

**The United States in the Global Soybean Market: Where Do We go From Here?**

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## **Abstract**

This study applies the concept of a dynamic dominant-firm oligopoly model to the international soybean market. It has been suggested that the international soybean market should be viewed as an oligopoly among exporting nations. Consistent with Gaskins (1971) dynamic dominant firm model, our results indicate that the current U.S. loan deficiency-payment prices and their predecessors created an environment in which smaller (fringe) exporters could prosper and expand. The reduction of U.S. market share is thus a logical outcome of an “optimally managed decline” a la Gaskins. The study finds U.S. market share to decline at a reducing rate and predicts U.S. market share eventually to stabilize, given the expanding international market for soybeans and products. Recognition of the structure of international soybean market has policy implications for the 2002 farm program as the classic dominant firm model suggests.

Keywords: U.S. soybeans, international market, oligopoly market, dominant seller, Gaskins model

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## The United States in the Global Soybean Market: Where Do We go From Here?

The United States, the leading producer, had a dominant market share of the international soybean and product market<sup>1</sup> for decades. Argentina and Brazil were smaller competitors. This study traces the history of the changing market shares of the United States in the international soybean market and examines the underlying market structure in which the United States is operating in the context of Gaskin's (1971) dynamic dominant firm model. Looking at the international market in an oligopoly framework reveals important implications for policymakers in setting support prices in the next round of the U.S. Farm Bill.

Since the 1980's, Argentina and Brazil have captured a growing share of the international soybean and product market. In 1998, these two countries accounted for 45 percent of the international soybean market in terms of soybean equivalents for soybeans, soybean oil, and soybean meal, while the United States accounted for 29 percent. The United States, with 55 percent of the market in 1980, saw its share initially decline and then stabilize (figure 1). While the market grew, nominal and real prices for soybeans declined in the international market, as measured by the c.i.f. Rotterdam prices for soybeans (figure 2).

Looking at the costs of production, soybeans in Argentina and Brazil, and their costs of getting soybeans to the international soybean market in Rotterdam, are competitive with the United States (Dohlman, 2000). At the farm, per bushel total production costs in the main producing areas of the U.S. Midwest amounted to \$5.49 a

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<sup>1</sup> From here, soybean market means soybeans, soybean oil, and soybean meal expressed in soybean equivalents for simplicity of reading.

bushel, compared with \$3.63 a bushel in Mato Grosso and \$4.33 a bushel in Parana state of Brazil. Per acre costs in Brazil demonstrate a similar comparative advantage. While variable costs in the United States are lower, fixed costs, particularly land, are higher than in Mato Grosso and Parana. Transportation costs from the farm to the international market in Rotterdam close much of the price advantage of Brazilian and Argentine farmers, compared to U.S. farmers. As recently as 1998, Ketelhohn estimated that U.S. soybean delivery costs to Rotterdam were higher than Argentina's but lower than Brazil's.

This study looks at soybean producing nations as oligopolists, rather than exporting nations, a change from the net trade model, the more typical way of viewing the international soybean market. By viewing the market in this way, one is able to ascribe certain characteristics to the market. Early studies by Carter, et al., (1994), and McCall, et al., (1981) suggested that the international grain market should be viewed as an oligopoly among exporting nations. While wheat was often employed as the example, the same argument can be applied to soybean exports. By viewing the market as an oligopoly, one is able to describe the actions of a dominant country in relation to fringe countries using a dynamic approach.

The classic static dominant firm model shows that when a dominant company supports its product price at a noncompetitive level, it leaves room for fringe companies to prosper and gain market share over time, eventually eroding the position of the dominant company. In contrast, this study employs the dynamic model developed by Gaskins (1971) and applies it to the international soybean market. The Gaskins model is a unique framework as it pertains to a growing market where the dominant firm maintains

a stable market share, as long as the market grows. Furthermore, the model accommodates for a wide range of differences in the relative cost of production between the dominant firm and the fringe firms, even for cases where the dominant firm lacks a cost advantage.

In the next section we summarize models of a dominant firm with a competitive fringe and examine the implications of these models. We look at the static model and secondly, we apply the Gaskins (1971) dynamic model to capture the dominant firm's in a growing market. Lastly, we examine the policy implications for the proposed 2002 farm bill. The Gaskins model implies that the setting of the loan deficiency payment has ramifications for our future competitive position in the international market.<sup>2</sup>

### **Theoretical Specifications**

As we have defined the issue, the main problem faced by U.S. soybean exporters was market penetration by fringe firms—or in this case, smaller exporters.<sup>3</sup> The smaller exporters simply respond to the existing price but individually cannot influence price (Scherer and Ross, 1990). In the static model, the dominant firm knows the fringe supply curve, which is the horizontal summation of the fringe firms' marginal cost curves, and incorporates the fringe supply into its decision. Thus, the dominant firm maximizes profit given the residual market demand. Market price (determined by the dominant firm's actions) is above marginal cost in the static or short-run model.

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<sup>2</sup> In recent years the loan deficiency payment price (LDP) has become the floor price to U.S. grain and oilseed producers, but was operational in soybeans only since 1998. In recent years, the loan deficiency payment was set as a percent of the simple average price received by producers for the immediately preceding 5 crops (USDA Farm Service Agency Fact Sheet). In the formulation, the highest and lowest prices are excluded, but the LDP rate is not to exceed \$5.26 per bushel and not to be less than \$4.92 per bushel.

<sup>3</sup> The international soybean market is mostly characterized by the presence of a few oligopolistic firms that operate worldwide. In this study, we treat the countries where the firms are originated as oligopolists, rather than the firms.

The international soybean market is a more stylized case (figure 3), where the dominant country has lost any cost advantage that would have precluded others from entering the international market.  $DD$  is market demand,  $S_F$  is the fringe supply schedule, and  $MC$  is the dominant firm's marginal cost curve. The dominant firm incorporates the fringe supply schedule into market demand to construct residual demand  $ABD$  over which it is the effective monopolist. Using standard first order conditions, the dominant firm would supply  $Q_D$  at the market price  $P_D$  and the fringe would supply  $Q - Q_D$ . In this case, by virtue of its position of market power, the dominant firm takes on the responsibility of restricting supply to the market. But the result of this is that the fringe can free ride on the big firm's price enhancing efforts.

In the static model, the fringe supply will increase in the long run if the market price yields excess rents to the fringe. If fringe supply increases, then the dominant firm's captive residual demand shrinks and its market share dwindles (fig. 3). The current soybean case is like figure 3, where production (plus transportation) costs in the fringe countries are as low or lower than production (plus transportation) costs of the dominant country. With the supply price of the fringe countries approaching the market price generated by the demand curve  $ABD$  and the dominant firm's marginal cost curve ( $MC$ ), the chance of the dominant firm making excess profits disappears. The static model predicts, *ceteris paribus*, greater penetration over time by fringe firms. If demand is constant, the fringe expansion will effectively crowd out the dominant firm.

The Gaskins dynamic limit pricing model (1971) accommodates a growing market and a dominant firm that has higher costs of production than the fringe firms. He sets up a case where even a very moderate rate of growth in the product market can ensure

stabilized market share for all participants in the market, a more optimistic outcome than that of the static model. Gaskins shows that depending on the discount factor and the original size of the fringe, the dominant firm will choose either a limit price or a price trajectory that declines towards the limit price.

### The Model

The dominant producer wishes to maximize the objective functional given by

$$V = \int_0^{\infty} [p(t) - c]q(p(t), t)e^{-rt} dt, \quad (1)$$

where  $V$  is the present value of the firm's profit stream,  $p(t)$  is product price,  $c$  is average total cost of production,  $q(p(t), t)$  and  $r$  are the dominant producer's output and discount rate respectively. Assume that the dominant producer's current sales can be represented as follows

$$q(p(t), t) = f(p(t))e^{\gamma t} - x(t), \quad (2)$$

where  $f(p)$  is initial demand,  $\gamma$  is the market growth rate, and  $x(t)$  is the level of fringe sales. The rate of entry/expansion by fringe producers depends on the market price. The entry response coefficient,  $k$ , is a growing exponential function of time. Assume  $\bar{p}$  is the limit price (the price that yields a fringe supply equal to zero, see fig. 3), and  $x_0$  is the initial output of the competitive fringe.

$$k(t) = k_0 e^{\gamma t} \quad (3)$$

$$\dot{x}(t) = k_0 e^{\gamma t} [p(t) - \bar{p}] \quad (4)$$

In the control theory framework,  $x(t)$  --the level of rival sales-- is the state variable, and  $p(t)$  --or product price--- is the control variable. We can collect terms to state the dominant producer's optimal control problem as:

$$\text{Maximize} \quad V = \int_0^{\infty} \{ [p(t) - c](f(p(t))e^{\gamma t} - x(t)) \} e^{-rt} dt, \quad \gamma < r, \quad (5)$$

$$\text{subject to} \quad \dot{x}(t) = k_0 e^{\gamma t} [p(t) - \bar{p}], \quad x(0) = x_0. \quad (6)$$

The necessary conditions generate the simultaneous differential equations,

$$\dot{x}^*(t) = k_0 e^{\gamma t} [p^*(t) - \bar{p}], \quad x^*(0) = x_0. \quad (7)$$

$$\dot{z}^*(t) = [p^*(t) - c] e^{-rt}, \quad \lim_{t \rightarrow \infty} z^*(t) = 0 \quad (8)$$

where  $z^*(t) = (x^*(t)e^{-\gamma t} - f(p^*) - (p^*(t) - c)f'(p^*))e^{-rt} / k$  and  $z^*(t)$  is the optimal shadow price of additional rival entry and is necessarily negative.

Eliminating nonsense trajectories leaves two optimal paths. This model demonstrates that as  $p(t)$  and  $w(t)$  (where  $w(t) = x(t)e^{-\gamma t}$ ) reach their equilibrium levels, the dominant firm's share approaches a constant. The optimal pricing strategy which is greater than the limit price yields a constant long-run market share for the dominant firm  $s(t)$  where the conditions of optimization are met.

$$s(t) = \frac{f(p)e^{\gamma t} - w(t)e^{\gamma t}}{f(p)e^{\gamma t}} = \frac{f(p) - w(t)}{f(p)} \quad (9)$$

Where  $f(p)$  is the total demand of the market and  $w(t)$  is some optimal portion of the market supplied by the fringe countries. In this model, a firm with no cost advantage will not price itself out of the market. Gaskins demonstrates that if the curvature of the



demand curve is not too great, an increase in the growth rate of the market will always increase the dominant firm's market share. This allows the dominant firm (or country) with insignificant cost advantages to "maintain a constant market share over the long haul" (Gaskins, pg. 137).

In sum, by applying the Gaskins model that pertains to a growing market and a dominant firm that has lost its cost advantages over fringe countries, we can conclude from this special case that even a very moderate rate of growth in the product market ensures a market share that stabilizes.

### **Empirical Results**

In this section, we analyze the behavior of the dominant as well as the fringe participant countries' growth and production patterns in the soybean market. We empirically estimate the growth pattern, the speed of convergence and the stability of the global soybean market. We assess this by estimating the following growth equation:

$$\log( s_{it} / s_{i,t-1} ) = \alpha - (1 - e^{-\beta} ) * \log( s_{i,t-1} ) + u_i \quad (10)$$

where  $s_{it}$  are the market shares of the dominant and the fringe countries, the subscript  $i$  denotes the county, the subscript  $t$  denotes the year while  $u$  is the random disturbance. Using the market shares of the soybean equivalent, which includes soy-oil and soy-meal, we estimated equation (10). The results clearly indicate that although the United States is the dominant country in the soybean market, the market shares of the United States, Argentina, and Brazil have converged and stabilized (see Table 1).

Table 1—Estimation Results of the Soybean Equivalent Market Shares

Years	Intercept $\alpha$	$\beta$ <i>Converge</i>	$\sigma$ <i>Converge</i>
1980-1998	0.153 (0.0080)	0.119 (0.256)	0.0036
1980-1989	0.209 (0.254)	0.099 (0.0226)	0.0068
1990-1998	0.209 (0.0930)	0.0930 (0.0193)	0.0067

The estimated  $\beta$  converge for the entire period and for the two sub-periods is positive implying that the market shares are converging. During the longer time span, the effect of the initial position of the dominant country declined and the market shares of the fringe countries grew faster than the dominant country. The  $\beta$  *converge* of the two sub-periods 1980-89 and 1990-98 is almost the same (0.099 and 0.093, respectively). The estimated  $\sigma$  *converge*, measured by the variance of the regression, captures the dispersion of the process or the degree of uneven growth. For the entire period (1980-98) the market converged with minimal dispersion. The estimated  $\sigma$  *converge* was also nearly the same for the two subperiods, indicating that the market grew with about the same degree of variability during the 1980's as in the 1990's.

We also estimated the rate of convergence of soybeans, soy-oil, and soy-meal separately for each product. The estimated growth pattern of soybeans followed the same pattern of convergence as the soybean equivalent. The results of the soy-oil and soy-meal, however, are not very significant, indicating that the soybean by-products are affected by immediate market conditions. The rate of domestic use and the relationship between soybean oil and other vegetable oils help determine soybean oil exports.

Domestic feed use for poultry and pork and the international demand for pork and poultry

help determine soybean meal exports. Relative prices between soybeans and by-products also affect the decision to export raw soybeans or products to the international market.

### **Policy Implications**

The Gaskins model would indicate that the U.S. market share could be stable as the overall market grows. But if there is no growth, as the static textbook model indicates, the U.S. dominant position could erode completely. There is perhaps some opportunity for supply management between the United States, Argentina, and Brazil to shore up international prices, if indeed such a prospect were allowed by international organizations such as the World Trade Organization. As the fringe countries, in this case, Argentina and Brazil, acquire a larger market share, any price or supply management policy initiated solely by the United States becomes less effective and more costly to administer. In this regard the interplay between the United States, Argentina, and Brazil becomes a very important factor in writing the 2002 U.S. farm bill in regard to soybeans. This study also demonstrates that U.S. policymakers, using loan deficiency payment prices, and the United States, acting as the dominant supplier, and other countries acting as fringe suppliers, kept the dominant share of the market for the United States during the 1990's. By keeping loan deficiency payment prices high, U.S. policy encouraged soybean production, providing a large supply of soybeans and products to international markets. If indeed, the United States had experienced lower production, the U.S. market share would have declined further.

## **Conclusions**

The soybean and soybean product market is growing, but the U.S. market share is lower than it was in 1980. After hitting a low in 1994, the U.S. market share stabilized for several years. Nominal and real prices declined in the international market as market supplies exceeded demand for soybeans and soybean products. Our empirical model shows that market shares converged in the late 1990's. The convergence suggests that the Gaskins model of a dominant firm is the appropriate way to look at the international soybean market.

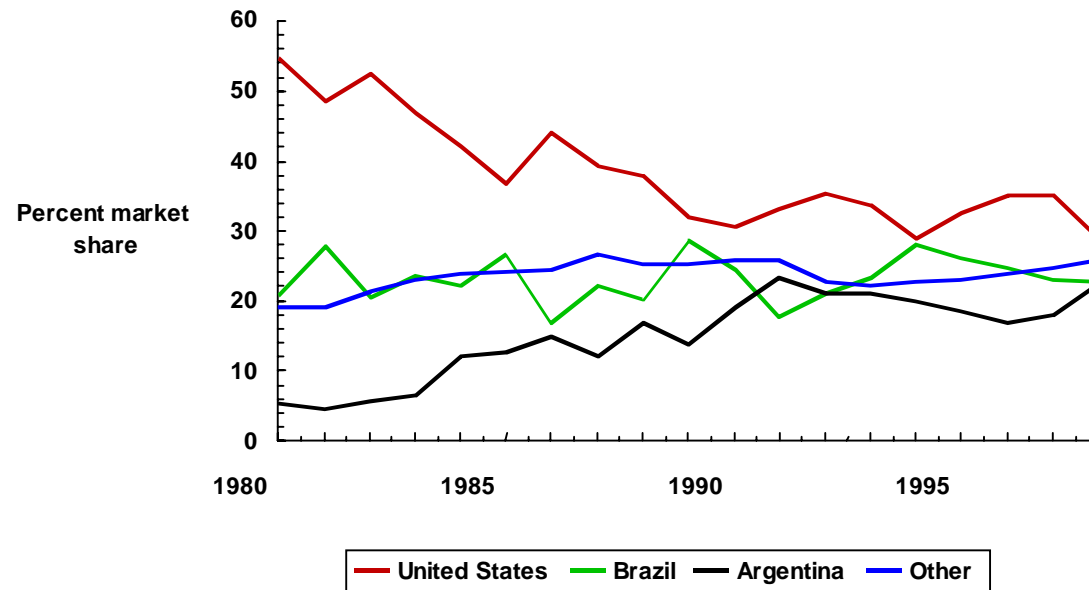
Apparently Argentina and Brazil see themselves as price takers, or "fringe firms" in the international market. There is no indication that Argentina or Brazil limited production to maintain a stable international market price. The increased production and trade by the major producers precludes that conclusion. Until the present, U.S. policymakers, by using the loan deficiency payment, maintained the U.S. market share.

From the static model, one could conclude that there is no way out for the U.S. soybean industry. The Gaskins model for an expanding market is more optimistic in its outcome. A dominant firm with no cost advantage does not necessarily price itself out of the market, but instead maintains a constant market share over the long haul. This study demonstrates that unless a policy maker looked at the case of a growing market as described by Gaskins, his view of the soybean market would be much too pessimistic. One sticky problem, however, is that as long as the major players operate as they have, any U.S. attempt to unilaterally maintain domestic support prices becomes more and more expensive.

## References

- Carlos, Ann M. and Jamie Brown Kruse. "The decline of the Royal African Company: fringe firms and the role of the charter," *Economic History Review*, XLIX, No. 2, pp. 291-313, 1996.
- Carter, Colin Andre, and Donald MacLaren. "Alternative oligopolistic structures in international commodity markets: price or quantity competition?" IATRC Working Paper 94-4, International Agricultural Trade Research Consortium, St. Paul, MN, 1994.
- Dohlman, Erik. "Production and marketing costs for Argentina and Brazilian soybeans in the international market," Northeastern Agricultural and Resource Economics Association Meetings, NAREA 2000, Whispering Pines Conference Center, University of Rhode Island, June 13, 2000.
- Gaskins, D.W., Jr., "Dynamic limit pricing: optimal pricing under the threat of entry," *Journal of Economic Theory*, Vol. 3, pp. 306-22, 1971.
- Ketelhohn, Werner, Maron Moncayo, and Bernard Allen. "Competitiveness in the Latin American Oilseed Industry." Instituto Centroamericano de Administracion de Empresas (INCAE, Latin American Center for Competitiveness and Sustainable Development), Costa Rica, 1998.
- McCall, Alex F., and Timothy E. Josling, eds. *Imperfect Markets and Agricultural Trade*, Osmun Allanheld, Montclair, NJ, 1981.
- Scherer, F.M. and Ross, D., *Industrial Market Structure and Economic Performance*, Princeton, 1990.
- U.S. Department of Agriculture, Economic Research Service, Oil Crops, Situation and Outlook Yearbook, OCS-1999, Oct. 1999.
- U.S. Department of Agriculture, Farm Service Agency. Fact Sheet, Soybeans and Minor Oilseeds, July 1998.

Fig. 1-- Market shares of the United States, Brazil, and Argentina in the world soybean market



**Fig. 2-- C.i.f. Rotterdam price for soybeans**

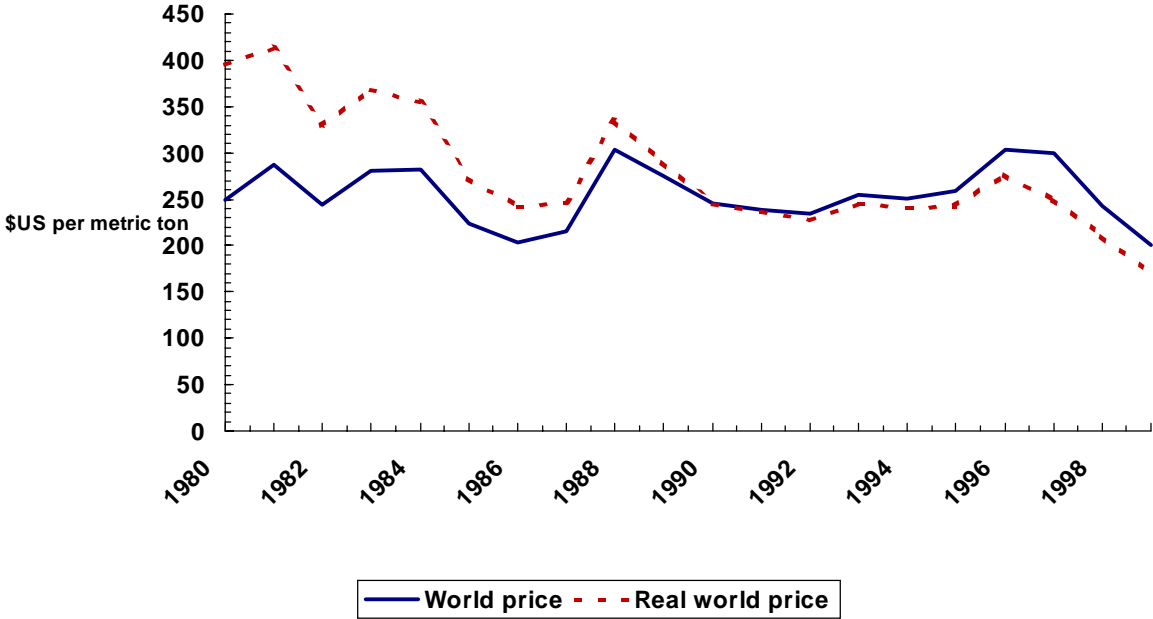


Fig. 3--Static model of dominant firm with competitive fringe

