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THE RETURN TO SOYBEAN CHECKOFF INVESTMENTS

A Report to the Audit and Evaluation Committee
United Soybean Board
St. Louis Missouri

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Report to the Audit and Evaluation Committee of the United Soybean Board, St. Louis, Missouri, July 2014.

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THE RETURN TO SOYBEAN CHECKOFF INVESTMENTS

EXECUTIVE SUMMARY

The soybean checkoff program is a cooperative investment scheme of U.S. soybean producers aimed at enhancing their joint profitability through investments in production research and demand promotion. Beginning in the 1950s through the early 1990s, producer contributions to this investment scheme were facilitated by voluntary, state-level checkoff programs. A national soybean checkoff program was implemented in 1991 under authorization of the 1990 Farm Bill which was upheld by soybean producers in a subsequent referendum required by the legislation. The right of soybean producers to demand a refund of the mandatory checkoff assessment was terminated in a second referendum also required by the legislation. The 1996 Farm Bill requires an independent evaluation of the effectiveness of all commodity promotion programs not less than every 5 years. In compliance with that legislation and given that the last evaluation of the soybean checkoff program was conducted in 2008, the United Soybean Board (USB) commissioned this study to update the research on the effectiveness of the checkoff program over the last two decades through 2012/13.

The primary objective of this study is to answer two key questions regarding the U.S. soybean checkoff program over time: (1) What have been the effects of the soybean checkoff program on U.S. and world soybean and soybean product markets? (2) Has the soybean checkoff program benefited soybean producers? In answering the first key question, the focus is on the effects of the soybean checkoff program on U.S. and foreign soybean, soybean meal, and soybean oil supplies, demands, prices, and trade. The answer to the second question involves a benefit-cost analysis of the checkoff program based on the answer to the first question in which the additional net producer revenues generated by the checkoff program are compared to the producer cost of the checkoff program over the years. The analysis covers the period of 1980/81 through 2012/13. The results are decomposed into two time periods corresponding to the periods before and after implementation of the mandatory national soybean checkoff program. In general, the study concludes that the soybean checkoff program has been highly effective in enhancing the profitability, competiveness, and size of the U.S. soybean industry over the study period.

The study first provides a detailed look at how soybean checkoff funds have been spent over the years given the available data on soybean checkoff expenditures and discusses why expenditure patterns are important for the effectiveness of the program. Then an analysis of how commodity checkoff programs affect markets is provided along with a review of pertinent literature and a comparison of the results of previous studies of the soybean and other commodity checkoff programs. The methodology used in this study to measure the effectiveness of the soybean checkoff program is then outlined which is followed by a discussion of the analytical results. Finally, the major conclusions of the study and implications for the management of soybean checkoff investments are considered.

Since 1970/71, at least $1.38 billion of soybean checkoff funds have been invested in production research and demand promotion (domestic and international) to benefit U.S. soybean producers. In addition, funds have been invested in producer communications as a means of insuring that

those who pay for the program are kept abreast of the activities and effectiveness of the checkoff program. Before the national program was implemented, annual soybean checkoff research and demand promotion expenditures grew from a total of almost $1.3 million in 1970/71 to a high of nearly $17.8 million in 1992/93. Implementation of the national program in 1992/93 led to a tripling of research and demand promotion expenditures to $55.0 million by 1998/99. Following a few years of slight decline, those expenditures took off again in 2004/05 reaching $120.2 million in 2011/12. A review of the research and demand promotion expenditure trends over time reveals several key characteristics of soybean checkoff expenditure patterns that have impacted the returns to the soybean checkoff program: (1) production research expenditures have increased over time at the expense of international market promotion expenditures; (2) the emergence of domestic promotion programs with the implementation of the mandatory checkoff program has assisted in the erosion of checkoff allocations for international promotion; (3) the share of checkoff expenditures allocated to domestic promotion has remained fairly even since the late 1990s; (4) the focus of international marketing expenditures over time has switched from maintaining and building a few large markets to opening and developing many new, smaller markets; (5) the commodity emphasis of international marketing expenditures since the mid-1980s has been shifting from value-added soybean products to soybeans; (6) total checkoff expenditures are extremely small compared to the value of U.S. soybean production so that their absolute impacts on the market are small as well; (7) stakeholder communications expenditures are known to have little effect on commodity markets; and (8) inflation in all countries and changes in the value of the U.S. dollar in foreign markets have seriously eroded the purchasing power of soybean checkoff expenditures in the U.S. and in many other countries.

The analysis of the returns to producers from the soybean checkoff program in this study utilizes a 235-equation, annual econometric, non-spatial, price equilibrium simulation model of world soybean and soybean product markets known as SOYMOD which allows for the simultaneous determination of the supplies, demands, prices, and trade of soybeans, soymeal, and soyoil in seven major world trading regions: (1) the United States, (2) Brazil, (3) Argentina, (4) the European Union, (5) Japan, (6) China, and (7) a Rest-of-the-World region which accounts for the many smaller, new demand growth areas in world soybean markets. The domestic market of each region in SOYMOD is divided into four simultaneous blocks of equations: (1) a soybean block, (2) a soybean meal block, (3) a soybean oil block, and (4) an excess supply or excess demand block. In each region, the first three blocks contain behavioral relationships specifying the manner in which soybean supply (acreage planted, acreage harvested, soybean yields, and production), soybean domestic demand (crush and stocks), and the supply, consumption, and stocks of soybean meal and soybean oil behave in response to changes in variables like prices of soybeans and products, prices of various competing commodities, technology, income, livestock production and prices, government policy, etc. as appropriate.

A large data set of all soybean checkoff expenditures across all commodities, activities, and countries over a long period of time was required for this analysis. The expenditure data for fiscal years 1970 through 2007 were available from previous research on the soybean checkoff program. The expenditure data for fiscal years 2008 through 2012 were provided by the USB primary contractors through a companion project to develop an on-line checkoff expenditure data system. The expenditure data were converted to a constant dollar basis to remove the effects of inflation. Expenditures in foreign markets were also converted to local currency values. The data were then transformed into research and promotion stock variables to account for the time lag between expenditure and market impact for each commodity (soybeans, soymeal, and soyoil) in domestic and international markets. Model specification tests were conducted to determine appropriate lag structures for calculating the stock variables. The research stock variables enter the model as arguments of the U.S. regional soybean acreage and yield functions. The domestic and international soybean, soybean meal, and soybean oil demand promotion expenditure stock variables enter SOYMOD as arguments of the respective demand functions in the U.S. and in the importing regions in which the expenditures were made. The parameters of SOYMOD were estimated using standard econometric procedures. Validation of the model through dynamic, within-sample simulation indicated a highly satisfactory fit of the historical, dynamic simulation solution values to observed data. A sensitivity test indicated that the model is highly stable to changes in checkoff expenditures over time.

To answer the two key questions of this analysis, two simulations of SOYMOD were conducted representing two scenarios: (1) a *with* soybean checkoff expenditures scenario and (2) a *without* soybean checkoff expenditures scenario. The *with* scenario represents actual history over the 1980/81 to 2012/13 period of analysis, that is, the level of supply, demand, prices, trade, etc. in world soybean and soybean product markets that include any effects on those markets from soybean checkoff expenditures in the U.S. and around the world. The *without* scenario analysis was conducted by setting the historic values of soybean checkoff production research and U.S. and international market promotion expenditures to zero in SOYMOD and then simulating the model once again over the same period to generate new values for U.S. and world soybean and product production, consumption, trade, prices, etc. Because the changes in the model variables in the *without* scenario were generated by changing only the levels of checkoff expenditures, they represent the levels of supply, demand, prices, trade, etc. that would have existed over time if the soybean checkoff program had not existed.

What have been the effects of the soybean checkoff program on U.S. and world soybean and soybean product markets? The simulation results demonstrate clearly that the U.S. soybean checkoff program has created a positive "lift" of both the U.S. and world soybean and soybean product markets. The "lift" is how much higher production, price or other variables were on average each year than would have been the case if there had not been a checkoff program. The estimated annual lift of U.S. soybean and product markets from the checkoff program over the 1980/81 to 2012/13 included the following:

- Soybean planted acreage: 3.0%
- Soybean production: 4.3%
- Soybean farm cash receipts: 5%
- Soybean crush: 3.7%
- Soybean exports: 5.8%
- Soybean farm price: 0.6%
- Soybean crush margin: -0.3%
- Soymeal consumption: 2.1%
- Soymeal exports: 9.5%
- Soymeal price: 0.1%
- Soyoil consumption: 2.2%
- Soyoil exports: 16.3%
- Soyoil price: -0.7%

The small changes in prices reflect the price-offsetting effects of simultaneously investing checkoff dollars in production research and demand promotion and the substantial increase in the production research share relative to the demand promotion share of checkoff expenditures over the last decade. The slightly negative effect on soyoil price also results from the relatively larger increase in oil supplies from the checkoff-induced increased in soybean crush then the increase in soyoil consumption as a result of domestic promotion expenditures.

The soybean checkoff program has also created some lift in exports of U.S. export competitors but to a much lesser extent. Thus, the U.S. export shares of world soybean, soymeal, and soyoil imports were higher by 0.8, 1.1, and 1.9 percentage points, respectively, while those of Brazil and Argentina were lower.

China experienced by far the largest lift of soybean imports among all importing regions from the checkoff program since the implementation of the national program of 1.24 million metric tons (mt) (6%). The soybean import lift was 383,000 mt (3.3%) for the group of smaller importing countries (referred to as "rest of the world"), nearly 220,000 mt (1.5%) for the EU 15/27, and almost 100,000 mt (2.3%) for Japan. For soymeal imports over the same period, the rest of the world experienced the largest lift of about 775,000 mt (4.6%), followed by the EU 15/27 of almost 420,000 mt (2.4%), and Japan of only just over 60,000 mt (5.0%). For soyoil imports over the same period, the rest of the world experienced the largest lift of just over 200,000 mt (4.2%).

Has the soybean checkoff program benefited soybean producers? Based on the simulation scenario results, the net profit Benefit-Cost Ratio (NBCR) for the U.S. soybean program is $6.5 per checkoff dollar invested over the entire 1980/81 to 2012/13 period and $5.2 per dollar invested since the implementation of the national checkoff program. In other words, the benefits in terms of the net additional soybean industry profits generated by the U.S. soybean checkoff program have far exceeded the cost of the program expenditures over time.

The calculated NBCR was substantially higher in the *voluntary* checkoff period of 1980/91 to 1991/92 ($11.0) than since the *national* checkoff program was implemented in 1992/93 ($5.2) for several reasons. First, the average and marginal rates of return from promotion and advertising by any commodity checkoff program are known to decline as the level of checkoff funding increases. So, the BCR should be somewhat lower in recent years simply because of the huge increase in checkoff expenditures that has occurred. Also, the shift in funding allocation strategy that has funneled more funds to production research over time and less to international market promotion and even domestic demand promotion has added tremendous "supply push" to the market effects of the checkoff program while reducing the "demand pull" of the program. In fact, the simulation results indicate that the "supply push" of production research expenditures began to have a greater impact on U.S. and world soybean and product markets than the "demand pull" of the domestic and international marketing promotion programs in about 2000/01. The consequence has been a smaller positive effect of the program on the U.S. soybean farm price and, therefore, a smaller positive effect on soybean producer profits per checkoff dollar spent in recent years than was the case during the *voluntary* period of the program.

The main conclusion of this study is that the U.S. soybean checkoff program continues to be highly effective in enhancing the profitability, competitiveness, and size of the U.S. soybean industry. Among the major findings of this study are the following:

- *The Benefit-Cost Ratio (BCR) of the soybean checkoff program has been relatively high at $6.5 in additional profit earned by U.S. soybean farmers for every checkoff dollar spent between 1980/81 and 2012/13 and $5.2 since the implementation of the national checkoff program in 1992/93.*

- *The Benefit-Cost Ratio for the soybean checkoff program was lower in the period following implementation of the national checkoff program ($5.2) than was the case during the voluntary checkoff program years ($11.0).*
- *The soybean checkoff program has increased the size of the U.S. soybean industry.*
- *The soybean checkoff program has reduced the competitive threat of the South American soybean industry.*
- *The soybean checkoff program has boosted imports of soybean products around the world and particularly in China and many smaller, less developed countries.*

These conclusions suggest a number of implications for program management purposes:

1. The U.S. soybean industry continues to underinvest in the soybean checkoff program despite the increase in funding with the *national* checkoff program which imposes an opportunity cost on the soybean industry. For every dollar *not* contributed by producers and spent on production research and demand promotion, the industry loses $5.2 in additional revenues.
2. Care must be taken to determine the proper share of funds to allocate to production research which boosts U.S. soybean production and ensures that the demand created by domestic and international promotion expenditures is supplied from U.S. production. However, too heavy an emphasis on production research tends to limit the positive price impact and producer profits from demand promotion and reduces the net returns to the soybean checkoff program.
3. A failure to maintain and enhance the growth in soybean checkoff expenditures in any time period can have serious negative impacts on soybean producer profitability over many years. Because checkoff expenditures create a stream of new revenues over time, their market effects are not realized immediately but rather are distributed over a number of years. Consequently, a reduction in funding for even one year can seriously erode the effectiveness of the program in raising producer profits not just in that year but over a long period of time.
4. How demand promotion expenditures (domestic and international) are allocated among soybeans and soybean products and across countries can have important implications for the return to those investments and for U.S. competitiveness in foreign markets.
5. The current mix of checkoff expenditures appears to be reducing the potential return. Thus, a consideration of the following adjustments in the funding allocation strategy which might enhance returns to soybean producers is recommended:

   (1) an increased share of expenditures to domestic demand and international marketing promotion to enhance the demand pull of the checkoff program relative to the supply push from the growing share of expenditures currently going to production research;

   (2) an increased share of expenditures to international promotion relative to domestic demand promotion given the relatively higher BCR to international marketing expenditures;

   (3) an increased emphasis of promotion expenditures on value-added products (soymeal, soyoil, soyfood) compared to the promotion of the raw product (soybeans); and

   (4) some re-examination of the limited international marketing promotion expenditures in larger, established markets like the European Union, Japan, and even China compared to those in smaller, less developed country markets.

6. The BCR for any commodity checkoff program is not indicative of the level of impact of the program on the U.S. and world soybean and product markets. Despite the reasonably high BCR calculated for the soybean checkoff program, the total amount spent is actually quite small relative to the value of U.S. soybean production and so could hardly be expected to have a major impact on U.S. and world soybean and soybean product markets.

7. The BCR calculated in this study provides a measure of the *average* return to producers from soybean checkoff investments and not the return realized by individual producers. Because the BCR is an average, some producers earn higher returns while others earn lower.

8. Care must be taken in communicating these results to producers. Inevitably some producer will ask something like: "If the returns were $5.2 for every dollar invested in the soybean checkoff program, where are my $5.2 for every checkoff dollar I have been assessed?" The question conveys a common lack of understanding of not just the results of checkoff evaluation studies but how checkoff programs return value to them. The basic problem is that all producers can easily identify the line on their balance sheets for the cost to them of the checkoff assessment. But there is no line on their balance sheets for what their contributions to the checkoff program have returned to them in additional revenues. Producers often fail to understand that some part of the revenues they have earned has come from the larger volume of soybeans the checkoff program has enabled them to produce and sell at a higher price. This study determines that the soybean checkoff program has contributed 4% of the U.S. soybean cash receipts on average over the period of 1980/81 to 2012/13 and 5.3% of those receipts since the *national* soybean checkoff program was implemented.

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The Return to Soybean Checkoff Investments

The soybean checkoff program is a cooperative investment scheme of U.S. soybean producers aimed at enhancing their joint profitability through investments in production research and demand promotion. Beginning in the 1950s through the early 1990s, producer contributions to this investment scheme were facilitated in many soybean-producing states by state legislation requiring producers to pay (or "check off") from ½ to 2 cents per bushel sold. Such contributions were considered to be "voluntary" because any producer could receive a full refund upon request. About 50% of the checkoff funds collected in each state during that period was allocated to and managed by that state's soybean association. The other half was controlled by the national soybean producer organization, the American Soybean Association (ASA) in St. Louis, Missouri.

The 1990 Farm Bill[1] authorized a national program of mandatory soybean producer checkoff contributions to fund research and promotion activities. Implemented in the Soybean Promotion, Research, & Consumer Information Act of 1990[2], the national soybean checkoff program replaced the state-level programs in 1991 and was upheld by soybean producers in a subsequent referendum required by the legislation. Under the national program, every soybean producer is required to participate in the checkoff at the rate of 0.5% of the market price per bushel when the crop is first sold. The right of soybean producers to demand a refund of the checkoff assessment was terminated in a second referendum also required by the legislation.

Half of the checkoff funds collected under the mandatory national soybean checkoff program remains in the states with the other half accruing to a national producer-controlled checkoff board (the United Soybean Board (USB) in St. Louis, Missouri). To manage the half of the checkoff funds allocated to the states, the legislation required the establishment of state-level, producer-controlled checkoff boards (Qualified State Soybean Boards or QSSBs). Both the QSSBs and the USB invest checkoff dollars in production research to reduce production costs and to enhance soybean productivity. They also allocate funds to promote domestic and foreign demand for soybeans. Finally checkoff funds are also used for producer communications to keep stakeholders informed of the activities funded by checkoff dollars and the benefits they receive.

Title V of the 1996 Farm Bill[3] requires an independent evaluation of the effectiveness of all new and existing promotion programs, not less than every 5 years, to assist Congress and the Secretary of Agriculture in ensuring that the objectives of the programs are met. In compliance with that legislation and given that the last evaluation was conducted in 2008, USB commissioned this study to update the research on the effectiveness of the soybean checkoff and related investments in production research and promotion over the last two decades through 2012/13.

[1] Food, Agric., Conservation & Trade Act of 1990, PL 101-624, 104 Stat. 3838-3928, Nov. 28, 1990, Title XIX.
[2] 7 U.S.C. 6301-6311; 56 F.R. 31048-31068, CFR. pt. 1220.
[3] Federal Agriculture Improvement and Reform Act of 1996, PL 104-727, 7 U.S.C. 7201 *et seq.*

The primary objective of this study is to answer two key questions regarding the U.S. soybean checkoff program over time: (1) What have been the effects of the soybean checkoff program on U.S. and world soybean and soybean product markets? (2) Has the soybean checkoff program benefited soybean producers? In answering the first key question, the focus is on the effects of the soybean checkoff program on U.S. and foreign soybean, soybean meal, and soybean oil supplies, demands, prices, and trade.

Once the market effects have been determined, they are then used to answer the second question in a benefit-cost analysis of the checkoff program at the producer level. In the analysis, the producer benefit-cost ratio (BCR) of the soybean checkoff program is calculated as the additional net producer revenues generated by the checkoff program divided by the cost of the checkoff program. The analysis covers the period of 1980/81 through 2012/13 and then decomposes the results for comparison purposes into two time periods corresponding to the periods before and after implementation of the mandatory national soybean checkoff program.

The study first provides a detailed look at how soybean checkoff funds have been spent over the years and why expenditure patterns are important for the effectiveness of the program. Then an analysis of how commodity checkoff programs affect markets is provided along with a review of pertinent literature and a comparison of the results of previous studies of the soybean and other commodity checkoff programs. The methodology used in this study to measure the effectiveness of the soybean checkoff program is then outlined which is followed by a discussion of the analytical results. Finally, the major conclusions of the study and implications for the management of soybean checkoff investments are considered.

BACKGROUND ON SOYBEAN CHECKOFF EXPENDITURES

Expenditures of U.S. soybean checkoff funds over the years to enhance the profitability of the U.S. soybean industry can be classified as either supply-oriented or demand-oriented. Supply-oriented expenditures include production research investments to improve agricultural productivity and reduce production costs. Demand-oriented expenditures, on the other hand, attempt to shift out the demand schedules for soybeans and soybean products (soybean meal[4] and soybean oil) through domestic and international market development and promotional activities. If demand is successfully increased, then price would be expected to increase which would lead to increased output and producer revenues.

Although checkoff dollars have been invested in both supply- and demand-oriented activities since the mid-1950s, useable data and documentation of those investments are available only since the 1970s. This section begins with a brief overview of soybean checkoff investment activities over time and then the expected market effects of those investments are considered.

[4] Soybean checkoff funds have also been used to promote "soyfood" products. However, inasmuch as these products are manufactured from the meal portion of the soybean, they are treated as "soymeal" products in this study.

Historical Soybean Checkoff Expenditures

Since 1970/71, at least $1.38 billion of soybean checkoff funds have been invested in supply-oriented and demand-oriented activities to benefit U.S. soybean producers[5,6]. In addition, funds have been invested in producer communications as a means of insuring that those who pay for the program are kept abreast of the activities and effectiveness of the checkoff program.

In the years before the national mandatory program (pre-1992), annual soybean checkoff expenditures[7] grew from a total of almost $1.3 million in 1970/71 to a high of nearly $17.8 million in 1992/93 (see Figure 1). With the implementation of the mandatory program in 1992/93, annual soybean checkoff expenditures grew rapidly, more than tripling to $55.0 million by 1998/99. Following a few years of slight decline, expenditures took off again in 2004/05 reaching $120.2 million in 2011/12.

Not only did the establishment of the national soybean checkoff program dramatically increase the level of funds available for investment in both supply-oriented and demand-oriented programs to increase industry profitability, it also signaled a major and program-defining shift in expenditure strategy away from international market promotion and toward domestic market promotion and research. In the 1970s and 1980s, international market promotion consistently accounted for 70-80% of the total soybean checkoff investments with production research expenditures accounting for the remainder (Figure 2). With the implementation of the national soybean checkoff program in 1993/94, however, an increasingly larger share of checkoff funds was allocated to production research and domestic demand promotion. By 2002/03, the international market promotion share had declined to only 31.6% while the production research share nearly tripled from 20%-30% in the 1970s and 1980s to nearly 56% in 1993/94. Meanwhile the domestic market promotion share increased from nothing before the mandatory program to 29% in 1997/98 before declining to 15% in 2000/01 (Figure 2). Since that time, the domestic promotion share of total expenditures has struggled to stay between 20-25%. Since 1995/96, domestic market promotion and production research together have accounted for almost 60% of annual expenditures with international market promotion accounting for only about 30%.

The QSSBs spend roughly half of the checkoff funds and account for about 70% of all checkoff expenditures on production research and 60% of all expenditures on domestic promotion programs but only about 15%-16% of international marketing expenditures (Figure 3). With the approximately 50% of the soybean checkoff assessments received each year, USB subcontracts to outside agencies to carry out most of its programs in production research, domestic marketing, international marketing, and producer communications. A few projects each year are handled in-house by the small USB staff in St. Louis. The large majority of all international marketing activities (75%-80%) are conducted by the USB through the U.S. Soybean Export Council (USSEC) based in St. Louis (Figure 4). Through SmithBucklin Corporation, the USB carries out

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[5] This amount includes funds provided by the Foreign Agriculture Service (USDA) through the cooperator program

[6] Unless otherwise indicated, all checkoff expenditure data presented in this section and in corresponding tables and figures are in nominal U.S. dollars. As discussed later, however, all research and domestic demand promotion expenditures were deflated and international marketing expenditures were also corrected for changes in exchange rates for the empirical analysis of the effectiveness of those expenditures.

[7] Unless otherwise specified, all subsequent references to “soybean checkoff expenditures/investments” in this report include not only producer-contributed soybean checkoff funds invested in soybean production research, domestic promotion, and international market promotion programs but also the foreign market promotion funds contributed by the USDA through the Foreign Agriculture Service. Producer communications expenditures are not included.

Figure 1: Total Soybean Research and Promotion Checkoff Expenditures, 1970/71-2011/12

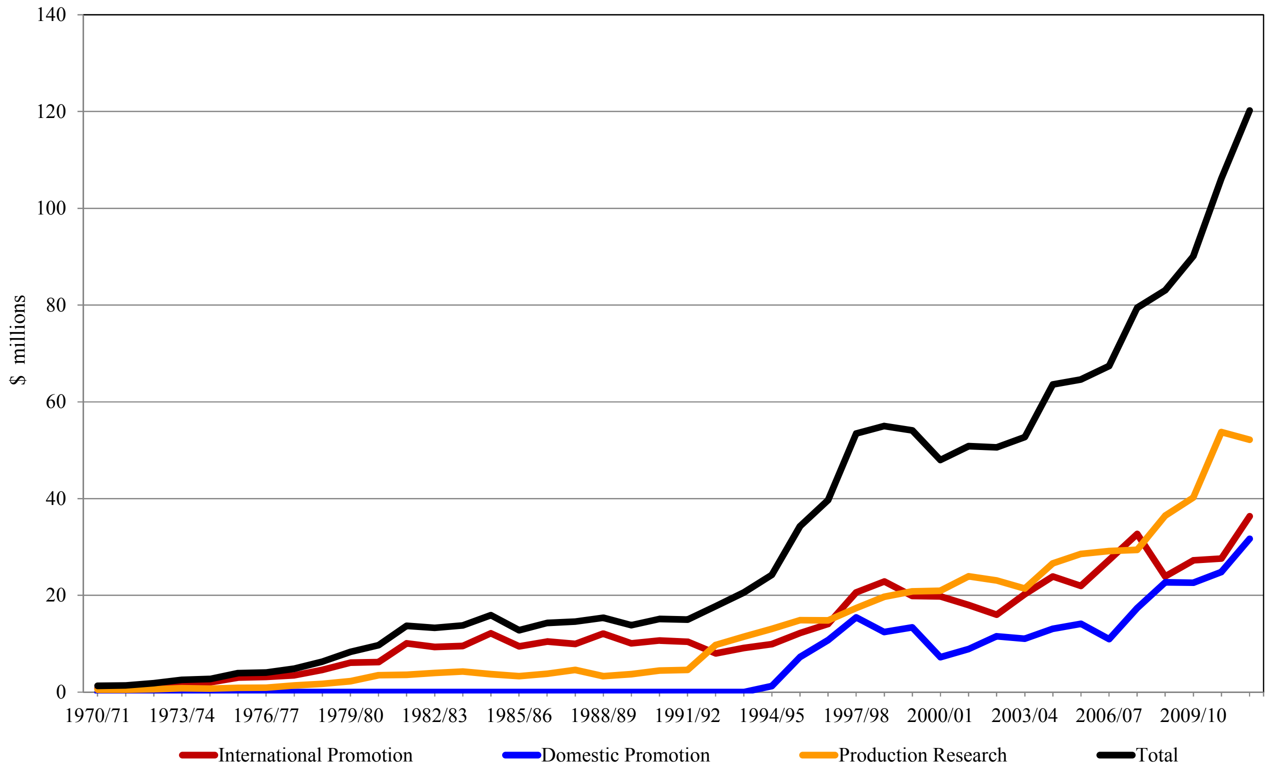


Figure 2: Share of Soybean Checkoff Expenditures Allocated to International Market Promotion, Domestic Market Promotion, and Production Research, 1970/71-2011/12

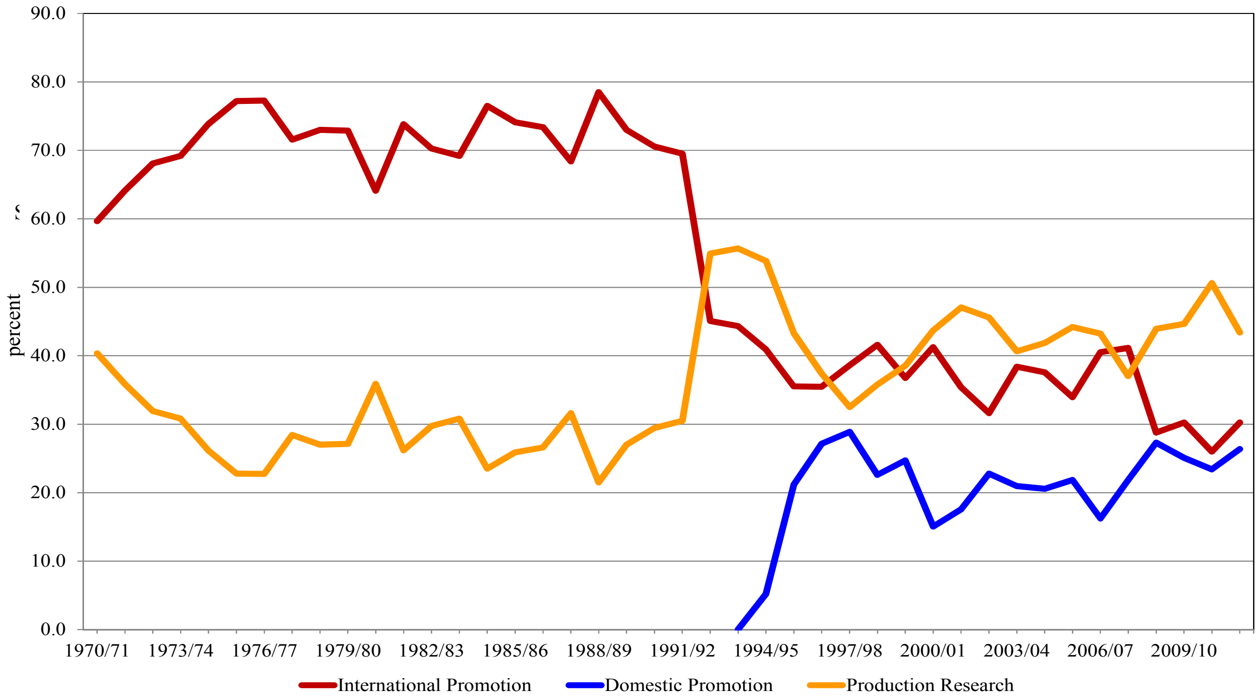


Figure 3: QSSB Share of Total Checkoff Spending by Category, 2007/08-2011/12

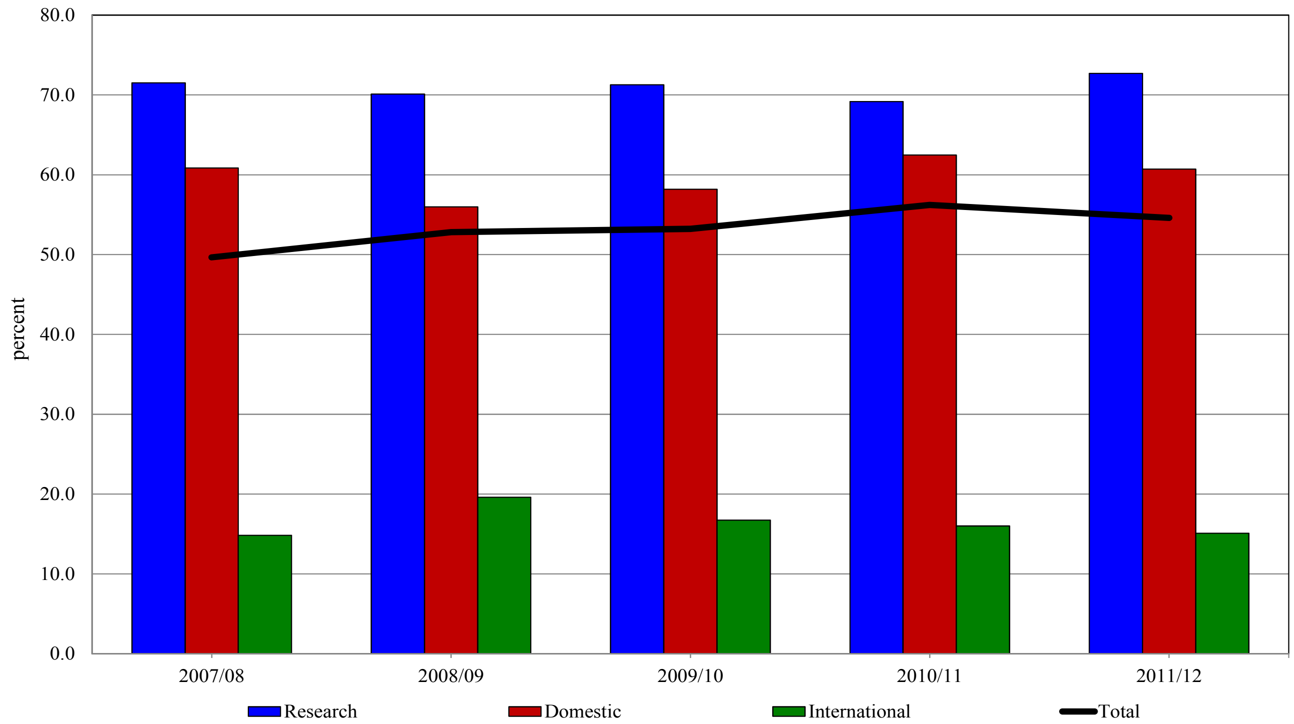
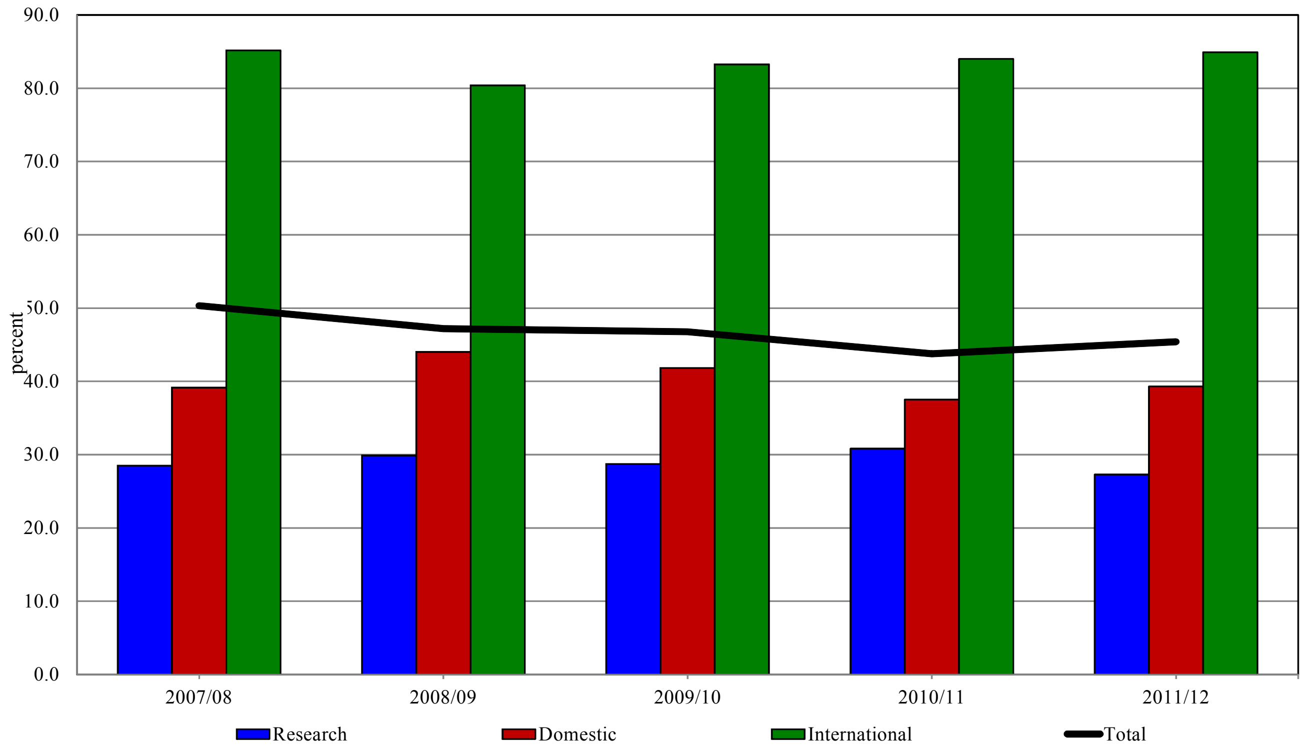


Figure 4: USB Share of Total Checkoff Spending by Category, 2007/08-2011/12



about 40% of all domestic promotion programs, about 30% of all production research activities, and about 4% of all international marketing activities. Osborn & Barr is the USB subcontractor for all producer communications activities.

Even though soybean farmers have spent over a billion checkoff dollars on production research and demand promotion since the 1970s, annual expenditures actually have been quite meager when compared to the annual industry revenues (cash receipts) earned by U.S. soybean farmers (Figure 5). Between 1970/71 and 2011/12, total soybean checkoff investments have amounted to only between 0.03% and 0.44% of total soybean farm cash receipts each year. With such a low checkoff investment intensity, i.e., the level of investment compared to the size of the soybean market as measured by farm sales, the overall impact of the program could hardly be expected to be highly significant in a practical sense in its effects on U.S. production, prices, exports, and world market shares even if the impact could be said to be statistically significant.

International Market Promotion Expenditures

Between 1970/71 and 2011/13, $559.2 million were invested in promoting foreign consumption of U.S. soybeans and soybean products[8]. Of that total, roughly half came directly from soybean checkoff revenues and the other half from USDA through the Foreign Agriculture Service (FAS) Cooperator Program. Under the USDA Cooperator Program, commodity groups obtain federal funds to assist in developing foreign markets for U.S.-produced agricultural commodities by submitting marketing plans to FAS detailing how they intend to spend the requested funds. If FAS approves the marketing plan, the commodity cooperator is expected to share in the cost of implementing the plan for which, under the Soybean Cooperator Program, a large portion of soybean checkoff funds have been used over the years.

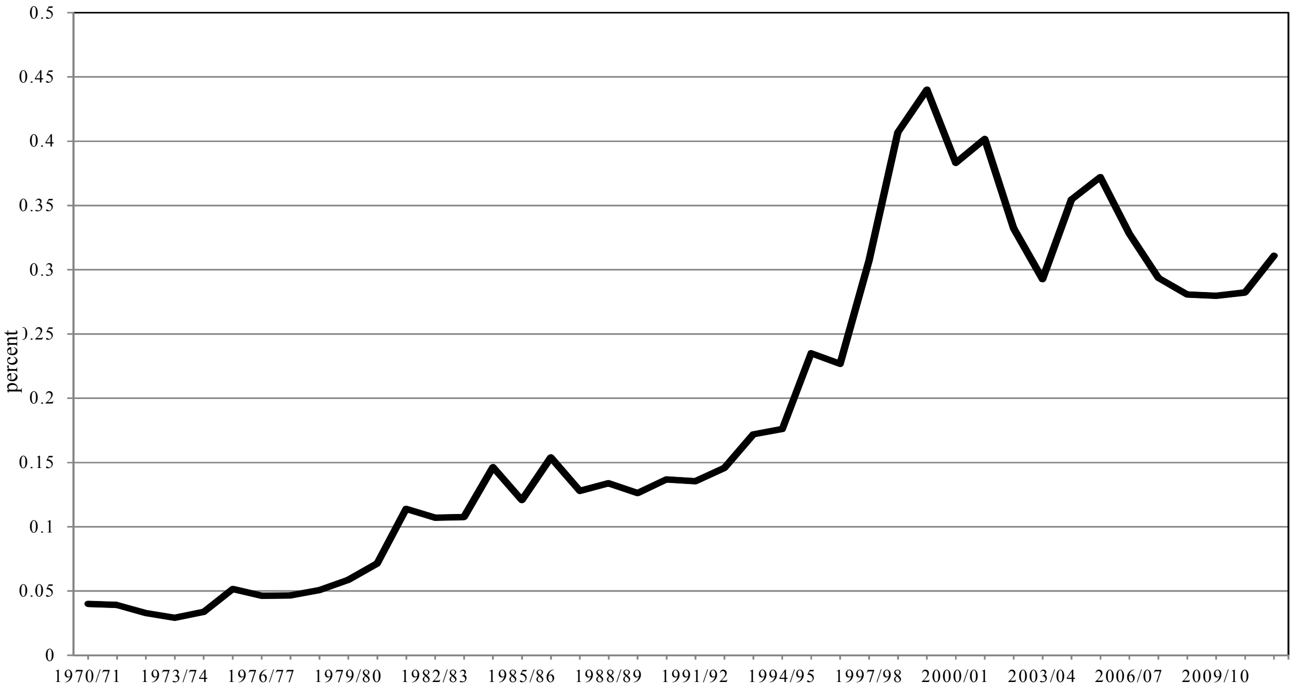
Between 1970/71 and 1984/85, total international marketing promotion expenditures consistently grew from $767,201 (60% of all checkoff expenditures) to $12.2 million (76.5% of all checkoff expenditures) before hitting a plateau and then declining to $8.0 million in 1992/93 (45.1% of all checkoff expenditures) as funds were re-directed to production research projects.

With the implementation of the national soybean checkoff program, however, international market promotion expenditures jumped again to a new high of $22.9 million in 1998/99. Nevertheless, the share of total expenditures allocated to international market promotion continued to slide to 41.6% in that same year as allocations to production research and domestic promotion grew even faster.

The growth rate in allocations to international market promotion turned negative once again over the following four years through 2002/03 as allocations to production research jumped dramatically over that period. Since that time, allocations to international marketing have generally increased with expenditures hitting a record $36.3 million in 2011/12. Even so, the share of expenditures accounted for by international marketing has continued to slide hitting an all-time low of 26.0% in 2010/11 with some increase to 30.2% in 2011/12.

[8] The American Soybean Association (ASA) initially served as the primary contractor to the United Soybean Board for managing the international market promotion program. Since 2005, the international market promotion program has been managed by the United States Soybean Export Council (USSEC).

Figure 5: Soybean Checkoff Expenditures as a Percent of Soybean Cash Receipts, 1970/71-2011/12



Between 2007/08 and 2011/12, the QSSBs expended an average of 16.2% of the total soybean checkoff dollars spent on international marketing promotion activities while USB spent the remaining 83.8% through its subcontractors, SmithBucklin (4.4%) and USSEC (79.4%).

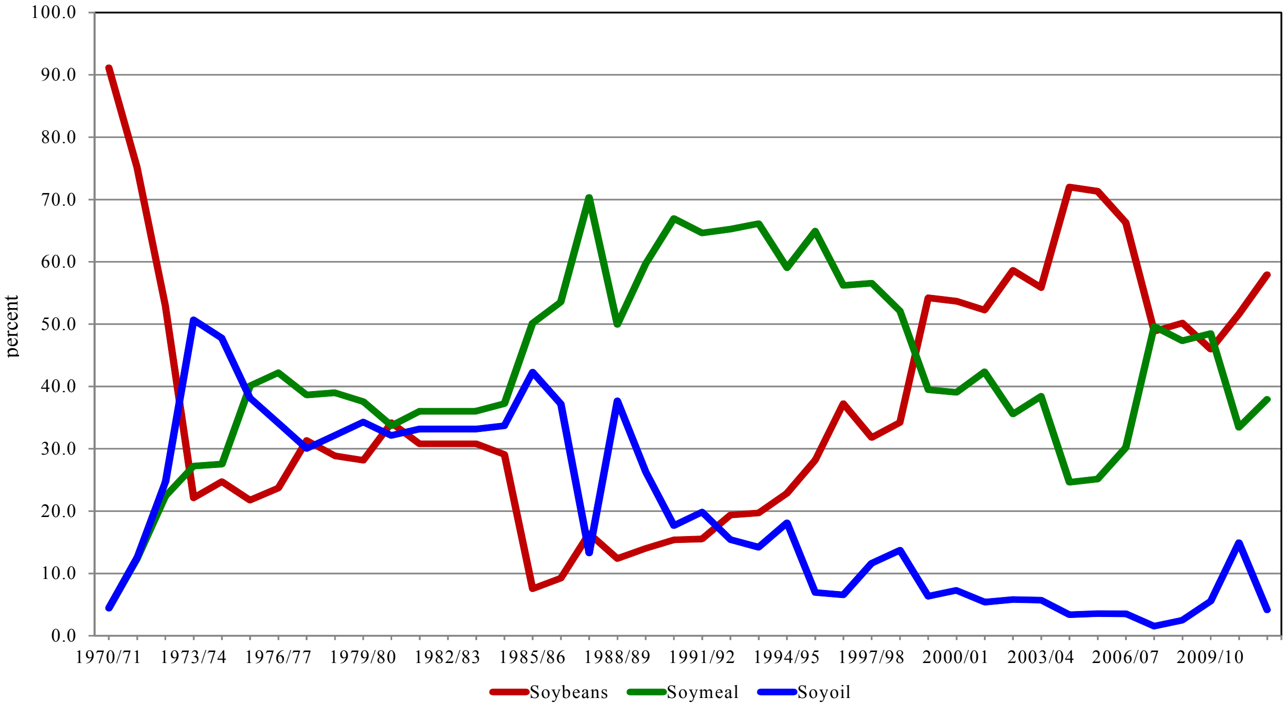
Commodity Shares of International Market Promotion Expenditures

Before the implementation of the national soybean checkoff program, the international marketing promotion program emphasized soybean products (soybean oil and soybean meal[9]) rather than soybeans as the primary export promotion objective (Figure 6). From a fairly balanced program of expenditures on soybeans and products in the mid-1970s through the early 1980s, the expenditure mix shifted dramatically away from soybeans and soybean oil to emphasize primarily soybean meal after 1984/85. Between the mid-1980s and the mid-1990s, soybean meal promotion projects accounted for nearly two-thirds of all international marketing activities.

Another shift in the commodity focus of international marketing activities began in the late 1990s as international expenditures for soybean oil and then soybean meal activities were shifted to emphasize soybeans instead (Figure 6). By 2004/05, soybeans were the primary focus of 72% of international marketing expenditures. Some re-balancing of expenditures between soybeans and soybean meal occurred in subsequent years to bring their respective shares of total expenditures to around 50%. In 2010/11 and 2011/12, some shift back towards soybeans and away

[9] For this study, expenditures to promote soyfood in target countries were added together with such expenditures for soybean meal into one category referred to here as "soybean meal."

Figure 6: Commodity Shares of International Market Promotion Expenditures, 1970/71-2011/12



from soybean meal occurred. Soybean oil has continued to be a relatively unimportant part of international marketing promotion activities, accounting for only 15% of total expenditures in the mid-1990s down to 1.5% in 2007/08 with a one-year uptick to 15% in 2010/11.

The motivation behind the switch from promoting exports of soybean meal in the pre-national checkoff period to promoting soybean exports in recent years is unclear. Most likely, as suggested later, the change in emphasis was related to a shift in the regional focus of expenditures that occurred with the implementation of the national soybean checkoff program. As the regional emphasis of expenditures shifted from the EU and Japan to smaller, less developed countries over time, the commodity emphasis also shifted to soybeans rather than soybean products.

Regional Shares of International Market Promotion Expenditures

In the early 1970s, Japan and the European Community (6 members) accounted for 80%-85% of all international market promotion expenditures (Figure 7.) Over time, however, the international marketing program expanded into a number of other countries, resulting in a steadily declining share of expenditures first in Japan and then in the European Union (EU) despite the growth in the number of EU member countries. By 2008/09, Japan and the EU (which by then included 27 member countries) together accounted for only about 8% of total international market promotion expenditures (Figure 7). In contrast, the share of those expenditures going to smaller, less developed countries outside Japan and the EU-27 increased dramatically and consistently from around 10% in 1970/71 to around 80% between 2007/08 and 2011/12.

Soybean checkoff investments to build the Chinese market for soybeans and products began shortly following U.S. diplomatic recognition of China in 1978. In 1980/81, $148,622 of soybean checkoff funds were spent in China, only about 1.5% of the total international soybean checkoff expenditures in that year (Figure 7). After a few years of exchanges of delegations and scientific personnel with China, ASA opened an office in Beijing in 1982 (Shurtleff and Aoyagi 2007). Since then, soybean checkoff investments in China have grown slowly compared to expenditures in other markets of the world outside the EU and Japan. International marketing expenditures in China reached a high of $4.9 million in 2011/12 but its share of those expenditures has trended downward in recent years from 17% in 2003/04 to 14% in 2011/12. Over two-thirds of the checkoff investments in China have been for soymeal promotion and have focused on technical assistance to Chinese livestock producers and feeders to enhance the efficiency and productivity of their operations. A major emphasis of the assistance has been shifting livestock feeding away from traditional feedstuffs like table scraps and stover to more balanced rations that include soymeal as a protein supplement. Just over 30% of the checkoff dollars invested in China has assisted its oilseed processing industry to adopt more efficient soybean extraction technologies and other forms of technical assistance to processors.

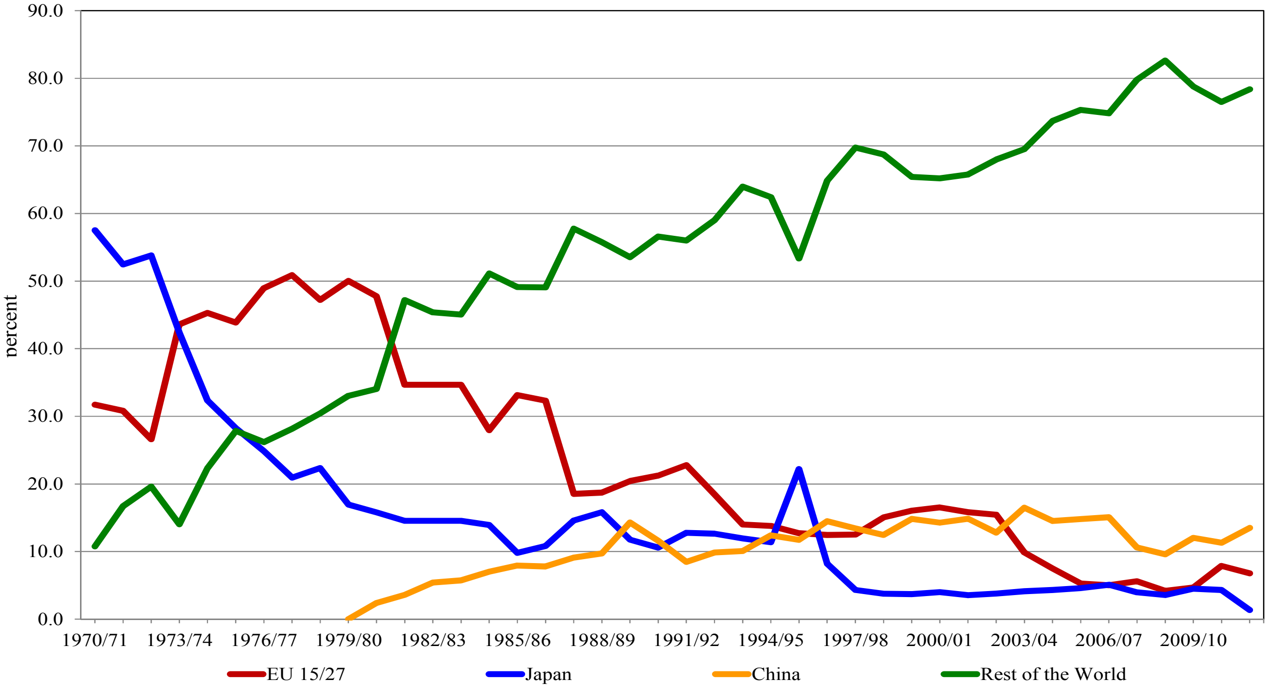
The shift in the allocation of expenditures away from developed countries towards China and other smaller, emerging markets over time represents another key shift in the international market promotion strategy of the soybean checkoff program. This shift over time may help explain the concurrent shift in expenditures away from value-added products (soybean oil and meal) toward soybeans as noted in the previous section (also see Figure 6). Note that in the early years (1970s) of the international market promotion effort, the focus of the program activities and expenditures was on soybeans, primarily in Japan and the EU. As those two markets matured, the emphasis in promotion activities began to switch to value-added products. Then as the strategy for international market promotion broadened to include new, emerging markets including China at first and then a broad number of other, smaller less developed countries, the focus once again shifted to soybeans rather than value-added products.

This strategy makes sense, of course, because before growth in consumption of value-added products can occur in a new market, a supply of value-added products must be available. Working with importers, processors, and refiners in new markets to enhance efficiency and capacity, develop products suited to the needs of the consumers in that country, and improve the production, handling, and marketing process and infrastructure is an important first step to developing the needed supply of value-added soybean products in a new market.

Soybean Production Research Expenditures

Between 1970/71 and 2011/12, U.S. soybean farmers spent a total of about $564.7 million in checkoff funds on soybean production research projects. From $518,803 in 1970/71, the combined allocation of checkoff funds through both national (USB) and state-level (QSSB) organizations for soybean production research increased steadily to $52.2 million in 2011/12 (see Figure 1). Over that period, QSSBs have contributed 71% of the funds to finance soybean production

Figure 7: Regional Shares of International Market Promotion Expenditures, 1970/71-2011/12

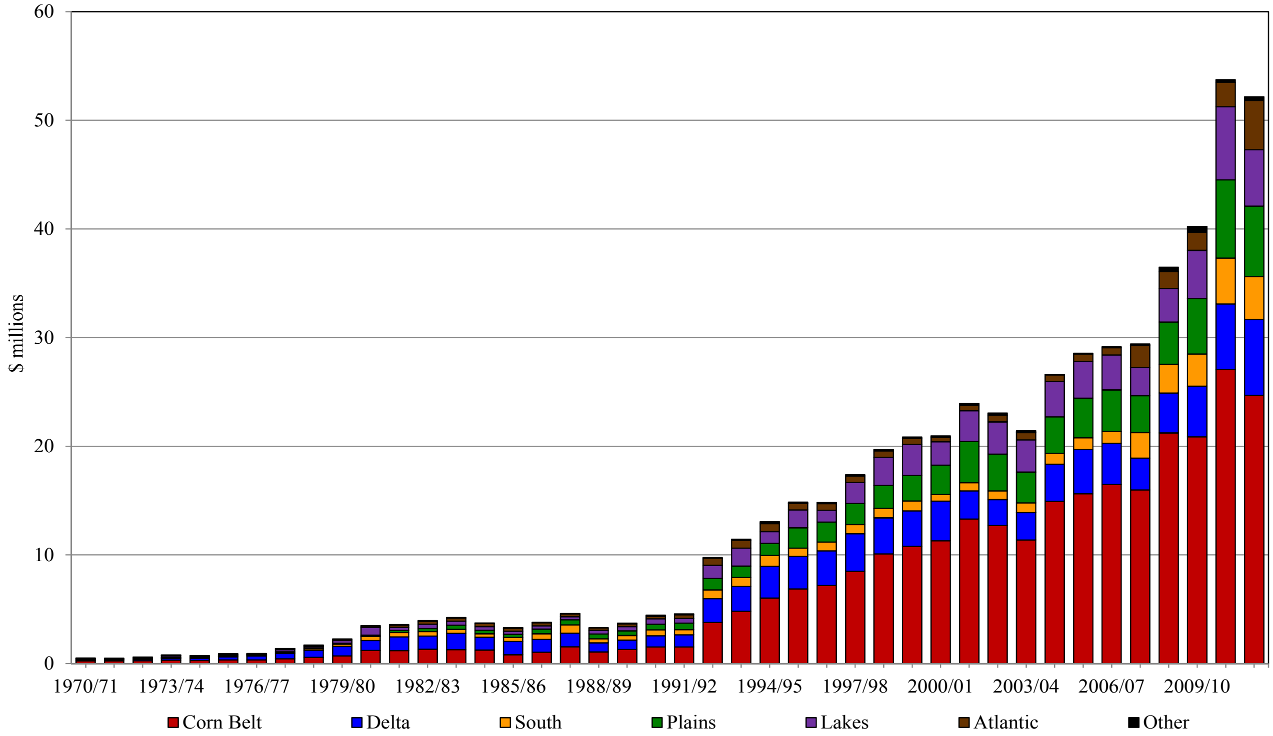


research while USB has contributed the other 29.1%. Although soybean production research accounted for about 40% of total checkoff expenditures in 1970/71, the production research share of total expenditures declined steadily to an all-time low of 21.5% in 1988/89 (see Figure 2). Aided by the implementation of the mandatory checkoff program in the early 1990s, the production research share jumped to 55.7% in 1993/94, the highest level since 1970/71. A shift in expenditures towards domestic promotion temporarily eroded the production research share of expenditures to 32.5% by 1997/98. Since then, the production research share has recovered to about 40%- 45% except in 2010/11 when the share hit 50.6%.

Production research projects funded with soybean checkoff dollars over at least the last decade have tended to fall into one of several broad categories: (1) soybean production research, including production systems research; gene discovery and bioengineering studies; soybean disease and pest control; and soybean germplasm screening and variety testing and development; (2) soybean composition and quality research; (3) soybean processing and utilization research; (4) education and communication projects; and (5) various other research activities. Soybean production research is the largest category and accounted for about two-thirds of all production research funding in 2011/12.

Checkoff funding for soybean research in Cornbelt states (Illinois, Iowa, Indiana, Missouri, and Ohio) has accounted for 50%-60% of all production research funding since the mid-1990s (Figure 8). The Delta states (Arkansas, Louisiana, and Mississippi) and the Plains states (Kansas, Nebraska, North Dakota, and South Dakota) together have accounted for a declining share of soybean-checkoff-funded production research from nearly half in the mid-1970s to about 25% in 2011/12. Most of the remaining soybean production research funded by the checkoff occurs in

Figure 8: Soybean Checkoff Production Research Expenditures by Region, 1970/71-2011/12



many states across three regions, including the Southern region (Alabama, Florida, Georgia, Kentucky, Oklahoma, Tennessee, and Texas), the Lakes region (Michigan, Minnesota, and Wisconsin), and the Atlantic region (Delaware, Maryland, North Carolina, South Carolina, and Virginia). Less than 1% of the research funding occurs in other states.

Domestic Promotion Program Expenditures

Prior to the implementation of the national checkoff program, relatively few checkoff dollars were allocated at either the national or state level for activities designed to promote the domestic use of soybeans and soybean products. Nearly all checkoff funds during that period were used either to promote foreign use of soybeans and soybean products in an effort to enhance U.S. exports or to fund production research in an effort to boost productivity and reduce costs of production.

Few records exist to provide much insight on the objectives and amount of checkoff dollars used to fund domestic promotion activities prior to the early 1990s. The data available for that period and discussions with ASA and USB personnel both indicate that until after the implementation of the national soybean checkoff program, domestic promotion accounted for an extremely small proportion of all soybean checkoff funds expended in those years.

With the implementation of the national soybean checkoff program, the strategy for checkoff expenditures was expanded to include a broad range of activities to promote the use of soybeans and soybean products in U.S. markets. Domestic soybean promotion funding has included new use projects focused on soybean composition and quality, trade and consumer communication projects, and a wide variety of soybean chemistry, genetics, processing, and utilization projects. Domestic soymeal and soyfood promotion programs have focused on financing partnerships with meat marketing organizations, seminars and research on the nutritional and health aspects of soyfoods, and many projects related to animal nutrition, feeding technology, high protein meal development, and soymeal use in aquaculture production, among many others. Soybean oil promotion programs have focused on developing industrial applications for soyoil and the use of soyoil in biodiesel fuel production, among many others.

USB domestic promotion expenditures increased markedly after implementation of the national checkoff program from $1.3 million in 1994/95 (5.2% of all checkoff promotion and research expenditures) to a high of $31.7 million in 2011/12 (26.4% of promotion and research expenditures) for a total of $256.6 million (Figure 9). The share of USB domestic promotion funds spent on soybean projects has varied widely from less than 1% in most years before 2001/02 to 39.5% in 2002/03. The soybean share of USB domestic promotion has declined over the last few years from 25.2% in 2008/09 to 11.6% in 2011/12.

Soybean oil projects have accounted for the largest share of USB domestic promotion expenditures (40% to 60%) in most years after 2002/03. About 59% of domestic promotion expenditures were for soybean oil projects in 2011/12. Projects related to soybean meal accounted for the remainder of USB domestic promotion expenditures. Between 2006/07 and 2011/12, the share of domestic promotion spending on soymeal-related projects declined from 39.5% to 29.4%.

While QSSBs spend much less than the USB on international marketing, they spend about 50% more than the USB on domestic promotion. From about $27.0 million in 2007/08, the amount spent by QSSBs on domestic promotion has increased 81% to $49.0 million in 2011/12[10] (Figure 10). QSSBs also have tended to allocate a larger share of their domestic promotion expenditures to soybean projects rather than to soybean product projects compared to the USB. Over the 2007/08 to 2011/12 period, QSSBs spent 29.1% of their domestic promotion funds on soybean projects compared to just 19.0% for the USB. The remaining 70.8% of QSSB domestic promotion expenditures over that period were for soybean product projects (31.5% for soybean meal and 39.4% for soybean oil). In contrast, the USB allocated 81% of its domestic promotion expenditures for soybean product projects (27.5% for soybean meal and 42.6% for soybean oil).

Producer Communications Expenditures

From 1992/93 to 2011/12, anywhere from 4% (1995/96) to slightly more than 25% (1993/94) of USB soybean checkoff program expenditures were allocated to producer communications for an average of 14.3% over the period. In 2012/13, producer communications accounted for 14.2% of total expenditures. Many other checkoff commodity organizations spend similar amounts on producer communications, from 1.0% by the Dairy Checkoff (DMI) to 20% by the national Watermelon Promotion Board (Table 1). Most small checkoff organizations spend little on producer communications.

[10] Data on QSSB domestic promotion expenditures are only available for 2007/08 through 2011/12.

Figure 9: USB Domestic Promotion Expenditures, 1994/95-2011/12

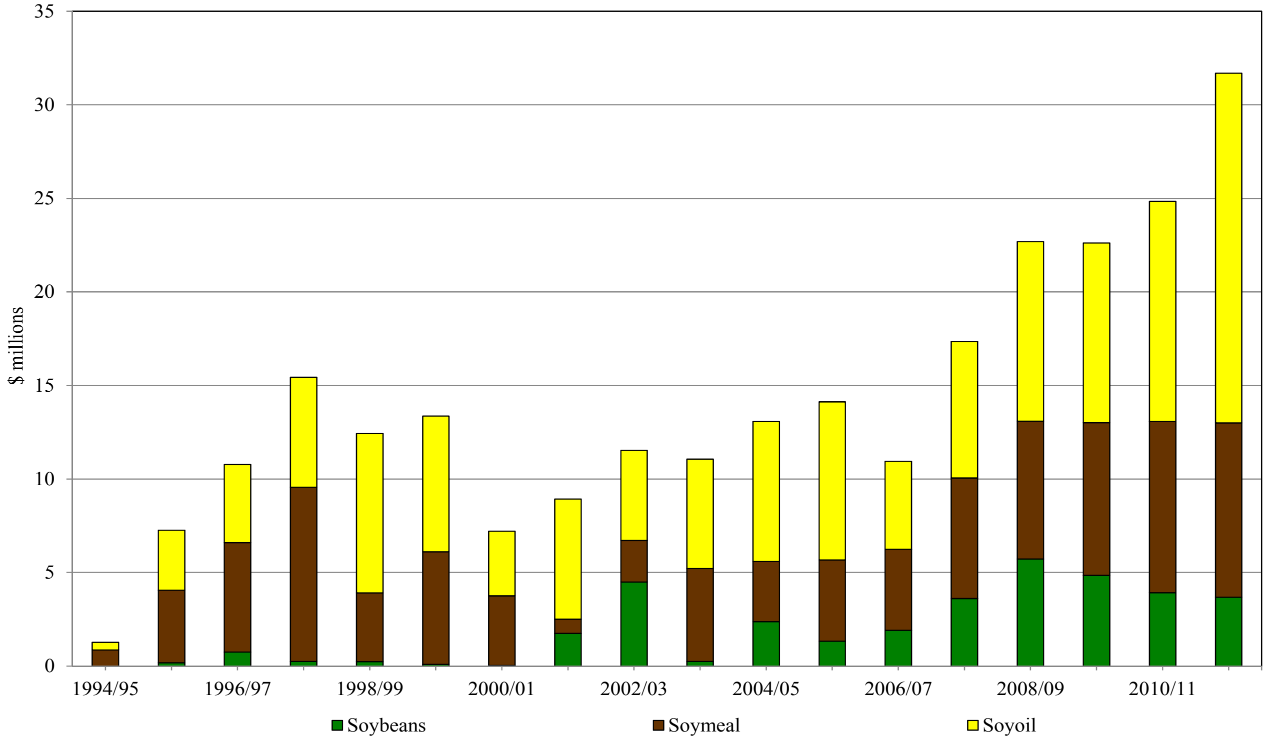
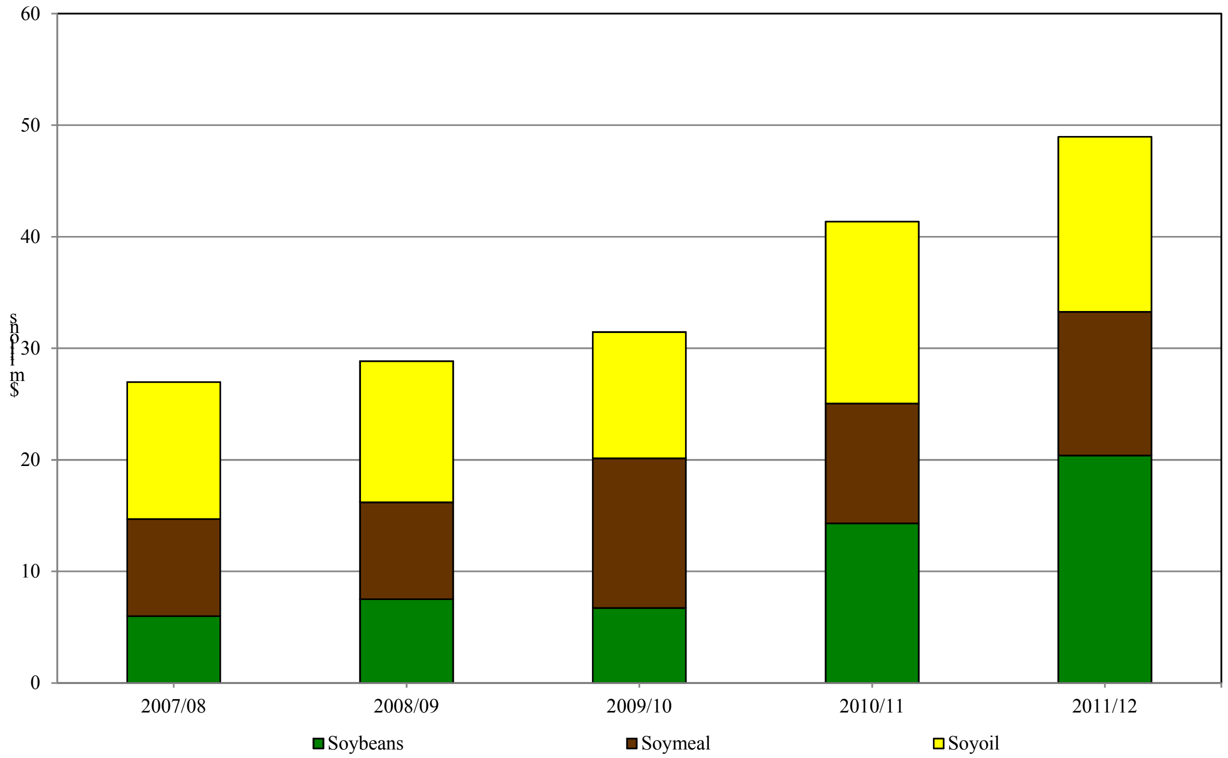


Figure 10: QSSB Domestic Promotion Expenditures, 2007/08-2011/12[a]



[a] QSSB data on domestic promotion are available only for 2007/08 to 2011/12.

Table 1: Comparison of Selected Commodity Checkoff Board Expenditures on Producer Communications

Commodity Checkoff Boards	Producer Communications	Total Expenses	Percent of Total
Beef Board (2013)[1]	$1,529,824	$36,372,737	4.2
Pork Board (2013)[2]	$2.0 million	$91.8 million	2.2
Dairy Management Inc. (DMI) (2012)[3]	$2.0 million*	$199.0 million	1.0
American Lamb Board (2013)[4]	$260,623	$2,163,993	12.0
United Soybean Board (2012)[5]	$13,218,442	$92,911,394	14.2
National Corn Growers Assn (2013)[6]	$553,425	$16,305,938	3.4
National Peanut Board (2012)[7]	$228,454	$5,167,170	4.4
United Sorghum Board (2013)[8]	$634,201	$8,012,670	7.9
National Watermelon Promotion Board (2012)[9]	$551,132	$2,825,886	19.5

* = "Business and Integrated Communications."
Sources: [1] http://viewer.epageview.com/Viewer.aspx?docid=90d59cde-740f-4491-b804-a2bb00a7d768
[2] http://www.pork.org/FileLibrary/PORKFileLibrary3/2013_Year_In_Review.pdf
[3] http://dmistorage.teamdairy.com/dairyorg/index.html#/page/5
[4] http://www.lambcheckoff.com/wp-content/uploads/2012/10/ALB_AnnualReport2013_011014_reader.pdf
[5] http://unitedsoybean.org/wp-content/uploads/2012-Annual-Report.pdf
[6] http://ncga.com/upload/files/documents/pdf/publications/13grwr-0022013anlrptfnllores.pdf
[7] http://issuu.com/nationalpeanutboard/docs/annual_report_2012
[8] http://sorghumcheckoff.com/wp-content/uploads/2012/11/2013_USCP_AnnualReport_Web.pdf
[9]http://www.watermelon.org/IndustryMembers/pdfs/2011-12_AnnualReport.pdf

While comparing expenditures on producer/industry communications among checkoff groups is interesting, the comparison provides little information on the relative effectiveness of their communications programs. A lower percentage spent on communications by some checkoff organization could mean that the group is quite cost-effective in getting out its messages to stakeholders. On the other hand, the low percentage simply may imply that the group is under-investing in producer communications so that stakeholders are relatively less well-informed and, as a result, potentially less satisfied with the results of their checkoff program.

Soybean checkoff expenditures for communications are a critical component of sustaining a successful checkoff program. Maintaining support for the continuation of the checkoff program among stakeholders requires that they be kept informed of the programs, activities, and successes of the checkoff in which they are the chief investors. Thus, rather than attempting to increase soybean productivity, reduce soybean production costs, or promote demand for soybeans or soybean products, the core effort of communications activities is to ensure that all USB stakeholders are informed and aware of pertinent actions and information related to soybean checkoff activities. In addition, communication activities focus on ensuring consistent messaging across the soybean industry, building relationships among key influencers in agriculture and in agricultural media industries, establishing the soybean checkoff and the USB as resources for information pertaining to the soybean industry, and related activities (USB 2013).

Certainly increased information enhances efficiency which can have a positive effect on the industry. Nevertheless, given that the primary goal is to inform rather than to grow the industry, the effectiveness of the communications expenditures of the soybean checkoff or any other checkoff program cannot be measured with the same statistical procedures used to analyze the effectiveness of supply- and demand-oriented expenditures. Thus, studies of checkoff program effectiveness normally do not include producer communications expenditures as part of their analyses.

Measuring the effectiveness of producer communications requires a different type of approach, one that measures whether the specific goals of the expenditures have been met. Most efforts to measure the effectiveness of producer communications focus on the effect of the expenditures on enhancing stakeholder awareness of the checkoff program, its activities, and benefits.

The most common method to determine the effectiveness of producer communications activities is to survey stakeholders and measure their awareness of the checkoff program and their support, opposition, and beliefs regarding the program. The initial survey normally establishes a benchmark against which changes in the levels of awareness, support, and beliefs of producers regarding the program can be tracked over the years in subsequent surveys. The Tarrance Group, Inc. has been tracking attitudes among soybean farmers for many years. Comparing the Tarrance Group survey results in 2008 at the time of the last ROI study with those in their March 2013 report provides some insights on how effective soybean checkoff communications efforts have been over that period:

- About 14% of soybean producers indicate they are now extremely or very familiar with the details and specifics of the soybean checkoff program, 64% indicate they are somewhat familiar, and 21% indicate they are not at all familiar with the details and specifics of the checkoff. At the time of the last ROI study, the Tarrance Group reported that slightly fewer producers (13%) were familiar with the program, slightly more (66%) were somewhat familiar, and slightly fewer (20%) were not at all familiar;
- Producer support for the program is now about 76% which is slightly higher than what the Tarrance Group reported at the time of the last ROI study (75%) while opposition over that period has declined from 14% to 12%;
- The percentage of producers who believe that the program has helped to expand new international markets for U.S. soybeans remained at 81%, the same as was reported by the Tarrance Group at the time of the last ROI study;
- The percentage of producers who believe that production research expenditures have helped develop new soybean production advances is now slightly lower at 75% compared to the 76% reported by the Tarrance Group at the time of the last ROI study; and
- The percentage of producers who believe that the program is still a good investment for the industry was 70%, down slightly from 71% as reported by the Tarrance Group at the time of the last ROI study.

The Purchasing Power of Soybean Checkoff Investments

Despite a strong upward trend in the nominal dollar value of soybean checkoff expenditures over the years, inflation in the U.S. and foreign countries and a general depreciation in the value of the U.S. dollar against foreign currencies have eroded the real purchasing power of those expenditures over time in the U.S. and in importing countries. In other words, each U.S. dollar could purchase less promotion and research in 2011/12 than was the case in 1970/71 because of inflation and because of exchange rate changes which have eroded the market impacts of checkoff program expenditures at home and abroad over time.

In the U.S., inflation has had an important effect on the real level of research and domestic promotion purchased (Figure 11). As a result of inflation, research and domestic promotion dollars spent in 2011/12 purchased only about 20% of what those dollars would have purchased in 1970/71. In other words, the $52.1 million spent on research in 2011/12 purchased only about $11.4 million in research when the effects of inflation are removed. In the case of domestic promotion, despite an expenditure of about $31.7 million in 2011/12, the actual promotion purchased was worth only about 18% of that figure (about $5.7 million) when measured in 1970/71 dollars.

In foreign markets, inflation and a depreciating U.S. dollar combined for an even more serious impact on the purchasing power of checkoff dollars spent on international market promotion programs. In both the EU15/27 and Japan, for example, inflation and a declining value of the dollar reduced the purchasing power of soybean checkoff expenditures in those countries even more rapidly than actual reduction in nominal dollars (Figures 12 and 13).

In China, the undervaluation of the Renmimbi actually increased the purchasing power of soybean checkoff expenditures in that country over time (Figure 14). In other, smaller countries to which checkoff dollars have been increasingly shifted over the years, progressively rapid inflation, particularly since the mid-1980s, has seriously reduced the purchasing power of checkoff dollars and limited the effectiveness of the market development activities in many of those countries (Figure 15). In essence, the rate of inflation in the cost of goods and services in many of those countries has far outpaced the annual rate of increase in checkoff dollars expended in those same countries. The consequence has been serious erosion in the purchasing power of the budgets of the foreign soybean promotion offices (USSEC) which has hindered their ability to maintain levels of promotion much less expand activities in many cases.

Summary of Key Characteristics of Soybean Checkoff Expenditures

For any checkoff program, three main factors affect the estimate of its market effects and returns to producers: (1) the number of dollars spent, (2) the relative effectiveness and impact of checkoff expenditures on market demand and supply across countries, and (3) the expenditure strategy of the checkoff board as revealed by the commodity, region, and promotional activity patterns of expenditures over time. The results of statistically measuring the country by country, commodity by commodity, and program by program impact of soybean checkoff expenditures on soybean and soybean product market demand and supply are presented and discussed later in this report.

Figure 11: U.S. Production Research and Domestic Promotion Expenditures, Nominal vs. Real, Inflation Adjusted, (million 1970/71 $US), 1970/71-2011/12

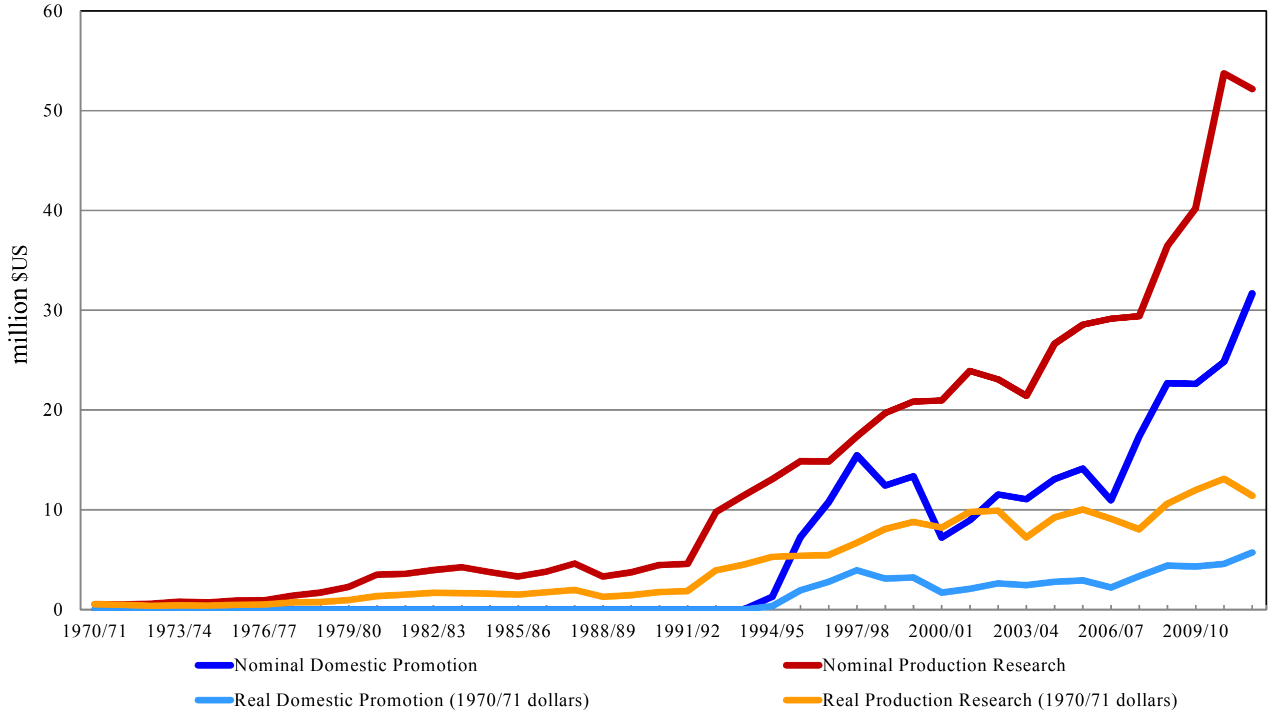


Figure 12: EU15/27 International Market Promotion Expenditures, Nominal (million $US) vs. Real (million 1970/71 SDRs), 1970/71-2011/12

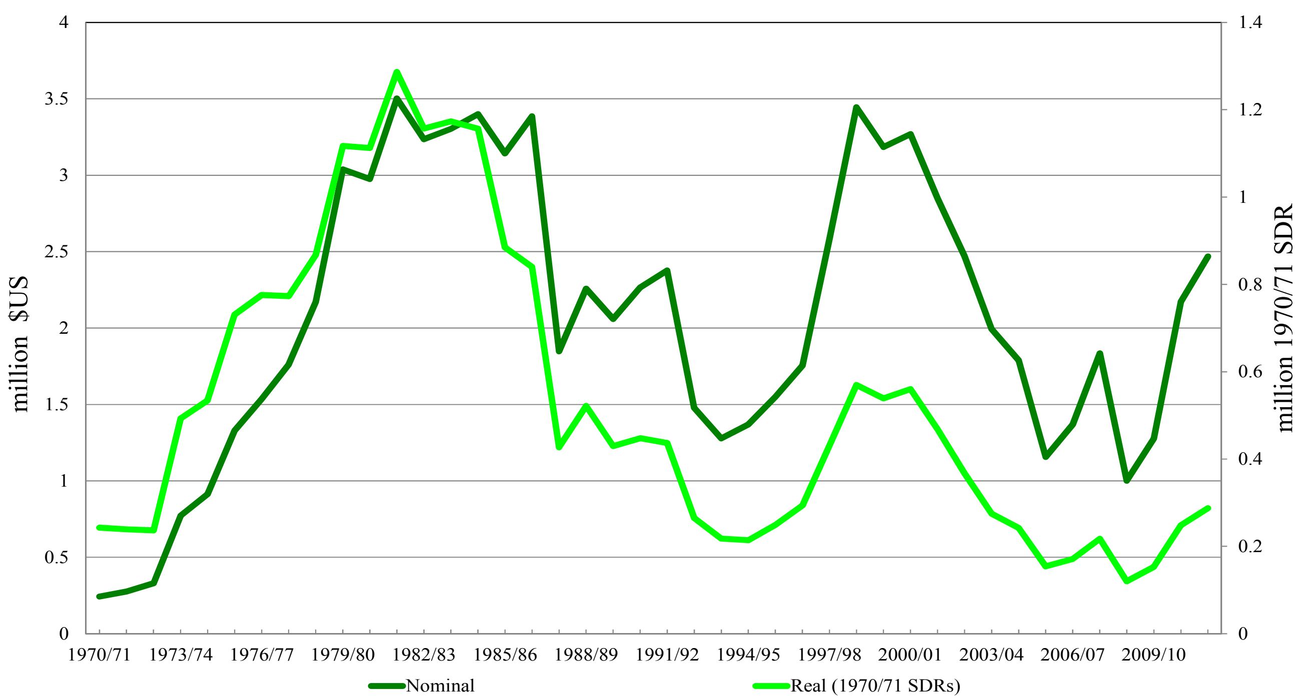


Figure 13: Japan International Market Promotion Expenditures, Nominal (million $US) vs. Real (million 1970/71 Yen), 1970/71-2011/12

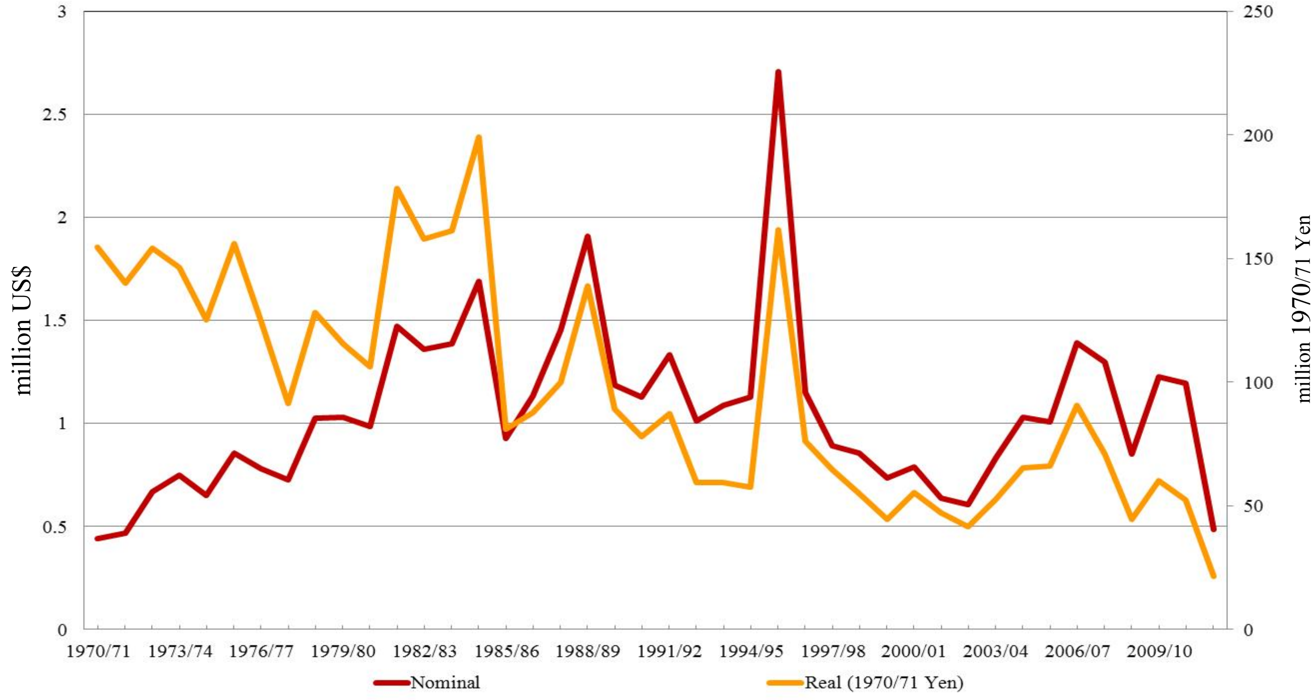


Figure 14: China International Market Promotion Expenditures, Nominal (million $US) vs. Real (million 1970/71 Renmimbi), 1980/81-2011/12

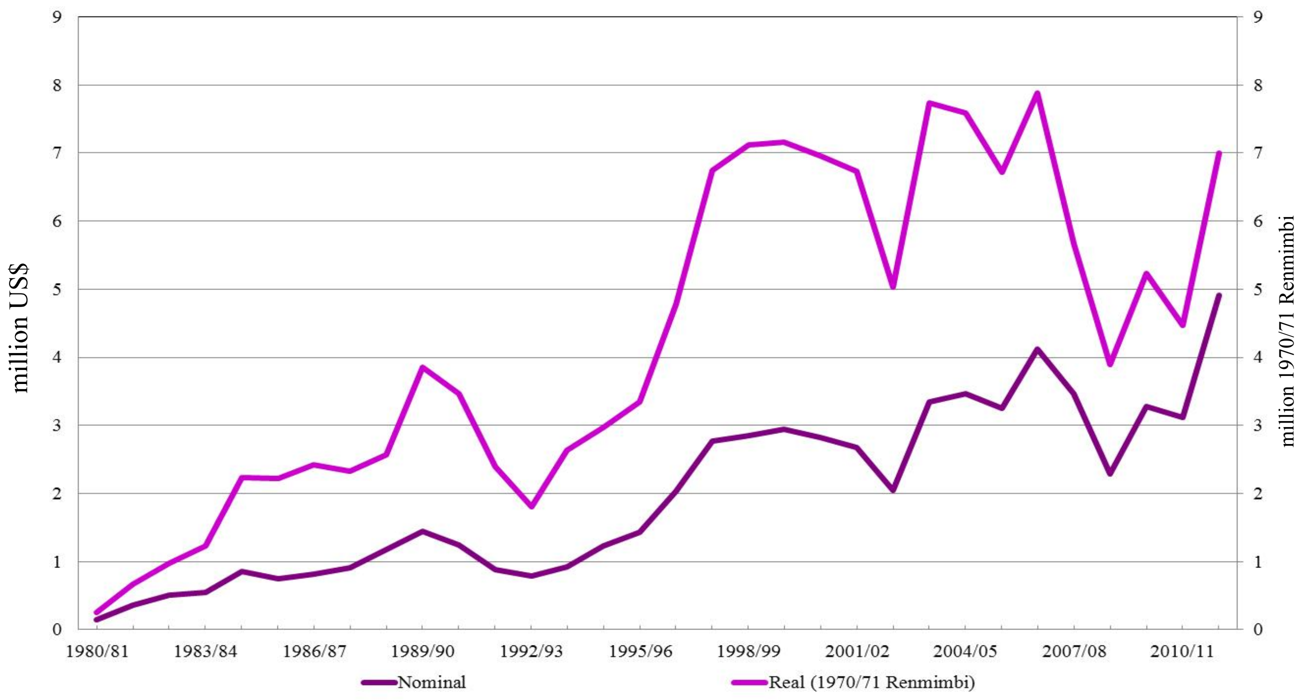
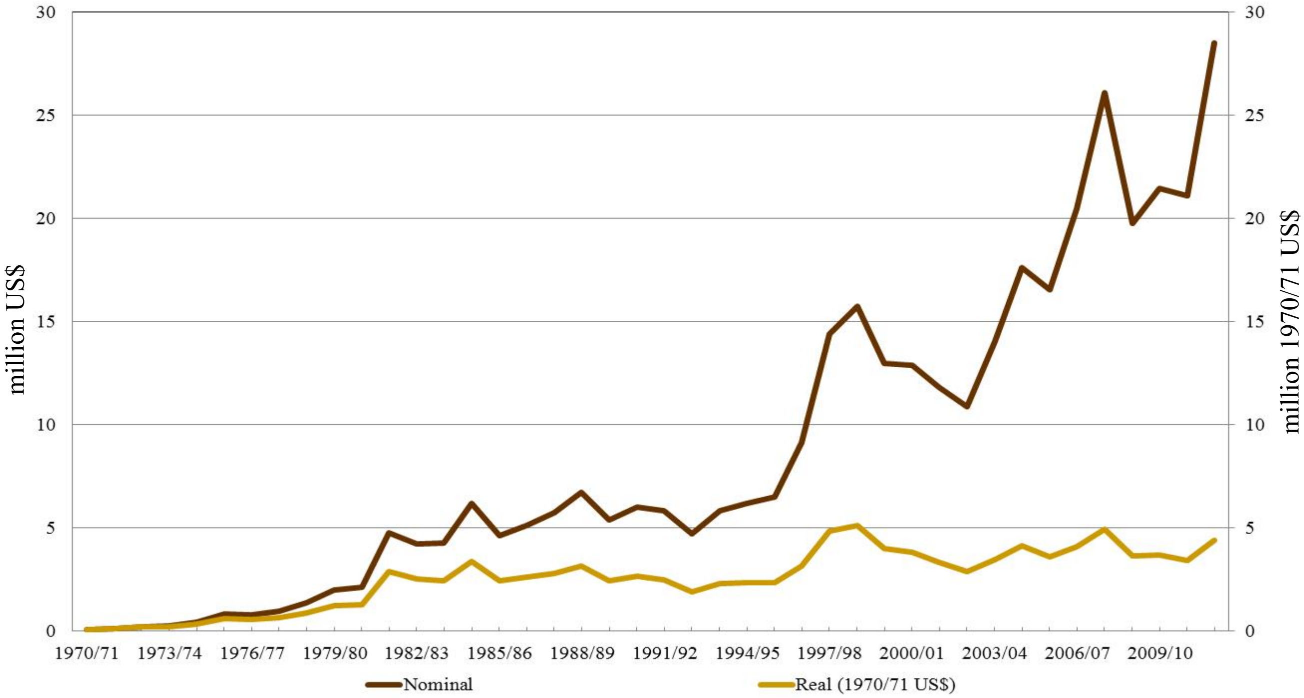


Figure 15: Rest of the World International Market Promotion Expenditures, Nominal (million $US) vs. Real (million 1970/71 $US), 1970/71-2011/12



In this section of the report, the key features and patterns of soybean checkoff expenditures over the years are highlighted to provide a basis for understanding the statistical results and related interpretation and conclusions presented later in this report. The following characteristics of checkoff expenditures over the years highlight changes in checkoff promotion strategies, particularly since the implementation of the national checkoff program in the early 1990s:

1. *Production research expenditures were increased from the 1980s to the 1990s and beyond at the expense of international market promotion expenditures.* The share of checkoff expenditures allocated to international market promotion dropped steadily from 70-75% before the early 1990s to about 30% in recent years while the production research share jumped from 30%-35% to 45%-50% over the same period. The consequence has been less demand "pull" being generated in world markets by the checkoff program and more supply "push" leading to less support for soybean and product prices since implementation of the national soybean checkoff program.

2. *The emergence of domestic promotion programs with the implementation of the mandatory checkoff program has assisted in the erosion of checkoff allocations for international promotion.* From virtually nothing in the early 1990s, the share of expenditures allocated to domestic promotion programs spiked at nearly 30% in 1997/98 while expenditure allocations for production research were also increasing. The result was a double hit to the share of total soybean checkoff expenditures accounted for by international marketing promotion.

3. *The share of checkoff expenditures allocated to domestic promotion has remained fairly even since the late 1990s.* After the initial surge in the share of checkoff expenditures allocated to

domestic promotion to almost 30% between 1994/95 and 1997/98 and a subsequent retreat to about 15% in 2000/01, the share of checkoff funds spent on domestic promotion has tended to stabilize at around 25%. With the share of expenditures for international market promotion declining and for domestic promotion fairly stable, the result was even greater emphasis on production research to shift out the supply curve while emphasis on demand promotion waned. This change added even more supply "push" to soybean checkoff programs and less demand "pull."

4. *In international promotion programs, the focus over time has switched from maintaining and building a few large markets to opening and developing many new, smaller markets.* The share of international market promotion expenditures going to the European Union and Japan declined from 80%-90% in the 1970s to only 8.1% in 2011/12. The reduction in international marketing promotion expenditures in those two markets makes sense because the share of world soybean imports accounted for by the two countries has declined from about 90% in the mid-1990s to about 16% in 2012/13. At the same time, however, the share of international market promotion dollars going to China, currently the single largest market for U.S. soybeans, has declined in recent years to about 13% in 2011/12 from a high of only 17% in 2003/04 while China's share of world imports has exploded from virtually nothing in the mid-1990s to about 63% in 2012/13. About 75%-80% of all international market promotion expenditures are now allocated to smaller, less developed countries and regions which account for only about 21% of world soybean imports. The shift in focus of international marketing promotion expenditures from larger to smaller developing countries has pitted a philosophy of maintaining and building sales in large countries with established or stable soybean and product markets against one of building sales in a large number of smaller, growing markets. The challenge is that the re-direction of international market promotion expenditures from the larger established markets to new, growing markets must generate at least the same return to the checkoff dollars spent as might have been achieved without re-directing those expenditures to avoid a loss of returns to the investment of international marketing promotion dollars. It can take years of expenditures in new markets before substantial returns are generated but only a short period of no expenditures to lose any gains previously achieved.

5. *In international promotion programs, the commodity emphasis of expenditures since the mid-1980s has been shifting from value-added soybean products, primarily soybean meal, to soybeans.* Over time, checkoff dollars allocated to international market promotion have been increasingly used to promote foreign demand for U.S. soybeans rather than for soybean products. This shift may be the consequence of the growing emphasis on new, less developed markets rather than the larger, more established markets as a part of the long-term international market promotion strategy. Over time, as the newer markets mature, market demand and promotion expenditures might be expected to shift towards value-added products (soymeal, soyfood, and soyoil) once again. In the meantime, lower returns may be generated by an increase in promotion-induced soybean exports relative to those of value-added products.

6. *Total checkoff expenditures are extremely small compared to the value of U.S. soybean production.* Although the $120 million of checkoff funds spent on research and promotion in 2011/12 is a great deal of money to most soybean producers, that amount of money

represents a drop in the bucket compared to the value of U.S. soybean production each year. Checkoff expenditures represent less than one-half of one percent (0.5%) of the value of U.S. soybean farm cash receipts. Consequently, it would be unreasonable to expect that such a relatively small amount of money to have huge impacts on market supply, demand, and price. The effects are likely to be small but as long as the cost of bringing about small changes is even smaller, the returns to producers per dollar spent could be quite large.

7. *Stakeholder communications expenditures have little effect on the supply of or demand for soybeans and soybean products in U.S. or world markets.* While necessary to maintain support among stakeholders for the checkoff program, checkoff expenditures for such are not directed primarily at increasing soybean productivity, reducing soybean production costs, or promoting the demand for soybeans or soybean products. Thus, the effectiveness of producer communications expenditures cannot be measured using the same statistical procedures used to analyze the effectiveness of supply- and demand-oriented expenditures. Consequently, this study, like those of other commodity checkoff programs, does not include producer communications expenditures in the analysis of the effectiveness of the soybean checkoff program.

8. *Inflation in all countries and changes in the value of the U.S. dollar in foreign markets have seriously eroded the purchasing power of soybean checkoff expenditures in the U.S. and in many other countries.* In the U.S., checkoff dollars spent in 2011/12 purchased only about 20% of what those dollars would have purchased in 1970/71. In foreign markets, depreciation in the dollar combined with rapid inflation have caused the cost of goods and services in many of those countries to far outpace the annual rate of increase in checkoff dollars expended in those same countries. The only exception is China where the undervalued Renmimbi has tended to boost the purchasing power of checkoff dollars in that country. Thus, despite growth in the *nominal* value of dollars spent at home and abroad, the real, effective purchasing power of those dollars has increased much less rapidly and even declined in many areas of the world.

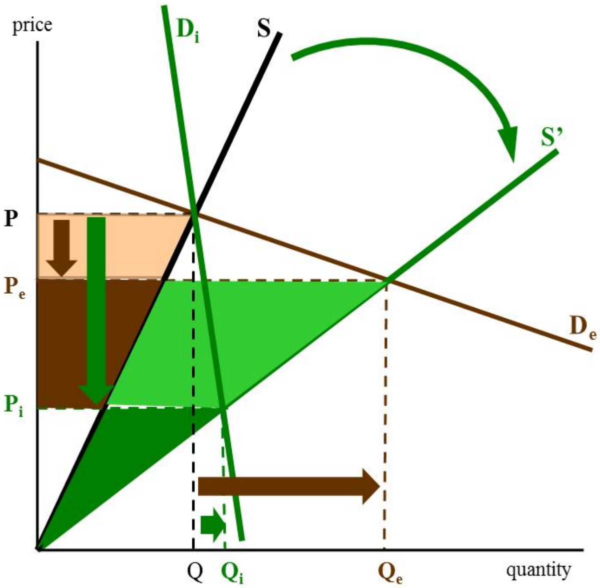
The Expected Market Effects of Research and Demand Promotion Expenditures

The primary objective of any commodity checkoff program is to foster the growth and profitability of the production of that commodity. Ultimately, however, the individual producers contributing to the program expect that the funds will be spent in such a way that they are individually better off than they would have been without the checkoff program. What can reasonably be expected of a research and promotion program in terms of the market effects and the effects on producers? This section explores what could be expected - and what should not be expected - from a checkoff program.

The Expected Effects of Investments in Research

From the perspective of the individual soybean producer, checkoff expenditures on production research offer the potential for increased profits through technological advances that reduce their production costs and/or boost their yields (i.e., output per unit of input). From a market perspective, however, if such research-induced technological advances are successful at reducing costs and/or boosting yields and are adopted by a majority of producers, the effect is an increase

Figure 16: Production Research Expenditures: Market and Producer Welfare Effects



in the aggregate market supply of soybeans. The impact on producer profits (sales revenues minus production costs) depends critically on the responsiveness of demand to price changes.

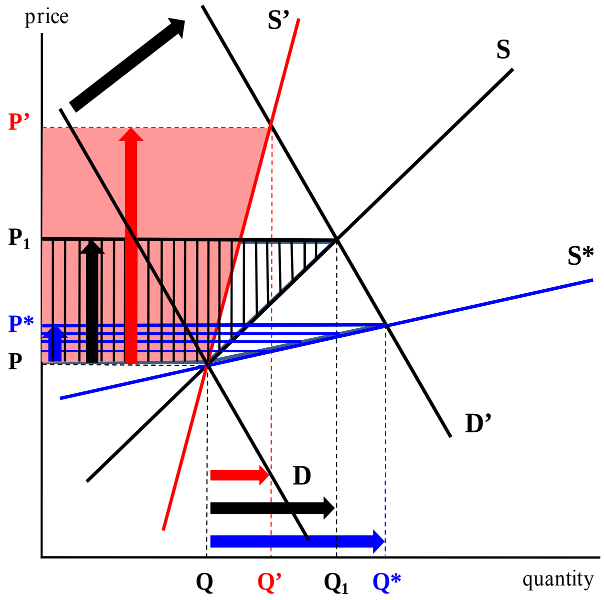
Assume, for example, that market demand is highly price responsive (i.e., price elastic) as represented by demand curve D_e in Figure 16. A research-induced shift out in the market supply curve from S to S' leads to an increase in the market sales of the commodity from Q to Q_e and a decline in the market price from P to P_e. In this case, total sales revenues (i.e., farm cash receipts) actually increase even though the price declines because the percentage increase in the quantity sold from Q to Q_e is greater than the percentage drop in market price from P to P_e. Although the total cost of production (represented by the area under the supply curve up to the point of production) also increases as production increases for a highly elastic demand curve, the revenue increase is likely to be greater than the cost increase resulting in a net increase in producer profits. The positive net effect on producer profits is represented in Figure 16 by the sum of the two greenish areas minus the light brown area (i.e., the net change in producer surplus).

On the other hand, if market demand is highly unresponsive to price (i.e., price inelastic), as is the case with demand curve D_i in Figure 16, then the same research-induced shift in supply (S to S') leads to a larger percentage drop in market price (P to P_i) than the percentage increase in the quantity sold in the market (Q to Q_i). As a consequence, farm cash receipts decline. Total production costs might also decline in this second case as well but, given a highly inelastic demand curve, the revenue drop is likely greater than the cost decline resulting in a net loss to producers represented in Figure 16 by the darker green area minus the sum of the two brownish areas (dark brown and tan). The more inelastic the demand, the more likely the darker green area will be smaller than the two brownish areas resulting in a net loss to producers. That is, the more unresponsive demand is to price changes, the more likely it is that checkoff expenditures on research will lead to a drop rather than an increase in farm profits.

Some researchers (e.g., Schuh 1984) have argued that while domestic market demand for agricultural products tends to be fairly unresponsive to price (i.e., price inelastic), export demand tends to be quite responsive to price changes (i.e., price elastic). Consequently, total demand (domestic plus export demand) for agricultural products could well be elastic. If that is the case, then checkoff-induced increases in supply would be expected to enhance farm profits.

Other researchers (e.g., Schmitz 1988 and Bredahl, Meyers, and Collins 1979), however, have argued that the protectionism in world markets, including import restrictions and nontariff

Figure 17: Demand Promotion Expenditures: Market and Producer Welfare Effects



barriers of all types, state trading, and other institutional arrangements "make the excess demand curve facing the U.S. relatively price inelastic" (Schmitz 1988). If the export demand for an agricultural product is indeed price inelastic, then total demand for that product is likely price inelastic so that a research-induced outward shift in supply could well result in a loss in producer profits.

The Expected Effects of Demand Promotion

The objective of demand promotion is to shift out demand and, thereby, increase the market price on a higher volume of sales over time. Indeed, promotion programs that successfully move out the demand curve raise price. In raising the price, however, they also stimulate a greater level of production over time than would have occurred which moderates the extent of the price increase.

Assume, for example, that a particular demand promotion program shifts out the demand for soybeans in a given year from D to D' in Figure 17. Given a supply of soybeans of S*, the demand shift would tend to raise the price from P to P*. In this case, supply is so responsive to price changes (i.e., price elastic) that most of the adjustment to a successful promotion program is manifest as an increase in output and sales (Q to Q*) rather than an increase in price. Even though the price increase from the promotion-induced demand shift is moderated by the vigorous supply response in this case, farm sales revenue increases by a greater percentage than the price increases over time because the quantity sold at the somewhat higher price also increases.

Although the total cost of production also increases in this case, the increase in revenue given a demand shift is greater than the cost increase so that the net effect on producer profits is positive, represented by the small blue-lined area in Figure 17. Thus, while it could appear to individual producers that the promotion program was not highly successful because the price did not increase much or as much as expected over time, in fact the program is quite successful in boosting farm revenues and even profits.

A much less price-responsive supply (such as S' in Figure 17), however, would result in a higher price increase (P_0 to P') relative to the increase in sales (Q to Q') as a result of the same demand increase (D to D') and, thus, a larger positive effect on farm profits (represented by the light red area in Figure 17). Thus, the extent of the increase in farm profits from a promotion-induced increase in demand depends on the responsiveness of supply to price over time (i.e., the long-run price elasticity of supply). The stronger the competition from competing suppliers of a commodity, the more likely the long-run market supply curve will look like S* (price elastic) rather than S' (price inelastic) in Figure 17.

For example, if a U.S. industry faces stiff competition in an international market relatively free of trade restrictions, a price rise induced by an increase in world demand will stimulate production not only in the U.S. but also in competing countries so that world supply increases by more than just the increase in the U.S. supply. Given the strong competition U.S. soybean producers face in the world market from South American producers, any increase in foreign demand for soybeans is likely to generate a worldwide supply response to meet that demand which would moderate any price increase that might be expected.

The important issue, then, is whether or not and by how much an increase in world soybean demand from checkoff-supported promotion activities would increase the U.S. share of world soybean sales compared to that of U.S. competitors in the world market. Given the intensity of competition in world soybean and soybean product markets, the effects of a checkoff-supported international market promotion program on both the level and world market share of U.S. exports of soybeans and products is perhaps a better indicator of the successfulness of the program than changes in U.S. soybean and product price.

A number of researchers have reported that supply response can effectively prevent a long-term rise in producer price or even completely offset the effects of producer-funded commodity promotion programs. Previous studies of the effectiveness of the soybean checkoff program (Williams 1985, Williams, Shumway, and Love 2002, and Williams, Capps, and Bessler 2009) concluded that although the program was effective in expanding demand and generated a high benefit-cost ratio, the farm price of soybeans was not much affected as the result of supply expansion.

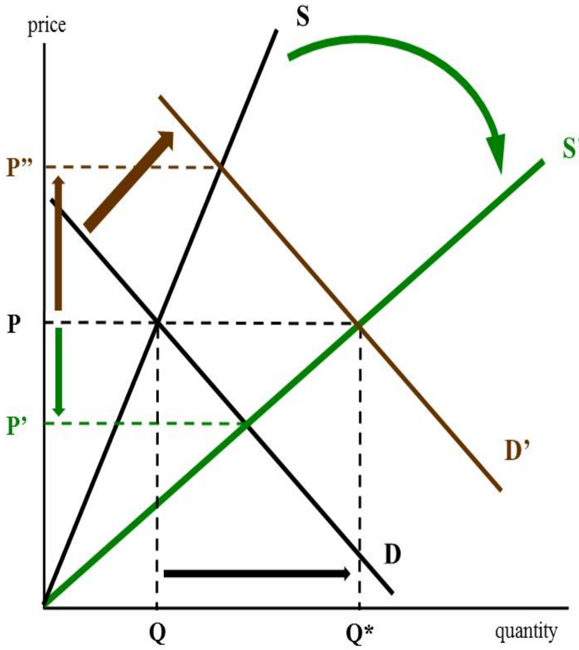
Similar results have been found by other researchers for other checkoff commodities. The problem of advertising response in an industry without supply controls was first discussed in a now classic article by Nerlove and Waugh in 1961. Nevertheless, relatively few studies of the effects of advertising have considered the possibility of a supply response. Kinnucan, Nelson, and Xiao (1995) determined that supply response completely eliminated returns to advertising of catfish over time.

Carman and Green (1993) found that avocado producers benefitted from generic advertising during the initial years of the program (1960s and mid-1970s) but supply expansion eventually led to negative returns from continued advertising. While avocado producers existing at the time the advertising program was initiated benefitted, they conclude that "as acreage expanded, prices were forced down toward a level that would have existed for a smaller acreage without advertising. Now real returns per acre for avocados are similar to those that would have occurred without the advertising but the advertising has become a built-in cost." They question whether there are long-run benefits to advertising in an industry without supply control.

The Price-Offsetting Effects of Simultaneous Checkoff Investments in Production Research and Demand Promotion

Analyzing the separate effects of checkoff investments in research and in demand promotion is instructive but fails to consider the tendency for the two types of investments to push market price in opposite directions when applied at the same time.

Figure 18: Market Effects of Simultaneous Investments in Production Research and Demand Promotion



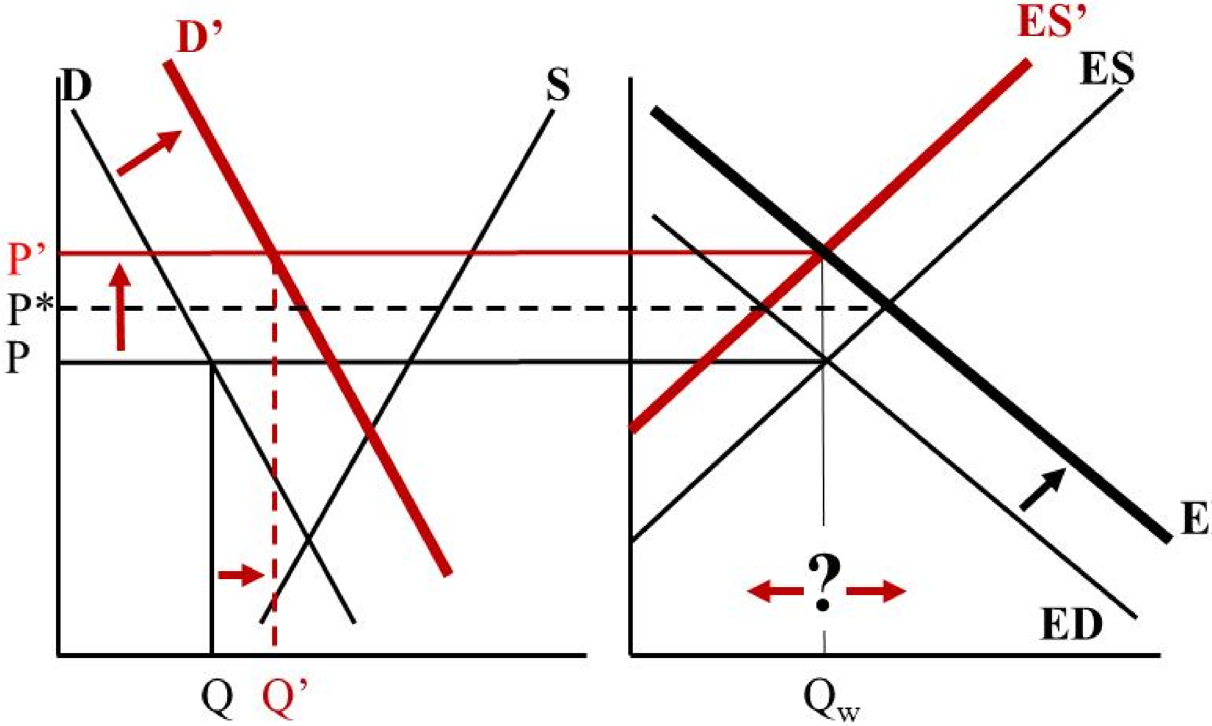
If checkoff-funded research shifts out the supply of soybeans as in Figure 16 while checkoff funding simultaneously shifts out the demand for soybeans as in Figure 17, then we get the situation depicted in Figure 18. On its own, checkoff-funded demand promotion would tend to shift demand to D' and increase price to P'' in Figure 18. On the other hand, checkoff funded research, on its own, would tend to shift out supply to S' and reduce price to P'. Funded at the same time, however, the price increasing effects of demand promotion are muted by the price-reducing effects of supply enhancement from research investments. The net effects on price could be higher, lower, or just about the same as the initial price (P) depending on the relative shifts of the demand and supply curves as result of checkoff activities. Without question, however, the two types of investments work together to generate more production and more sales of soybeans.

The evident strategy of the soybean checkoff program based on the observed pattern of expenditures has been to enhance demand and generate additional supply to feed that growing demand. While a reasonable strategy, the challenge the checkoff program faces is to manage the level and growth of investments in demand promotion and in supply enhancement to maintain profitability. Too much emphasis on research investments relative to demand promotion would lead to lower market prices and profits of producers as supply increases overbalance the demand increase achieved. On the other hand, too much emphasis on demand promotion relative to supply enhancement will lead to demand increases outrunning supply increases so that demand unfilled by U.S. production will be filled by our world export competitors. Balancing supply enhancement through research investments and demand promotion is the key to capturing the returns from checkoff investments while maintaining the global competitiveness of the U.S. soybean industry.

The Trade-Offsetting Effects of Simultaneous Checkoff Investments in Domestic and Foreign Demand Promotion

In the early years of the checkoff program, demand promotion programs were conducted primarily in foreign markets. With the implementation of the mandatory checkoff program in the mid-1990s, however, checkoff funds began to be invested heavily in domestic promotion programs as well. To soybean producers demand is demand. As long as someone purchases their product, it doesn't really matter whether it is a foreign consumer or a domestic consumer. Demand increases prices whether it is foreign demand or domestic demand. However, what happens to U.S. exports of soybeans and products depends on whether the promotion is domestic

Figure 19: Effects of Simultaneously Investing in Domestic and Foreign Demand Promotion



or international. Figure 19 illustrates the problem in the case of U.S. soybean exports. The left panel of Figure 19 illustrates the domestic U.S. supply and demand for soybeans (curves S and D, respectively, in Figure 19). The horizontal difference between domestic supply and demand is the U.S. excess supply of soybeans available at each price (that is, the supply not consumed by domestic users and, therefore, available for export) shown as the curve ES in the right panel of Figure 19. The foreign demand for U.S. soybeans is the downward sloping excess demand (ED) curve in the right panel of Figure 19.

A checkoff-induced increase in domestic promotion is shown in the left panel of Figure 19 as a shift of the domestic demand to the right (the red line marked D'). With greater domestic demand, the excess supply of soybeans available for export at every price is now less which is shown as a leftward shift of the excess supply curve in the right panel of Figure 19 to the red line marked ES'. The consequence would be an increase in price to P* and a lower level of exports because of the increase in domestic use of the available supply.

If, instead, checkoff expenditures shift out the foreign demand for soybeans (a shift of the excess demand curve from ED to ED' in Figure 19), the consequence is, again, an increase in the price of soybeans to the same price level achieved by the domestic demand increase (P*) but this time accompanied by a greater level of exports and a lower level of domestic soybean use.

Now if both domestic and foreign demand are simultaneously promoted so that both the domestic demand and the foreign demand curves for soybeans shift to the right (a shift of D to D' in the left panel of Figure 19 and a shift of ED to ED' in the right panel of Figure 19), the result is an even higher price achieved (P') than with only domestic or only foreign demand promotion. The consequence for soybean exports, however, is ambiguous. If checkoff expenditures favor foreign demand promotion over domestic demand promotion, exports are likely to increase with price at a level somewhat lower than P'. If, however, expenditures on domestic promotion are favored, then the consequence would likely be lower exports with, again, a price somewhat lower than P'. Either way, the soybean price tends to increase but surprisingly, despite foreign promotion efforts, exports could actually decline because of a heavy investment in domestic demand promotion relative to foreign demand promotion.

The Joint Product Complications for the Markets Effects of the Checkoff Program

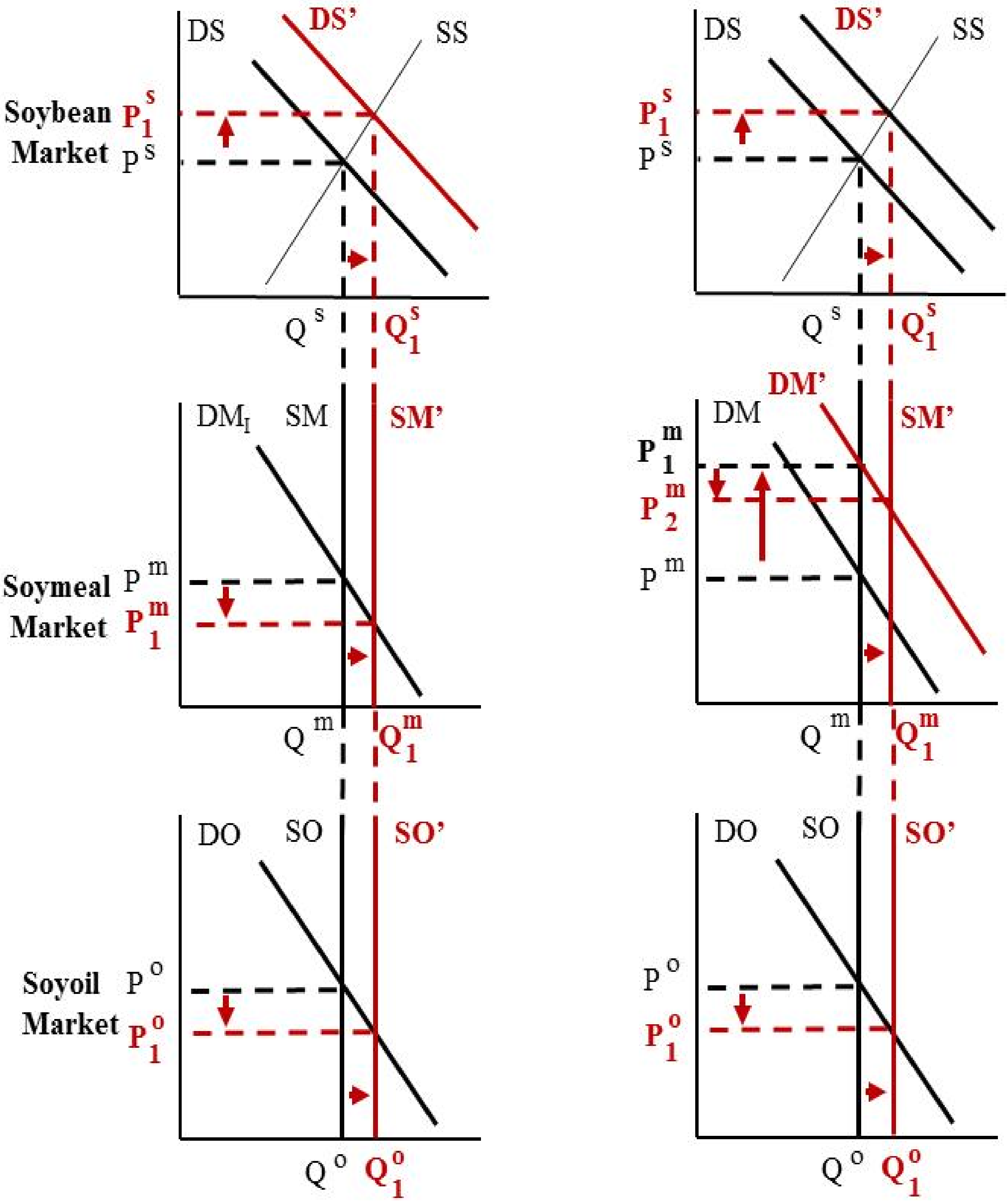
The soybean checkoff program invests not only in the promotion of soybeans but also in the promotion of soybean oil and soybean meal, joint products of the processing of soybeans. In fact, the demand for soybeans is derived from the demand for its joint products. It is the joint product characteristics of soybean and product markets that create some offsetting effects of promotion in those markets.

For example, if the demand for soybeans is promoted relative to that of its joint products, the consequence is lower soymeal and soyoil prices but more quantity of soymeal and soyoil produced and consumed as shown in the column of graphs on the left side of Figure 20. In those graphs, the top set of supply and demand curves represent the soybean market, the middle set represents the soybean meal market, and the bottom set represents the soybean oil market. Note in the top graph that the quantity of soybeans processed (Q^S) at the market price (P^S) results in a supply of soybean meal and a supply of soybean oil represented by the vertical lines marked SM and SO, respectively. The vertical nature of the SM and SO curves in Figure 20 reflects the fact that when soybeans are processed, a fixed amount of meal and oil are produced and that the quantity of meal and oil supplied to the market cannot change as their prices change unless the volume of soybeans processed changes first.

If the demand for soybeans is promoted with checkoff funds, the result is a rightward shift of the soybean demand curve from DS to the red line marked DS' in the top left graph of Figure 20. As a result, the price of soybeans increases from P^S to P^S_1 as shown in the top left graph of Figure 20. At the same time, the increased volume of soybeans processed increases the supply of soymeal from SM to SM' and of soyoil from SO to SO'. The result is lower prices in the markets for both joint products (P^m_1 in the soymeal market and P^o_1 in the soybean oil market). The lower prices, however, result in some increase in the quantities of soybean meal and oil consumed in those markets.

Rather than promoting soybeans over soybean products in the domestic market, the checkoff promotion could focus on promoting the demand for the joint products. In the right hand column of graphs in Figure 20, which also represents the markets for soybeans and its joint products, the demand for one of the joint products is assumed to be promoted (soybean meal in this case) rather than soybeans. The resulting increased demand for soybean meal is represented by a shift of the soybean meal demand curve from DM to DM' in the middle graph of the right hand column of graphs in Figure 20. The result is an initial increase in the price of soybean meal to P^m_1 which increases the crush margin for soybean processors and leads to an increase in the demand for

Figure 20: Effects of Checkoff Promotion in Joint Product Markets



soybeans for processing (a shift of the soybean demand curve from DS to DS' in the top right panel of Figure 20). The increase in processing, however, increases the supply of both soybean meal and soybean oil to SM' and SO', respectively, in the right hand column of graphs in Figure 20. The increase in the meal supply moderates the initial soybean meal price increase to some extent resulting in a somewhat lower price like P^m_2 in the middle graph of the right column of graphs in Figure 20. In the soybean oil market, the increased demand for soybean meal which prompted increased additional soybean crushing leads to an increased supply of soybean oil as well and a lower market price for soybean oil (SO' and P^o_1, respectively, in the bottom right panel of Figure 20). A similar story would hold if soybean oil were promoted more aggressively than soybean meal. The difference would be a decline in the market price of soybean meal while the price of soybean oil increased.

Summary of the Ambiguous Net Effects of Soybean Checkoff Promotion on U.S. and World Soybean and Soybean Product Markets

Given the joint product nature of soybean markets and the fact that soybean checkoff funds are used to simultaneously promote production research, the domestic demand for soybeans and soybean products, and the foreign demand for soybeans and soybean products, the effects of the checkoff program on U.S. soybean and soybean product supplies, demands, trade, and prices are unclear in many respects. The offsetting price and quantity effects of the various types of promotion make tracking the effects by any simple spreadsheet process impossible. The effects depend critically on not just the relative levels of expenditures on production research and demand promotion but also on the relative levels of promotion expenditures on soybean demand relative to expenditures to promote the demands for soybean products as well as the relative levels of promotion expenditures on domestic and foreign demand.

The effects of checkoff promotion also depend critically on not just relative levels of expenditures but also the relative effectiveness of those expenditures. Even though more may be spent promoting demand in foreign markets than in domestic markets, for example, that does not necessarily mean that foreign market promotion is more effective in enhancing producer profits. If each dollar spent in foreign markets has lower impact on demand targets compared to the impact of each dollar spent promoting domestic demand, then the lower amount spent on domestic promotion could have a bigger overall impact on the market.

The Relationship between Checkoff Spending and Demand Promotion

In addition to the various complications of supply response, joint products, and more as discussed above, the linkage between investments in demand promotion and the anticipated market effects is further complicated by a number of well documented characteristics of the response of sales to advertising and promotion programs, including: (1) the magnitude of the sales response to promotion, (2) the minimum promotion threshold, (3) the delay effects of promotion, (4) the lagged or carryover effects of promotion, (5) the decay of promotion effects, and (6) advertising and promotion wearout.

Research has shown that the *response of sales to advertising* is normally positive and statistically significant but fairly small in magnitude or elasticity (Ward 2006). Also, research has demonstrated that some *minimum level of promotion expenditures* and messages are normally required for the expenditures to begin having any effect. Below that level, promotion expenditures may be simply unable to generate sufficient recall or awareness to motivate consumers.

Even if investments in promotion activities well above the minimum threshold level are made, there may be a *delay effect of promotion,* that is, a delay between the time that the investment is made and the market impact of the investment is expected depending on the type and objective of the promotion program. Thus, attempts to measure the effectiveness of the promotion effort in the early stages of a checkoff program may yield disappointing results.

Promotion expenditures also tend to have *lagged or carryover effects*. Expenditures in a given period often do not have their full impact within that period but continue to impact sales over an extended period of time. Generic promotion activities, like those generally funded by soybean checkoff dollars in both the domestic and foreign markets, are generally directed toward longer-term responses and, therefore, have often been found to generate lengthy lagged or carryover effects (Forker and Ward 1993).

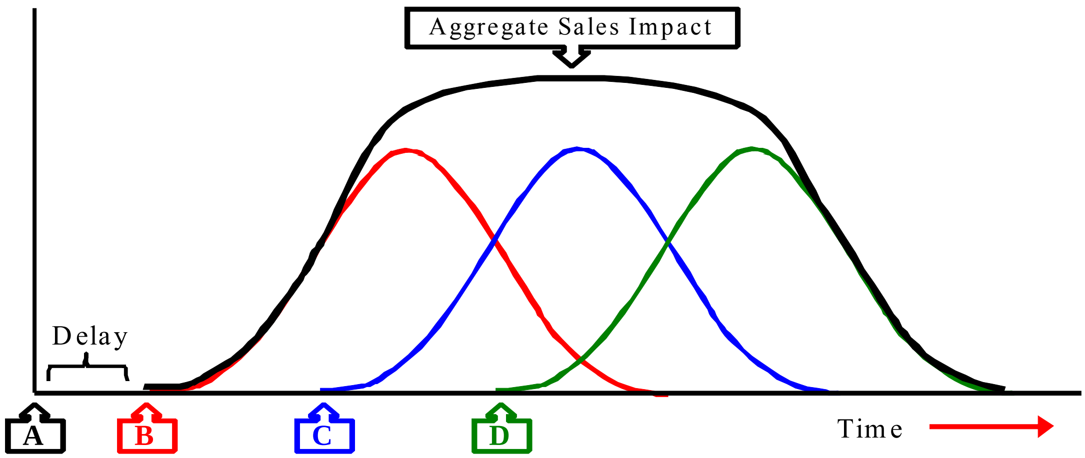
Promotion activities also often display *decay effects* over time. That is, despite persisting over time to some extent, the effects of a promotion activity will not last forever and eventually begin to fade at some point.

Figure 21 illustrates a typical pattern of promotion effects on sales. Following the initial treatment (expenditure) at point A, there is usually some delay before the expenditures begin having an effect on sales at point B, assuming that the promotion expenditures are above some threshold level. The maximum impact of the initial treatment in Figure 21 is eventually reached after which there is some decay in the sales effects. The decay from the initial treatment can be avoided and aggregate sales boosted if additional expenditures are made before the decay begins (point B).

Continued promotion treatments (expenditures) (points C and D) can maintain the aggregate level of sales achieved with the first two treatments (dark black line in Figure 21). Higher and higher expenditures, however, can push sales to higher levels while a drop off in the level of promotion expenditures results in a decay in the sales effects. If promotion activities are ended altogether, the level of sales will taper off toward the pre-promotion program level over time. Research suggests, however, that because promotion programs may achieve some permanent change in user behavior, sales will not drop all the way back to pre-program levels after a promotion campaign. Forker and Ward (1993) note that without the decay phenomenon, there would be no reason for continued expenditures on promotion activities after the initial effort.

Advertising wearout is also possible. Even though the continual exposure of an advertising message to consumers can help stem the decay effects of promotion expenditures, after long periods of exposure to a particular message, additional promotion expenditures on that message normally have decreasing impacts on sales. For example, the effectiveness of feeding trials to demonstrate the improved performance of livestock on balanced rations as a means of promoting the use of soybean meal in a particular country will likely erode over time as soybean meal is adopted into standard feeding regimes.

Figure 21: Delay, Carryover, and Decay Effects of Demand Promotion



Overview of Research on the Effectiveness of Commodity Checkoff Programs

Early evaluation of the effectiveness of and producer returns from commodity checkoff programs relied largely on anecdotal evidence and simple comparisons of gross promotion expenditures against changes in prices, profitability, and utilization of the commodities being promoted. When commodity markets and producer profits as well as checkoff program expenditures are all growing, this approach to evaluation can yield a persuasive upward-sloping graphical relationship between promotion expenditures and market prices, demand, and profits.

The problem with this comparison-of-checkoff-expenditures-to-market-variables approach to checkoff program evaluation is that many factors other than checkoff expenditures affect the markets for agricultural commodities, many of which have considerably greater influence on commodity markets than checkoff programs. Market events like changes in the costs of production inputs, currency exchange rate fluctuations, changes in the performance of U.S. and foreign macroeconomies, changes in consumer buying habits, and changes in government policies around the world, to name just a few, can move markets up or down over a given time period despite what checkoff programs may be doing to influence markets. This problem becomes rather apparent when commodity markets experience downturns despite continued expenditures by the related checkoff programs. If checkoff programs take credit for increased producer profits when checkoff expenditures and markets are growing, then they are usually forced to take the blame for failing to prevent a reduction in producer profits when markets decline. The need to isolate and measure the unique contribution of commodity checkoff programs to the performance and profitability of the related commodity markets has led researchers to devise improved means of evaluating the effectiveness and stakeholder returns from those checkoff programs. While much of the research has focused on measuring the impacts of advertising and promotion on commodity demand, some research has also been done to better measure the effects of production research on commodity supply.

Research on the Effectiveness and Returns to Investments in Research

The evaluation of the economic returns to investments in agricultural research builds on the seminal work of T.W. Schultz and Zvi Griliches in the 1950s. Major contributions to both the theory and empirical literature concerned with measuring the returns to investments in the development and implementation of new agricultural production technologies subsequently have been made by a variety of researchers, including Evenson (1967), Peterson (1967), Norton and Davis (1981), Fox (1985), Pardey and Craig (1989), Chavas and Cox (1992), Yee (1995), and Huffman and Evenson (2006), among many others. Fuglie and Heisey (2007) provide a brief review of research on the economic returns to research. Empirical estimates of the rate of return to agricultural research are remarkably high and vary widely from about 20% to 95% depending on the commodity, location, time period, and method of estimation (Fuglie and Heisey 2007). The estimated of the rates of return to public agricultural research are typically above the corresponding estimated rates of return to private investments.

Unfortunately, most studies on the returns to production research have held prices exogenous to the models used. That is, the price-depressing effects of research-induced supply expansion over the years have not been generally accounted for in these studies. Because the demand for agricultural products is often price-inelastic, the negative price effects of research-induced supply expansion over the years could turn positive measured welfare gains from such research into welfare losses.

Although research on the economic returns to agricultural research investments in general has been substantial, comparatively little attention has been paid to the returns to commodity checkoff program expenditures on production research. Two studies consider the returns to soybean producers from their investments in production research through the voluntary and mandatory soybean checkoff programs. Lim, Shumway, and Love (2002) conclude that checkoff-funded expenditures on production research over 1970-1994 returned $2.22 (present value) per dollar invested. They also found that returns to yield-enhancing research was negative but highly positive for cost-reducing research and conclude that “yield-enhancing research should be discontinued as one of the Soybean Board’s investments” (p. 145).

In a broader study of the soybean checkoff program, Williams, Shumway, and Love (2002) consider the returns to soybean checkoff expenditures on production research and demand promotion together over the period of 1978-1994. For production research expenditures, they find a negative return to producers and conclude that “production research not only failed to recover its investment, it actually had a negative impact on farmer net returns” (p. 109). The most recent previous study of the soybean checkoff program by Williams, Capps, and Bessler (2009) arrives at the same conclusion.

Research on the Effectiveness and Returns to Investments in Commodity Promotion

A standard method of determining if advertising and promotion pay has been to calculate the *average* return per dollar spent on advertising and promotion, i.e., a benefit-cost ratio (BCR), as the increase in *market sales revenue or cash receipts* (net of promotion costs) per checkoff dollar spent on advertising and promotion, referred to as a *revenue BCR* (RBCR). Some researchers have preferred to report the *marginal* BCR which is the increase in returns to stakeholders from a $1 (or 1%) increase in checkoff expenditures.

When any additional production costs are first netted out of the additional revenue calculated to be generated by the program, the resulting BCR can be referred to as a *profit BCR* (PBCR). Sometimes economists use measures of the producer economic welfare, or producer surplus, generated by the program instead of revenue or profit to calculate a *surplus BCR* (SBCR).

The BCR reported in many studies is a static or *ceteris paribus* measure of the effectiveness of advertising and promotion. In other words, many reported BCRs (both average and marginal) are calculated assuming that nothing (including prices) but demand changes when advertising expenditures change.[11] An increasing number of studies, however, now report a more appropriate, dynamic BCR calculated as the sum of the returns to stakeholders (in additional sales, profits, or economic surplus) over time divided by total advertising and promotion expenditures during that period, allowing not just demand but also supply, prices, and other clearly endogenous variables to change in response to the advertising and promotion expenditures (e.g., Williams 1985; Reberte, Schmit, and Kaiser 1996; Sellen, Goddard, and Duff 1997; Schmit et al. 2002; Williams, Shumway, and Love 2002; Capps and Williams 2006; Williams, Capps, and Bessler 2008; Williams, Capps, and Bessler 2009; Capps and Williams 2011; and USDA 2012). To account for the time value of money, a dynamic BCR can be discounted to present value by first discounting the calculated returns to stakeholders over time before dividing by total advertising and promote on expenditures to generate a *discounted BCR* (DBCR).

However calculated, an estimated BCR of greater than 1 is taken as an indication that the program is beneficial because sales, profits, or economic surplus have increased by more than one dollar for every dollar spent on advertising and promotion. On the other hand, a BCR of less than 1 is taken to mean that advertising and promotion do not pay since each dollar spent generates less than a dollar in additional sales, profits, or economic surplus.

Most studies of commodity checkoff programs have found that advertising and promotion increase sales revenues (gross or net of costs) by more than the cost of the advertising and promotion programs that generated those revenues. In most cases, the calculated BCRs have been found to be much in excess of 1. For the dairy checkoff program, for example, the most recent study of the program's effectiveness estimated returns in the range of $2.14 to $9.63, depending on the product (Table 2). Other recent studies focusing on diverse checkoff commodities such as beef, pork, lamb, orange juice, cotton, avocados, sorghum, and rice have likewise reported returns in the range of about $2 to $17 from their respective advertising and promotion programs (Table 2).

For the soybean checkoff program over the 1978-1994 period, Williams, Shumway, and Love (2002) estimated a producer profit ROI of $8 ($5 when discounted to present value over the life of the program). Using a model that the authors admit basically "mimicked" that of Williams, Shumway, and Love (2002), World Perspectives, Inc. and AgriLogic, Inc. (2002) estimated a

[11] In other words, the BCR is calculated from the regression coefficient for advertising expenditures in the demand equation valued at the mean of historical demand.

Table 2: Returns to Generic Commodity Promotion, Selected Studies

Commodity/Study	Benefit-Cost Ratio (BCR)
	average $ earned per $ spent on promotion
Dairy	
USDA (2012):	
All Dairy	3.05
Fluid milk	2.14
Cheese	4.26
Butter	9.63
Exports	5.12
Meat	
Beef: Ward (2009)	5.55
Pork: Kaiser (2012)	17.4 (marginal)
Lamb: Ghosh and Williams (2014)	14.44
Soybeans	
Williams, Capps, and Bessler (2009)	6.4
Williams, Shumway, and Love (2002)	8.0
World Perspectives/AgriLogic (2003)	6.75
Orange Juice	
Capps, Williams, and Bessler (2004)	6.1
Cotton	
Capps and Williams (2006)	7.6
Capps and Williams (2011):	
Producers	4.2
Importers	10.7
Avocados	
Carman, Li, and Sexton (2009)	2.5-4.0[a]
Sorghum	
Capps, Williams, and Málaga (2013):	
Renewables and high-value markets	8.48
Exports	NS[b]
Rice	
Rusmevichientong and Kaiser (2009)	6.21-14.48[a]

[a] Depending on the magnitude of the assumed prices elasticity of excess supply.
[b] NS = Not significantly different from zero.

producer profit BCR for the soybean checkoff program of $6.75 for the years 1995 through 2001. The most recent previous analysis of the soybean checkoff program by Williams, Capps, and Bessler (2009) estimated a producer profit BCR of $6.4 over the years of 1980/81 through 2006/07.

The estimated BCRs for many other checkoff commodities are similar to those presented here in terms of both magnitude and range. The consensus across a wide range of studies by many researchers covering a large number of checkoff commodities is that the return to producers from advertising and promotion by commodity checkoff organizations is positive. That is, in general, commodity checkoff program advertising and promotion have been found not only to increase sales but to increase sales by more than enough to cover the costs of the advertising and promotion activities.

Although the estimated level of return per dollar spent in advertising varies widely across commodities, countries, and time periods, the BCRs calculated by most studies for domestic advertising and promotion programs fall in the range of about $2 to $10. Unfortunately, many of these studies ignore cross-promotion effects, i.e., the effects of promoting one commodity on the sales of another. Thus, for example, expenditures that successfully promote the demand for pork likely shift some consumption from beef to pork, reducing beef consumption and offsetting to some extent the effects of beef promotion expenditures on the demand for beef.

METHODOLOGY AND DATA

To measure and compare the returns to soybean checkoff program investments in research and demand promotion, the first step was to isolate the effects of those investments in domestic and foreign soybean and soybean product markets from those of other events that may have affected those same markets over the years. For this purpose, soybean checkoff research, domestic promotion, and foreign demand promotion stock variables were constructed and incorporated into a world model of soybeans and soybean products. The model was then simulated over the 1980/81-2012/13 period under alternative assumptions regarding soybean checkoff research and domestic and international market promotion expenditure levels and the results used to calculate benefit-cost ratios for the soybean checkoff program.

The Structural Model

The analysis of the returns to producers from the soybean checkoff program in this study utilizes a 235-equation, annual econometric, non-spatial, price equilibrium simulation model of world soybean and soybean product markets known as SOYMOD (see Williams 1981, Williams and Thompson 1984, Williams 1985, Williams 1994, Williams 1999, Williams Shumway, and Love 2002, and Williams, Capps, and Bessler 2009 for more details on the model). Because they all have their roots in the early work of Houck, Ryan, and Subotnik (1972), SOYMOD is similar in form and specification to the world oilseed models utilized by FAPRI/CARD (2014), Meilke and Griffith (1983), and Meilke, Wensley, and Cluff (2001).

SOYMOD allows for the simultaneous determination of the supplies, demands, prices, and trade of soybeans, soymeal, and soyoil in seven major world trading regions: (1) the United States, (2) Brazil, (3) Argentina, (4) the European Union, (5) Japan, (6) China, and (7) a Rest-of-the-World region which accounts for the effects of primarily smaller, new demand growth areas in world soybean markets.

The domestic market of each region in the model is divided into four simultaneous blocks of equations: (1) a soybean block, (2) a soybean meal block, (3) a soybean oil block, and (4) an excess supply or excess demand block (Figure 22). For each region, the first three blocks contain behavioral relationships specifying the manner in which soybean supply (acreage planted, acreage harvested, soybean yields, and production), soybean domestic demand (crush and stocks), and the supply, consumption, and stocks of soybean meal and soybean oil behave in response to changes in variables like prices of soybeans and products, prices of various competing commodities, technology, income, livestock production and prices, government policy, etc. as appropriate.

For the U.S., the soybean block contains regional rather than national acreage planted, acreage harvested, yield, and production equations (equation (1) in Figure 22) for seven production regions (Atlantic, Cornbelt, Delta, Lakes, Plains, South, and Other) to represent the soybean supply relationship and account for interregional competition within the United States:

$$[1]\ AS_{kt} = AS_{kt}(PS^{e}_{kt}, RS_{kt}, \alpha_{kt}),$$

$$[2]\ HS_{kt} = HS_{kt}(AS_{kt}),$$

$$[3]\ YS_{kt} = YS_{kt}(RS_{kt}, \Theta_{kt}),$$

$$[4]\ SS_{kt} = YS_{kt} \bullet HS_{kt},$$

where k = production region 1, ..., 7; t = time period; AS = soybean acreage planted; HS = soybean acreage harvested; YS= soybean yield; SS = soybean production; RS = soybean research stock variable; α and θ are appropriate shift variables and PS^e = expected real soybean farm price defined for each region as:

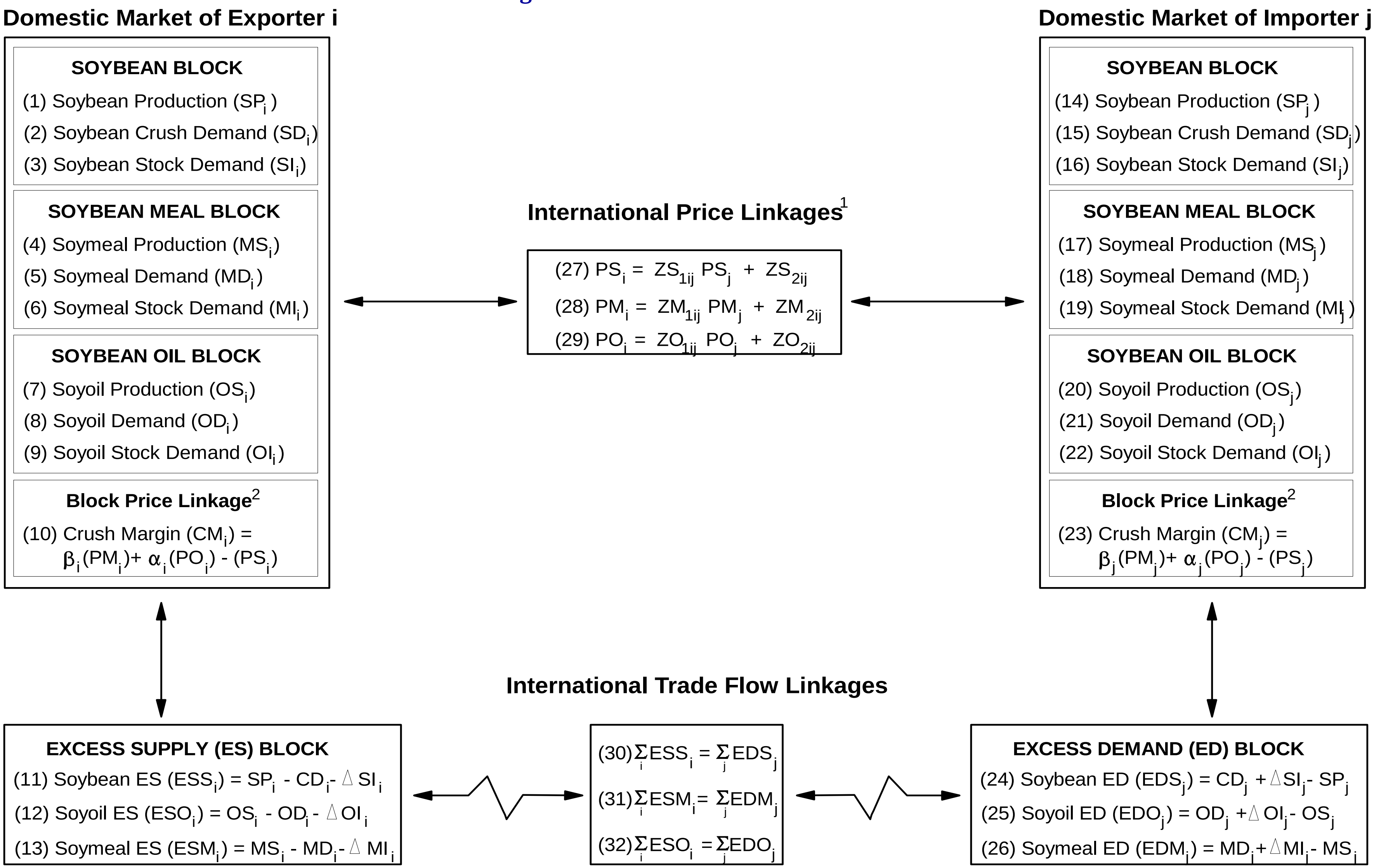
$$[5]\ PS^e = MAX(PS_{t-1}, LS_t) \bullet D5901 + MAX(PS_{t-1}, 0.85 \bullet TS_t + 0.15 \bullet MAX(PS_{t-1}, LS_t)) \bullet D0212$$

where LS = the real soybean loan rate; TS = real soybean target price; D5901 = indicator variable which equals 1 for 1959/60 through 2001/02 and 0 otherwise; and D0212 = indicator variable which equals 1 for 2002/03 through 2012/13 and 0 otherwise.

The soybean research stock variables (RS_k) used in equations (1) and (3) were developed based on two main results from previous research on the returns to research: (1) research benefits are not immediate so that a lag exists from the time the expenditures are made and possible real time adoption of results in the field and (2) research results from many years ago may still yield benefits for a number of years into the future. Consequently, the RS_k are formed as weighted averages of historical soybean checkoff expenditures on production research at the national and state level measured in constant dollars to account for the time lag in the impact of research expenditure. So, in general, for any region k:

$$[6]\qquad RS_k = \sum_{r=i}^{s} \lambda_r IS^*_{t-r}, \quad \sum_{r=i}^{s} \lambda_r = 1,$$

Figure 22: Structure of SOYMOD



Note: i = any exporter i=1, ... , n; and j = any importer j=1, ... , k. Also, Δ should be read "change in."

[1] The Z_1 and Z_2 include all multiplicative (e.g. exchange rates and *ad valorem* subsidies) and additive (transportation costs, specific tariffs, etc.) measures that come between prices of country i and j.

[2] β and α are meal and oil extraction rates; PS, PO, and PM are soybean, soyoil, soymeal prices.

where $IS_t^* = IS_t/p_t$ is the constant-dollar research investment in year t, IS_t is the nominal-dollar research investment in year t, p_t is the corresponding research price index, λ_r is the weight on the constant dollar research expenditures lagged r years, i is the number of years before the first impact, and s is the lag length over which research investments are expected to impact farm decisions. The RS_k are proxies for the quantity of effective research in each region (k).

Because research expenditures tend to reduce production costs and/or increase yields, two sets of research stock variables were developed – one set for use in the regional acreage equations (equation [1] above) and the second for use in the regional yield equations. Cost-reducing production research expenditures affect soybean production by shifting the acreage planted function to the right while yield-enhancing production research expenditures affect soybean production by shifting the yield function to the right.

To determine which of several alternative weighting schemes and lag structures on research investment is preferred for purposes of defining the acreage and yield research stock variables, a series of model specifications were tested, balancing fit and forecasts (or parsimony) in possible models. The Akaike Information Criterion (AIC) was used as the model selection metric. The model specification that minimized the AIC criterion for both regional acreage and yield was a second-degree polynomial distributed lag model with both head and tail restrictions and a delay of one period between actual expenditures of (real) check-off production research dollars and new technology adoption and use in the field across all seven U.S. soybean production regions. The optimal lag length, however, differed substantially by production region for both acreage and yield functions.

For regional soybean acreage, the longest lag length was determined for the Other region at 25 periods followed by the Atlantic and Lakes regions at 12 periods, the South region at 11 periods, the Plains region at 10 periods, the Delta region at four periods, and the Cornbelt region at two periods. Besides the real regional research expenditures and the expected regional real soybean farm prices as defined in equation [5], other explanatory variables in the seven regional acreage equations (the α_{kt} in equation [1] above) included the expected real prices of competing crops in each region as appropriate, and soybean acreage in the previous year. Crop year data over the time period 1959/60 to 2012/13 were used.

For regional soybean yields, the longest optimal lag length was determined for the South region at 15 periods followed by the Lakes region at 8 periods, the Delta region at 6 periods, and the Atlantic, Cornbelt, Other, and Plains regions at two periods. Besides the real regional research expenditures, other explanatory factors of the regional yield equations (the Θ_{kt} in equation [3] above) included weather effects (El Niño and La Niña).

The specification of the domestic demand functions (D) in the soybean, soybean meal, and soybean oil blocks of SOYMOD (corresponding to equations (2), (5), and (8) for the United States and equations (15), (18), and (21) for importing regions in Figure 22) include promotion stock variables, referred to as "goodwill" variables (G), to capture the effects of soybean check-off funded promotion activities in each region where such activities have been conducted:

$$[7]\ D_{ist} = D_{ist}(P_{ist}, G_{ist}, \beta_{ist}),$$

where i = world region (1, ... , 7); s = commodity (soybeans, soybean meal, and soybean oil); t = time period; P = domestic market price; and β represents appropriate shift variables.

The G_{is} (promotion stock variables) used as regressors in the appropriate SOYMOD demand equations were constructed following Williams (1999), Williams, Shumway, and Love (2002), and Williams, Capps, and Bessler (2009) as weighted averages of the respective inflation- and exchange-adjusted expenditures on promotion activities in each region as appropriate. To capture diminishing marginal returns to domestic and foreign checkoff promotion expenditures, a square root transformation of the G_{is} was used. In most evaluations of the effectiveness of promotion campaigns, a logarithmic transformation of promotion expenditures is used to capture diminishing marginal returns. However, because of the presence of zero promotion expenditures for some commodities in some years in some regions, a square root transformation was used in this study instead following the work of Williams, Capps, and Bessler (2009), USDA (2012), Ghosh and Williams (2014), and others.

To account for the time lag in the impact of the promotion investments on the soybean, soybean meal, and soybean oil demands in each region, Williams (1999) and Williams, Shumway, and Love (2002) used a second order polynomial inverse lag (PIL) formulation based on Mitchell and Speaker (1986). The Almon polynomial distributed lag (PDL) is an alternative lag formulation commonly used in the analysis of advertising effectiveness (see, for example, Williams, Capps, and Bessler (2009), USDA (2012), and Ghosh and Williams (2014)). Other lag models have been employed in the literature on checkoff promotion programs, including moving averages and unrestricted lags of varying lengths.

The lag formulation and lag length used for each demand equation for each commodity (soybeans, soymeal, and soyoil) in each relevant region of the model (U.S., EU15/27, Japan, China, and the Rest-of-the-World) were selected using the process described earlier for production research expenditures. Although the PIL does not require specifying the lag length, it is conceptually an infinite lag. Thus, the use of the PIL lag formulation imposes the assumption on the model that advertising expenditures in one period have infinitely long impacts over time on consumption. Consequently, in testing for lag length, the PIL model was not included leaving the PDL formulation, moving averages, and simple lags of varying lengths as the potential lag formulations to be considered.

The search for the pattern and time period over which soybean checkoff promotion expenditures influence soybean and soybean product demand in each region in the model involved a series of nested OLS regressions. For each lag formulation considered, lags of up to 10 years were considered and for the PDL up to fourth degree polynomials with alternative choices of head and tail restrictions. Based on a composite set of criteria, including the Akaike Information Criterion (AIC), the Schwarz statistic, and heuristic measures[12] (i.e., the number of significant parameters and the number of expected signs on own-price demand response), a second order PDL of one lag with head and tail restrictions was selected for U.S. soybeans, soymeal, and soyoil demand functions.

[12] The heuristic aspect of the composite criteria may be viewed as *ad hoc* but is equivalent to restricting the class of models to be only those consistent with underlying theory. This procedure is commonly encountered in the literature, especially in analyses where equilibrium displacement models are used and only parameter values consistent with theory are utilized.

For foreign market demands, simple, one-year lags of the square root transformation of the respective G_{is} were selected using the same criteria. Before being transformed in this way, however, the G_{is} for the U.S. and foreign markets were first deflated by the wholesale price index in the respective regions and then the foreign G_{is} were converted from U.S. dollars to foreign currency using the respective exchange rates.

Simultaneous interaction of soybean and soybean product markets within each region in SOYMOD is insured through the endogenous soybean crush margin (equations (10) and (23) in Figure 22) which is the own price variable in the crush demand equations ((2) and (15) in Figure 22). The fourth block in each domestic market (equations (11)-(13) and (24)-(26) in Figure 22) of the model includes net excess supply relationships for exporting regions and net excess demand relationships for importing regions specified as the residual differences between their respective domestic supply and demand schedules.

The soybean and soybean product markets of the trading countries in the model are linked through international price and trade flow relationships. The prices of soybeans, soymeal, and soyoil in exporting and importing regions are linked through price transmission equations (equations (27)-(29) in Figure 22) following Bredahl, Meyers, and Collins (1979) which account for the effects of exchange rates as well as tariffs, export subsidies, border taxes, transportation costs, etc. and other factors (the Z_{ij}) that drive a wedge between prices in each world region. International market clearing conditions (equations (30)-(32) in Figure 22) require equality of the world excess supply and demand for soybeans, soymeal, and soyoil in each time period.

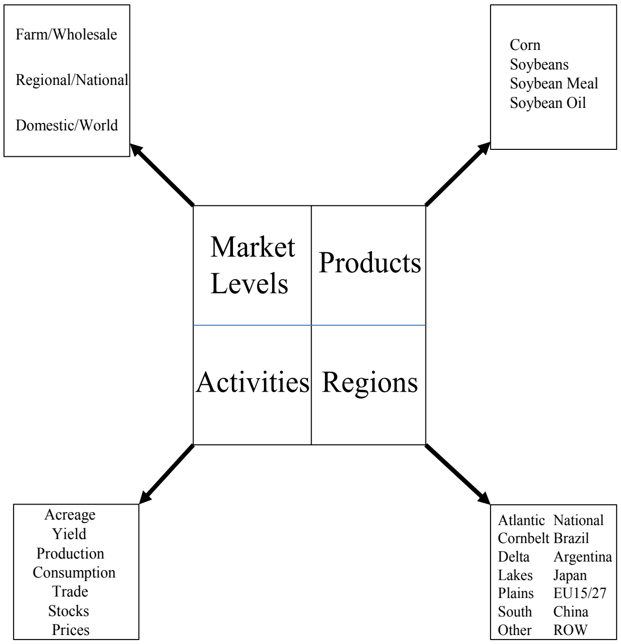
Figure 23 summarizes the many dimensions of SOYMOD. The model includes acreage, yield, production, consumption, inventory, price, and trade relationships and operates at both the farm and wholesale levels in all countries and regions for three products (soybeans, soymeal, and soyoil). The U.S. model includes seven production regions and the full model includes seven world trading countries/regions. The U.S. component of SOYMOD also includes a sub-model of the U.S. corn market which features regional acreage and production as well as national consumption (feed, food, other), inventory, price, and net export demand relationships and operates at both the farm and wholesale levels. The U.S. corn market relationships are included in SOYMOD given the importance of corn as a substitute in regional soybean production and as a complement in national livestock feed demand.

Data

SOYMOD includes 200 equations and endogenous variables and over 400 exogenous and predetermined variables. Two types of data were needed for the analysis of the soybean checkoff program: (1) data to support SOYMOD (e.g., supply, demand, trade, price, policy, etc. data by country and commodity over time) and (2) soybean checkoff expenditures over time.

The first set of data relate to most of the model endogenous and exogenous variables (supply, demand, trade, price, policy, etc. by country and commodity over time) and are taken from numerous public sources, including USDA (for example, USDA-ERS, USDA-FAS, and USDA-NASS) for 1959/60 through 2012/13 as available. The International Financial Statistics of the International Monetary Fund (IMF 2014) was particularly useful for many of the exogenous

Figure 23: Dimensions of SOYMOD



macro variables (income, inflation exchange rates, etc.) required in the model. The remainder of the data came from numerous country specific private and government sources.

Three categories of national and state-level soybean checkoff expenditures were required: (1) soybean production research, (2) domestic promotion, and (3) international market promotion. The expenditure data for production research for 1970/71 through 2006/07 were available from previous research as provided by Keith Smith and Associates. Those data are now available on the Internet from about 2003/04 (USB 2014). Unfortunately, the production research data for 1996/97 through 1999/00 were never collected and maintained and, thus, were interpolated following a random walk model (Bessler 2009). Recent production research expenditure data (both QSSB and national) were made available by the United Soybean Board through a companion project to collect and warehouse all soybean checkoff expenditures since 2007/08.

National-level (USB) data on expenditures to promote the domestic demand for soybeans, soymeal, and soyoil beginning in 1994/95 with the implementation of the national checkoff program through 2006/07 also were available from previous checkoff analysis research. Those data were collected manually by the authors from SmithBucklin Corp., a management contractor of the United Soybean Board. For 2007/08 through 2011/12, the USB data on domestic promotion expenditures were provided by SmithBucklin Corp. as part of the same USB companion project to collect and warehouse all soybean checkoff expenditure data.

Unfortunately, data for state-level (QSSB) expenditures to promote domestic soybean and product demand were not systematically collected and maintained over the years. All previous studies of the soybean checkoff program, including Williams, Shumway, and Love (2002), World Perspectives, Inc./AgriLogic, Inc. (2003), and Williams, Capps and Bessler (2009), reported the same problem with the QSSB promotion expenditure data. Williams, Shumway, and Love (2002) and Williams, Capps, and Bessler (2009) attempted to collect the needed data by survey but reported that the data made available by the QSSBs "were fragmentary, highly inconsistent in quality, type, time period, and level of aggregation" and, therefore, not useful for analytical purposes. Consequently, in all previous analyses of domestic soybean checkoff promotion programs, only national-level data for domestic promotion were used.

Since that time, the USB-funded project to collect and warehouse all checkoff expenditure data has made state-level (QSSB) data on domestic promotion expenditures available since 2007/08. Attempts to merge the QSSB expenditure data for 2007/08-2011/12 with the 1994/95-2011/12 national-level data for domestic soybean checkoff expenditures resulted in a large data discontinuity beginning in 2007/08 which is hardly surprising given that the QSSBs have spent nearly 30% of their funds on domestic promotion activities since 2007/08 compared to only about 20% for the USB. Consequently, the QSSB expenditure data for domestic promotion could not be included in this analysis of the impact of the checkoff on domestic promotion programs. To the extent that the USB and QSSB expenditures are correlated, however, the omission of the state-level data likely may have little effect on the analytical results.

Data on national-level international marketing promotion expenditures by product, country, and contributor for 1970/71 through 2006/07 again were available from previous studies. Those data were compiled manually by the authors from various sources, primarily the American Soybean Association (ASA), the U.S. Soybean Export Council (USSEC), the USDA Foreign Agriculture Service (FAS), SmithBucklin, Corp., and various other previous USB subcontractors. State-level (QSSB) data on international promotion expenditures were not available for that time period. Both the national- and state-level expenditure data on international marketing for 2007/08-2011/12 were made available through the companion USB project to collect all checkoff expenditure data. The national-level international marketing expenditure data were provided through that project by USSEC, SmithBucklin, and USB (direct-managed) and merged with the corresponding earlier data available from previous research on the soybean checkoff. The state-level international marketing expenditures were also made available through the expenditure data collection project by the QSSBs for the 2007/08-20011/12 time period. Given the smaller level of international promotion by QSSBs, their international marketing expenditure data for 2007/08-2011/12 were merged with the national level data for 1970/71-2011/12. The result was a complete series of available national- and state-level international marketing expenditure data by commodity and country from 1970/71 through 2011/12. The fragmentary data available prior to 1970/71 indicate that international promotion expenditures were quite small during that period and that promotion activities occurred almost entirely in Japan. Consequently, soybean and product international market promotion expenditures were assumed to be zero for the pre-1970/71 period.

Model Parameter Estimation and Validation

The parameters of SOYMOD were estimated using the Ordinary Least Squares (OLS) estimator with crop year data for 1960/61 through 2011/12 for many equations but shorter time periods in cases of limited data availability. Normalization by an exogenous price index maintained linear homogeneity in prices. Two or three-stage least squares procedures sometimes are used in the estimation of simultaneous systems. In this case, the large size of the model and associated endogenous and exogenous variables and the limited number of annual observations resulted in a greater number of predetermined variables than observations. Given that the efficiency gained in parameter estimation with the use of 2SLS and 3SLS is actually consistent with a large number of data points, OLS was the estimator of choice in this analysis. Also, data for some years of the 1960/61-2011/12 time period were not available for some behavioral equations, further necessitating the use of OLS to estimate the behavioral equation parameters in the model.

The model regression statistics indicate an excellent fit of the data. Also, the signs and sizes of all estimated parameters in each model equation are consistent with *a priori* expectations[13]. The estimated parameters of the behavioral equations in all U.S. soybean production regions are unconstrained, consistent with *a priori* expectations in sign and magnitude, and statistically significant. All Durbin-h and Durbin Watson statistics indicate no evidence of autocorrelation.

As expected, the responsiveness of soybean acreage to changes in the soybean farm price, particularly over the long-run, is generally higher outside the Cornbelt in the less traditional and more marginal U.S. soybean production regions (Table 3). The opposite tends to be the case for the estimated responsiveness of regional acreage and yields to the soybean research stock. That is, production research investments are estimated to have had a larger impact on acreage and yields in the larger soybean production regions than in the smaller production regions. Both price and research stock elasticities for planted acreage and yields are similar across regions (Table 3).

The estimated direct price and promotion stock elasticities of demand are provided in Table 4. In each case, the promotion stock elasticities are small and consistent in both magnitude and sign with the results of Williams, Shumway, and Love (2003) and Williams, Capps, and Bessler (2009) as well as with studies of other checkoff commodities. Note that the promotion expenditure elasticities for soybeans, meal, and oil are the highest in Japan where expenditures tend to be the lowest among the regions in the model. The lowest promotion elasticities are for soybean promotion in the U.S. and the EU/27. The other promotion elasticities are similar at about 0.03. Most of the estimated promotion elasticities are statistically significant at the 1% or 5% level.

Validation of the structural model included both a check of the dynamic, within-sample (*ex-post*) simulation statistics for the fully simultaneous structural model and a sensitivity analysis to check the stability of the model. The common time period across all data types defined 1980/81 to 2012/13 as the period available for the simulation analysis of the effectiveness of the soybean checkoff program. Dynamic simulation statistics (e.g., the root mean squared error, Theil inequality coefficients, and the Theil error decomposition proportions) were calculated from simulating the full model over the 1980/81 to 2012/13 sample period, i.e., the baseline historical simulation. Those statistics indicate a highly satisfactory fit of the historical, dynamic simulation solution values to observed data. The Theil U coefficients were small with all less than 0.3. The Theil bias error proportion indicated no systematic deviation of simulated from actual data values for any of the endogenous variables.

To check the stability of the model, a test of the sensitivity of the model to a one-period shock in checkoff investments was conducted. First, nominal checkoff investments both in U.S. soybean production research and in demand promotion in the U.S. and across all importing regions and all commodities were increased by 10% in 1980/81 (the first year of the simulation sample period). The respective investment stock variables were then re-generated and the model was re-simulated over the 33-year period of 1980/81 to 2012/13. Following the initial period shock, all endogenous variables returned to equilibrium within a reasonable time period (most within 5-10 years) indicating that the model is highly stable to changes in checkoff investments over time.

[13] The model regression statistics, the structure of the full simulation model, and definitions of model variables are available in the Appendix to this report.

Table 3. SOYMOD Estimated U.S. Soybean Acreage and Yield Elasticities[a]

U.S. Production Region	U.S. Planted Acreage				U.S. Yield	
	Soybean Farm Price		Research Stock		Research Stock	
	Short Run	Long Run	Short Run	Long Run	Short Run	Long Run
Atlantic	0.5945*	2.1577*	0.0034**	0.0109**	0.0198*	0.0719*
Corn Belt	0.1611*	0.6842*	0.0067*	0.0248*	0.0132*	0.0560*
Delta	0.3665*	1.9258*	0.0046*	0.0240*	0.0076**	0.0399**
Lakes	0.2429*	0.6799*	0.0042*	0.0118*	0.0024*	0.1669*
Other	0.5045*	2.3191*	0.0050*	0.0231*	0.0038*	0.0175*
Plains	0.2512*	1.6897*	0.0040**	0.0268**	0.0069*	0.0465*
South	0.7791*	3.0375*	0.0054*	0.0211*	0.0002**	0.0008**

[a] Elasticities evaluated at the means of the data based on the coefficients used in the simulation model. * = coefficient significant at the 1% level. **= coefficient significant at the 5% level.

Table 4. SOYMOD Estimated Domestic Price and Promotion Stock Elasticities of U.S. and Foreign Demand[a]

Region	Domestic Price			Promotion Stock		
	Soybeans[b]	Soymeal[c]	Soyoil[c]	Soybeans	Soymeal	Soyoil
U.S.	0.018*	-0.108*	-0.099*	0.023***	0.032***	0.035***
EU-15/27	0.041*	-0.090*	-0.146*	0.027*	0.030**	0.035**
Japan	0.011***	-0.536*	-0.245*	0.035*	0.044*	0.047***
China	0.056*	-0.200*	-0.302*	0.035***	0.032*	0.026**
ROW	-1.00[d]	-1.00[d]	-1.00[d]	0.032*	0.032*	0.033*

[a] All elasticities evaluated at the means of the data.. * = significant at the 1% level. **= significant at the 5% level, and ***=significant at the 10% level.
[b] Elasticities of domestic demand with to respect to the gross soybean crushing margin for the U.S., EU-15/27, Japan, and China and the elasticity of import demand with respect to soybean price for the Rest-of-the-World (ROW).
[c] Direct price elasticities of domestic demand for U.S., EU-15/27, Japan, and China and direct import demand elasticities for ROW.
[d] For the ROW (Rest-of-the-World) region, price elasticities are constrained.

ANALYSIS OF THE SOYBEAN CHECKOFF PROGRAM EFFECTIVENESS

Recall that the primary objective of this analysis of the effectiveness of the soybean checkoff program is to answer two key questions: (1) What have been the effects of the soybean checkoff program over time on U.S. and world soybean and soybean product markets (supplies, demands, prices, trade, etc.)? and (2) Have soybean producers benefitted from the soybean checkoff program and, if so, by how much? To answer these questions, two scenarios were analyzed using SOYMOD (as developed and discussed earlier in this report): (1) a *with* soybean checkoff expenditures scenario (referred to as the "*with* scenario") and (2) a *without* soybean checkoff expenditures scenario (referred to as the "*without* scenario").

The *with* scenario represents actual history, that is, the level of supply, demand, prices, trade, etc. in world soybean and soybean product markets that include any effects on those markets from soybean checkoff expenditures in the U.S. and around the world. The *with* scenario analysis was conducted through historical simulation of SOYMOD over the 1980/81 through 2012/13 period of analysis to generate a baseline scenario of the endogenous variables in the model (e.g., production, demand, prices, trade, etc.) that closely replicate the actual, historical values of those variables[14].

Because the baseline historical simulation for this study was generated in the process of validating SOYMOD, the accuracy of the model in tracking the historical values of model values can be determined through inspection of the baseline simulation statistics. As discussed earlier, the simulation statistics show that the model replicates the functioning of U.S. and world soybean markets extremely well and that the baseline simulation of the model variables fits the historical data equally as well.

The *without* scenario analysis was conducted by setting the historic values of soybean checkoff production research, U.S. domestic promotion expenditures, and international marketing promotion expenditures to zero in their respective equations in SOYMOD and then simulating the model again over the 1980/81 to 2012/13 period of analysis to generate new values for U.S. and world soybean and product production, consumption, trade, prices, etc. Because the changes in the endogenous model variables in this *without* scenario were generated by changing only the levels of checkoff expenditures, they represent those that would have existed over time *if there had been no checkoff program.*

Differences in the simulated levels of the model variables (supplies, demand, prices, trade, etc.) in the *with* scenario from those in the *without* scenario are then taken as direct measures of the effects of the checkoff expenditures. Because no other exogenous variable in the model (e.g., levels of inflation, exchange rates, income levels, agricultural and trade policies, etc.) other than checkoff expenditures is allowed to change in either scenario, this process effectively isolates the effects of the soybean checkoff program on the U.S. and world soybean markets, prices, and trade. That is, the simulated differences between the values of the endogenous variables from the

[14] Even though the data for soybean checkoff expenditures end in 2011/12, the simulations were able to be run through 2012/13 because all expenditure stock variables (for production research, domestic promotion, and international marketing) entered their respective model equations with at least one lag.

with checkoff expenditures scenario and from the *without* checkoff expenditures scenario provide direct measures of the historical effects of the soybean checkoff expenditures (and only those expenditures) on the U.S. and world soybean and product markets.

The analysis of the effectiveness of the soybean checkoff program begins by considering the first question posed earlier through an examination of the simulated effects of the soybean checkoff program on U.S. and world soybean product markets, that is, the differences between the *with* and *without* scenario results. Then the second question is considered by using the scenario analysis results to conduct a benefit-cost analysis of the soybean checkoff program over the 1980/81-2012/13 period of analysis at the soybean grower level.

What Have Been the Effects of the Soybean Checkoff Program on U.S. and World Soybean and Soybean Product Markets?

A comparison of the *with* and *without* scenario analyses results clearly indicates that the soybean checkoff program has been effective in increasing U.S. soybean production, crush, exports, world market share, and producer profits. The results indicate that the soybean checkoff program provided U.S. soybean planted acreage a 3.0% lift between 1980/81 and 2012/13 (Table 5). The "lift" is the average annual increase in some variable like production, demand, trade, or prices over the period of analysis (1980/81-2012/13). Likewise, the program provided a lift of 4.3% to U.S. soybean production, 0.6% to soybean farm price, and 0.1% to soymeal price. The small lift in the prices of soybean, soymeal, and soyoil largely reflect the price-offsetting effects of simultaneously investing checkoff dollars in production research and demand promotion and the substantial increase in the production research share of checkoff expenditures from 20%-30% in the 1980s to 40%-50% over the last decade. The result of the increasing emphasis of production research over demand promotion in checkoff program expenditures has been a relatively larger increase in U.S. soybean production relative to the demand for U.S. soybeans and products over time and, therefore, little upward movement of prices as a result of the soybean checkoff program.

The net negative lift for the soyoil price as a result of the checkoff program over the full 1980/81-2012/13 period is likely due to the higher oil supplies resulting from the higher U.S. soybean crush combined with the declining share of expenditures allocated to soyoil in international market promotion from a high of 50% in the mid-1980s to near zero in recent years (Table 5). The small change in the crush margin reflects the offsetting effects of the higher soybean price against a slightly higher soymeal price and a lower soyoil price. The average annual lift of U.S. soybean crush and soymeal and soyoil consumption from the soybean checkoff program was 3.7%, 2.1%, and 2.2%, respectively (Table 5).

Table 5 decomposes the U.S. soybean industry lift provided by the soybean checkoff program into two time periods: (1) the 1980/81-1991/92 period prior to the implementation of the national soybean checkoff program (referred to as the "*voluntary* checkoff period") and (2) the 1992/93-2012/13 period since the national program was implemented (referred to as the "*national* checkoff period"). Note that over the *national* checkoff period, the crush demand lift was 4.7% and 3.1% for both soymeal and soyoil consumption. During the *voluntary* checkoff period, however, the crush demand lift was much smaller while the soymeal and soyoil demand lift was

Table 5: U.S. Soybean Industry Lift from the Soybean Checkoff Program, 1980/81-2012/13

Annual Average Change In:	1980/81-91/92		1992/93-2012/13		**1980/81-2012/13**	
	1,000 acres	%	1,000 acres	%	**1,000 acres**	**%**
U.S. Soybean Planted Acres						
Cornbelt	354.2	1.2	1,306.2	4.0	**960.0**	**3.0**
Delta	254.2	2.9	260.5	4.5	**258.2**	**3.8**
South	244.7	3.8	126.7	3.6	**169.6**	**3.7**
Plains	149.5	2.5	317.1	2.5	**256.2**	**2.5**
Lakes	88.5	1.4	136.1	1.4	**118.8**	**1.3**
Atlantic	146.6	3.6	191.7	6.4	**175.3**	**5.2**
Other	14.9	4.6	15.0	2.3	**15.0**	**2.8**
Total	1,252.6	2.0	2,353.4	3.4	**1,953.1**	**3.0**
	mil. bu.	%	mil. bu.	%	**mil. bu.**	**%**
U.S. Soybean Production						
Cornbelt	15.1	1.4	89.1	6.4	**62.2**	**4.9**
Delta	6.8	3.6	10.2	5.6	**8.9**	**4.8**
South	5.9	4.1	4.0	3.6	**4.7**	**3.8**
Plains	4.6	2.8	17.2	3.8	**12.6**	**3.6**
Lakes	3.1	1.5	6.8	1.8	**5.5**	**1.7**
Atlantic	4.4	4.8	8.5	10.3	**7.0**	**8.2**
Other	0.5	5.0	0.7	2.9	**0.6**	**3.3**
Total	40.3	2.2	136.6	5.2	**101.6**	**4.3**
U.S. Soybean Crush	12.1	1.1	71.8	4.7	**50.1**	**3.7**
	1,000 tons	%	1,000 tons	%	**1,000 tons**	**%**
U.S. Soybean Meal Consumption	-64.5	-0.3	906.3	3.1	**553.3**	**2.1**
	mil. lbs.	%	mil. lbs.	%	**mil. lbs.**	**%**
U.S. Soybean Oil Consumption	-36.0	-0.3	491.9	3.1	**300.0**	**2.2**
	$/unit	%	$/unit	%	**$/unit**	**%**
U.S. Wholesale Soybean and Product Prices						
Soybean ($/bu)	0.12	1.9	0.00	0.0	**0.04**	**0.6**
Soymeal ($/ton)	6.95	3.7	-3.72	-1.5	**0.16**	**0.1**
Soyoil (cents/lb)	0.42	2.0	-0.53	-1.8	**-0.19**	**-0.7**
Crush Margin ($/bu)	0.09	10.3	-0.15	-8.1	**-0.06**	**-0.3**
	$ billion	%	$ billion	%	$ billion	%
U.S. Soybean Cash Receipts	5.5	4.0	23.2	5.3	28.6	5.0

actually negative. The reason is that domestic demand promotion began in earnest with the implementation of the *national* checkoff program. The consequence was higher domestic demand for soybeans, soybean meal, and soybean oil during that period. The growing investments in production research and the declining share to international marketing promotion during that period, however, eroded any positive lift for soybean price from the soybean demand increase induced by the domestic promotion activities. At the same time, because soymeal and soyoil are joint products of soybean crushing, the larger soybean crush during that period produced greater supplies of meal and oil, resulting in somewhat lower prices of soymeal and soyoil despite the lift in both their demands as a result of domestic demand promotion activities.

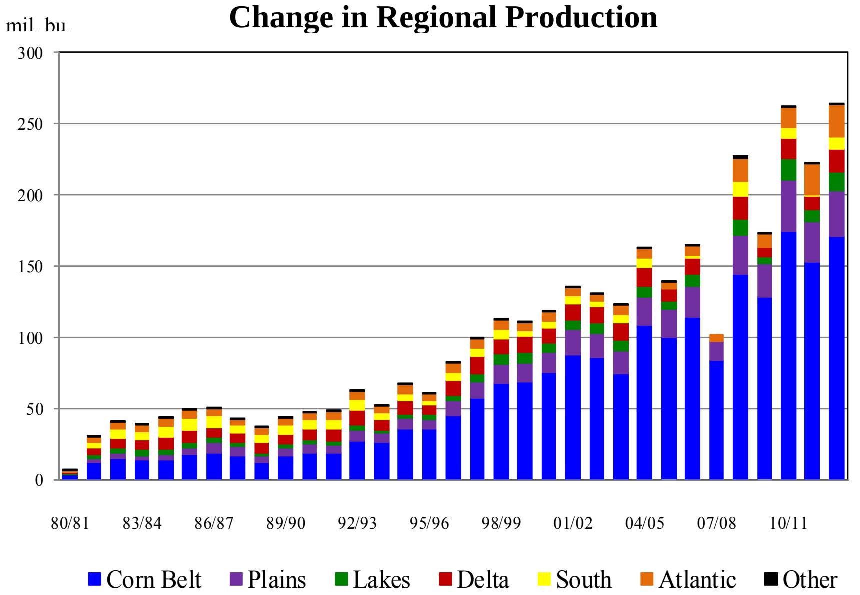
During that *voluntary* checkoff period, there was no checkoff-financed domestic promotion program impacting the domestic demands for soybeans and soybean products. Large expenditures on international market promotion relative to those on production research during that period provided a lift to foreign demand for soybeans, soymeal, and soyoil and a corresponding lift in their prices of 1.9%, 3.7%, and 2.0%, respectively. Despite the higher crush margin during that period, the soybean crush lift was only marginal as increased soybean exports reduced the availability of soybeans for domestic processing. The higher soybean meal and oil prices resulted in a lower level of consumption of both soymeal and soyoil during that period.

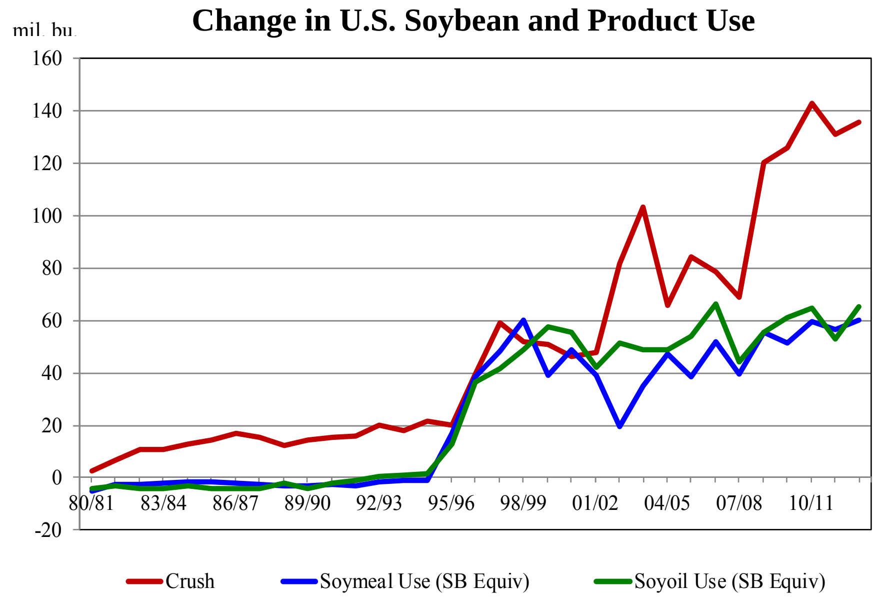
Figure 24 provides some insights on the lift provided by the checkoff program to U.S. markets and prices over time. During the *voluntary* checkoff period, the checkoff program provided a 40.3 million bushel lift in U.S. soybean production (top left graph in Figure 23). The production lift remained steady until about 1997/98 when growing soybean research expenditures during the *national* checkoff period began to create a growing lift in production. While the average annual production lift increased to 136.6 million bushels during the *national* checkoff period (see Table 5), the annual lift has continued to grow, hitting about 264.6 million bushels in 2012/13. The growth in the checkoff program's production lift will likely persist as past expenditures continue to have an impact into the future and additional expenditures are made. Recall from an earlier section that there are lengthy periods over which expenditures on production research have effects on acreage and yields in many regions. In other words, the research expenditures in any given period continue to have effects on acreage and yields for many years in most soybean production regions.

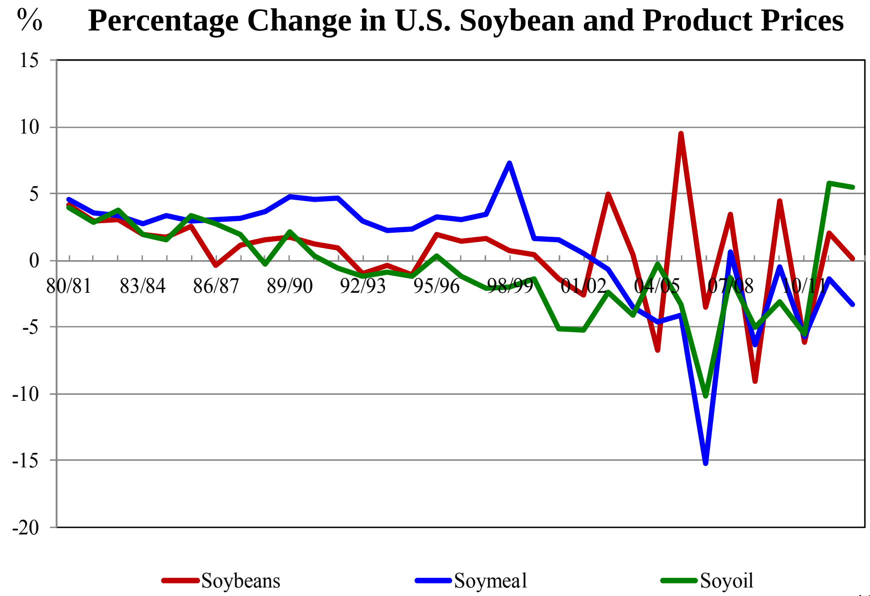
The larger production lift of the checkoff program during the *national* checkoff program period sharply increased the available supplies of soybeans for crushing and export during that period. The annual lift in the soybean crush jumped from an average of about 12.1 million bushels during the *voluntary* period to a high of over 140 million bushels in 2010/11 following implementation of the national checkoff program (see top right graph of Figure 23). At the same time, the large production lift during that period meant that instead of supporting soybean and soybean product prices as it had during the voluntary period, the checkoff program actually pressured prices down to lower levels than otherwise would have existed during the national period (bottom left graph in Figure 23).

The higher soybean production lift during the *national* period from the checkoff program together with a growing shift of international promotion funds to promote soybeans rather than value-added soybean products also led to a sharp increase in soybean exports over that period to just under 3.5 million metric tons (mt) in 2012/13 and an average annual export lift of about 1.7 million mt (6.4%) during the *national* period (Table 6). The checkoff program also created a positive soybean export lift for Brazil and Argentina but to a much smaller extent (137,900 mt or 0.8% and 84,200 mt or 1.3%, respectively). As a consequence, the U.S. share of world soybean

Figure 24: Soybean Checkoff Program Lift of U.S. Acreage Planted, Domestic Use, Prices, and Exports, 1980/81-2012/13







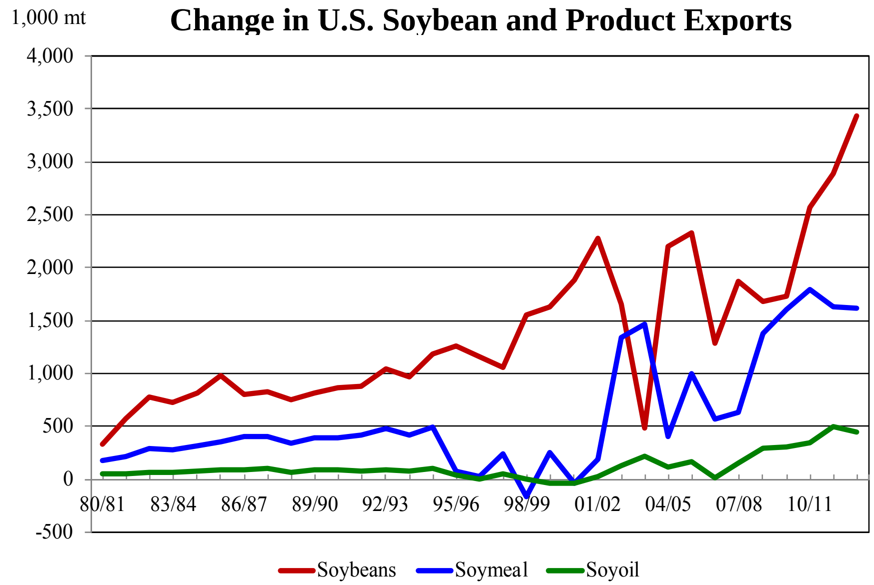


Table 6: World Soybean and Products Trade Lift from the Soybean Checkoff Program, 1980/81-2012/13

Average Change In:	1980/81-1991/92		1992/93-2012/13		1980/81-2012/13	
	1,000 mt	%	1,000 mt	%	1,000 mt	%
World Soybean Imports						
EU-27	474.8	3.7	219.1	1.5	312.1	2.3
Japan	120.0	2.7	98.1	2.3	106.1	2.5
China	297.2	-- [a]	1237.0	6.0	895.2	7.0
Rest of the world	43.3	0.6	383.2	3.3	259.6	2.6
Total	935.4	4.0	1,937.4	3.8	1,573.0	3.9
World Soybean Exports						
United States	756.2	4.0	1,715.3	6.4	1,366.5	5.8
Brazil	162.0	7.9	137.9	0.8	146.6	1.2
Argentina	17.2	0.7	84.2	1.3	59.9	1.2
Total	935.4	4.0	1,937.4	3.8	1,573.0	3.9
World Soymeal Imports						
EU-27	533.3	6.5	417.6	2.4	459.7	3.2
Japan	46.8	14.1	62.5	5.0	56.8	6.2
Rest of the world	-36.6	-0.4	776.1	4.6	480.5	3.4
Total	543.5	1.8	1,256.1	3.5	997.0	3.4
World Soymeal Exports						
United States	319.6	6.0	726.0	11.2	578.2	9.5
Brazil	145.1	1.8	24.5	0.2	68.4	0.6
Argentina	57.8	1.7	4.8	0.0	24.1	0.2
Total	543.5	1.8	1,256.1	3.5	997.0	3.4
World Soyoil Imports						
Japan	24.4	-- [a]	-7.6	-27.8	4.0	35.8
China	-69.6	-24.4	-30.7	-2.1	-44.9	-4.4
Rest of the world	127.5	5.1	203.2	4.2	175.7	4.4
Total	82.3	3.0	164.9	2.6	134.8	2.7
World Soyoil Exports (000 mt)						
United States	75.2	11.7	142.3	18.4	117.9	16.3
Brazil	31.1	4.3	4.5	0.3	14.2	1.1
Argentina	12.8	2.0	0.2	0.0	4.8	0.2
EU-27	-36.9	-4.9	17.9	6.2	-2.0	-0.4
Total	82.3	3.0	164.9	2.6	134.8	2.7
	change	%	change	%	change	%
Exporter Share of Soybean Imports						
United States	0.1	0.1	1.2	2.3	0.8	1.5
Brazil	0.3	4.2	-0.9	-3.1	-0.5	-0.4
Argentina	-0.4	-3.4	-0.3	-2.3	-0.3	-2.7
Exporter Share of Soymeal Imports						
United States	0.9	3.1	1.2	8.6	1.1	6.6
Brazil	-0.5	-1.1	-0.9	-2.7	-0.8	-2.1
Argentina	-0.3	-0.7	-1.5	-3.0	-1.1	-2.2
Exporter Share of Soyoil Imports						
United States	2.1	2.0	1.8	1.7	1.9	1.8
Brazil	0.5	0.3	-0.6	-0.8	-0.2	-0.4
Argentina	-0.6	-0.7	-1.5	-2.1	-1.2	-1.6
EU-15	-2.0	-2.1	0.3	0.2	-0.6	-0.6

[a] Mathmatically undefined percentage change from a negative number to a positive number.

imports was higher by 0.8 percentage points as a result of the checkoff program while those of Brazil and Argentina were lower by 0.5 and 0.3 percentage points, respectively.

For U.S. soymeal and soyoil exports, the checkoff program lift was 9.5% and 16.3%, respectively, over the full 1980/81-2012/13 period (Table 6). Although both Brazil and Argentina also experienced higher soymeal and soyoil exports as a result of the checkoff, the lift in those exports was less than 1% and, therefore, insufficient to maintain their shares of world trade in the two products. Consequently, the U.S. share of world soymeal and soyoil exports increased by 1.1 and 1.9 percentage points, respectively, while those of Brazil and Argentina declined. Thus, the U.S. soybean checkoff program not only boosted U.S. soybean, soymeal, and soyoil exports but also the U.S. share of world imports of all three products while reducing the shares accounted for by both Brazil and Argentina.

By comparing the lift from the checkoff program of world soybean and product trade before and after the implementation of the national soybean checkoff program, the effects of the shift in international marketing promotion strategy become clearer. The increasing share of international marketing promotion funds allocated to China and smaller, less developed countries and away from the EU-27 and Japan resulted in a decline in the soybean and product import lift by the latter two countries between the *voluntary* and *national* checkoff program periods and a surge in imports by other countries (Table 6). The lift in the soybean imports of the EU-27 and Japan as a result of international marketing promotion expenditures in those countries also dropped from 474,800 mt (3.7%) and 120,000 mt (2.7%), respectively, during the *voluntary* period to only 219,100 mt (1.5%) and 98,100 mt (2.3%), respectively, during the *national* period. In contrast, the average annual increase in soybean imports by China and the rest of the world as a result of the checkoff program jumped substantially from only 297,200 mt and 43,300 mt (0.6%), respectively, in the *voluntary* period to over 1.2 million mt (6.0%) and 383,200 mt (3.3%), respectively, in the *national* checkoff period. The story is the same for the lift in the soymeal and soyoil imports of China and the rest of the world. In the case of the EU-27, checkoff promotion provided a positive lift to domestic oil consumption in those countries resulting in a negative lift in their soyoil exports during the *voluntary* checkoff period (Table 6). However, a sharp reduction in the promotion of soyoil consumption in EU-27 countries over time led to lower soyoil demand by those countries and, thus, a positive lift in EU exports of soyoil in competition with U.S. soyoil exports during the *national* checkoff period.

Have Soybean Producers Benefitted from the Soybean Checkoff Program?

Clearly, based on a comparative analysis of the *with* and *without* checkoff expenditure scenarios as summarized in the previous section and illustrated in Tables 5 and 6 and Figure 24, the answer to the first key question regarding the U.S. soybean checkoff program posed earlier is that the checkoff has effectively increased the supply, demand, trade, and export market shares of U.S. soybean and soybean products.

The second, more critical question that must be answered about the U.S. soybean checkoff program, is whether any gains in profit realized by soybean producers as a result of the program have been sufficient to more than pay for the cost of the program. That is, has the program run at a profit or a loss over time? Has the market lift induced by the checkoff program been substantial enough to generate sufficient additional profits to soybean producers over time to more than cover the cost of the checkoff program to them? If not, then the conclusion would be that the program should be discontinued because the program costs producers more than it returns to them. On the other hand, if the profits generated more than cover the costs, the program would be deemed a successful investment opportunity for soybean producers. This section, then, provides a benefit-cost analysis of the soybean checkoff program to answer these questions based on the results of the scenario analyses discussed in the previous section.

Calculating the Benefit-Cost Ratio for the Soybean Checkoff Program

As usually calculated, the producer *profit* Benefit Cost Ratio (PBCR) is the additional industry profits (additional cash receipts net of additional production costs and checkoff assessments) earned by producers as a consequence of the checkoff expenditures (as measured through the scenario analyses) divided by the historical level of checkoff expenditures made to generate those additional profits. For the soybean checkoff program, the additional soybean industry profits (in $ million) generated by the program in any given year (t) are calculated as:

$$[8] \quad R_t = (p_t^w q_t^w - c_t^w A_t^w) - (p_t^{wo} q_t^{wo} - c_t^{wo} A_t^{wo})$$

where p is the farm price of soybeans ($/bu.); c is production cost ($/acre); A is the soybean area harvested (million acres); q is production of soybeans (million bu.) which is the product of yield (y) and harvested acreage (A); and "wo" and "w" indicate the values from the *with* checkoff expenditure scenario (baseline simulation) and the *without* checkoff expenditures scenario (zero checkoff expenditures), respectively.

Then the grower profit BCR is calculated as:

$$[9] \quad PBCR = \sum_{t=1}^{T} \frac{R_t}{E_t}$$

where E is total checkoff expenditures ($ million) (production research, domestic promotion, and international market promotion). Because the checkoff represents a cost to producers, checkoff expenditures in each year (E_t) must be netted out of the additional profit generated (R_t) in those years (i.e., R_t - E_t) to arrive at the *net* grower profit BCR:

$$[10] \quad NBCR = PBCR - 1 .$$

If the time value of money is accounted for, then the discounted net grower profit BCR would be calculated as:

$$[11] \quad DBCR = \frac{\sum_{t=1}^{T} (R_t - E_t)/(1+i)^t}{\sum_{t=1}^{T} E_t}$$

where i is the interest rate chosen to discount the additional profit flows to present value.

Obviously the level of the DBCR depends on the rate used to discount the benefits over time. In this study, the DBCR was calculated using the 30-day Treasury bill interest rates (IMF 2014) for 1980/81 through 2012/13 as done by Williams (1999), Williams, Shumway, and Love (2002), Williams, Capps, and Bessler (2009) and others. Sellen, Goddard, and Duff (1997) and Davis *et al.* (2001) made an arbitrary choice of an annual 5% fixed rate as the discount rate. The Treasury bill interest rate, which declined rather steadily from a high of 14.1% in 1980/81 to a low of 0.059% in 2012/13, was selected simply because it represents a realistic alternative investment rate for the 1980/81 through 2012/13 period.

A BCR as calculated in equations [9], [10], and [11] that is greater than 1 is interpreted as meaning that the program has more than paid for itself. Otherwise, the program would be considered to be ineffective in increasing the profits of the soybean producers who pay for the program.

Benefit-Cost Analysis of the U.S. Soybean Checkoff Program

Using the *with* and *without* soybean checkoff expenditure scenario results and equations [8] – [11] above, the net profit BCR (NBCR) for the U.S. soybean program over the entire 1980/81 to 2012/13 period is calculated to be $6.5, indicating that the benefits in terms of the net additional soybean industry profits generated by the U.S. soybean checkoff program far exceeded the cost of the program expenditures over that period (Table 7). This NBCR compares quite favorably to those found by earlier studies of the soybean checkoff program and for other checkoff commodities. The BCRs calculated for the soybean checkoff program in the last three five-year studies (in order) have been $8.0 (Williams et al. 1998), $6.75 (World Perspectives, Inc. and AgriLogic, Inc. 2003), and $6.4 (Williams, Capps, and Bessler 2009). Even when the net grower benefits are discounted to present value (the DBCR), the ratio of benefits (net grower profits) to costs is still respectable at $2.5 (Table 7).

Interestingly, the calculated NBCR for the soybean checkoff program was substantially higher in the *voluntary* checkoff period of 1980/91 to 1991/92 ($11.0) than since the *national* checkoff program was implemented in 1992/93 ($5.2) (Table 7). Does that mean that the program was more effective *before* the implementation of the national soybean checkoff program than *after*? Not necessarily. In the first place, while the return per checkoff dollar spent was higher during the *voluntary* checkoff period than in the *national* checkoff period, over $100 million more checkoff dollars were spent in 2011/12 than in 1970/71. So, despite the lower average return per dollar, the sheer size of checkoff program in recent years compared to the 1970s insured a much larger effect of the current program on U.S. and world soybean and soybean product markets and prices than was the case in previous years.

Also, research has shown that both the average and marginal rates of return from promotion and advertising tend to decline as the level of funding increases. In other words, the relationship between expenditures and returns is not linear. As expenditures increase, each additional dollar spent is less and less effective at moving out the demand curve. Hence, the BCR would be expected to be somewhat lower in the *national* program period of the checkoff compared to the *voluntary* period simply because of the huge increase in checkoff expenditures since implementation of the *national* program.

Table 7: U.S. Soybean Checkoff Program Benefit-Cost Analysis, 1980/81-2012/13

	1980/81-1991/92	1992/93-2012/13	**1980/81-2012/13**
Added Soybean Cash Receipts ($ million)	5,467.0	23,181.9	**28,648.9**
Soybean Checkoff Investment[a] ($ million)	234.8	1,175.9	**1,353.5**
Revenue Benefit-Cost Ratio (RBCR) ($/$ spent))	23.3	19.7	**21.2**
Cost of Production ($/acre)			
Total	179.71	275.16	**240.45**
Variable cash expenses	60.44	93.60	**81.54**
All other (capital, land, etc.)	119.27	181.56	**158.90**
Cost of Production ($/bu)			
Total	5.87	6.98	**6.58**
Variable cash expenses	1.97	2.36	**2.22**
All other (capital, land, etc.)	3.90	4.59	**4.34**
Cost of Added Production ($ million)			
Total	2,653.9	15,887.8	**18,541.7**
Variable cash expenses	896.3	4,907.9	**5,804.2**
All other (capital, land, etc.)	1,757.6	10,979.9	**12,737.5**
Net Revenue[b] ($ million)	2,813.0	7,294.2	**10,107.2**
Grower Profit Benefit-Cost Ratio (PBCR) ($/$ spent)	12.0	6.2	**7.5**
Grower Net Profit Benefit-Cost Ratio (NBCR) ($/$ spent)	11.0	**5.2**	**6.5**
Discounted NBCR[c] (DBCR) ($/$Invested)	8.0	3.8	**2.5**

[a] Production Research (ASA, USB (SmithBucklin) and QSSBs) + Domestic Promotion (USB (SmithBucklin)) + International Marketing Promotion (ASA, USB (USSEC and SmithBucklin), QSSBs, and FAS).
[b] Added cash receipts minus added production costs.
[c] The interest rate on the 30-day Treasury Bill used as the discount rate.

The large increase in checkoff expenditures, however, is not likely the whole reason for the drop in the BCR between the two periods. The decline is likely also due, at least in part, to the shift in funding allocation strategy that funneled more funds to production research and less to international market promotion since the implementation of the *national* program. Previous analyses of the soybean checkoff program have come to the same conclusion. The share of checkoff funds allocated to production research was only 21.5% in 1988/89 but was 50.6% in 2010/11. At the same time, the share of checkoff expenditures allocated to international marketing promotion dropped from 78.5% to 26.0% over the same period (see Figure 2). Expenditures for domestic promotion activities also increased initially under the *national* checkoff program. After the initial surge in spending on domestic promotion activities through about 1998/99, however, the continuing increase in the allocation of checkoff funds to production research came at the expense of the expenditure shares of both international market promotion and domestic promotion. At the same time, the international promotion strategy was moving away from funding value-added product promotion activities and focusing more on soybean promotion smaller, less developed countries.

The net effect of the strategy of increasing emphasis on production research and away from demand promotion (domestic and international) under the *national* checkoff program added tremendous “supply push” to the market effects of the checkoff program while reducing the “demand pull” of the program. In fact, the simulation results indicate that the “supply push” of production research expenditures began to have a greater impact on U.S. and world soybean and product markets than the “demand pull” of the domestic and international marketing promotion programs in about 2000/01.

This strategy was exactly the opposite of what had occurred under the *voluntary* checkoff program. The consequence has been a smaller positive effect of the program on the U.S. soybean farm price and, therefore, a smaller positive effect on soybean producer profits per checkoff dollar spent than was the case during the *voluntary* period of the program. Note in Table 5 and in Figure 24 how the positive average annual increase in the soybean price during the *voluntary* checkoff period disappears with the implementation of the *national* checkoff program. At the same time, the positive annual increases in the prices of soymeal and soyoil during the *voluntary* period turn negative during the *national* program period.

Another reason that the BCR in the more recent *national* program period is likely lower than in the earlier *voluntary* period is the estimated time period, lengthy for some regions of the country, over which production research and demand promotion expenditures are estimated to have market impacts. The major impacts of checkoff expenditures in any given year occur primarily in future years and not in the year of expenditure. Consequently, the BCR for the period since the implementation of the *national* checkoff likely underestimates the true BCR since the future returns from recent expenditures have yet to be realized.

CONCLUSIONS AND IMPLICATIONS FOR PROGRAM MANAGEMENT

The main conclusion of this study is that the U.S. soybean checkoff program continues to be highly effective in enhancing the profitability, competitiveness, and size of the U.S. soybean industry. Among the major findings of this study are the following:

- *The Benefit-Cost Ratio (BCR) of the soybean checkoff program has been relatively high at $6.5 in additional profit earned by U.S. soybean farmers for every checkoff dollar spent between 1980/81 and 2012/13 and $5.2 since the implementation of the national checkoff program in 1992/93.*

For every checkoff dollar spent to promote the demand for U.S. soybeans and soybean products and to improve the international competitiveness of U.S. soybean production through soybean production research between 1980//81 and 2012/13, U.S. soybean farmers earned an additional $6.5 in profits (cash receipts minus production costs and checkoff assessments). Since the implementation of the *national* checkoff program in 1992/93, the return has been $5.2 in industry profits per checkoff dollar spent. These BCRs compare favorably to those found by similar studies for other commodities and by all previous studies of the soybean checkoff program. Even when the benefits are discounted to present value to account for the time value of money, the benefit-cost ratio for the 1980/81 to 2012/13 period is still a reasonable $2.5 and $3.8 for the *national* program period of 1992/93-2012/13.

- *The Benefit-Cost Ratio for the soybean checkoff program was lower in the period following implementation of the national checkoff program than was the case during the voluntary checkoff program years.*

While the BCR for the soybean checkoff program was estimated to be a highly respectable $5.2 since the implementation of the *national* checkoff program in the early 1990s, the BCR during the preceding *voluntary* checkoff program period was estimated to be about twice as high at $11.0. Economics, program funding strategy, and the nature of returns from production research likely account for the lower BCR in the more recent period. A well-established feature of the economics of commodity checkoff programs is that the returns per dollar spent tend to decline as the level of promotion expenditures increase. The rush of funds into the checkoff program coffers with the implementation of the *national* soybean checkoff program undoubtedly worked to reduce the marginal and average returns to program expenditures. Also, a new funding strategy was adopted with the *national* checkoff program which has favored production research over international market promotion and even over domestic promotion in recent years. The consequence has been a smaller positive impact of the *national* checkoff program on the soybean price and even negative effects on soymeal and soyoil prices compared to the impact of the *voluntary* program, and therefore, a smaller boost to industry revenues and profits per checkoff dollar spent. Finally, the BCR is also likely lower because the returns from production research expenditures in recent years have not yet been fully realized and may not be for some time to come.

- *The checkoff program has increased the size and profitability of the U.S. soybean industry.*

The U.S. soybean checkoff program has provided a positive “lift” to U.S. soybean and soybean product markets. The “lift” is how much higher production, price or other variables were on average each year than would have been the case if there had not been a checkoff program. The estimated annual lift over the 1980/81 to 2012/13 included the following:

- Soybean planted acreage: 3.0%
- Soybean production: 4.3%
- Soybean farm cash receipts: 5%
- Soybean crush: 3.7%
- Soybean exports: 5.8%
- Soybean farm price: 0.6%
- Soybean crush margin: -0.3%
- Soymeal consumption: 2.1%
- Soymeal exports: 9.5%
- Soymeal price: 0.1%
- Soyoil consumption: 2.2%
- Soyoil exports: 16.3%
- Soyoil price: -0.7%

The small changes in the prices reflect the price-offsetting effects of simultaneously investing checkoff dollars in production research and demand promotion and the substantial increase in the production research share relative to the demand promotion share of checkoff expenditures over the last decade. The slightly negative effect on soyoil price also results from the relatively larger increase in oil supplies from the checkoff-induced increased in soybean crush than the increase in soyoil consumption as a result of domestic promotion expenditures.

- *The soybean checkoff program has reduced the competitive threat of the South American soybean industry.*

  The soybean checkoff program also created some lift in exports of U.S. export competitors but to a much lesser extent. Thus, the U.S. export shares of world soybean, soymeal, and soyoil imports were higher by 0.8, 1.1, and 1.9 percentage points, respectively, while those of Brazil and Argentina were lower as a result of the soybean checkoff program.

- *The soybean checkoff program has boosted imports of soybeans and soybean products around the world, particularly by China and many smaller, less developed countries.*

  China experienced by far the largest soybean-checkoff-induced lift of soybean imports of all importing regions since the implementation of the national checkoff program of 1.24 million mt (6%). The soybean import lift was 383,000 mt (3.3%) for the group of smaller importing countries (referred to as "rest of the world"), nearly 220,000 mt (1.5%) for the EU 15/27, and almost 100,000 mt (2.3%) for Japan. For soymeal imports over the same period, the rest of the world experienced the largest lift of about 775,000 mt (4.6%), followed by the EU 15/27 of almost 420,000 mt (2.4%), and Japan of only just over 60,000 mt (5.0%). For soyoil imports over the same period, the rest of the world experienced the largest lift of just over 200,000 mt (4.2%).

These conclusions suggest a number of implications for program management purposes. First and foremost is that despite the sharp increase in funding with the *national* checkoff program the U.S. soybean industry continues to underinvest in the soybean checkoff program. The underfunding imposes an opportunity cost on the soybean industry. The estimated checkoff BCR suggests that for every dollar *not* contributed by producers and spent on production research and demand promotion, the industry loses $5.2 in additional revenues. As the level of expenditures increase, of course, the BCR would be expected to drop to some extent. But because the current level of expenditure is still low relative to the size of the soybean industry (currently only about 0.3% of soybean farm cash receipts), even an extraordinary expansion in the current level of investments would likely have only a modest negative effect on the benefit-cost ratio.

Second, care must be taken in determining the proper share of funds to allocate to production research. Production research expenditures help boost U.S. soybean production and ensure that the demand created by domestic and international promotion expenditures is supplied from U.S. production. The difficulty is that the increase in U.S. soybean supply generated by production research expenditures tends to limit the positive price impact and producer profits from the additional demand generated by the demand promotion. The implication is that too much emphasis on production research can reduce the overall returns to the soybean checkoff program.

If production research activities are de-emphasized too much, however, the consequence could be a reduction in the competitiveness of the U.S. soybean industry in world markets. Brazil, Argentina, and other U.S. competitors in world soybean markets invest heavily in research to boost their soybean yields and reduce their soybean production costs to gain a greater competitive edge in world soybean markets. The failure of the U.S. to continue investing aggressively in research to develop new, high-yielding and cost-efficient soybean production technologies and techniques would allow the comparative advantage in the production and export of soybeans and soybean products to shift slowly over the long run to our export competitors who continue to invest heavily in production research.

Finding the proper mix of expenditures on production research vs. demand promotion, however, is a complicated problem and requires additional research much beyond the scope of this study. Given that federal research funds are expected to continue to decline over the foreseeable future and that private soybean breeders tend to invest more in applied research rather than in more basic research because of the difficulty of capturing the returns to basic research, the soybean checkoff program may play a key role in financing critically needed basic research that might otherwise go unfunded. In any case, soybean growers must weigh carefully the tradeoff between the cost of investments in production research from a lower overall return to checkoff investments and the possible loss of competitiveness in world markets from curtailing such investments.

Third, a failure to maintain and enhance the growth in soybean checkoff expenditures over some time period can have serious negative impacts on soybean producer profitability over many years. Checkoff expenditures are intended to create a stream of new revenues over time. The market effects of expenditures in any given year are not realized immediately but rather are distributed over a number of years. Consequently, any reduction in funding for even one year can erode the effectiveness of the program in boosting exports and raising producer profits not just in that year but over a longer period of time. By the same token, increasing funding levels again after some period of lapse usually requires years before the benefits are fully realized once again. In the meantime, the returns from the program drop. In essence, this is what occurred with the severe reduction in the share of funding allocated to international marketing that began in the early 1990s and likely explains at least some of the drop in the BCR to the soybean checkoff program since that time (see Figure 2 and Table 7 and related discussion).

Fourth, the way in which funds for international and domestic demand promotion are allocated among soybeans and soybean products and across countries can have important implications for the return to those investments and for U.S. competitiveness in foreign markets. For example, a shift in the commodity allocation of international promotion funds which pushed the soybean share from 8% in 1985/86 to over 72% by 2004/05 (see Figure 6) maintained positive upward pressure on the soybean price during that period despite the downward price pressure of the production-research-induced increase in soybean supplies. The reduction in the soybean share of international marketing promotion expenditures in favor of soybean meal since that time, however, has weakened the upward pressure on the soybean price in the face of growing production research expenditures. At the same time, international promotion funds were being redirected from the larger, more established markets (Japan, Europe, and even China) to newer, less developed country markets in Asia, Latin America, and elsewhere. Research is needed to determine the optimal or highest yielding regional and commodity allocation of international promotion programs.

Fifth, the current mix of checkoff expenditures appears to be reducing potential returns. Based on the results of this study and an examination of the key characteristics of current and past checkoff expenditures discussed earlier in the report, a consideration of the following adjustments in the current funding allocation strategy that might enhance the returns to soybean producers is recommended:

(1) an increase in the share of expenditures to domestic and international demand promotion to enhance the demand pull of the checkoff program relative to the supply push from the growing share of expenditures currently going to production research;

(2) an increase in the share of expenditures to international promotion relative to domestic demand promotion given the relatively higher BCR to the international marketing expenditures under the *voluntary* program;

(3) an increase in the emphasis of promotion expenditures on value-added products (soymeal, soyoil, soyfood) compared to the promotion of the raw product (soybeans); and

(4) some re-examination of the limited international marketing promotion expenditures in larger, established markets like the European Union, Japan, and even China compared to those in smaller, less developed country markets.

Sixth, the BCR for any commodity checkoff program is not indicative of the lift provided by the program to U.S. and world soybean and product markets. Despite the reasonably high BCR calculated for the soybean checkoff program, the total amount of funds spent is actually quite small relative to the value of U.S. soybean production and world soybean and soybean product trade and so could hardly be expected to have a major impact on U.S. and world markets. The research presented here demonstrates that the checkoff program has had a modest impact on U.S. and world soybean prices and quantities (see Tables 5 and 6) and generated a modest positive benefit to U.S. soybean producers. That modest positive benefit divided by an even more modest level of checkoff expenditures has resulted in a reasonably large BCR of $5.2 per checkoff dollar since the implementation of the *national* checkoff program. Checkoff groups sometimes interpret estimated BCRs much in excess of 1:1 to imply large absolute impacts of their program on the market. Nothing could be further from the truth. A BCR of 5:1, for example, results by dividing a $5 billion industry profit benefit by a $1 billion checkoff investment or by dividing a $5 benefit by a $1 investment. Both investments yield a 5-to-1 return. The *national* soybean checkoff program BCR of $5.2 simply means that for every dollar that producers have invested, they have earned $5.2 in return, a much higher return to the investment of producer dollars than could have been obtained from just about any other investment opportunity, particularly in the current environment of low rates of interest.

Seventh, the producer BCR calculated in this study provides a measure of the *average* return to producers from soybean checkoff investments and <u>not</u> the return realized by individual producers. In other words, not all producers have earned $5.2 or even $3.8 on a discounted basis for every dollar they have paid in assessments since the implementation of the national checkoff program. Because the BCR is an average, some producers have realized higher returns while others have earned lower. To suggest that all producers benefit equally from the checkoff program would be to commit the inferential error termed "the fallacy of division" where one reasons that something true for the whole must also be true of all or some of its parts.

Finally, care must be taken in communicating these results to producers. Past experience suggests that inevitably some producers will ask something like: "If the returns were $5.2 for every dollar invested in the soybean checkoff program, where are my $5.2 for every checkoff dollar I have been assessed?" The question conveys a common lack of understanding of not just the results of checkoff evaluation studies but how checkoff programs return value to them. The basic problem is that all producers can easily identify the line on their balance sheets for the cost to them of the checkoff assessment. But there is no line on their balance sheets for what their contributions to the checkoff program have returned to them in additional revenues. What they often fail to understand is that the benefits to them are included in the revenue line on their balance sheet. Some part of that revenue has come from the larger volume of soybeans the checkoff program has enabled them to produce and sell at a higher price. The problem is that they cannot tell how many more bushels of soybeans the checkoff program has enabled them to produce at how much of a lower cost and to sell at how much of a higher price as a result of the checkoff program. In essence, that is what this study does – identifies that part of the industry revenue stream that is the result of the checkoff program rather than any other market event or force. This study determines that the soybean checkoff program has contributed 4% of the cash receipts received by soybean producers on average over the period of 1980/81 to 2012/13 and 5.3% of those revenues since the implementation of the *national* soybean checkoff program (see Table 5).

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APPENDIX

This appendix provides details on SOYMOD, the SIMULATION model used in the evaluation of the soybean checkoff program, including the model structure, parameter estimates, and regression statistics as well as the historical model simulation validation statistics. The econometric, structural equations that make up SOYMOD are presented in Appendix Table 1.1. The definitions of variables are provided in Appendix Table 1.2.

Note that the equations are organized by world region (U.S., EU-15/27, Japan, China, Rest-of-the-World, Brazil, and Argentina). Within each region in Appendix Table 1, the equations are organized by commodity block (soybeans, soymeal, soyoil, and corn (U.S. only)). Within each commodity block, the supply equations are presented first and then those for demand followed by the market clearing identities.

The dependent variables of the four model equations that were re-normalized on prices (soybeans, soymeal, soyoil, and corn) are marked with an asterisk (*) after the dependent variable of the equation. For more details on the model, the reader is referred to the "Methodology and Data" section of this report and to Williams (1981), Williams and Thompson (1984), Williams (1985), Williams (1994), Williams (1999), Williams, Shumway, and Love (2002), and Williams, Capps, and Bessler (2009).

The estimated parameters are those presented below each equation with the t-value in parentheses. The adjusted R^2 and the Durbin-Watson or Durbin-h statistics for serial correlation are provided for each equation. All Durbin-Watson and Durbin-h statistics indicate the absence of serial correlation. The parameters of SOYMOD were estimated using the Ordinary Least Squares (OLS) estimator with annual data for 1960/61 through 2011/12 for many equations but shorter time periods in cases of limited data availability. Normalization by an exogenous price index maintained linear homogeneity in prices. All equations were estimated in linear or log-linear form. The parameters for the price variables in the Rest-of-the-World soybean, soymeal, and soyoil demand equations were constrained to insure elasticities of -1.0. For those and the few other constrained coefficients in the model, the t-values of those coefficients are given as (c).

Appendix Table 3 provides the Theil forecast error (i.e., the Mean Squared Error (MSE) Decomposition Proportions Inequality Coefficients) simulation validation statistics from simulating SOYMOD over the 1980/81 to 2012/13 sample period (*ex post* simulation). Those statistics indicate a highly satisfactory fit of the historical, dynamic simulation solution values to observed data. The Theil U coefficients were small with all but three less 0.2 and only one greater than 0.3. The one variable with a higher Theil coefficient (0.59) was Japanese soyoil imports which historically have been extremely small and have fluctuated from a positive to a negative (net exports) number. The Theil bias error proportions (UM) indicate no systematic deviation of simulated and actual data values for any of the endogenous variables. The variance proportions (US) are also remarkably low for such a large, highly simultaneous, and complex model.

Appendix Table 1: SOYMOD Structure and Regression Results

United States

U.S. Soybean Supply

Regional and Total U.S. Acreage Planted

ASOYSAC=ASOYSAC0+ASOYSAC1*ASOYPCC/UFPI67+ASOYSAC2*ACORPPC/UFPI67
+ASOYSAC3*AOATPPC/UFPI67+ASOYSAC4*LAG(ASOYSAC+ASOYSAC5*D82
+ASOYSAC6*D1011+ $\sum_{n=1}^{12}$ ASOYSAC7$_n$*LOG(ASOYR/UFPI67)$_{t-n}$

ASOYSAC0: 106.958 (0.38) ASOYSAC1: 785.9225 (8.23) ASOYSAC2: -535.119 (-2.69)
ASOYSAC3: -778.41(-2.20) ASOYSAC4: 0.72447 (19.08) ASOYSAC5: 1004.202(4.92)
ASOYSAC6: -553.06(-4.05) ASOYSAC7n=1.2500, 2.2917, 3.1251, 3.7501, 4.1668, 4.3751, 4.3751, 4.1668, 3.7501, 3.1251, 2.2917, 1.2500 (t-values=1.4829) for n=lag period
Adj R^2=0.9399 Dh=0.8485

CSOYSAC=CSOYSAC0+CSOYSAC1*CSOYPCC/UFPI67+CSOYSAC2*CCORPPC/UFPI67
+CSOYSAC3*LAG(CSOYSAC)+CSOYSAC4*TIME+CSOYSAC5*DETH+CSOYSAC6*DRGHT07
+$\sum_{n=1}^{2}$ CSOYSAC7$_n$*LOG(CSOYR/UFPI67)$_{t-n}$

CSOYSAC0: -147818(-4.12) CSOYSAC1: 1827.461(4.46) CSOYSAC2: -4802.06 (-4.75)
CSOYSAC3: 0.764475(17.92) CSOYSAC4: 78.29215(4.22) CSOYSAC5: -1106.13(-2.03)
CSOYSAC6: -5095.17 (-5.62) CSOYSAC7n=439.482, 439.482 (t-values=4.8885) for n= lag period
Adj R^2=0.9813 Dh=0.2175

DSOYSAC=DSOYSAC0+DSOYSAC1*DSOYPCC/UFPI67+DSOYSAC2*DRICPPC/UFPI67
+DSOYSAC3*DWHEPPC/UFPI67+DSOYSAC4*LAG(DSOYSAC)+DSOYSAC5*SHIFT+
+DSOYSAC6*DRGHT07+$\sum_{n=1}^{4}$DSOYSAC7$_n$*LOG(DSOYR/UFPI67)$_{t-n}$

DSOYSAC0: 174.8568(0.29) DSOYSAC1:1067.216(5.06) DSOYSAC2: -329.42(-3.01)
DSOYSAC3: -337.534(-1.18) DSOYSAC4: 0.809675(24.76) DSOYSAC5: 936.824(4.98)
DSOYSAC6: -503.103(-1.15) DSOYSAC7n=34.8697, 52.3046, 52.3046, 34.8697 (t-values=2.3473) for n=lag period
Adj R^2= 0.9643 Dh=0.5745

LSOYSAC=LSOYSAC0+LSOYSAC1*LSOYPCC/UFPI67+LSOYSAC2*LCORPPC/UFPI67
+LSOYSAC3*LBARPPC/UFPI67+LSOYSAC4*LAG(LSOYSAC)+LSOYSAC5*TIME
+LSOYSAC6*DFB96+LSOYSAC7*DLBW+LSOYSAC8*DRGHT07
+$\sum_{n=1}^{12}$ LSOYSAC9$_n$*LOG(LSOYR/UFPI67)$_{t-n}$

LSOYSAC0: -113334 (-4.00) LSOYSAC1: 671.3326(4.64) LSOYSAC2: -1045.18(-2.33)
LSOYSAC3: -969.581(-2.55) LSOYSAC4: 0.642771(7.29) LSOYSAC5: 58.52058(4.02)
LSOYSAC6: 365.2151(2.00) LSOYSAC7: -552.154(-4.15) LSOYSAC8: -1244.71(-3.53)
LSOYSAC9n=6.111, 11.2037, 15.2778, 18.3333, 20.3704, 21.3889, 21.3889, 20.3704, 18.3333, 15.2778, 11.2037, 6.1111 (t-values=2.1026) for n=lag period
Adj R^2= 0.9878 Dh=0.0693

OSOYSAC=OSOYSAC0+OSOYSAC1*OSOYPCC/UFPI67+OSOYSAC2*OCORPPC/UFPI67
+OSOYSAC3*OWHEPPC/UFPI67+OSOYSAC4*LAG(OSOYSAC)+OSOYSAC5*TIME
+OSOYSAC8*DOBW+$\sum_{n=1}^{25}$ OSOYSAC9$_n$*LOG(OSOYR/UFPI67)$_{t-n}$

OSOYSAC0: -8249.8(-4.15) OSOYSAC1: 78.25527(7.94) OSOYSAC2: -83.5373(-3.15)
OSOYSAC3: -74.507(-4.32) OSOYSAC4: 0.782456(13.73) OSOYSAC5: 4.204118(4.17)
OSOYSAC7: -36.7881(-4.77) OSOYSAC9n=0.0653, 0.1253, 0.1802, 0.2298, 0.2742, 0.3133, 0.3473, 0.3760, 0.3995, 0.4178, 0.4308, 0.4387, 0.4413, 0.4387, 0.4308, 0.4178, 0.3995, 0.3760, 0.3473, 0.3133, 0.2742, 0.2298, 0.1802, 0.1253, 0.0653 (t-values=3.4144) for n=lag period
Adj R^2 = 0.9948 Dh=0.1936

Appendix Table 1 (continued)

PSOYSAC=PSOYSAC+PSOYSAC1*PSOYPCC/UFPI67+PSOYSAC2*PCORPPC/UFPI67
+PSOYSAC3*LAG(PSOYSAC) +PSOYSAC4*OWHEPPC/UFPI67+PSOYSAC5*TIME
+PSOYSAC6*DFB96+PSOYSAC7*DPBW+PSOYSAC8* DRGHT07
$+\sum_{n=1}^{10}$ PSOYSAC9$_n$*LOG(PSOYR/UFPI67)$_{t-n}$

PSOYSAC0: -92070.1(-2.76) PSOYSAC1: 763.2605(4.41) PSOYSAC2: -2137.3(-3.42)
PSOYSAC3: 0.851356(18.44) PSOYSAC4: -58.9028(-0.14) PSOYSAC5: 47.18893(2.78)
PSOYSAC6: 648.3102(1.83) PSOYSAC7: -1101.92(-5.59) PSOYSAC8: -2628.08(-11.17)
PSOYSAC9n=6.8806, 12.3850, 16.5134, 19.2656, 20.6417, 20.6417, 19.2656, 16.5134, 12.3850, 6.8806 (t-values=1.4838) for n=lag period
Adj R^2= 0.9952 Dh=1.3938

SSOYSAC=SSOYSAC0+SSOYSAC1*SSOYPCC/UFPI67+SSOYSAC2*SCORPPC/UFPI67
+SSOYSAC3*LAG(SSOYSAC) +SSOYSAC4*DRTH1011+SSOYSAC5*D0608
$+\sum_{n=1}^{11}$ SSOYSAC6$_n$*LOG(SSOYR/UFPI67)$_{t-n}$

SSOYSAC0: -1672.24(-5.24) SSOYSAC1: 1405.712(11.91) SSOYSAC2: -523.894(-3.47)
SSOYSAC3: 0.743503(38.99) SSOYSAC4: 867.9833(3.03) SSOYSAC5: 620.3095(4.73)
SSOYSAC6n=53.4038, 79.0007, 82.2200, 68.4907, 43.2419, 11.9027, -20.0977, -47.3303, -64.3659, -65.7755, -46.1299 (t-values=3.0775, 3.0736, 3.0673, 3.0554, 3.0241, 2.7784, -3.1856, -3.1399, -3.1239, -3.1161, -3.1115) for n=lag period
Adj R^2=0.9886 Dh= -0.8226

USOYSAC=(CSOYSAC+LSOYSAC+PSOYSAC+ASOYSAC+SSOYSAC+DSOYSAC+OSOYSAC)/**1000**

Regional and Total U.S. Acreage Harvested
ASOYSHC=ASOYSHC0+ASOYSHC1*ASOYSAC+ASOYSHC2*TIME

ASOYSHC0: -5823.78 (-6.68) ASOYSHC1: 0.998558(111.35) ASOYSHC2: 2.86203(6.49)
Adj R^2= 0.9960 DW=1.9084

CSOYSHC=CSOYSHC0+CSOYSHC1*CSOYSAC

CSOYSHC0: -117.442(-1.03) CSOYSHC1: 0.994483(257.28)
Adj R^2=0.9992 DW=2.1294

DSOYSHC=DSOYSHC0+DSOYSHC1*DSOYSAC

DSOYSHC0: -22.6499(-0.45) DSOYSHC1: 0.975306(149.64)
Adj R^2=0.9977 DW=2.0655

LSOYSHC=LSOYSHC0+LSOYSHC1*LSOYSAC

LSOYSHC0: 18.14867(0.72) LSOYSHC1: 0.979452(248.21)
Adj R^2=0.9996 DW=1.8679

OSOYSHC=OSOYSHC0+OSOYSHC1*OSOYSAC

OSOYSHC0: -3.83079(-2.95) OSOYSHC1: 0.988147(373.39)
Adj R^2=0.9997 DW=2.0802

PSOYSHC=PSOYSHC0+PSOYSHC1*PSOYSAC

PSOYSHC0: -28.5613(-1.43) PSOYSHC1: 0.983503(451.22)
Adj R^2=0.9997 DW=1.8874

Appendix Table 1 (continued)

SSOYSHC=SSOYSHC0+SSOYSHC1*SSOYSAC

SSOYSHC0: -107.024(-3.52) SOYSHC1: 0.969836(163.02)
Adj R^2=0.9980 DW=1.6011

USOYSHC=(CSOYSHC+LSOYSHC+PSOYSHC+ASOYSHC+SSOYSHC+DSOYSHC+OSOYSHC)/**1000**

Regional Soybean Yields

ASOYSYC=ASOYSYC0+ASOYSYC1*DLANINA+ASOYSYC2*DELNINO
$+\sum_{n=1}^{2}$ ASOYSYC3$_n$*LOG(ASOYR/UFPI67)$_{t-n}$

ASOYSYC0: -3.5454 (-1.1340) ASOYSYC1: 0.0375(0.0418) ASOYSYC2: -1.2746(-1.4254)
ASOYSAC3n=1.3263, 1.3263 (t-values=9.3343) for n=lag period
Adj R^2=0.6068 DW=1.9148

CSOYSYC=CSOYSYC0+CSOYSYC1*DLANINA+CSOYSYC2*DELNINO
$+\sum_{n=1}^{2}$ CSOYSYC3$_n$*LOG(CSOYR/UFPI67)$_{t-n}$

CSOYSYC0: -9.3055 (-3.7856) CSOYSYC1: -1.6743(-2.0178) CSOYSYC2: 0.6164(0.7491)
CSOYSAC3n=1.7547, 1.7547 (t-values=18.3463) for n=lag period
Adj R^2=0.8500 DW=1.7598

DSOYSYC=DSOYSYC0+DSOYSYC1*DLANINA+DSOYSYC2*DELNINO
$+\sum_{n=1}^{6}$ DSOYSYC3$_n$*LOG(DSOYR/UFPI67)$_{t-n}$

DSOYSYC0: -13.6634 (-0.4437) DSOYSYC1: -1.4126(-1.2648) DSOYSYC2: -0.0604(0.621)
DSOYSAC3n=0.3590, 0.5983, 0.7181, 0.7181, 0.5983, 0.3590 (t-values=1.4238) for n=lag period
Adj R^2=0.6567 DW=2.2528

LSOYSYC=LSOYSYC0+LSOYSYC1*DLANINA+LSOYSYC2*DELNINO
$+\sum_{n=1}^{8}$ LSOYSYC3$_n$*LOG(LSOYR/UFPI67)$_{t-n}$

LSOYSYC0: -5.7083 (-2.1221) LSOYSYC1: -1.4449(-1.0605) LSOYSYC2: 0.9331(0.9055)
LSOYSAC3n=0.2258, 0.3951, 0.5080, 0.5645, 0.5645, 0.5080, 0.3951, 0.2258 (t-values=13.8473) for n=lag period
Adj R^2=0.7927 DW=1.7371

OSOYSYC=OSOYSYC0+OSOYSYC1*DLANINA+OSOYSYC2*DELNINO
$+\sum_{n=1}^{2}$ OSOYSYC3$_n$*LOG(OSOYR/UFPI67)$_{t-n}$

OSOYSYC0: 26.0370(13.0431) OSOYSYC1: -1.2477(-0.8904) OSOYSYC2: -2.9145(-2.5526)
OSOYSAC3n=0.5612, 0.5612 (t-values=5.5044) for n=lag period
Adj R^2=0.7005 DW=2.3148

PSOYSYC=PSOYSYC0+PSOYSYC1*DLANINA+PSOYSYC2*DELNINO
$+\sum_{n=1}^{2}$ PSOYSYC3$_n$*LOG(PSOYR/UFPI67)$_{t-n}$

PSOYSYC0: -2.1790(-1.0790) PSOYSYC1: -2.0285(-2.0380) PSOYSYC2: 1.0856(1.0977)
PSOYSAC3n=1.3948, 1.3948 (t-values=15.9690) for n=lag period
Adj R^2=0.8099 DW=1.82258

SSOYSYC=SSOYSYC0+SSOYSYC1*DLANINA+SSOYSYC2*DELNINO
$+\sum_{n=1}^{15}$ SSOYSYC3$_n$*LOG(SSOYR/UFPI67)$_{t-n}$

SSOYSYC0: 19.9406 (2.7242) SSOYSYC1: -1.4288(-0.9983) SSOYSYC2: 0.0131(0.0094)

Appendix Table 1 (continued)

SSOYSAC3n=0.0214, 0.0399, 0.0556, 0.0684, 0.0784, 0.0855, 0.0898, 0.0912, 0.0898, 0.0855, 0.0784, 0.0684, 0.0556, 0.0399, 0.0214 (t-values=13.8473) for n=lag period
Adj R^2=0.4494 DW=1.8852

Regional and Total U.S. Production
ASOYSPC=ASOYSYC*ASOYSHC
CSOYSPC=CSOYSYC*CSOYSHC
DSOYSPC=DSOYSYC*DSOYSHC
LSOYSPC=LSOYSYC*LSOYSHC
OSOYSPC=OSOYSYC*OSOYSHC
PSOYSPC=PSOYSYC*PSOYSHC
SSOYSPC=SSOYSYC*SSOYSHC
USOYSPC=(CSOYSPC+LSOYSPC+PSOYSPC+ASOYSPC+SSOYSPC+DSOYSPC+OSOYSPC)/1000

Regional Market Price (Farm Level)
ASOYPFC=ASOYPFC0+ASOYPFC1*USOYPFC

ASOYPFC0: 0.014289(0.28) ASOYPFC1: 0.996945(113.91)
Adj R^2=0.9974 DW=2.2923

CSOYPFC=CSOYPFC0+CSOYPFC1*USOYPFC

CSOYPFC0: -0.06268(-1.75) CSOYPFC1: 1.01841(180.34)
Adj R^2=0.9984 DW=2.6584

DSOYPFC=DSOYPFC0+DSOYPFC1*USOYPFC

DSOYPFC0: 0.030527(0.37) DSOYPFC1: 1.008922(70.09)
Adj R^2=0.9928 DW=1.8446

LSOYPFC=LSOYPFC0+LSOYPFC1*USOYPFC+LSOYPFC2*D76

LSOYPFC0: 0.009334(0.23) LSOYPFC1: 0.980259(151.04) LSOYPFC2: 1.004676(8.10)
Adj R^2=0.9978 DW=1.5705

OSOYPFC=OSOYPFC0+OSOYPFC1*USOYPFC

OSOYPFC0: -0.13938(-1.75) OSOYPFC1: 1.014442(80.69)
Adj R^2= 0.9921 DW=2.3219

PSOYPFC=PSOYPFC0+PSOYPFC1*USOYPFC+PSOYPFC2*D76

PSOYSHC0: -28.5613(-1.43) PSOYSHC1: 0.983503(451.22)
Adj R^2=0.9997 DW=1.8874

SSOYPFC=SSOYPFC0+SSOYPFC1*USOYPFC
SSOYPFC0:-0.04814(-0.97) SSOYPFC1: 1.009051(128.82)
Adj R^2=0.9969 DW=2.3005

Regional Expected Farm Price
ASOYPCC=MAX(LAG(ASOYPFC),ASOYPLC)*D5901+MAX(LAG(ASOYPFC),0.85*USOYPTC
+0.15*MAX(LAG(ASOYPFC),ASOYPLC))*D0212
CSOYPCC=MAX(LAG(CSOYPFC),CSOYPLC)*D5901+MAX(LAG(CSOYPFC),0.85*USOYPTC
+0.15*MAX(LAG(CSOYPFC),CSOYPLC))*D0212
DSOYPCC=MAX(LAG(DSOYPFC),DSOYPLC)*D5901+MAX(LAG(DSOYPFC),0.85*USOYPTC

Appendix Table 1 (continued)

+0.15*MAX(LAG(DSOYPFC),DSOYPLC))*D0212
LSOYPCC=MAX(LAG(LSOYPFC),LSOYPLC)*D5901+MAX(LAG(LSOYPFC),0.85*USOYPTC
+0.15*MAX(LAG(LSOYPFC),LSOYPLC))*D0212
OSOYPCC=MAX(LAG(OSOYPFC),OSOYPLC)*D5901+MAX(LAG(OSOYPFC),0.85*USOYPTC
+0.15*MAX(LAG(OSOYPFC),OSOYPLC))*D0212
PSOYPCC=MAX(LAG(PSOYPFC),PSOYPLC)*D5901+MAX(LAG(PSOYPFC),0.85*USOYPTC
+0.15*MAX(LAG(PSOYPFC),PSOYPLC))*D0212
SSOYPCC=MAX(LAG(SSOYPFC),SSOYPLC)*D5901+MAX(LAG(SSOYPFC),0.85*USOYPTC
+0.15*MAX(LAG(SSOYPFC),SSOYPLC))*D0212

Soybean Demand and Market Clearing Condition

USOYDCC=USOYDCC0+USOYDCC1*USOYGCC/UWPI67R+USOYDCC2*UOISCPC
+USOYDCC3*(LAG(USOYHTC)+USOYSPC) USOYDCC4*LAG(SQRT(USOYEXP))
+USOYDCC5*D90T06+USOYDCC6*D07

USOYDCC0: 23.16515(1.08) USOYDCC1: 45.6665(2.79) USOYDCC2: 0.375353(7.54)
USOYDCC3: 0.258446(9.20) USOYDCC4: 2.4583(6.19) USOYDCC5: 89.52396(6.35)
USOYDCC6: 158.7041(4.03)
Adj R^2= 0.9930 DW=1.2322

*USOYHEC=USOYPFC0+USOYPFC1*USOYPFC/UFPI67+USOYPFC2*UCORPPC/UFPI67
+USOYPFC3*USOYSPC+USOYPFC4*USOYHGC+USOYPFC5*LAG(USOYHEC)
+USOYPFC6*D60T94

USOYPFC0: -86.9264(-1.40) USOYPFC1: -75.2336(-4.50) USOYPFC2: 58.32009(1.65)
USOYPFC3: 0.115039(8.05) USOYPFC4: -0.34456(-2.92) USOYPFC5: 0.338483(6.36)
USOYPFC6: 168.8487(7.92)
Adj R^2=0.9072 DW=1.9995

USOYPWC=USOYPWC0+USOYPWC1*USOYPFC+USOYPWC2*D72+USOYPWC3*D74+USOYPWC4*D87
+USOYPWC5*D11

USOYPWC0: 0.087449(0.97) USOYPWC1: 1.037023(71.21) USOYPWC2: 1.590759(6.13)
USOYPWC3: -0.65328(-2.52) USOYPWC4: 0.574853(2.22) USOYPWC5: 0.409758(1.48)
Adj R^2=0.9913 DW=2.1239

USOYGCC=USOMQ*USOMPWC/1000+USOOQ*USOOPWC/100-USOYPFC
USOYHEC=USOYHTC-USOYHGC
USOYHTC=LAG(USOYHTC)+USOYSPC+USOYMMC-USOYDCC-USOYMEC-USOYDZC

Soybean Meal Supply, Demand, and Market Clearing Condition

USOMSPC=USOMQ*USOYDCC

*UHPMDDC=UHPMDDC0+UHPMDDC1*UHPMPWC/UWPI67R+UHPMDDC2*UFIMPWA/UWPI67R
+UHPMDDC3*UHOGPFC/UFPI67+UHPMDDC4*USLSPFC/UFPI67
+UHPMDDC5*UCORDFC/UFPI67+UHPMDDC6*UHPAUC2+UHPMDDC7*LAG(SQRT(USOMEXP))
+UHPMDDC8*D1012

UHPMDDC0: -26105(-8.52) UHPMDDC1: -35.6537(-3.70) UHPMDDC2: 12.02798(2.13)
UHPMDDC3: 206.3362(3.17) UHPMDDC4: 150.9584(2.45) UHPMDDC5: -2.23348(-8.04)
UHPMDDC6: 396.4098(25.60) UHOMDDC7: 34.9125(5.41) UHPMDDC8: -4665.57(-4.86)
Adj R^2=0.9816 DW=1.7491

Appendix Table 1 (continued)

LOG(UCOMDPC)=UCOMDPC0+UCOMDPC1*LOG((USOMDPC+UPEMDPC)*UCOMPWC/(USOMDPC
*USOMPWC+UPEMDPC*UPEMPWC))+UCOMDPC2*LOG(**.8103***UCOMSPC/(USOMSPC+**.8103**
*UCOMSPC+**1.124***UPEMSPC))+UCOMDPC3*LOG(LAG(UCOMDPC))+UCOMDPC4*D80

UCOMDPC0: 0.064771(3.37) UCOMDPC1: -0.23936(-5.01) UCOMDPC2: 0.856509(45.53)
UCOMDPC3: 0.147471(7.37) UCOMDPC4: -0.78759(-25.82)
Adj R^2=0.9986 Dh=0.2133

USOMDPC=**1**-UCOMDPC-UPEMDPC
UHPMDDC=USOMDDC/USOMDPC
USOMPWC=(UHPMPWC-UCOMDPC*UCOMPWC-UPEMDPC*UPEMPWC)/USOMDPC

USOMHEC=USOMHEC0+USOMHEC1*USOMPWC/UWPI67R+USOMHEC2*LAG(USOMHEC)
+USOMHEC3*LAG(EMBARGO) +USOMHEC4*D82+USOMHEC5*D84

USOMHEC0: 244.5715(8.57) USOMHEC1: -0.80366(-3.36) USOMHEC2: 0.295198(3.97)
USOMHEC3: 290.8988(7.29) USOMHEC4: 232.2889(5.89) USOMHEC5: 103.4803(2.64)
Adj R^2=0.8313 Dh=0.5687

USOMDDC=LAG(USOMHEC)+USOMMMC+USOMSPC-USOMDZC-USOMHEC-USOMMEC

Soybean Oil Supply, Demand, and Market Clearing Condition

USOOSPC=USOOQ*USOYDCC

UOLODDC/UPOPA=UOLODDC0+UOLODDC1*UOLOPWC/UWPI67R+UOLODDC2*ULAOPWC/UWPI67R
+UOLODDC3*UYDA/UCPI67/UPOPA+UOLODDC4*LAG(UOLODDC)
+UOLODDC5*LAG(SQRT(USOOEXP))+UOLODDC6*D0809

UOLODDC0: 4.427115(2.84) UOLODDC1: -0.53831(-4.58) UOLODDC2: 0.267679(3.33)
UOLODDC3: 4.597913(6.66) UOLODDC4: 0.549629(8.41) UOLODDC5: 15.5241(3.89)
UOLODDC6: -6.91408(-8.52)
Adj R^2=0.9953 Dh= -1.5667

LOG(UCOODPC)=UCOODPC0+UCOODPC1*LOG((USOODPC+UPEODPC)*UCOOPWC/(USOODPC
*USOOPWC+UPEODPC*UPEOPWC))+UCOODPC2*LOG(UCOOSPC/(USOOSPC+UPEOSPC))
+UCOODPC3*LOG(LAG(UCOODPC))+UCOODPC4*D7475

UCOODPC0: -0.0819(-1.31) UCOODPC1: -0.4126(-3.18) UCOODPC2: 0.151385(3.54)
UCOODPC3: 0.821052(16.73) UCOODPC4: -0.36396 (-5.08)
Adj R^2=0.9790 Dh= -0.8788

USOODPC=**1**-UCOODPC-UPEODPC
USOODDC=UOLODDC*USOODPC
UOLOPWC=UCOODPC*UCOOPWC+UPEODPC*UPEOPWC+USOOPWC*USOODPC

*USOOHEC=USOOPWC0+USOOPWC1*USOOPWC+USOOPWC2*USOOSPC+USOOPWC3*USOOMGC
+USOOPWC4*USOOHGC+USOOPWC5*LAG(USOOHEC)+USOOPWC6*LAG2(USOOHEC)
+USOOPWC7*DSOOH3

USOOPWC0: -331.173(-1.93) USOOPWC1: -41.2117(-7.33) USOOPWC2: 0.194364(12.01)
USOOPWC3: -0.65883(-1.85) USOOPWC4: 2.986795(1.89) USOOPWC5: 0.716027(9.54)
USOOPWC6: -0.38085(-4.79) USOOPWC7: 561.7939(6.61)
Adj R^2=0.9317 Dh=0.7330

USOOMEC=USOOMTC-2.20462*USOOMGC
USOOHEC=USOOHTC-USOOHGC
USOOHTC=LAG(USOOHTC)+USOOSPC+USOOMMC-USOODZC-USOOMTC-UOLODDC*USOODPC

Appendix Table 1 (continued)

U.S. Corn Supply

Regional and Total U.S. Acreage Planted

ACORSAC=ACORSAC0+ACORSAC1*ACORPPC/UFPI67+ACORSAC2*ASOYPCC/UFPI67
+ACORSAC3*AOATPPC/UFPI67+ACORSAC4*LAG(ACORSAC)+ACORSAC5*DPIK
+ACORSAC6*UCORARP+ACORSAC7*NORFLEX+ACORSAC8*D1112

ACORSAC0: 961.4747(3.06) ACORSAC1: 502.042(6.09) ACORSAC2: -378.896(-3.04)
ACORSAC3: -1963.35(-5.05) ACORSAC4: 0.899166(18.04) ACORSAC5: -750.499(-3.60)
ACORSAC6: -4.94471(-1.28) ACORSAC7: -17.0019(-2.56) ACORSAC8: -497.098(-3.06)
Adj R^2= 0.9324 Dh= -1.3905

CCORSAC=CCORSAC0+CCORSAC1*CCORPPC/UFPI67+CCORSAC2*CSOYPCC/UFPI67
+CCORSAC3*LAG(CCORSAC)+CCORSAC4*DPIK+CCORSAC5*UCORARP
+CCORSAC6*DBWCCOR

CCORSAC0: 22881.58(6.80) CCORSAC1: 4736.821(3.24) CCORSAC2: -969.35(-1.45)
CCORSAC3: 0.31448(3.74) CCORSAC4: -9449.26(-6.72) CCORSAC5: -144.846(-5.27)
CCORSAC6: 3522.632(4.32)
Adj R^2=0.8136 Dh= -0.6257

DCORSAC=DCORSAC0+DCORSAC1*DCORPPC/UFPI67+DCORSAC2*DSOYPCC/UFPI67
+DCORSAC3*DRICPPC/UFPI67+DCORSAC4*LAG(DCORSAC)+DCORSAC5*UCORARP
+DCORSAC6*DBWDCOR

DCORSAC0: 236.2827(1.73) DCORSAC1: 223.817(1.94) DCORSAC2: -76.778(-1.24)
DCORSAC3: -43.0805(-1.96) DCORSAC4: 0.827699(25.81) DCORSAC5: -3.5919(-1.69)
DCORSAC6: -308.189(-3.85)
Adj R^2= 0.9588 DW= -0.2718

LCORSAC=LCORSAC0+LCORSAC1*LCORPPC/UFPI67+LCORSAC2*LSOYPCC/UFPI67*(D60T90
+NORFLEX/100+D96T11)+LCORSAC3*LBARPPC/UFPI67+LCORSAC4*LAG(LCORSAC)
+LCORSAC5*UCORARP+LCORSAC6*DPIK+LCORSAC7*DBWLCOR

LCORSAC0: 4409.879(3.53) LCORSAC1: 2803.291(3.21) LCORSAC2: -319.655(-2.20)
LCORSAC3: -2074.52(-2.63) LCORSAC4: 0.671296(8.77) LCORSAC5: -99.1034(-5.17)
LCORSAC6: -4089.42(-6.31) LCORSAC7: -852.891(-2.43)
Adj R^2= 0.8719 Dh= -0.5049

OCORSAC=OCORSAC0+OCORSAC1*OCORPPC/UFPI67+OCORSAC2*OSOYPCC/UFPI67
+OCORSAC3*OWHEPPC/UFPI67+OCORSAC4*LAG(OCORSAC)+OCORSAC5*DPIK
+OCORSAC6*DBWOCOR

OCORSAC0: 116.2348(1.11) OCORSAC1: 651.2845(8.85) OCORSAC2: -138.139(-4.01)
OCORSAC3: -145.47(-3.57) OCORSAC4: 0.887753(28.16) OCORSAC5: -427.296(-6.53)
OCORSAC6: -160.456(-4.94)
Adj R^2=0.9786 Dh=0.8040

PCORSAC=PCORSAC0+PCORSAC1*PCORPPC/UFPI67+PCORSAC2*PSOYPCC/UFPI67
+PCORSAC3*LBARPPC/UFPI67+PCORSAC4*LAG(PCORSAC)+PCORSAC5*DPIK
+PCORSAC6*UCORARP+PCORSAC7*(D60T90+NORFLEX/100+D96T11)+PCORSAC8*DBWPCOR

PCORSA0: 7285.524(4.83) PCORSA1: 4608.371(4.53) PCORSA2: -343.539(-1.09)
PCORSA3: -5994.51(-6.62) PCORSA4: 0.666752(11.00) PCORSA5: -4276.33(-6.34)
PCORSA6: -117.503(-6.00) PCORSA7: 442.4599(1.26) PCORSA8: -1807.59(-5.38)
Adj R^2=0.9633 Dh= -0.2446

Appendix Table 1 (continued)

SCORSAC=SCORSAC0+SCORSAC1*SCORPPC/UFPI67+SCORSAC2*SSOYPCC/UFPI67
+SCORSAC3*LAG(SCORSAC)+SCORSAC4*DPIK+SCORSAC5*UCORARP+SCORSAC6*D73

SCORSAC0: 685.2415(2.72) SCORSAC1: 1723.906(7.10) SCORSAC2: -390.576(-3.45)
SCORSAC3: 0.709774(26.06) SCORSAC4: -1029.68(-4.64) SCORSAC5: -11.7366(-3.14)
SCORSAC6: 727.4285(3.26)
Adj R^2= 0.9564 DW= -0.8070

TCORSAC=TCORSAC0+TCORSAC1*TCORPPC/UFPI67+TCORSAC2*OSOYPCC/UFPI67
+TCORSAC3*OWHEPPC/UFPI67+TCORSAC4*LAG(TCORSAC)+TCORSAC5*DPIK
+TCORSAC6*D75T84 +TCORSAC7*D96T11

TCORSAC0: 359.6425(1.93) TCORSAC1: 339.1059(2.27) TCORSAC2: -28.7321(-0.43)
TCORSAC3: -369.515(-4.39) TCORSAC4: 0.932162(21.26) TCORSAC5: -511.693(-3.86)
TCORSAC6: 118.7229(2.12) TCORSAC7: 132.1899(2.55)
Adj R^2 =0.9602 Dh= -0.8710

UCORSAC=(ACORSAC+CCORSAC+DCORSAC+LCORSAC+OCORSAC+PCORSAC+SCORSAC
+TCORSAC)/10000

Regional and Total U.S. Acreage Harvested
ACORSHC=ACORSHC0+ACORSHC1*ACORSAC

ACORSHC0: -135.154(-2.50) ACORSHC1: 0.884626(54.92)
Adj R^2=0.9860 DW=1.7226

CCORSHC=CCORSHC0+CCORSHC1*CCORSAC+CCORSHC2*TIME

CCORSHC0: -44111.1(-6.71) CCORSHC1: 0.952017(55.50) CCORSHC2: 22.36075(6.49)
Adj R^2=0.9885 DW=1.8338

DCORSHC=DCORSHC0+DCORSHC1*DCORSAC+DCORSHC2*TIME

DCORSHC0: -2366.98(-7.11) DCORSHC1: 0.975244(234.43) DCORSHC2: 1.159465(6.88)
Adj R^2=0.9993 DW=1.9084

LCORSHC=LCORSHC0+LCORSHC1*LCORSAC +LCORSHC2*D7683

LCORSHC0: -1573.57(-6.30) LCORSHC1: 0.995034(53.60) LCORSHC2: -1343.84(-10.82)
Adj R^2=0.9877 DW=1.5658

OCORSHC=OCORSHC0+OCORSHC1*OCORSAC+OCORSHC2*D6061+OCORSHC3*D72

OCORSHC0: -548.778(-7.41) OCORSHC1: 0.80242(30.34) OCORSHC2: 192.4216(3.45)
OCORSHC3: -232.575(-3.17)
Adj R^2=0.9505 DW=1.7217

PCORSHC=PCORSHC0+PCORSHC1*PCORSAC+PCORSHC2*TIME

PCORSHC0: -34716.7(-1.98) PCORSHC1: 0.979782(35.90) PCORSHC2: 16.90055(1.89)
Adj R^2= 0.9943 DW=1.8060

SCORSHC=SCORSHC0+SCORSHC1*SCORSAC+SCORSHC2*TIME

SCORSHC0: -9929.03(-4.67) SCORSHC1: 0.927561(58.81 SCORSHC2: 4.849127(4.66)
Adj R^2=0.9908 DW=1.9782

Appendix Table 1 (continued)

TCORSHC=TCORSHC0+TCORSHC1*TCORSAC+TCORSHC2*DBWTCH

TCORSHC0: -151.161(-3.39) TCORSHC1: 0.646773(39.16) TCORSHC2: -124.517(-5.10)
Adj R^2=0.9885 DW=1.6022

UCORSHC=(ACORSHC+CCORSHC+DCORSHC+LCORSHC+OCORSHC+PCORSHC+SCORSHC+TCORSHC)/1000

Regional and U.S. Production
ACORSPC=ACORSYC*ACORSHC
CCORSPC=CCORSYC*CCORSHC
DCORSPC=DCORSYC*DCORSHC
LCORSPC=LCORSYC*LCORSHC
OCORSPC=OCORSYC*OCORSHC
PCORSPC=PCORSYC*PCORSHC
SCORSPC=SCORSYC*SCORSHC
TCORSPC=TCORSYC*TCORSHC
UCORSPC=(ACORSPC+CCORSPC+DCORSPC+LCORSPC+OCORSPC+PCORSPC+SCORSPC+TCORSPC)/1000

Regional Market Price (Farm Level)
ACORPFC=ACORPFC0+ACORPFC1*UCORPFC+ACORPFC2*DACORP

ACORPFC0: 0.070563(2.63) ACORPFC1: 1.070297(106.15) ACORPFC2: -0.30249(-9.12)
Adj R^2=0.9954 DW=2.0380

CCORPFC=CCORPFC0+CCORPFC1*UCORPFC

CCORPFC0: -0.03285(-4.06) CCORPFC1: 1.01616(334.60)
Adj R^2=0.9995 DW=1.8709

DCORPFC=DCORPFC0+DCORPFC1*UCORPFC +DCORPFC2*DDCORP

DCORPFC0: 0.237335(4.69) DCORPFC1: 0.970104(50.41) DCORPFC2: 0.490863(5.81)
Adj R^2=0.9802 DW=1.7664

LCORPFC=LCORPFC0+LCORPFC1*UCORPFC+LCORPFC2*DLCORP

LCORPFC0: -0.03895(-2.71) LCORPFC1: 0.98442(184.56) LCORPFC2: -0.09792(-4.06)
Adj R^2=0.9985 DW=1.8495

OCORPFC=OCORPFC0+OCORPFC1*UCORPFC+OCORPFC2*DOCORP

OCORPFC0: 0.236744(6.76) OCORPFC1: 1.06809(97.54) OCORPFC2: 0.434741(8.82)
Adj R^2= 0.9959 DW=2.0571

PCORPFC=PCORPFC0+PCORPFC1*UCORPFC+PCORPFC2*D82

PCORPFC0: -0.01442(-1.32) PCORPFC1: 0.982929(239.05) PCORPFC2: 0.280933(7.79)
Adj R^2= 0.9991 DW=1.4545

SCORPFC=SCORPFC0+SCORPFC1*UCORPFC+SCORPFC2*DFB96 +SCORPFC3*DSCORP

SCORPFC0: 0.112927(4.27) SCORPFC1: 1.025884(106.97) SCORPFC2: 0.10383(3.57)
SCORPFC3: -0.45123(-7.71)
Adj R^2=0.9959 DW=1.6833

Appendix Table 1 (continued)

TCORPFC=TCORPFC0+TCORPFC1*UCORPFC +TCORPFC3*DTCORP
TCORPFC0: 0.232785(9.72) TCORPFC1: 0.988296(113.39) TCORPFC3: 0.185884(4.23)
Adj R^2= 0.9961 DW=1.2690

Regional Expected Price

ACORPPC=MAX(LAG(ACORPFC),UCORPLC*(1-UCORARP/100))*D5973
+MAX(LAG(ACORPFC),UCORPTC*(1UCORARP/100))*D7490
+MAX(LAG(ACORPFC),UCORPTC*(1-UCORARP/100-NORFLEX/100)
+MAX(LAG(ACORPFC),UCORPLC)*NORFLEX/100)*D9195
+MAX(LAG(ACORPFC),UCORPLC)*D9601+MAX(LAG(ACORPFC),UCORPTC*.85
+MAX(LAG(ACORPFC),UCORPLC)*.15)*D0212

CCORPPC=MAX(LAG(CCORPFC),UCORPLC*(1-UCORARP/100))*D5973
+MAX(LAG(CCORPFC), UCORPTC*(1-UCORARP/100))*D7490
+MAX(LAG(CCORPFC),UCORPTC*(1-UCORARP/100-NORFLEX/100)
+MAX(LAG(CCORPFC),UCORPLC)*NORFLEX/100)*D9195
+MAX(LAG(CCORPFC),UCORPLC)*D9601+MAX(LAG(CCORPFC),UCORPTC*.85
+MAX(LAG(CCORPFC),UCORPLC)*.15)*D0212

DCORPPC=MAX(LAG(DCORPFC),UCORPLC*(1-UCORARP/100))*D5973
+MAX(LAG(DCORPFC), UCORPTC*(1-UCORARP/100))*D7490
+MAX(LAG(DCORPFC),UCORPTC*(1-UCORARP/100-NORFLEX/100)
+MAX(LAG(DCORPFC),UCORPLC)*NORFLEX/100)*D9195
+MAX(LAG(DCORPFC),UCORPLC)*D9601+MAX(LAG(DCORPFC),UCORPTC*.85
+MAX(LAG(DCORPFC),UCORPLC)*.15)*D0212

LCORPPC=MAX(LAG(LCORPFC),UCORPLC*(1-UCORARP/100))*D5973
+MAX(LAG(LCORPFC), UCORPTC*(1-UCORARP/100))*D7490
+MAX(LAG(LCORPFC),UCORPTC*(1-UCORARP/100 -NORFLEX/100)
+MAX(LAG(LCORPFC),UCORPLC)*NORFLEX/100)*D9195
+MAX(LAG(LCORPFC),UCORPLC)*D9601+MAX(LAG(LCORPFC),UCORPTC*.85
+MAX(LAG(LCORPFC),UCORPLC)*.15)*D0212

OCORPPC=MAX(LAG(OCORPFC),UCORPLC*(1-UCORARP/100))*D5973
+MAX(LAG(OCORPFC),UCORPTC*(1UCORARP/100))*D7490
+MAX(LAG(OCORPFC),UCORPTC*(1-UCORARP/100-NORFLEX/100)
+MAX(LAG(OCORPFC),UCORPLC)*NORFLEX/100)*D9195
+MAX(LAG(OCORPFC),UCORPLC)*D9601+MAX(LAG(OCORPFC),UCORPTC*.85
+MAX(LAG(OCORPFC),UCORPLC)*.15)*D0212

PCORPPC=MAX(LAG(PCORPFC),UCORPLC*(1-UCORARP/100))*D5973
+MAX(LAG(PCORPFC),UCORPTC*(1-UCORARP/100))*D7490
+MAX(LAG(PCORPFC),UCORPTC*(1-UCORARP/100-NORFLEX/100)
+MAX(LAG(PCORPFC),UCORPLC)*NORFLEX/100)*D9195
+MAX(LAG(PCORPFC),UCORPLC)*D9601+MAX(LAG(PCORPFC),UCORPTC*.85
+MAX(LAG(PCORPFC),UCORPLC)*.15)*D0212

SCORPPC=MAX(LAG(SCORPFC),UCORPLC*(1-UCORARP/100))*D5973
+MAX(LAG(SCORPFC),UCORPTC*(1-UCORARP/100))*D7490
+MAX(LAG(SCORPFC),UCORPTC*(1-UCORARP/100-NORFLEX/100)
+MAX(LAG(SCORPFC),UCORPLC)*NORFLEX/100)*D9195
+MAX(LAG(SCORPFC),UCORPLC)*D9601+MAX(LAG(SCORPFC),UCORPTC*.85
+MAX(LAG(SCORPFC),UCORPLC)*.15)*D0212

Appendix Table 1 (continued)

TCORPPC=MAX(LAG(TCORPFC),UCORPLC*(1-UCORARP/100))*D5973
+MAX(LAG(TCORPFC),UCORPTC*(1-UCORARP/100))*D7490
+MAX(LAG(TCORPFC),UCORPTC*(1-UCORARP/100-NORFLEX/100)
+MAX(LAG(TCORPFC),UCORPLC)*NORFLEX/100)*D9195
+MAX(LAG(TCORPFC),UCORPLC)*D9601 +MAX(LAG(TCORPFC),UCORPTC*.85
+MAX(LAG(TCORPFC),UCORPLC)*.15)*D0212

UCORPPC=(CCORSPC*CCORPPC+LCORSPC*LCORPPC+ACORSPC*ACORPPC+DCORSPC*DCORPPC
+SCORSPC*SCORPPC+PCORSPC*PCORPPC+TCORSPC*TCORPPC
+OCORSPC*OCORPPC)/(UCORSPC*1000)

U.S. Corn Demand and Market Clearing Condition

UCORDFC=UCORDFC0+UCORDFC1*UCORPWC/UWPI67R+UCORDFC2*UGCAUA
+UCORDFC3*UHOGPFC/UFPI67+UCORDFC4*DCORETH

UCORDFC0: -1829.13(-2.48) UCORDFC1: -958.906(-7.56) UCORDFC2: 86.50075(12.54)
UCORDFC3: 21.44957(1.95) UCORDFC4: -723.411(-6.05)
Adj R^2= 0.9551 DW=1.9399

LOG(UCORDOC)=UCORDOC0+UCORDOC1*LOG(UCORPWC/UWPI67R)
+UCORDOC2*LOG(UYDA/UCPI67)+UCORDOC3*LOG(UWHEPFC/UFPI67)
+UCORDOC4*LOG(LAG(UCORDOC))+UCORDOC5*DCORETH

UCORDOC0: -0.60679(-3.15) UCORDOC1: -0.07029(-2.80) UCORDOC2: 0.146066(3.07)
UCORDOC3: 0.076739(2.58) UCORDOC4: 0.949164(44.34) UCORDOC5: 0.087265(5.81)
Adj R^2= 0.9989 Dh=1.0267

UCORMEC=UCORMEC0+UCORMEC1*ECORPIA*XECUSA +UCORMEC2*LAG(UCORMEC)
+UCORMEC3*RCORMEC+UCORMEC4*(JGCAUA/1000+EGCAUA)+UCORMEC5*DCORME

UCORMEC0: -1063.49(-2.67) UCORMEC1: -3.66902(c) UCORMEC2: 0.833856(11.25)
UCORMEC3: -0.32731(-5.95) UCORMEC4: 11.8366(3.79) UCORMEC5: -657.978(-3.45)
UCORMEC5: 465.8424(8.05)
Adj R^2=0.9165 Dh=0.0441

*UCORHOC=UCORPWC0+UCORPWC1*UCORPWC+UCORPWC2*UCORSPC
+UCORPWC3*LAG(UCORHCC)+UCORPWC4*LAG(UCORHOC) +UCORPWC5*D60T88
+UCORPWC6*D7212+UCORPWC7*D8285+UCORPWC8*D0912+UCORPWC9*DFB02

UCORPWC0: -1490(158.6) UCORPWC1: -379.429(27.9919) UCORPWC2:0.354474(0.0187)
UCORPWC3: 0.26304(0.0802) UCORPWC4: 0.442028(0.0325) UCORPWC5:878.8443(83.0599)
UCORPWC6: 495.4917(86.1659) UCORPWC7: 1161.305(134.3) UCORPWC8: -786.429 (136.2)
UCORPWC9: -437.693(88.2962)
Adj R^2= 0.9618 Dh=0.2971

UCORPFC=UCORPFC0+UCORPFC1*UCORPWC

UCORPFC0: -0.04599(-1.95) UCORPFC1: 0.94161(112.10)
Adj R^2= 0.9961 DW=2.1408

ECORPIA=ECORPIA0+ECORPIA1*UCORPWC+ECORPIA2*XECUSA+ECORPIA3*D72+ECORPIA4*D82
+ECORPIA5*D12

ECORPIA0: 30.69637(2.80) ECORPIA1: 41.96067(36.30) ECORPIA2: -33.8341(-3.13)
ECORPIA3: 20.39691(2.72) ECORPIA4: 18.92128(2.48) ECORPIA5: -49.9015(-5.72)
Adj R^2=0.9826 DW=2.0265

Appendix Table 1 (continued)

UCORHOC=UCORHTC-UCORHCC
UCORHTC=LAG(UCORHTC)+UCORSPC+UCORMMC-UCORDFC-UCORDOC-UCORMEC-UCORDZC

European Union (15/27)
EU 15/27 Soybean Demand and Market Clearing Condition

ESOYDCC=ESOYDCC0+ESOYDCC1*((ESOMQ*ESOMPIA+ESOOQ*ESOOPXA-ESOYPIA)*XECUSA)
+ESOYDCC2*EGCAUA+ESOYDCC3*LAG(ESOYDCC)+ ESOYDCC4*LAG(SQRT(ESOYEXP))
+ESOYDCC5*DEU27+ESOYDCC6*D99

ESOYDCC0: -4056.3(-1.62) ESOYDCC1: 39.09615(3.18) ESOYDCC2: 54.95514(2.58)
ESOYDCC3: 0.721221(13.12) ESOYDCC4: 135.8192(1.75) ESOYDCC5: -1368.07(-4.09)
ESOYDCC6: -2459.05(-3.23)
Adj R^2= 0.9760 Dh= -0.5327

ESOYPIA=ESOYPIA0+ESOYPIA1*USOYPWC*36.7437+ESOYPIA2*D06+ESOYPIA3*D11

ESOYPIA0: 5.646364(0.90) ESOYPIA1: 0.991176(37.46) ESOYPIA2: 68.83751(3.82)
ESOYPIA3: 41.90937(2.16)
Adj R^2=0.9708 DW=2.2272

ESOYMIC=ESOYDCC+ESOYDZC+ESOYHEC-LAG(ESOYHEC)-ESOYSPC

EU 15/27 Soybean Meal Supply, Demand, and Market Clearing Condition

ESOMSPC=ESOMQ*ESOYDCC

ESOMDDC=ESOMDDC0+ESOMDDC1*(ESOMPIA*XECUSA/ECWPI2)+ESOMDDC2*(EGDP/ECWPI2)
+ESOMDDC3*EGCAUA+ESOMDDC4*LAG(ESOMDDC) + ESOMDDC5*LAG(SQRT(ESOMEXPR))
+ ESOMDDC6*D07

ESOMDDC0: -14382.9(-3.59) ESOMDDC1: -574.056(-3.49) ESOMDDC2: 47.03415(1.64)
ESOMDDC3: 151.753(4.81) ESOMDDC4: 0.649248(9.45) ESOMDDC5: 272.9532(1.72)
ESOMDDC6: 2060.249(1.82)
Adj R^2=0.9886 Dh=0.2842

ESOMPIA=ESOMPIA0+ESOMPIA1*USOMPWC*1.01231+ESOMPIA2*D11

ESOMPIA0: -1.19465(-0.34) ESOMPIA1: 1.052434(60.49) ESOMPIA2: 53.08554(4.88)
Adj R^2=0.9885 DW=1.9530

ESOMMIC=ESOMDDC+ESOMDZC+ESOMHEC-LAG(ESOMHEC)-ESOMSPC

EU 15/27 Soybean Oil Supply, Demand, and Market Clearing Condition

ESOOSPC=ESOOQ*ESOYDCC

ESOODDC=ESOODDC0+ESOODDC1*ESOOPXA*XECUSA/ECWPI2+ESOODDC2*EPAOPIA/ECWPI2
+ESOODDC3*EGDP/ECWPI2+ESOODDC4*LAG(ESOODDC)+ESOODDC5*LAG(SQRT(ESOOEXPR))
+ESOODDC6*DEU27+ESOODDC7*D11

ESOODDC0: 25.92273(0.14) ESOODDC1: -32.6241(-3.89) ESOODDC2: 40 (c)
ESOODDC3: 7.560626(1.87) ESOODDC4: 0.702542(8.34) ESOODDC5: 33.1394(2.47)
ESOODDC6: 104.8954(1.34) ESOODDC7: -783.036(-4.75)
Adj R^2=0.9466 Dh= -0.6372

Appendix Table 1 (continued)

ESOOPXA=ESOOPXA0+ESOOPXA1*USOOPWC*22.04622+ESOOPXA2*D74+ESOOPXA3*D06
+ESOOPXA4*D09

ESOOPXA0: -18.3175(-2.48) ESOOPXA1: 1.022552(74.96) ESOOPXA2: -199.34(-8.55)
ESOOPXA3: 118.7712(5.09) ESOOPXA4: 132.6992(5.64)
Adj R^2= 0.9916 DW=1.5918

ESOOMXC=LAG(ESOOHEC)+ESOOSPC-ESOODDC-ESOODZC-ESOOHEC

Japan

Japan Soybean Demand and Market Clearing Condition

JSOYDCC=JSOYDCC0+JSOYDCC1*((JSOMQ*JSOMPUA+JSOOQ*JSOOPUA-JSOYPUA)
*XJAUSA/JWPI85R)+JSOYDCC2*LAG(JSOYDCC)+ JSOYDCC3*LAG(SQRT(JSOYEXP))
+JSOYDCC4*D03

JSOYDCC0: 152.6062(1.89) JSOYDCC1: 0.003678(1.34) JSOYDCC2: 0.954764(39.15)
JSOYDCC3: 0.4289(2.01) JSOYDCC4: -664.604(-4.00)
Adj R^2=0.9682 Dh= -1.430

JSOYPUA=JSOYPUA0+JSOYPUA1*USOYPWC*36.7437+JSOYPUA2*D72 +JSOYPUA3*D04567

JSOYPUA0: -13.2409(-2.27) JSOYPUA1: 1.380219(59.44) JSOYPUA2: -89.4252(-5.30)
JSOYPUA3: 65.56319(7.22)
Adj R^2=0.9867 DW=1.4427

JSOYMIC=JSOYDCC+JSOYDZC+JSOYHEC-LAG(JSOYHEC)-JSOYSPC

Japan Soybean Meal Supply, Demand, and Market Clearing Condition

JSOMSPC=JSOMQ*JSOYDCC

JSOMDDC=JSOMDDC0+JSOMDDC1*(JSOMPUA*XJAUSA/JWPI85R)+JSOMDDC2*JGCAUA
+ JSOMDDC3* LAG(SQRT(JSOMEXPR))+JSOMDDC4*D7276

JSOMDDC0: 1866.702(5.45) JSOMDDC1: -0.0277(-10.45) JSOMDDC2: 0.12822(13.40)
JSOMDDC3: 0.5926(2.41) JSOMDDC4: 594.7586(3.37)
Adj R^2=0.9609 DW=1.5277

JSOMPUA=JSOMPUA0+JSOMPUA1*USOMPWC*1.01231+JSOMPUA2*D72+JSOMPUA3*D80

JSOMPUA0: 4.231442(0.87) JSOMPUA1: 1.312797(57.87) JSOMPUA2: -108.846(-7.72)
JSOMPUA3: 40.428(2.88)
Adj R^2= 0.9860 DW=1.3273

JSOMMIC=JSOMDDC+JSOMDZC+JSOMHEC-LAG(JSOMHEC)-JSOMSPC

Japan Soybean Oil Supply, Demand, and Market Clearing Condition

JSOOSPC=JSOOQ*JSOYDCC

JSOODDC=JSOODDC0+JSOODDC1*JSOOPUA*XJAUSA/JWPI85R+0.0015*EPAOPIA*XJAUSA/JWPI85R
+JSOODDC3*LAG(JSOODDC)+JSOODDC4*JGDP00/1000+ JSOODDC5* LAG(SQRT(JSOOEXPR))
+JSOODDC6*DTFATJ

Appendix Table 1 (continued)

JSOODDC0: 11.20192(0.28)　JSOODDC1: -0.00083(-6.84)　JSOODDC2: 0.0015(c)
JSOODDC3: 0.874867(18.82)　JSOODDC4: 0.164966(2.60)　JSOODDC5: 0.2000(7.16)
JSOODDC6: -71.2278(-4.37)
Adj R^2=0.9662　Dh=0.6712

JSOOPUA=JSOOPUA0+JSOOPUA1*USOOPWC*22.04622+JSOOPUA6*DOUTJ

JSOOPUA0: 314.0196(12.62)　JSOOPUA1: 1.122007(32.54)　JSOOPUA6: 214.3758(8.21)
Adj R^2=0.9839　DW=2.0975

JSOOMIC=JSOODDC+JSOODZC+JSOOHEC-LAG(JSOOHEC)-JSOOSPC

China

China Soybean Demand and Market Clearing Condition

HSOYSHC=HSOYSHC0+HSOYSHC1*LAG(HSOYPFA/HFPI85)+HSOYSHC2*LAG(HCORPFA/HFPI85)
+HSOYSHC3*LAG(HSOYSHC)+HSOYSHC4*DHBW

HSOYSHC0: 2404.766(3.15)　HSOYSHC1: 83.32866(3.66)　HSOYSHC2: -179.725(-3.75)
HSOYSHC3: 0.707549(7.37)　HSOYSHC4: -707.119(-2.42)
Adj R^2=0.8246　Dh= -0.3574

HSOYSPC=HSOYSYC*HSOYSHC

HSOYDCC=HSOYDCC0+HSOYDCC1*(HSOMQ*HSOMPWA+HSOOQ*HSOOPWA-HSOYPIA)/HIPPI05
+HSOYDCC2*LAG(HSOYDCC)+HSOYDCC3*LAG(SQRT(HSOYEXP))+HSOYDCC4*HSOYMIC
*DPSTWTO +HSOYDCC5*HSOYSPC*DPREWTO+HSOYDCC6*TIME

HSOYDCC0: -870812(-4.60)　HSOYDCC1: 87.91186(2.31)　HSOYDCC2: 0.748621(12.91)
HSOYDCC3: 204.8996(2.96)　HSOYDCC4: 437.7659(4.61)　HSOYDCC5: -2174.59(-4.42)
HSOYDCC6: 7870.817(6.71)
Adj R^2=0.9979　Dh=0.9284

HSOYPFA=HSOYPFA0+HSOYPFA1*HSOYPIA+HSOYPFA2*D0206

HSOYPFA0: 130.9177(1.86)　HSOYPFA1: 1.171475(32.44)　HSOYPFA2: 623.2601(4.25)
Adj R^2=0.9739　DW=1.9595

HSOYPIA=HSOYPIA0+HSOYPIA1*USOYPWC*XCHUSA +HSOYPIA3*D0345

HSOYPIA0: -180.152(-4.35)　HSOYPIA1: 44.18075(51.54)　HSOYPIA2: 758.1975(10.99)
HSOYPIA3: -473.548(-7.31)
Adj R^2=0.9897　DW=1.6785

HSOYMIC=HSOYDCC+HSOYDZC+HSOYHEC-LAG(HSOYHEC)-HSOYSPC

China Soybean Meal Supply, Demand, and Market Clearing Condition

HSOMSPC=HSOMQ*HSOYDCC

HSOMDDC=HSOMDDC0+HSOMDDC1*HSOMPWA/HGDPI05+HSOMDDC2*LAG(HSOMDDC)
+HSOMDDC3*LAG(SQRT(HSOMEXP)) +HSOMDDC4*D0608

HSOMDDC0: 1890.051(1.37)　HSOMDDC1: -76.6866(-3.08)　HSOMDDC2: 0.486755(5.69)
HSOMDDC3: 68.16551(1.84)　HSOMDDC4: 5.757648(6.72)　HSOMDDC4: -3334.76(-6.60)
Adj R^2= 0.9982　Dh=-0.0729

Appendix Table 1 (continued)

HSOMPWA=HSOMPWA0+HSOMPWA1*USOMPWC*XCHUSA+HSOMPWA3*D0607

HSOMPWA0: 608.8966(4.07) HSOMPWA1: 1.242329(14.60) HSOMPWA3: 633.8578(3.80)

Adj R^2=0.9242 DW=1.8054

HSOMMXC=LAG(HSOMHEC)+HSOMSPC-HSOMDDC-HSOMHEC-HSOMDZC

China Soybean Oil Supply, Demand, and Market Clearing Condition

HSOOSPC=HSOOQ*HSOYDCC

HSOODDC=HSOODDC0+HSOODDC1*HSOOPWA/HGDPI05+HSOODDC2*LAG(SQRT(HSOOEXPR))
+HSOODDC3*HPOP/1000 +HSOODDC4*D90

HSOODDC0: -32679.7 (-23.27) HSOODDC1: -15.7609(-3.41) HSOODDC2: 255.3617(3.33)
HSOODDC3: 30.77169(26.83) HSOODDC4: -1171.35(-2.41)

Adj R^2=0.9875 DW=2.2982

HSOOPWA=HSOOPWA0+HSOOPWA1*USOOPWC*XCHUSA+HSOOPWA2*D93

HSOOPWA0: 999.0394(4.29) HSOOPWA1: 34.73327(25.69) HSOOPWA2: -1159.71(-2.11)

Adj R^2=0.9726 DW=1.7693

HSOOMIC= HSOODDC+HSOOHEC+HSOODZC-LAG(HSOOHEC)-HSOOSPC

Rest-of-the-World (ROW)
ROW Soybean Demand and Market Clearing Condition

RSOYMIN=RSOYMIN0+ RSOYMIN1*USOYPWC+RSOYMIN2*RGDP85+RSOYMIN3*TIME
+RSOYMIN4*LAG(SQRT(RSOYEXP))+RSOYMIN5*D11+RSOYMI6*D0508

RSOYMIN0: 373986.4(8.82) RSOYMIN1: -1355.02 (c) RSOYMI2: 16194.26(36.49)
RSOYMI3: -185.479(-8.63) RSOYMI4: 7.192879(1.35) RSOYMI5: -14199.9(-35.63)
RSOYMI6: -6341.24 (-23.01)
Adj R^2=0.9937 DW=2.3805

ROW Soybean Meal Supply, Demand, and Market Clearing Condition

RSOMSPN=.795*RSOYMIN*.8

RSOMDDN=RSOMDDN0+RSOMDDN1*USOMPWC+RSOMDDN2*RGDP85
+RSOMDDN3*LAG(SQRT(RSOMEXP))+RSOMDDN4*TIME+RSOMDDN5*D11
+RSOMDDN6*D87+RSOMDDN7*D05

RSOMDD0: 1444514(24.98) RSOMDDN1: -91.1031(c) RSOMDD2: 43439.38(72.39)
RSOMDD3: 20.91554(2.85) RSOMDD4: -725.763(-24.71) RSOMDD5: -12001(-26.16)
RSOMDD6: 9766.978(23.90) RSOMDDN7: -8671.08(-21.47)
Adj R^2= 0.9982 DW=1.6946

RSOMMIN=RSOMDDN-RSOMSPN

Appendix Table 1 (continued)

ROW Soybean Oil Supply, Demand, and Market Clearing Condition

RSOOSPN=.179*RSOYMIN*.8
RSOODDN=RSOODD0+RSOODDN1*USOOPWC+RSOODD2*RGDP85+RSOODD3*LAG(RSOODDN)
+RSOODD4*TIME+RSOODD5*LAG(SQRT(RSOOEXP))+RSOODD6*D08+RSOODD7*D9711

RSOODD0: 302696.1(16.98) RSOODDN1: -205.761(c) RSOODD2: 8107.054(41.72)
RSOODD3: 0.474789(28.89) RSOODD4: -151.668(-16.74) RSOODD5: 6.170759(2.85)
RSOODD6: -3685.21(-26.59) RSOODD7: 2375.105(21.63)
Adj R^2=0.9968 DH=0.2919

RSOOMIN=RSOODDN-RSOOSPN

Brazil

Brazil Soybean Supply, Demand, and Market Clearing Condition

LOG(BSOYSHC=BSOYSHC0+BSOYSHC1*LAG(LOG(BSOYPXC*XBZUSA/BWPI85R))
+BSOYSHC2*LAG(LOG(BSOYSHC)) +BSOYSHC3*LOG(TIME)+BSOYSHC4*DBBW

BSOYSHC0: -404.002(-9.88) BSOYSHC1: 0.368159(8.92) BSOYSHC2: 0.675341(28.86)
BSOYSHC3: 54.30989(9.90) BSOYSHC4: -0.2238(-7.65)
Adj R^2=0.9988 Dh=0.5297

BSOYSPC=BSOYSYC*BSOYSHC

BSOYDCC=BSOYDCC0+BSOYDCC1*BSOMPXC*XBZUSA/BWPI85R*1000000000
+BSOYDCC2*BSOOPXC*XBZUSA/BWPI85R*1000000000
+BSOYDCC3*BSOYPXC*XBZUSA/BWPI85R*1000000000+BSOYDCC4*(LAG(BSOYHEC)
+BSOYSPC)+BSOYDCC5*LAG(BSOYDCC)+BSOYDCC6*D05

BSOYDCC0: 6597.184(7.77) BSOYDCC1: 11.90083(2.71) BSOYDCC2: 1.602817(2.43)
BSOYDCC3: -16.3866(-3.38) BSOYDCC4: 0.278483(11.14) BSOYDCC5: 0.2747(4.04)
BSOYDCC6: -2048.7(-2.66)
Adj R^2=0.9958 Dh= -0.0867

BSOYPXC=BSOYPXC0+BSOYPXC1*ESOYPIA+BSOYPXC2*D73+BSOYPXC3*D06

BSOYPXC0: -12.3777(-4.82) BSOYPXC1: 1.077239(102.07) BSOYPXC2: -46.7009(-6.07)
BSOYPXC3: -50.3764(-6.50)
Adj R^2=0.9953 DW=1.8782

BSOYMXC=LAG(BSOYHEC)+BSOYSPC-BSOYDCC-BSOYDZC-BSOYHEC

Soybean Meal Supply, Demand, and Market Clearing Condition

BSOMSPC=BSOMQ*BSOYDCC

BSOMDDC=BSOMDDC0+BSOMDDC1*BSOMPXC*XBZUSA/BWPI85R*1000000000
+BSOMDDC2*LAG(BSOMDDC)+BSOMDDC3*D72

BSOMDDC0: 1133.787(3.97) BSOMDDC1: -2.46487(-3.78) BSOMDDC2: 0.976086(50.82)
BSOMDDC3: 2053.11(3.95)
Adj R^2=0.9954 Dh= -0.6044

Appendix Table 1 (continued)

BSOMPXC=BSOMPXC0+BSOMPXC1*ESOMPIA+BSOMPXC2*D06

BSOMPXC0: 5.975587(2.02) BSOMPXC1: 0.930977(68.44) BSOMPXC2: -52.5208(-5.75)
Adj R^2=0.9903 DW=1.8586

BSOMMEC=LAG(BSOMHEC)+BSOMMMC+BSOMSPC-BSOMDDC-BSOMDZC-BSOMHEC

Brazil Soybean Oil Supply, Demand, and Market Clearing Condition

BSOOSPC=BSOOQ*BSOYDCC

BSOODDC=BSOODDC0+BSOODDC1*BSOOPXC*XBZUSA/BWPI85R*1000000000
+BSOODDC2*BGDP85/100+BSOODDC3*LAG(BSOODDC)+BSOODDC4*TIME
+BSOODDC5*D03T07

BSOODDC0: 109604.3(8.47) BSOODDC1: -0.16181(-3.85) BSOODDC2: 0.379961(9.40)
BSOODDC3: 0.409048(5.35) BSOODDC4: -56.1679(-8.48) BSOODDC5: -253.614(-4.42)

Adj R^2=0.9977 DW=2.0576

BSOOPXC=BSOOPXC0+BSOOPXC1*ESOOPXA+BSOOPXC3*D8706

BSOOPXC0: -50.0482(-4.48) BSOOPXC1: 1.052471(52.40) BSOOPXC2: 84.6325(6.11)
Adj R^2=0.9818 DW=1.6238

BSOOMXC=LAG(BSOOHEC)+BSOOSPC-BSOODDC-BSOODZC-BSOOHEC

Argentina
Argentina Soybean Supply, Demand, and Market Clearing Condition

LOG(GSOYSHC)=GSOYSHC0+GSOYSHC1*LOG(LAG(GSOYPXA*XARUSA/GWPI85R*1000000))
+GSOYSHC2*LOG(LAG(GSOYSHC))+GSOYSHC3*LOG(TIME)+GSOYSHC4*DGBW
+GSOYSHC5*D11

GSOYSHC0: -280.46(-12.74) GSOYSHC1: 0.184546(9.76) GSOYSHC2: 0.768784(49.46)
GSOYSHC3: 36.96127(12.63) GSOYSHC4: -0.30748(-18.27) GSOYSHC5: -0.2461(-8.34)
Adj R^2=0.999 Dh= -0.3880

GSOYSHC=EXP(LGSOYSH)
GSOYSPC=GSOYSYC*GSOYSHC

GSOYDCC=(GSOYDCC0+GSOYDCC1*(GSOMQ*GSOMPXA+GSOOQ*GSOOPXA)
*XARUSA/GWPI85R*1000000+GSOYDCC2*GSOYPXA*XARUSA/GWPI85R*1000000
+GSOYDCC3*(LAG(GSOYHEC)+GSOYSPC)+GSOYDCC4*LAG(GSOYDCC)+GSOYDCC5*D11

GSOYDCC0: -2062.33(-7.92) GSOYDCC1: 0.171771(3.09) GSOYDCC2: -0.05073(-1.14)
GSOYDCC3: 0.391591(24.74) GSOYDCC4: 0.564877(22.70) GSOYDCC5: -7687.69(-15.43)
Adj R^2=0.9994 Dh= -1.7574

GSOYPXA=GSOYPXA0+GSOYPXA1*ESOYPIA+GSOYPXA2*D72 +GSOYPXA3*D75

GSOYPXA0: 4.336205(0.95) GSOYPXA1: 0.994901(54.82) GSOYPXA2: 530.5226(38.49)
GSOYPXA3: 77.26767(5.61)
Adj R^2=0.9891 DW=2.0943

Appendix Table 1 (continued)

GSOYMEC=LAG(GSOYHEC)+GSOYMMC+GSOYSPC-GSOYDCC-GSOYDZC-GSOYHEC

Argentina Soybean Meal Supply, Demand, and Market Clearing Condition

GSOMSPC=GSOMQ*GSOYDCC

GSOMDDC=GSOMDDC0+GSOMDDC1*GSOMPXA*XARUSA/GWPI85R+GSOMDDC2*GGDP85
+GSOMDDC3*LAG(GSOMDDC)+GSOMDDC5*D1011

GSOMDD0: -45.284(-1.16) GSOMDD1: -4030.96(-1.97) GSOMDD2: 0.000729(3.80)
GSOMDD3: 0.728322(8.36) GSOMDD4: 97.22447(5.19) GSOMDD5: 78.08117(2.62)
Adj R^2=0.9916 Dh= 1.1369

GSOMPXA=GSOMPXA0+GSOMPXA1*ESOMPIA+GSOMPXA2*D72+GSOMPXA4*DFB02
+GSOMPXA5*D11

GSOMPXA0: 37.07105(10.20) GSOMPXA1: 0.702516(35.52) GSOMPXA2: -96.0335(-10.18)
GSOMPXA4: -26.0368(-6.21) GSOMPXA5: 72.43915(6.56)
Adj R^2=0.9889 DW=2.4877

GSOMMEC=LAG(GSOMHEC)+GSOMMMC+GSOMSPC-GSOMDDC-GSOMDZC-GSOMHEC

Argentina Soybean Oil Supply, Demand, and Market Clearing Condition

GSOOSPC=GSOOQ*GSOYDCC

GSOODDC=GSOODDC0+GSOODDC1*GSOOPXA*XARUSA/GWPI85R+GSOODDC2*LAG(GSOODDC)
+GSOODDC3*GGDP85+GSOODDC4*D12

GSOODDC0: 0.049495(0.00) GSOODDC1: -1808.05(-6.46) GSOODDC2: 0.938133(131.73)
GSOODDC3: 0.000222(4.14) GSOODDC4: -332.746(-28.33)
Adj R^2=0.9998 DW=1.7886

GSOOPXA=GSOOPXA0+GSOOPXA1*ESOOPXA+GSOOPXA2*D72+GSOOPXA3*D75

GSOOPXA0: 36.09051(4.15) GSOOPXA1: 0.900164(55.65) GSOOPXA2: 292.7601(16.96)
GSOOPXA3: 202.7716(7.52)
Adj R^2=0.9878 DW=1.5127

GSOOMXC=LAG(GSOOHEC)+GSOOSPC-GSOODDC-GSOODZC-GSOOHEC

World Market Clearing Conditions

USOYMEC=(RSOYMIN-BSOYMXC-GSOYMEC+ESOYMIC+JSOYMIC+HSOYMIC)/27.21555
USOMMEC=(RSOMMIN-BSOMMEC-GSOMMEC-HSOMMXC+ESOMMIC+JSOMMIC)/0.907185
USOOMTC=(RSOOMIN-BSOOMXC-GSOOMXC-ESOOMXC+JSOOMIC+HSOOMIC)/0.4535925

Appendix Table 2: SOYMOD Variable Definitions

ENDOGENOUS VARIABLES

U.S. Regional Soybean Variables

Region	Acres Planted (1,000 acres)	Acres Harvested (1,000 acres)	Yield[1] (bu/acre)	Production (1,000 bu)	Market Price[2] ($/bu)	Expected Price[3] ($/bu)
Atlantic	ASOYSAC	ASOYSHC	ASOYSYC	ASOYSPC	ASOYPFC	ASOYPCC
Cornbelt	CSOYSAC	CSOYSHC	CSOYSYC	CSOYSPC	CSOYPFC	CSOYPCC
Delta	DSOYSAC	DSOYSHC	DSOYSYC	DSOYSPC	DSOYPFC	DSOYPCC
Lakes	LSOYSAC	LSOYSHC	LSOYSYC	LSOYSPC	LSOYPFC	LSOYPCC
Other	OSOYSAC	OSOYSHC	OSOYSYC	OSOYSPC	OSOYPFC	OSOYPCC
Plains	PSOYSAC	PSOYSHC	PSOYSYC	PSOYSPC	PSOYPFC	PSOYPCC
South	SSOYSAC	SSOYSHC	SSOYSYC	SSOYSPC	SSOYPFC	SSOYPCC

[1] Weighted average regional yields with weights equal to the share of regional production accounted for by each state in the region.
[2] Average farm price over all states in the respective regions weighted by production in each state in the region.
[3] Expected price at the farm calculated as given in the model.

U.S. National Soybean and Product Market Variables

UCOMDPC	U.S. cottonseed meal share of high protein meal use (soymeal equivalents), marketing year
UCOODPC	U.S. cottonseed oil share of oleic/linoleic oil use, marketing year
UHPMDDC	U.S. high protein meal use, 1,000 tons, marketing year (calculated as in model)
UHPMPWC	U.S. high protein meal price, $/ton, marketing year, wtd ave. (calculated as in model)
UOLODDC	U.S. oleic/linoleic oil use, mil lb., marketing year (calculated as in model)
UOLOPWC	U.S. oleic/linoleic oil price, ¢/lb, marketing year, wtd ave. (calculated as in model)
USOMDDC	U.S. soymeal use, 1,000 tons, marketing year
USOMDPC	U.S. cottonseed meal share of high protein meal use, marketing year
USOMHEC	U.S. soymeal ending stocks, 1,000 tons, September 30
USOMMEC	U.S. soymeal exports, 1,000 tons, marketing year
USOMPWC	U.S. wholesale price of soymeal, $/ton, marketing year
USOMSPC	U.S. soymeal production, 1,000 tons, marketing year
USOODDC	U.S. soyoil use, mil lb., marketing year
USOODPC	U.S. soyoil share of oleic/linoleic oil use, marketing year
USOOHEC	U.S. soyoil ending stocks, mil lb., September 30
USOOHTC	U.S. soyoil total ending stocks, mil lb., September 30
USOOMEC	U.S. soyoil commercial exports, mil lb., marketing year
USOOMTC	U.S. soyoil total exports, mil lb., marketing year
USOOPWC	U.S. wholesale price of soyoil, ¢/lb, marketing year
USOOSPC	U.S. soyoil production, mil lb., marketing year
USOYDCC	U.S. soybean crush, million bu., crop year
USOYEHR	U.S. soybean stock to use ratio, crop year
USOYGCC	U.S. soybean crush margin, $/bu, crop year (calculated as in model)
USOYHEC	U.S. soybean private ending stocks, million bu., August 31
USOYHTC	U.S. soybean total ending stocks, million bu., August 31
USOYMEC	U.S. soybean exports, mil bu., crop year
USOYPFC	U.S. farm price of soybeans, $/bu, crop year
USOYPWC	U.S. wholesale price of soybeans, $/bu, crop year
USOYSAC	Total U.S. soybean acreage planted, million acres, crop year
USOYSHC	Total U.S. soybean acreage harvested, million acres, crop year
USOYSPC	Total U.S. soybean production acreage harvested, million bu., crop year

Appendix Table 2 (continued)

U.S. Regional Corn Variables

Region	Acres Planted (1,000 acres)	Acres Harvested (1,000 acres)	Production (1,000 bu)	Market Price[1] ($/bu)	Expected Price[2] ($/bu)
Atlantic	ACORSAC	ACORSHC	ACORSPC	ACORPFC	ACORPPC
Cornbelt	CCORSAC	CCORSHC	CCORSPC	CCORPFC	CCORPPC
Delta	DCORSAC	DCORSHC	DCORSPC	DCORPFC	DCORPPC
Lakes	LCORSAC	LCORSHC	LCORSPC	LCORPFC	LCORPPC
Other	OCORSAC	OCORSHC	OCORSPC	OCORPFC	OCORPPC
Plains	PCORSAC	PCORSHC	PCORSPC	PCORPFC	PCORPPC
South	SCORSAC	SCORSHC	SCORSPC	SCORPFC	SCORPPC
Residual	TCORSAC	TCORSHC	TCORSPC	TCORPFC	TCORPPC

[1] Average farm price over all states in the respective regions weighted by production in each state in the region.
[2] Expected price at the farm calcualted as given in the model.

U.S. National Corn Market Variables

UCORDFC	U.S. feed demand for corn, million bu., marketing year
UCORDOC	U.S. food demand for corn, million bu.,marketing year
UCORHOC	U.S. corn private ending stocks, million bu., September 30
UCORHTC	U.S. corn total ending stocks, million bu., September 30
UCORMEC	U.S. corn exports, million bu.,marketing year
UCORPFC	U.S. farm price of corn, $/bu, marketing year
UCORPPC	U.S. weighted ave. expected farm price of corn, $/bu, marketing year (calculated as in model)
UCORPWC	U.S. wholesale price of corn, $/bu, marketing year
UCORSAC	Total U.S. corn acreage planted, million acres, crop year
UCORSHC	Total U.S. corn acreage planted, million acres, crop year
UCORSPC	Total U.S. corn production,million bu, crop year

European Union (15) National Soybean and Product Market Variables

ECORPIA	EU import price of U.S. corn, cif Rotterdam, $/mt, annual
ESOMDDC	EU soymeal use, 1,000 mt, marketing year
ESOMMIC	EU net imports of soymeal (imports-exports), 1,000 mt, marketing year
ESOMPIA	EU import price of soymeal, cif Rotterdam, $/mt, annual
ESOMSPC	EU production of soymeal, 1,000 mt, marketing year
ESOODDC	EU soyoil use, 1,000 mt, marketing year
ESOOMXC	EU net exports of soyoil (exports-imports), 1,000 mt, marketing year
ESOOPXA	EU export price of soyoil, fob Rotterdam, $/mt, annual
ESOOSPC	EU production of soyoil, 1,000 mt, marketing year
ESOYDCC	EU soybean crush, 1,000 mt, marketing year
ESOYMIC	EU net imports of soybeans (imports-exports), 1,000 mt, marketing year
ESOYPIA	EU import price of soybeans, cif Rotterdam, $/mt, annual

Japan National Soybean and Product Market Variables

JSOMDDC	Japan soymeal use, 1,000 mt, marketing year
JSOMMIC	Japan net imports of soymeal (imports-exports), 1,000 mt, marketing year
JSOMPUA	Japan unit import price of soymeal, $/mt, annual
JSOMSPC	Japan production of soymeal, 1,000 mt, marketing year
JSOODDC	Japan soyoil use, 1,000 mt, marketing year
JSOOMIC	Japan net imports of soyoil (imports-exports), 1,000 mt, marketing year
JSOOPUA	Japan unit import price of soyoil, $/mt, annual
JSOOSPC	Japan production of soyoil, 1,000 mt, marketing year
JSOYDCC	Japan soybean crush, 1,000 mt, marketing year
JSOYMIC	Japan net imports of soybeans (imports-exports), 1,000 mt, marketing year
JSOYPUA	Japan unit import price of soybeans, $/mt, annual

Appendix Table 2 (continued)

China National Soybean and Product Market Variables

HSOMDDC	China soymeal disappearance, 1000 mt, marketing year
HSOMMXC	China soymeal net exports, 1000 mt, marketing year
HSOMPWA	China wholesale soymeal price, yuan/mt, annual
HSOMSPC	China soymeal production, 1000 mt, marketing year
HSOODDC	China soyoil disappearance, 1000 mt, marketing year
HSOOMIC	China soyoil net imports, 1000 mt, marketing year
HSOOPWA	China wholesale soyoil price, yuan/mt, annual
HSOOSPC	China soyoil production, 1000 mt, marketing year
HSOYSHC	China soybean acreage harvested, 1000 hectares, marketing year
HSOYSPC	China soybean production, 1000 mt, marketing year
HSOYDCC	China soybean crush, 1000 mt, marketing year
HSOYPFA	China soybean producer price, yuan/mt, annual
HSOYPIA	China soybean import price (unit value), youan/mt, annual
HSOYMIC	China soybean net imports, 1000 mt, marketing year

Rest-of-the-World (ROW)[1] National Soybean and Product Market Variables

RSOMDDN	ROW soymeal use, 1,000 mt (calculated as in model)
RSOMMIN	ROW net imports of soymeal (imports-exports), 1,000 mt (residual calculated as in model)
RSOMSPN	ROW soymeal production, 1,000 mt (calculated as in model)
RSOODDN	ROW soyoil use, 1,000 mt (calculated as in model)
RSOOMIN	ROW net imports of soyoil (imports-exports), 1,000 mt (residual calculated as in model)
RSOOSPN	ROW soyoil production, 1,000 mt (calculated as in model)
RSOYMIN	ROW net imports of soybeans (imports-exports), 1,000 mt (residual calculated as in model)

[1] Defined as all countries except the EU-15/27, Japan, China, Argentina, Brazil, and the U.S.

Brazil National Soybean and Product Market Variables

BSOMDDC	Brazil soymeal use, 1,000 mt, marketing year
BSOMMEC	Brazil exports of soymeal, 1,000 mt, marketing year
BSOMPXC	Brazil export price of soymeal, $/mt, marketing year
BSOMSPC	Brazil soymeal production, 1,000 mt, marketing year
BSOODDC	Brazil soyoil use, 1,000 mt, marketing year
BSOOMXC	Brazil net exports of soyoil (exports-imports), 1,000 mt, marketing year
BSOOPXC	Brazil export price of soyoil, $/mt, marketing year
BSOOSPC	Brazil soyoil production, 1,000 mt, marketing year
BSOYDCC	Brazil soybean crush, 1,000 mt, marketing year
BSOYMXC	Brazil net exports of soybeans (exports-imports), 1,000 mt, marketing year
BSOYPXC	Brazil export price of soybeans, $/mt, marketing year
BSOYSHC	Brazil soybean acreage harvested, 1,000 ha, crop year
BSOYSPC	Brazil soybean production, 1,000 mt, marketing year

Argentina National Soybean and Product Market Variables

GSOMDDC	Argentina soymeal use, 1,000 mt, marketing year
GSOMMEC	Argentina exports of soymeal (exports-imports), 1,000 mt, marketing year
GSOMPXA	Argentina export price of soymeal, $/mt, calendar year
GSOMSPC	Argentina soymeal production, 1,000 mt, marketing year
GSOODDC	Argentina soyoil use, 1,000 mt, marketing year
GSOOMXC	Argentina net exports of soyoil (exports-imports), 1,000 mt, marketing year
GSOOPXA	Argentina export price of soyoil, $/mt, calendar year
GSOOSPC	Argentina soyoil production, 1,000 mt, marketing year
GSOYDCC	Argentina soybean crush, 1,000 mt, marketing year
GSOYMEC	Argentina exports of soybeans (exports-imports), 1,000 mt, marketing year
GSOYPXA	Argentina export price of soybeans, $/mt, calendar year
GSOYSHC	Argentina soybean acreage harvested, 1,000 ha, crop year
GSOYSPC	Argentina soybean production, 1,000 mt, marketing year

Appendix Table 2 (continued)

EXOGENOUS VARIABLES

General	
Dn	Indicator variable for year n such that n=1 and all other years=0
Dnm	Indicator variable for years n and m such that years n and m =1 and all other years=0
DnTm	Indicator variable for years n through m such that years n through m =1 and all other years=0
TIME	Time trend (years=1960...2012)
United States	
ASOYR	Atlantic region soybean checkoff research expenditures, $1,000, crop year
ACORSYC	Atlantic region wtd average corn yield, bu/acre, crop year
AOATPPC	Atlantic region expected farm price for oats (same formula as for corn, see model for formula)
ASOYPLC	Atlantic region non-recourse soybean loan rate, $/bu, crop year
CSOYR	Cornbelt region soybean checkoff research expenditures, $1,000, cropyear
CCORSYC	Cornbelt region wtd average corn yield, bu/acre, crop year
CSOYPLC	Cornbelt region non-recourse soybean loan rate, $/bu, crop year
DACORP	Indicator variable for Atlantic corn farm price, 1996, 1999, 2002=1, all other years =0
DDCORP	Indicator variable for Delta corn farm price, 2006,-208, 2010=1, all other years =0
DLCORP	Indicator variable for Lakes corn farm price, 1996-1999=1, all other years =0
DOCORP	Indicator variable for Other corn farm price, 2008, 2010, 2012=1, all other years =0
DSCORP	Indicator variable for South corn farm price, 2008=-1, 2010=1, all other years =0
DTCORP	Indicator variable for Residual region corn farm price, 2007, 2009, 2010=1, all other years =0
DBWCCOR	Indicator variable, bad weather in Cornbelt corn region, 1962, 1995=1, all other years =0
DBWDCOR	Indicator variable, bad weather in Delta corn region, 2008, 2009=1, all other years =0
DBWLCOR	Indicator variable, bad weather in Lakes corn region, 1993, 1994, 1995=1, all other years =0
DBWPCOR	Indicator variable, bad weather in Plains corn region, 1995, 1999, 2001=1, all other years =0
DBWTCH	Indicator variable, bad weather in residual corn region at harvest, 2007, 2009=1, all other years =0
DCORETH	Indicator variable, effect of ethanol on corn feed demand, 2008-2012=1, all other years =0
DCORME	Indicator variable for exogenous effects on corn exports, 2006-2010=1, all other years =0
DSOYR	Delta region soybean checkoff research expenditures, $1,000, annual
DCORSYC	Delta region wtd average corn yield, bu/acre, crop year
DETH	Indicator variable, surge in demand for ethanol, 2004, 2005, 2006 = 1, all other years=0
DELNINO	Indicator variable, strong El Niño years, 1957, 1965, 1972, 1982, 1987, 1997=1, all other years=0
DEU27	Indicator variable for change in EU countries from 15 to 27, 2001-2012= 1, all other years=0
DFB96	Indicator variable, effects of the 1996 farm bill, 1996-2001=1, all other years =0
DFB02	Indicator variable, effects of the 1990 farm bill, 2002-2007=1, all other years =0
DLANINA	Indicator variable, strong La Niña years, 1973, 1975, 1988, 1999, 2010=1, all other years=0
DLBW	Indicator variable, bad weather in Lakes region, 1991, 2003 =1, all other years =0
DOBW	Indicator variable, bad weather in Other soybean region, 1997, 1998, 2004 =1, all other years =0
DPBW	Indicator variable, bad weather in Plains soybean region, 1984, 1994, 2006 =1, all other years =0
DPIK	Indicator variable for the 1982 U.S. payment-in-kind (PIK) program, 1982 =1, all other years =0
DRICPPC	Delta region expected farm price for rice (same formula as corn, see model for formula)
DRGHT07	Indicator variable for the drought in 2007=1, all other years =0
DRTH1011	Indicator variable for the drought in 2010, 2011=1, all other years =0
DSOYPLC	Delta region non-recourse soybean loan rate, $/bu, crop year
DWHEPPC	Delta region expected farm price for wheat (same formula as for corn, see model for formula)
EMBARGO	Dummy variable for the 1972 U.S. embargo of U.S. soybean and product exports
LBARPPC	Lakes region expected farm price for barley (same formula as for corn, see model for formula)
LSOYR	Lakes region soybean checkoff research expenditures, $1,000, annual
LCORSYC	Lakes region wtd average corn yield, bu/acre, crop year
LSOYPLC	Lakes region non-recourse soybean loan rate, $/bu, crop year
NORFLEX	Percent of acres required in the normal flex program under the 1990 farm bill, %
OSOYR	Other region soybean checkoff research expenditures, $1,000, annual
OCORSYC	Other region wtd average corn yield, bu/acre, crop year
OSOYPLC	Other region non-recourse soybean loan rate, $/bu, crop year
OWHEPPC	Other region expected farm price for wheat (same formula as corn, see model for formula)

Appendix Table 2 (continued)

United States (cont'd)

PSOYR	Plains region stock of soybean checkoff research expenditures, $1,000, annual
PCORSYC	Plains region wtd average corn yield, bu/acre, crop year
PSOYPLC	Atlantic region non-recourse soybean loan rate, $/bu, crop year
RCORMEC	Corn exports by non-U.S. corn exporting countries, mil bu., crop year
SHIFT	Indicator variable for structural shift for 1960 through 1982=1, all other years =0
SSOYR	South region stock of soybean checkoff research expenditures, $1,000, annual
SCORSYC	South region wtd average corn yield, bu/acre, crop year
SSOYPLC	South region non-recourse soybean loan rate, $/bu, crop year
TCORSYC	Residual other region wtd average corn yield, bu/acre, crop year
UCOMPWC	U.S. wholesale price of cottonseed meal, $/ton, marketing year
UCOMSPC	U.S. production of cottonseed meal, 1,000 tons, marketing year
UCOODPC	U.S. cottonseed oil share of oleic/linoleic oils use, marketing year
UCOOPWC	U.S. wholesale price of cottonseed oil, ¢/lb, marketing year
UCOOSPC	U.S. production of cottonseed oil, mil lb, marketing year
UCORARP	Corn acreage reduction program requirement, %
UCORDZC	U.S. seed, feed, and other use of corn, mil bu, marketing year
UCORHCC	U.S. government stocks of corn (CCC+FOR), mil bu., crop year
UCORMMC	U.S. imports of corn, mil bu., crop year
UCORPLC	U.S. average corn loan rate, $/bu, crop year
UCORPTC	U.S. corn target price, $/bu, crop year
UCPI67	U.S. consumer price index, 1967=100, annual
UFIMPWA	U.S. fishmeal price, $ ton, marketing year
UFPI67	U.S. farm input price index (1967=100), September-August
UGCAUA	U.S. grain consuming animal units, million head, marketing year
UHOGPFC	U.S. farm price of hogs (barrow/guilt), $/cwt, marketing year
UHPAUC2	U.S. high protein animal units, million head, marketing year
ULAOPWC	U.S. lauric oils price (wtd average of coconut and palm kernel oils), ¢/lb, marketing year
UOISCPC	U.S. soybean processing capacity, mil bu, marketing year
UPEMDPC	U.S. peanut meal share of high protein meal use, marketing year
UPEMSPC	U.S. production of peanut meal, 1,000 tons, marketing year
UPEMPWC	U.S. wholesale price of peanut meal, $/ton, marketing year
UPEODPC	U.S. peanut oil share of oleic/linoleic oils use, marketing year
UPEOPWC	U.S. wholesale price of peanut oil, ¢/lb, marketing year
UPEOSPC	U.S. production of peanut oil, mil lb, marketing year
UPOPA	U.S. population, millions, annual
USLSPFC	U.S. price of slaughter steers, $/cwt, marketing year
USOMDZC	U.S. other use (statistical discrepancy) of soymeal, 1,000 tons, marketing year
USOMEXP	U.S. checkoff expenditures for soymeal demand promotion, deflated by UCPI67, $1000, fiscal yr
USOMMMC	U.S. imports of soymeal, 1,000 tons, marketing year
USOMQ	U.S. soymeal extraction rate, 1,000 tons/mil bu
USOODZC	U.S. other use (statistical discrepancy) of soyoil, 1,000 tons, marketing year
USOOEXP	U.S. checkoff expenditures for soyoil demand promotion, deflated by UCPI67, $1000, fiscal yr
USOOHGC	U.S. government stocks of soyoil, mil lb, marketing year
USOOMGC	U.S. government PL480 exports of soyoil, mil lb, marketing year
USOOMMC	U.S. imports of soyoil, mil lb, marketing year
USOOQ	U.S. soyoil extraction rate, lbs/ bu
USOYDZC	U.S. seed, feed, and other use of soybeans, mil bu, marketing year
USOYEXP	U.S. checkoff expenditures for soybean demand promotion, deflated by UCPI67, $1000, fiscal yr
USOYHGC	U.S. government stocks of soybeans, mil bu, marketing year
USOYMMC	U.S. imports of soybeans, mil bu, marketing year
USOYPTC	U.S. soybean target price, $/bu, crop year
UWHEPFC	U.S. farm price of wheat, $/bu, crop year
UWPI67R	U.S. wholesale price index, 1967=100, annual
UYDA	U.S. personal disposable income, bil $US, annual

Appendix Table 2 (continued)

European Union (15/27)

ECWPI2	EU-15/27 wtd average wholesale price index, 1985=100, annual
EGCAUA	EU-15/27 grain consuming animal units, million head, January 1
EGDP	EU-15/27 aggregate GDP, billions of SDRs
EPAOPIA	EU-15/27 palm oil price, cif NW Europe, $/mt, annual
ESOMDZC	EU-15/27 other use (statistical discrepancy) of soymeal, 1,000 mt, marketing year
ESOMEXP	EU-15/27 international market promotion expenditures for soymeal, deflated, 1000 SDRs, FY
ESOMHEC	EU-15/27 ending stocks of soymeal, end of marketing year
ESOMQ	EU-15/27 soymeal extraction rate, mt of soymeal/mt of soybeans
ESOODZC	EU-15/27 other use (statistical discrepancy) of soyoil, 1,000 mt, marketing year
ESOOEXP	EU-15/27 international market promotion expenditures for soyoil, deflated, 1000 SDRs, FY
ESOOHEC	EU-15/27 ending stocks of soyoil, end of marketing year
ESOOQ	EU-15/27 soyoil extraction rate, mt of soyoil/mt of soybeans
ESOYDZC	EU-15/27 seed, feed, and other use of soybeans, 1,000 mt, marketing year
ESOYEXP	EU-15/27 international market promotion expenditures for soybeans, deflated, 1000 SDRs, FY
ESOYHEC	EU-15/27 ending stocks of soybeans, end of marketing year
ESOYSPC	EU-15/27 production of soybeans, marketing year
XECUSA	Exchange rate, SDR/$US, annual

Japan

DOUTJ	Indicator variable, price data discrepancies, 2005=-1, 2008-09=1, all other years=0
DTFATJ	Indicator variable, consumer preference shift to less saturated fats, 2004-12=1, all other years=0
JGCAUA	Japan grain consuming animal units, million head, February 1
JGDP00	Japan gross domestic product, 2000 prices, million yen
JSOMDZC	Japan other use (statistical discrepancy) of soymeal, 1,000 mt, marketing year
JSOMEXP	Japan international market promotion expenditures for soymeal, deflated, 1000 Yen, fiscal yr
JSOMHEC	Japan ending stocks of soymeal, 1,000 mt, end of marketing year
JSOMQ	Japan soymeal extraction rate, mt of soymeal/mt of soybeans
JSOODZC	Japan other use (statistical discrepancy) of soyoil, 1,000 mt, marketing year
JSOOEXP	Japan international market promotion expenditures for soyoil, deflated, 1000 Yen, fiscal yr
JSOOHEC	Japan ending stocks of soyoil, 1,000 mt, end of marketing year
JSOOQ	Japan soyoil extraction rate, mt of soyoil/mt of soybeans
JSOYDZC	Japan seed, feed, and other use of soybeans, 1,000 mt, marketing year
JSOYEXP	Japan international market promotion expenditures for soybeans, deflated, 1000 Yen, fiscal yr
JSOYHEC	Japan ending stocks of soybeans, 1,000 mt, end of marketing year
JSOYSPC	Japan soybean production, 1,000 mt, Japan crop year
JWPI85R	Japan wholesale price index, 1985=100, annual
XJAUSA	Exchange rate, Japanese Yen/$US, annual

China

DHBW	Indicator for bad weather, 2007, 2012=1, all other years=0
DPREWTO	Indicator variable for pre-WTO years, 1980-94=1, all other years=1
DPSTWTO	Indicator variable for post-WTO years, 1995-2012=1, all other years=1
HCORPFA	China corn farm price, yuan/mt, annual
HFPI85	China farm (agricultural products) price index, 1985=100
HGDPI05	China GDP Deflator, 2005=100
HIPPI05	China industry producer price index, 2005=100
HPOP	China Population, 1000 inhabitants, annual
HSOMDZC	China soymeal other use, 1000 mt, marketing year
HSOMEXP	China international market promotion expenditures for soymeal, deflated, 1000 yuan, fiscal yr
HSOMHEC	China soymeal ending stocks, 1000 mt, marketing year
HSOMQ	China soymeal extraction rate, mt of meal/mt of soybeans
HSOODZC	China soyoil other use, 1000 mt, marketing year
HSOOEXP	China international market promotion expenditures for soyoil, deflated, 1000 yuan, fiscal yr
HSOOHEC	China soyoil ending stocks, 1000 mt, marketing year

Appendix Table 2 (continued)

China (cont'd)

HSOOQ	China soyoil extraction rate, mt of meal/mt of soybeans
HSOYDZC	China soybean feed, seed, other use, 1000 mt, marketing year
HSOYEXP	China international market promotion expenditures for soybeans, deflated, 1000 yuan, fiscal yr
HSOYHEC	China soybean ending stocks, 1000 mt, marketing year
XCHUSA	China exchange rate, yuan/$US, annual

Rest-of-the-World (ROW)

RGDP85	ROW real GDP index, real 1985 prices, annual
RSOMEXP	ROW international market promotion expenditures for soymeal, deflated, 1000 $US
RSOOEXP	ROW international market promotion expenditures for soyoil, deflated, 1000 $US
RSOYEXP	ROW international market promotion expenditures for soybeans, deflated, 1000 $US

Brazil

DBBW	Indictor variable, bad weather in Brazil, 1968, 1971=1, all other years=0
BGDP85	Brazil real gross domestic product, 1985 prices, annual
BSOMDZC	Brazil other use (statistical discrepancy) of soymeal, 1,000 mt, marketing year
BSOMHEC	Brazil soymeal ending stocks, 1,000 mt, end of marketing year
BSOMMMC	Brazil soymeal imports, 1,000 mt, marketing year
BSOMQ	Brazil soymeal extraction rate, mt of soymeal/mt of soybeans
BSOODZC	Brazil other use (statistical discrepancy) of soyoil, 1,000 mt, marketing year
BSOOHEC	Brazil soyoil ending stocks, 1,000 mt, end of marketing year
BSOOQ	Brazil soyoil extraction rate, mt of soyoil/mt of soybeans
BSOYDZC	Brazil seed, feed, and other use of soybeans, 1,000 mt, marketing year
BSOYHEC	Brazil soybean ending stocks, 1,000 mt, end of marketing year
BSOYSYC	Brazil soybean yield, mt/hectare, crop year
BWPI85R	Brazil whole sale price index, 1985=1, annual
XBZUSA	Exchange rate, Trillion Brazilian Reais/$US, annual

Argentina

DGBW	Indicator variable, bad weather in Argentina, 1974, 1975, 1977, 2004=1, all other years=1
GGDP85	Argentina real gross domestic product, 1985 prices, annual
GSOMDZC	Argentina other use (statistical discrepancy) of soymeal, 1,000 mt, marketing year
GSOMHEC	Argentina soymeal ending stocks, 1,000 mt, end of marketing year
GSOMMMC	Argentina soymeal imports, 1,000 mt, marketing year
GSOMQ	Argentina soymeal extraction rate, mt of soymeal/mt of soybeans
GSOODZC	Argentina other use (statistical discrepancy) of soyoil, 1,000 mt, marketing year
GSOOHEC	Argentina soymeal ending stocks, 1,000 mt, end of marketing year
GSOOQ	Argentina soyoil extraction rate, mt of soyoil/mt of soybeans
GSOYDZC	Argentina seed, feed, and other use of soybeans, 1,000 mt, marketing year
GSOYHEC	Argentina soybean ending stocks, 1,000 mt, end of marketing year
GSOYMMC	Argentina soybean imports, 1000 mt, marketing year
GSOYSYC	Argentina soybean yield, mt/hectare, marketing year
GWPI85R	Argentina wholesale price index, 1985=1, annual
XARUSA	Exchange rate, million Argentina Austral/$US, annual

Appendix Table 3: SOYMOD Ex-Post Simulation Validation Statistics, Theil Forecast Error Statistics, 1980/81 to 2012/13

	MSE Decomposition Proportions					Inequality Coefficients	
Variable	Bias (UM)	Reg (UR)	Dist (UD)	Var (US)	Covar (UC)	Theil U1	Theil U
ASOYPCC	0.10	0.30	0.60	0.11	0.79	0.0819	0.0404
ASOYPCC	0.02	0.56	0.41	0.28	0.69	0.2504	0.1204
CSOYPCC	0.03	0.54	0.44	0.26	0.72	0.2519	0.1210
DSOYPCC	0.02	0.59	0.39	0.25	0.73	0.2736	0.1317
LSOYPCC	0.03	0.54	0.43	0.27	0.71	0.2457	0.1182
OSOYPCC	0.02	0.52	0.46	0.24	0.74	0.2460	0.1185
PSOYPCC	0.03	0.55	0.42	0.27	0.71	0.2539	0.1220
SSOYPCC	0.03	0.57	0.40	0.29	0.68	0.2475	0.1190
ASOYSAC	0.05	0.06	0.89	0.01	0.94	0.1181	0.0583
CSOYSAC	0.07	0.26	0.67	0.06	0.86	0.0517	0.0260
DSOYSAC	0.20	0.16	0.64	0.06	0.74	0.1159	0.0564
LSOYSAC	0.05	0.04	0.90	0.02	0.93	0.0344	0.0171
OSOYSAC	0.25	0.12	0.63	0.07	0.67	0.0827	0.0404
PSOYSAC	0.01	0.14	0.84	0.10	0.88	0.0490	0.0245
SSOYSAC	0.20	0.08	0.72	0.00	0.80	0.2411	0.1146
USOYSAC	0.02	0.49	0.49	0.30	0.68	0.0581	0.0289
ASOYSHC	0.06	0.07	0.87	0.00	0.94	0.1194	0.0589
CSOYSHC	0.07	0.22	0.70	0.04	0.89	0.0521	0.0262
DSOYSHC	0.22	0.19	0.60	0.08	0.70	0.1190	0.0577
LSOYSHC	0.06	0.03	0.92	0.01	0.94	0.0364	0.0181
OSOYSHC	0.26	0.12	0.62	0.07	0.66	0.0820	0.0401
PSOYSHC	0.01	0.13	0.86	0.09	0.89	0.0459	0.0229
SSOYSHC	0.20	0.09	0.71	0.00	0.80	0.2431	0.1154
USOYSHC	0.03	0.46	0.52	0.27	0.70	0.0568	0.0282
ASOYSPC	0.07	0.32	0.60	0.11	0.82	0.1330	0.0650
CSOYSPC	0.05	0.17	0.78	0.09	0.87	0.0532	0.0267
DSOYSPC	0.18	0.54	0.28	0.38	0.44	0.1498	0.0719
LSOYSPC	0.05	0.02	0.93	0.01	0.94	0.0343	0.0171
OSOYSPC	0.24	0.16	0.60	0.12	0.64	0.0835	0.0407
PSOYSPC	0.01	0.11	0.89	0.08	0.91	0.0452	0.0226
SSOYSPC	0.20	0.37	0.43	0.13	0.67	0.3008	0.1392
USOYSPC	0.02	0.37	0.61	0.27	0.71	0.0579	0.0287
ACORPPC	0.05	0.04	0.91	0.00	0.95	0.1103	0.0544
CCORPPC	0.06	0.06	0.87	0.01	0.93	0.1038	0.0512
DCORPPC	0.05	0.09	0.86	0.01	0.94	0.1134	0.0559
LCORPPC	0.04	0.06	0.90	0.01	0.95	0.0974	0.0482
OCORPPC	0.04	0.06	0.90	0.01	0.95	0.1047	0.0517
PCORPPC	0.06	0.07	0.87	0.01	0.93	0.1000	0.0494
SCORPPC	0.06	0.08	0.86	0.01	0.93	0.1163	0.0573
TCORPPC	0.06	0.06	0.88	0.01	0.93	0.1034	0.0510
UCORPPC	0.06	0.06	0.87	0.01	0.93	0.1023	0.0504
ACORSAC	0.53	0.03	0.44	0.00	0.46	0.1837	0.0862
CCORSAC	0.01	0.00	0.99	0.08	0.91	0.0360	0.0180
DCORSAC	0.01	0.08	0.92	0.15	0.85	0.1188	0.0599
LCORSAC	0.00	0.01	0.99	0.02	0.98	0.0440	0.0220
OCORSAC	0.58	0.03	0.39	0.00	0.41	0.0566	0.0277
PCORSAC	0.16	0.16	0.68	0.22	0.62	0.0416	0.0207
SCORSAC	0.09	0.09	0.82	0.00	0.91	0.0644	0.0319

Appendix Table 3 (continued)

Variable	Bias (UM)	Reg (UR)	Dist (UD)	Var (US)	Covar (UC)	Theil U1	Theil U
TCORSAC	0.03	0.12	0.84	0.03	0.94	0.0545	0.0274
UCORSAC	0.08	0.06	0.86	0.17	0.75	0.0337	0.0168
ACORSHC	0.51	0.03	0.47	0.00	0.49	0.1959	0.0918
CCORSHC	0.01	0.01	0.98	0.11	0.88	0.0373	0.0187
DCORSHC	0.01	0.09	0.90	0.17	0.83	0.1241	0.0626
LCORSHC	0.00	0.02	0.98	0.02	0.98	0.0522	0.0261
OCORSHC	0.39	0.00	0.61	0.03	0.58	0.0801	0.0391
PCORSHC	0.15	0.14	0.71	0.20	0.65	0.0478	0.0238
SCORSHC	0.09	0.10	0.81	0.00	0.91	0.0721	0.0357
TCORSHC	0.02	0.14	0.83	0.01	0.96	0.0781	0.0393
UCORSHC	0.06	0.08	0.87	0.19	0.76	0.0368	0.0183
ACORSPC	0.44	0.11	0.45	0.01	0.55	0.2156	0.1006
CCORSPC	0.02	0.05	0.93	0.09	0.89	0.0384	0.0193
DCORSPC	0.01	0.10	0.89	0.15	0.84	0.1049	0.0533
LCORSPC	0.00	0.00	1.00	0.01	0.99	0.0548	0.0274
OCORSPC	0.37	0.04	0.59	0.10	0.52	0.0740	0.0363
PCORSPC	0.13	0.09	0.79	0.12	0.75	0.0439	0.0219
SCORSPC	0.09	0.18	0.73	0.07	0.83	0.0779	0.0384
TCORSPC	0.02	0.12	0.86	0.02	0.96	0.0802	0.0403
UCORSPC	0.02	0.03	0.95	0.07	0.91	0.0365	0.0182
ASOYPFC	0.00	0.48	0.52	0.19	0.81	0.2801	0.1366
CSOYPFC	0.00	0.45	0.55	0.16	0.84	0.2815	0.1374
DSOYPFC	0.00	0.49	0.51	0.17	0.83	0.2979	0.1457
LSOYPFC	0.00	0.45	0.55	0.16	0.84	0.2759	0.1348
OSOYPFC	0.00	0.45	0.55	0.17	0.83	0.2768	0.1352
PSOYPFC	0.00	0.45	0.55	0.16	0.84	0.2839	0.1386
SSOYPFC	0.00	0.48	0.52	0.19	0.81	0.2780	0.1359
ACORPFC	0.00	0.17	0.83	0.07	0.93	0.1318	0.0655
CCORPFC	0.00	0.16	0.84	0.07	0.93	0.1327	0.0658
DCORPFC	0.00	0.18	0.82	0.07	0.93	0.1355	0.0673
LCORPFC	0.00	0.15	0.85	0.06	0.94	0.1357	0.0673
OCORPFC	0.00	0.15	0.85	0.06	0.94	0.1212	0.0602
PCORPFC	0.00	0.17	0.83	0.07	0.93	0.1316	0.0653
SCORPFC	0.00	0.18	0.82	0.07	0.93	0.1366	0.0679
TCORPFC	0.00	0.20	0.80	0.09	0.91	0.1207	0.0601
USOYDCC	0.05	0.00	0.94	0.00	0.95	0.0391	0.0194
USOYMEC	0.00	0.65	0.34	0.55	0.44	0.0978	0.0483
USOYPWC	0.00	0.45	0.55	0.17	0.83	0.2704	0.1320
USOYHEC	0.00	0.09	0.91	0.00	1.00	0.2011	0.0999
USOYHTC	0.00	0.09	0.91	0.00	1.00	0.2011	0.0999
USOYEHR	0.00	0.02	0.98	0.00	1.00	0.1466	0.0735
USOYGCC	0.00	0.49	0.51	0.03	0.96	0.6105	0.2946
USOMSPC	0.05	0.00	0.94	0.00	0.95	0.0391	0.0195
LCOMDPC	0.05	0.01	0.94	0.04	0.91	0.0187	0.0093
UCOMDPC	0.10	0.11	0.79	0.15	0.75	0.0541	0.0274
USOMDPC	0.10	0.11	0.79	0.15	0.75	0.0026	0.0013
UHPMDDC	0.00	0.00	1.00	0.01	0.99	0.0319	0.0160
USOMDDC	0.00	0.00	1.00	0.02	0.98	0.0321	0.0160
USOMPWC	0.00	0.29	0.70	0.13	0.86	0.1523	0.0751
USOMHEC	0.01	0.01	0.98	0.03	0.97	0.1444	0.0720
USOMMEC	0.06	0.41	0.53	0.18	0.75	0.1586	0.0772

Appendix Table 3 (continued)

Variable	Bias (UM)	Reg (UR)	Dist (UD)	Var (US)	Covar (UC)	Theil U1	Theil U
USOOSPC	0.05	0.00	0.94	0.00	0.95	0.0392	0.0195
LCOODPC	0.06	0.04	0.90	0.16	0.78	0.0403	0.0201
UCOODPC	0.10	0.02	0.88	0.13	0.77	0.1246	0.0639
USOODPC	0.10	0.02	0.88	0.12	0.78	0.0072	0.0036
UOLODDC	0.00	0.01	0.99	0.02	0.98	0.0203	0.0101
UOLOPWC	0.00	0.19	0.81	0.08	0.91	0.1252	0.0620
USOODDC	0.01	0.02	0.97	0.03	0.96	0.0187	0.0093
USOOHEC	0.01	0.03	0.96	0.01	0.98	0.1766	0.0878
USOOHTC	0.01	0.03	0.96	0.01	0.98	0.1766	0.0878
USOOMEC	0.03	0.33	0.63	0.09	0.87	0.3583	0.1697
USOOMTC	0.03	0.44	0.53	0.14	0.82	0.3092	0.1475
UCORDFC	0.00	0.00	1.00	0.02	0.98	0.0348	0.0174
UCORDOC	0.02	0.15	0.84	0.17	0.82	0.0368	0.0185
UCORHOC	0.00	0.00	0.99	0.01	0.99	0.1245	0.0622
UCORMEC	0.09	0.35	0.56	0.13	0.77	0.1339	0.0653
UCORHTC	0.00	0.00	1.00	0.02	0.98	0.1117	0.0559
UCORPFC	0.00	0.16	0.84	0.07	0.93	0.1314	0.0652
ECORPIA	0.01	0.06	0.93	0.01	0.98	0.1378	0.0683
USOYPFC	0.00	0.46	0.54	0.17	0.83	0.2804	0.1369
UHPMPWC	0.00	0.29	0.71	0.13	0.86	0.1485	0.0732
USOOPWC	0.00	0.19	0.81	0.08	0.92	0.1320	0.0654
UCORPWC	0.00	0.15	0.85	0.06	0.94	0.1227	0.0608
ESOYDCC	0.00	0.07	0.93	0.00	1.00	0.0615	0.0308
ESOYMIC	0.00	0.02	0.97	0.01	0.98	0.0604	0.0302
ESOMSPC	0.00	0.08	0.92	0.00	1.00	0.0613	0.0307
ESOMDDC	0.00	0.01	0.99	0.00	1.00	0.0412	0.0206
ESOMMIC	0.00	0.03	0.96	0.01	0.99	0.0622	0.0310
ESOOSPC	0.00	0.08	0.91	0.00	1.00	0.0622	0.0311
ESOODDC	0.00	0.04	0.96	0.00	1.00	0.0749	0.0375
ESOOMXC	0.00	0.06	0.94	0.01	0.99	0.2448	0.1215
ESOYPIA	0.00	0.35	0.64	0.11	0.88	0.2466	0.1205
ESOMPIA	0.00	0.26	0.74	0.11	0.89	0.1514	0.0748
ESOOPXA	0.00	0.20	0.80	0.09	0.91	0.1383	0.0687
JSOYDCC	0.02	0.02	0.96	0.09	0.89	0.0482	0.0240
JSOYMIC	0.02	0.02	0.96	0.08	0.90	0.0374	0.0187
JSOMSPC	0.02	0.02	0.96	0.08	0.90	0.0482	0.0241
JSOMDDC	0.06	0.23	0.71	0.03	0.91	0.0696	0.0351
JSOMMIC	0.07	0.02	0.92	0.01	0.92	0.2637	0.1369
JSOOSPC	0.02	0.02	0.96	0.08	0.90	0.0484	0.0241
JSOODDC	0.00	0.01	0.99	0.07	0.92	0.0468	0.0234
JSOOMIC	0.03	0.68	0.29	0.14	0.84	1.4058	0.5967
JSOYPUA	0.00	0.46	0.54	0.19	0.81	0.2803	0.1366
JSOMPUA	0.01	0.28	0.72	0.12	0.87	0.1597	0.0786
JSOOPUA	0.00	0.08	0.92	0.02	0.98	0.0993	0.0494
HSOYSHC	0.02	0.14	0.84	0.01	0.98	0.0618	0.0308
HSOYSPC	0.02	0.05	0.93	0.01	0.97	0.0619	0.0308
HSOYPFA	0.00	0.28	0.72	0.06	0.93	0.3256	0.1588
HSOYDCC	0.00	0.03	0.97	0.03	0.97	0.0188	0.0094
HSOYMIC	0.01	0.00	0.99	0.01	0.98	0.0488	0.0245
HSOMPWA	0.00	0.19	0.81	0.06	0.94	0.1395	0.0691
HSOOPWA	0.01	0.13	0.86	0.05	0.94	0.1490	0.0735

Appendix Table 3 (continued)

Variable	Bias (UM)	Reg (UR)	Dist (UD)	Var (US)	Covar (UC)	Theil U1	Theil U
HSOYPIA	0.00	0.34	0.66	0.13	0.87	0.3137	0.1517
HSOMDDC	0.00	0.00	1.00	0.00	1.00	0.0287	0.0144
HSOMSPC	0.00	0.03	0.97	0.03	0.97	0.0190	0.0095
HSOMMXC	0.00	0.02	0.98	0.04	0.96	0.5816	0.3077
HSOODDC	0.01	0.00	0.99	0.00	0.99	0.0674	0.0338
HSOOMIC	0.01	0.13	0.86	0.02	0.97	0.3138	0.1561
HSOOSPC	0.00	0.03	0.97	0.03	0.97	0.0174	0.0087
RSOYMIN	0.00	0.43	0.57	0.21	0.79	0.2576	0.1259
RSOMSPN	0.00	0.43	0.57	0.21	0.79	0.2576	0.1259
RSOMDDN	0.00	0.16	0.83	0.06	0.94	0.1425	0.0710
RSOMMIN	0.01	0.05	0.94	0.01	0.98	0.1072	0.0537
RSOOSPN	0.00	0.43	0.57	0.21	0.79	0.2576	0.1259
RSOODDN	0.00	0.03	0.96	0.00	1.00	0.1300	0.0652
RSOOMIN	0.00	0.01	0.99	0.04	0.95	0.1022	0.0514
BSOYDCC	0.10	0.07	0.82	0.13	0.77	0.0715	0.0363
BSOYMXC	0.01	0.07	0.92	0.15	0.84	0.1973	0.1021
BSOMSPC	0.10	0.07	0.82	0.13	0.77	0.0714	0.0362
BSOMDDC	0.00	0.01	0.99	0.02	0.98	0.0431	0.0216
BSOMMEC	0.11	0.02	0.87	0.01	0.88	0.1214	0.0620
BSOOSPC	0.10	0.08	0.82	0.13	0.77	0.0716	0.0363
BSOODDC	0.00	0.03	0.97	0.04	0.95	0.0250	0.0125
BSOOMXC	0.12	0.01	0.87	0.02	0.86	0.2082	0.1084
BSOYSHC	0.02	0.08	0.90	0.17	0.81	0.1084	0.0550
BSOYSPC	0.04	0.10	0.86	0.18	0.79	0.1133	0.0578
BSOYPXC	0.00	0.40	0.60	0.15	0.85	0.2591	0.1261
BSOMPXC	0.01	0.26	0.74	0.11	0.88	0.1529	0.0753
BSOOPXC	0.00	0.23	0.77	0.10	0.89	0.1505	0.0746
GSOYDCC	0.00	0.03	0.97	0.03	0.97	0.0248	0.0124
GSOYMEC	0.00	0.02	0.98	0.06	0.94	0.1353	0.0682
GSOMSPC	0.00	0.02	0.98	0.03	0.97	0.0249	0.0125
GSOMDDC	0.03	0.00	0.97	0.00	0.97	0.0355	0.0178
GSOMMEC	0.00	0.02	0.98	0.03	0.97	0.0258	0.0129
GSOOSPC	0.00	0.03	0.97	0.03	0.96	0.0243	0.0122
GSOODDC	0.00	0.00	0.99	0.00	1.00	0.0117	0.0058
GSOOMXC	0.00	0.01	0.99	0.02	0.98	0.0296	0.0148
GSOYSHC	0.00	0.11	0.89	0.13	0.87	0.0420	0.0211
GSOYSPC	0.00	0.09	0.91	0.11	0.89	0.0425	0.0213
GSOYPXA	0.01	0.28	0.71	0.07	0.92	0.2337	0.1143
GSOMPXA	0.01	0.11	0.88	0.04	0.95	0.1074	0.0533
GSOOPXA	0.00	0.14	0.86	0.05	0.95	0.1346	0.0667