on major food crops like rice and wheat, a few others have focused on poultry and broiler meat farms (Areerat et al. 2012; Begum et al. 2010).

Brazil's Broiler Production Systems

In Brazil, broiler production and processing is carried out under a system of tightly integrated production contracts operated by integrator firms, with independent chick growers. In Brazil, eight integrators account for 55 percent of broiler production, while the top four integrators account for 38 percent of production (EMBRAPA 2014). Under the system of production contracts, integrators provide growers with chicks, feed, vaccine, and veterinary/technical assistance. Growers provide housing, labor, and utilities and grow the chicks to market weights. Much like in the United States, Brazilian chick growers, who have exclusive contracts with integrators, receive payment for the services that they provide, with premiums and discounts tied to the efficiency with which feed is converted to live-weight broiler production (Caldas 2014).

Although broiler production occurs in all regions of Brazil, over three-fourths of broiler production is concentrated in the South and Southeast regions (Figure 1). In 2014, Paraná and São Paulo accounted for 22 percent and 17 percent, respectively of total broiler production (IBGE 2014). The integration system model was initiated in São Paulo State in the early 1960s and expanded to the South region (Paraná, Santa Catarina, and Rio Grande do Sul) in the 1970s where the feed availability, a large urban population, and the proximity to ports favored the development of broiler operations (EMBRAPA 2014). The South region now accounts for 56 percent of broiler production (IBGE 2014). Government subsidized credit for investments in the broiler sector, and technical assistance provided by the poultry industries, further contributed to the development of the broiler integration system in Brazil (EMBRAPA 2014).

Two decades later the accelerated westward expansion of agriculture to Brazil's Center-West region (Goias, Mato Grosso, and Mato Grosso do Sul) benefited primarily corn and soybean production. These benefits also extended to broiler (and hogs) operations, since close to 90 percent of Brazilian poultry feed is composed of corn (70 percent) and soymeal (20 percent). The development of commercial broiler production in the Center-West was initiated during the early 1990s when several major international companies sponsored the migration of the broiler (and pork) industries from the South to the Center-West region following the feed availability and with production targeted almost exclusively for international markets (De Jesus et al. 2007).

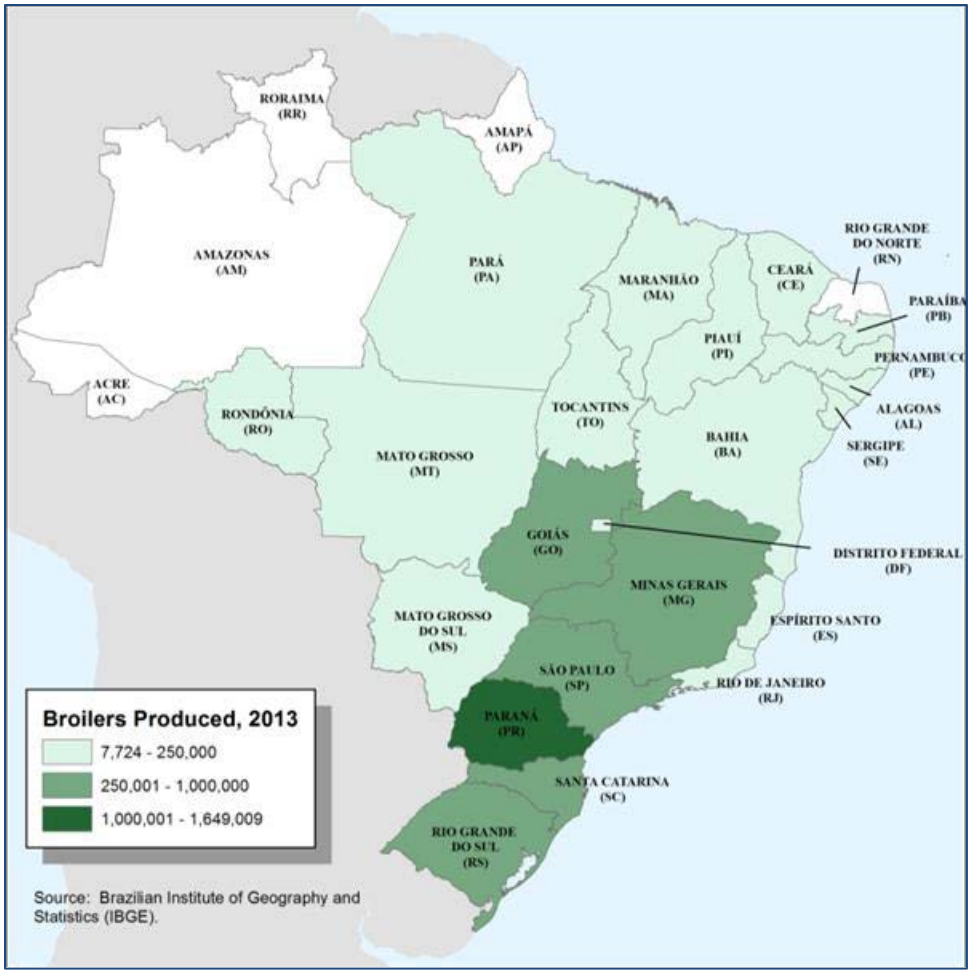

Figure 1. Brazil's Broiler Production by State

Our analysis seeks to identify the industry's productive structure, net returns, and characteristics of broiler operations in Brazil. To analyze Brazilian broiler operations characteristics and investigate technical efficiency of these operations, we use monthly cost of production survey data of 1,440 poultry operations as reported by Brazil's National Supply Company (*Companhia Nacional de Abastecimento,* CONAB) and the Brazilian Corporation for Agricultural Research (*Empresa Brasileira de Pesquisa Agropecuária,* EMBRAPA).

Carried out in the most important broiler producing areas in Brazil, the survey provides monthly information on costs, flock size, feed conversion, and types of climate technology in use during 2007-2010. The data includes labor expenses, feed costs, chick costs, bedding, antibiotics, technical assistance, and transportation. The survey separates costs for growers and integrators for broiler operations across ten important poultry-producing Brazilian States: Ceará, Goias, Mato Grosso, Mato Grosso do Sul, Minas Gerais, Paraná, Pernambuco, Santa Catarina, São Paulo, and Rio Grande do Sul.

It is generally recognized that the adoption of ventilation technologies on farms have implications for feed conversion and a faster grow-out time to maturity (MacDonald 2014). Given the extreme sensitivity of the flock to heat conditions we take into consideration technology levels with different types of ventilation systems used to manage temperatures:

Climate Control Ventilation Technology *(Climatizado)*, Conventional Ventilation Technology *(Automático)*, and Manual Ventilation Technology *(Manual)*. To examine Brazil's broiler production's overall efficiency and measure its competitiveness we use a stochastic frontier analysis (SFA) parametric method to measure technical efficiency associated with technology across different operation sizes and regions within Brazil.

Table 1 presents the balance sheet of broiler operations by region, revealing the heterogeneity in operations in Brazil. Revenues generated by the broiler enterprise and costs vary by location, and as a result net returns (the difference between revenues/gross value of production and total costs) vary widely. More detailed analysis of individual balance sheets of revenue and cost by size of operation reveal that the most profitable operations of the broiler industry are located in the Southeast and Center-West regions where larger contract operations generate better financial returns. Profitability increases with size: as operations become more intensive in raising broilers for meat they are more profitable, as is the case for Mato Grosso and for Paraná.

Table 1. Balance Sheet of Production and Costs of Broiler Operations by Region, 2010[1]

Region	Revenue	Labor Expenses	Variable Expenses	Feed	Chicks	Fixed Costs	Other Expenses	Total Cost	Returns[2]
Center-West	50,878	738	2,359	22,022	5,004	1,724	1,620	34,061	16,817
South	31,253	793	2,175	18,219	4,376	1,342	1,395	28,832	2,421
Southeast	41,501	812	1,836	14,160	4,319	752	1,283	24,205	17,296
Northeast	52,422	1,045	3,218	28,711	6,708	1,489	1,718	44,372	8,050

Notes. [1]Calculated in $ USD; [2] Above Total Cost.
Source. CONAB/EMBRAPA, Cost of Production Survey, 2010

Cost of production survey data indicates that in 2010 only a percentage of the broiler farms had positive net returns and were able to cover all costs, including costs of capital recovery. With size classes based on production per flock, poultry operations with at least 25,000 birds had net returns of $1.06 per bird while farms with less than 19,000 birds had net returns of $0.32 (Table 2). Larger broiler operations have substantial integrator costs advantages, particularly in feed, the dominant cost in the production of poultry meat. The largest broiler operations are located in Minas Gerais, which accounts for just seven percent of production. As Minas Gerais is an important corn producing State, broiler operations in this State had feed costs 16 percent below feed costs of the three smaller classes and were also able to realize economies of scale on housing facilities. Costs were much higher for smaller broiler operations, with less than 19,000 birds. About 43 percent of smaller operations are located in Pernambuco and Ceará, and nearly one-third have less than 5,000 birds.

Profitable broiler operations were more common among large farms in 2010. Estimates of net returns from CONAB's surveys are based on regional averages but there is variation around average performance in the broiler farms within each class size. For example, farms with less than 19,000 birds had average net returns of $0.32 per bird in 2010, but for only 36 percent of them realized positive net returns with the gross value of production exceeding total costs and less than half of the farms were able to cover the opportunity costs of capital and farmer's labor. Forty-four percent of farms with 19,000 - 20,999 birds earned positive net returns, as did 43 percent of farms in the 21,000 - 24,999 class (Figure 2).

Table 2. Broilers Grower and Integrator Costs of Production by Enterprise Size, 2010

	< 19,000	**19,000 - 20,999**	**21,000 - 24,999**	**> 25,000**
Mean Broiler Farm Size (Number of Birds)	14,960	19,400	22,313	26,000
Output (kg)	37,537	50,050	57,731	61100
Total operating costs[1]	**2.23**	**1.90**	**1.93**	**1.09**
Purchased feed	1.50	1.26	1.31	0.66
Labor	0.06	0.05	0.04	0.05
Bedding materials	0.03	0.02	0.02	0.02
Technical assistance	0.01	0.01	0.02	0.05
Chicks	1.50	1.26	1.31	0.66
Transportation costs	0.09	0.07	0.05	0.02
Total costs	**2.34**	**2.01**	**2.04**	**1.13**
Gross value of production	2.66	2.94	2.74	2.19
Net returns	0.32	0.94	0.70	1.06

Note: [1]All costs are calculated in $ USD per broiler.
Source. USDA-Economic Research Service Using Data from Cost of Production Survey, CONAB.

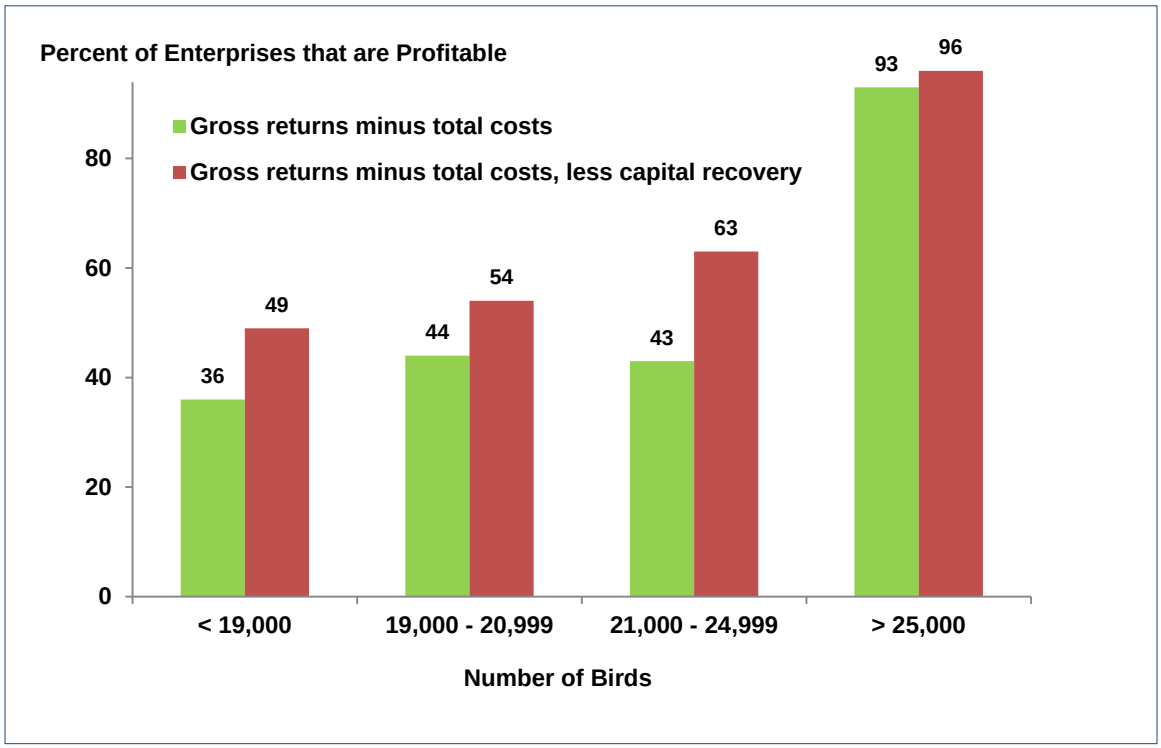

Figure 2. Profitable Broiler Enterprises in Brazil, by Size Class in 2010
Source. USDA-Economic Research Service Using Data from EMBRAPA, 2010.

Estimating Method

The stochastic frontier production function approach is used in this study for measuring technical efficiency while accounting for resource costs. Stochastic frontier modeling is often used to compare firms' relative efficiencies though it can also be used to derive estimates of productivity change over time. The technique has a number of benefits when compared to standard econometric estimation (OLS) of production functions. It estimates a 'true' production frontier rather than an average frontier, thus it fully represents the maximal properties of the production function. A stochastic frontier production function was first proposed by Aigner, Lovell and Schmidt (1977). The model takes the form:

$$\ln(y_i) = F(x_i : \beta) + v_i - u_i, i = 1,...N$$

where y_i is the output of the ith firm, x_i is a vector of inputs for the ith firm, β is a vector of parameters to be estimated, v_i a symmetric error term, and u_i a non-negative error term representing inefficiency.

We estimate a Cobb-Douglas function to analyze technical efficiency in 2007-2010 and model the inefficiency term with the Battese-Coelli (1995) model, which allows the inefficiency term to change over time to indicate some significant differences after 2007. Observations with missing data were dropped, giving us different number of observations by region.

The analysis identifies technical efficiency by climate control technology and by region within the country. Broiler grow-out data from CONAB and EMBRAPA used in the analysis include variables in the production function: labor, bedding, feed, chicks, antibiotics, transportation, and feed conversion; the dependent variable being the value of output. Technical assistance, flock size, and livestock credit are included in the inefficiency part of the model.

Results

The regression analysis reveals that the coefficients associated with labor, feed, chicks, and feed conversion are all positive as would be expected. All are significant at the 1 percent level. An increase in the quantity of feed consumed by the birds, labor used, and other inputs will cause increases in the output. The large elasticity for the use of feed reflects the importance of obtaining economies of scale in production. The sum of the elasticities for all inputs equals more than unity indicating increasing returns to scale. The feed conversion rate reflects the sensitivity of broiler production to increases in feed prices and highlights the importance of larger volume of feed purchases to reduce transaction costs.

With respect to transportation costs, the coefficient is negative, implying that an increase in transportation costs and longer distances to markets, negatively affects output. Antibiotics used to treat disease in animals, and which are sometimes provided routinely to birds in feed or water to prevent disease and to improve feed conversion, are not significant. In the inefficiency model, the variables explaining inefficiency include the size of the flock and access to resources such as technical support and credit. The coefficients for flock size and technical assistance are both negative, as expected. Large flock size significantly reduces inefficiency as it helps derive

economies of scale in feed purchases and output sales while access to technical assistance does not have a significant effect on inefficiency. Access to credit should increase the ability to use better quality inputs and services however results indicate that it was significantly less efficient.

Table 3. Parameter Estimates

Parameter	Estimated Value	Standard Error
Production Factors		
Labor	0.065***	(0.020)
Feed	0.774***	(0.028)
Chicks	0.061***	(0.022)
Antibiotics	-0.018	(0.012)
Transportation	-0.022*	(0.012)
Feed conversion	1.568***	(0.258)
Inefficiency Factors		
Technical assistance	-0.154	(0.100)
Flock size	-3.521***	(0.401)
Subsidized credit	0.592***	(0.137)

Note: * = significant at the 10% level, ** = significant at the 5% level, *** = significant at the 1% level
Source. Cost Data from CONAB/EMBRAPA Surveys.

Technical efficiency refers to the achievement of maximum potential output from a given quantity of input, given the available technology (Coelli et al. 1996). While efficient farms are those operating on the production frontier, inefficient farms are those operating below the production frontier. The average overall efficiency estimate for all 1,314 broiler operations which reported cost of production data is 0.924, indicating a high level of efficiency, but that farms have potential to reduce costs to increase efficiency. Estimates of the efficiency performance (TE) indicator by technology and by region are presented in Table 4 and Table 5.

The TE measures suggest that broiler enterprises have a greater potential to reduce costs by moving to a scale-efficient point. The efficiency or performance measures according to the type of ventilation technology used revealed that broiler enterprises using Climate Control technology are more efficient (0.943 on average) while broiler enterprises using Manual Control technology have the lowest scores (0.902 on average) and highest costs.

Table 4. Efficiency Estimation by Type of Technology Used

Technology	Efficiency (TE)
All farms	0.924
Climate Control	0.943
Conventional	0.927
Manual	0.902

Source. Model Results

An empirical assessment of broiler production also found that Climate Control technology yields higher productivity than other ventilation technologies in use (Caldas 2014). Another study computing technology coefficients for mortality rates, feed conversion, and bird weight gain across all three technologies also found that Climate Control technology outperforms the two other systems and is associated with bird housing capacity 52 and 64 percent higher than Conventional and Manual technology (Dos Santos et al. 1998).

On a regional basis, the detailed State-level results reveal that differences across regions reflect the differences between the modern and the more traditional segments of the broiler production sub-sector. Broiler enterprises in the Center-West States (Mato Grosso, Mato Grosso do Sul, Goias) report high overall efficiency ranging from 0.953 to 0.957. In the Center-West region, the efficiency indicators reflect high input intensity and high feed conversion efficiency.

Broiler enterprises in São Paulo, historically Brazil's leading agricultural State, are very efficient at 0.931, indicating high performance, despite the larger influence of labor costs in grower's total costs in São Paulo. A major factor responsible for this high level of efficiency in São Paulo is feed availability, as corn covers more area -25 percent of the State's cropland in 2007-2010- than any other crop in São Paulo. Feed costs in São Paulo and Mato Grosso are 7 percent lower compared to other States with feed costs totaling two-thirds of total costs (EMBRAPA 2014).

Broiler enterprises in Pernambuco and Ceará in the Northeast, where small and medium producers predominate have the lowest overall efficiency at 0.884 and 0.885, respectively. Given their increased dependence on government supplied feed, it might be relevant to investigate the impact of the timely delivery of such inputs on increased efficiency. The Southern region (Rio Grande do Sul, Paraná and Santa Catarina), has overall efficiency ranging from 0.886 to 0.893. In the South and Southern regions labor costs represent a larger share of grower's costs, compared to other States, but they receive the bulk of the government subsidized credit. In 2010, three-fourths of the credit, which helps reduce inefficiency, was allocated to broiler producers in São Paulo, Rio Grande do Sul, Paraná and Santa Catarina (Banco Central 2010).

Table 5. Efficiency Estimation by Region

	Farms	**Efficiency (TE)**
All Farms	1,314	0.924
Rio Grande do Sul	144	0.886
Santa Catarina	144	0.893
Paraná	144	0.889
Pernambuco	144	0.884
Ceará	144	0.885
São Paulo	99	0.931
Minas Gerais	108	0.956
Mato Grosso	99	0.953
Mato Grosso do Sul	144	0.957
Goias	144	0.955

Source. Model Results

Conclusions

Brazil's share of the global poultry meat market is significant and this share has been increasing rapidly over the past decade. With significant growth in domestic broiler meat demand -Brazil is the world's fourth-largest consumer market with over 9.4 million tons consumed in 2013- exports have increased at a much faster pace, making this country the largest exporter of broiler meat. Given the country's large feedstuffs production (corn, soybeans), Brazil is also able to keep the costs of feed rations low. Brazil's future productivity and efficiency gains in the broiler industry will have implications for global meats trade.

The Brazilian broiler industry is characterized by high productivity and high technology use. Technology advancements, low labor costs, and a large domestic market have encouraged the development of large broiler processing operations. We examined the structure of broiler production in Brazil and measure its efficiency using a stochastic frontier production function. Producer's survey data of 1,314 broiler farms collected in 2007-2010 was used to identify the distributional characteristics and the production profile of broiler operations in Brazil by region, type, and size.

After analyzing the structure of production costs directly from the survey data and estimating the overall efficiency and scale economies of broiler operations in the sample, we can conclude that the overall efficiency estimate, using all 1,314 operations for which data was available, is 0.924, indicating high overall efficiency. The analysis also found that there are economies of scale in production and that medium and large broiler operations are most cost effective and smaller poultry operations are least competitive. The efficiency or performance measures according to the type of ventilation technology indicate that broiler operations using the Climate Control technology are more efficient (0.943 on average) while broiler operations using Manual Control technology have the lowest scores (0.902 on average).

The results of frontier production function estimates indicates that there are differences in the average level of efficiency between the four regions and across States reflecting how large and medium broiler operations are more cost effective, and smaller broiler enterprises are least efficient. Our results indicate that the most integrated operations in the Center-West and Southeast are most efficient, with lower per-unit costs. Thus, broiler enterprises in these regions might reap the benefits of an expanded domestic and export demand-led market. Active support to growers such as technical assistance greatly contributes to get them to be more competitive. In Pernambuco and Ceará where broiler operations are least efficient, technical assistance represents less that 1 percent of total integrator's costs and equivalent to less than half the expenditures on technical assistance in Mato Grosso and Goias.

What is the situation for Brazil regarding the world broiler market? Brazil's broiler meat exports are expected to continue to account for a large share of the global meats market over the next decade, to represent nearly 41 percent of global broiler trade (USDA/OCE/WAOB 2014). Over the medium term to long term, broiler production is projected to increase 3.2 percent per year in 2015-2024 to reach nearly 19 million tons in 2024, in response to continued domestic and export demand-led growth (USDA/OCE/WAOB 2014).

Brazil's broiler industry future competitive position will depend not only on macroeconomic factors including volatility of the exchange rate and domestic and foreign income growth, but more importantly on the level of efficiency of individual broiler operations. Various factors including labor and feed availability, access to technical assistance, and access to credit significantly influence the level of efficiency of individual broiler operations. Policy and institutional arrangements that address these factors will lead to improved overall efficiency of an industry that remains as a benchmark due to the technical efficiency and technological advances attained in selected regions of the country.

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