An Economic Analysis of the United Soybean Board and Qualified State Soybean Boards' Demand- and Supply-Enhancing Programs

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This independent evaluation is carried out by Dr. Harry M. Kaiser, who is the Gellert Family Professor of Applied Economics and Management at Cornell University. Dr. Kaiser is a nationally and internationally renowned expert in the economics of generic advertising and promotion programs. Dr. Kaiser has extensive experience in conducting economic evaluation studies of domestic and international checkoff programs. Dr. Kaiser has written 150 refereed journal articles, five books, 17 book chapters, over 150 research bulletins, and received $8 million in research grants in the area of agricultural marketing with an emphasis on promotion programs.

UNITED SOYBEAN BOARD™

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Executive Summary

This research study had three central objectives:

1. To measure whether the United Soybean Board (USB) and the Qualified State Soybean Boards' (QSSB) promotion and research activities increased consumption and production of soybeans and soy products in the United States and foreign markets compared to what would have occurred in the absence of these activities.

2. To measure the benefits of the USB and QSSB activities in terms of incremental profitability for the entire industry and compare these benefits with the cost of the checkoff to compute a benefit-cost ratio (BCR) of this campaign to its stakeholders.

3. To measure the indirect benefits of the USB/QSSBs to the broader macro-economy.

To address these three objectives, econometric models of the domestic and international soybean markets were constructed, which enabled us to net out the impacts of other important factors besides USB/QSSBs activities affecting soybean and soy product demand such as soybean and other crop prices, income, exchange rates, and economic conditions in importing countries.

The main highlights of the study include the following results:

The USB/QSSBs had a positive and significant impact on soybean demand in the United States compared to what it would have been in its absence. Had there not been any domestic USB/QSSBs promotion and demand-enhancing activities over the latest 5-year period, 2019 through 2023, total domestic soybean demand would have been 9.2% lower than it actually was.

The USB/QSSBs had a positive and significant impact on soybean meal and soybean oil demand in the United States compared to what it would have been in its absence. Had there not been any domestic USB/QSSBs promotion and demand-enhancing activities over the latest 5-year period, total domestic soybean meal demand would have been 5.3% lower than it actually was. Had there not been any domestic USB/QSSBs promotion and demand-enhancing activities over the latest 5-year period, total domestic soybean oil demand would have been 3.8% lower than it actually was.

The U.S. soybean and soy product export promotion efforts supported by USB, QSSBs, USSEC, and FAS have had a positive and statistically significant impact on soybean

exports. Specifically, had there not been any U.S. soybean export promotion to foreign market development programs over the past 5 years, U.S. soybean exports would have been 18.1% lower to the seven countries/regions considered in this study.

The USB/QSSBs, partnered with the USDA/FAS, had a positive and statistically significant impact on U.S. soybean meal and soybean oil exports. Specifically, had there not been any U.S. soybean export promotion to foreign market development over the past 5 years, U.S. soybean meal exports to the seven countries/regions considered in this study would have been 7.5% lower than they actually were. Had there not been any U.S. soybean export promotion to foreign market development over the past 5 years, U.S. soybean oil exports would have been 40.1% lower to the seven countries/regions considered in this study than they actually were.

The USB/QSSBs had a significant impact on increasing soybean supply. Specifically, had there been no USB+QSSB-sponsored soybean production research since 1980, soybean production in the most recent 5 years would have been 9.5% lower than it actually was.

The highest BCRs for any of the four USB/QSSB activities are for domestic demand-enhancing research and export promotion, where an extra dollar invested returned $46.19 and $14.26, respectively, to soybean producer profit. The lowest BCR is for domestic promotion, which still returned $3.14 in incremental profits for an extra dollar invested.

As a strategic recommendation, the USB/QSSBs might consider reallocating some of its budget into demand-enhancing research and export promotion given their higher BCRs.

The overall benefits of the USB/QSSBs are substantially greater than their costs. Collectively, the overall BCR for all four USB activities (including foreign market development) is $12.30:1. In other words, an extra dollar invested in USB activities over the period, 2019-23, returned $12.30 to soybean industry producer profit.

The lower bound of a 95% confidence interval for the marginal BCR is 4.95, which is still well above one adding credence to the findings that the USB/QSSBs have been profitable for their stakeholders.

The direct effect of the USB/QSSBs is to add an incremental $4.75 billion to the soybean industry.

In addition, USB/QSSB promotion and research has positive spillover or indirect effects to the general economy, including:

- Increasing U.S. employment by almost 30,932 people.
- Increasing U.S. employment income by $2.6 billion.
- Increasing total value added by $5.9 billion in the U.S.
- Increasing U.S. GDP by over $9.8 billion.

> In addition, the existence of the USB/QSSBs increased tax revenue at the federal, state, and local levels. In 2023, this amounted to $36 million in county tax revenue, $244 million in state tax revenue, and $655 million in federal tax revenue for a grand total of a little under $1 billion in total tax revenue.

There are also two important caveats regarding the findings of this study. The first is this study relied on two different sets of data for expenditures on production research, demand-enhancing research, and domestic promotion, which are not perfectly compatible. To merge these two data sets, certain simplifying assumptions were made, which are discussed later in the report. Hence, some of these expenditures had to be estimated. In addition, we did not have access to all QSSB expenditures on various activities and had to assume that QSSBs, in the aggregate, allocated their expenditures the same way the USB did over time.

Second, we did not have access to data on expenditures by private companies nor the federal and state government in promoting and conducting research/development on soybeans and soy products domestically and in the export market. Both industry and government spend a significant amount of money on promoting U.S. soybeans and soy products domestically as well as abroad, and similarly invest in research and development of soybeans and soy products. In addition, the government, e.g., the Agricultural Research Service of the USDA, spends considerable money on research and development that enhances soybean and soy product production. It is therefore likely that the estimated impacts for USB and its partners' promotion and research activities capture some of these private and government research and promotion activities as well. Accordingly, the estimates reported here are likely upper bounds estimates of USB's impacts.

An Economic Analysis of the United Soybean Board and Qualified State Soybean Boards' Demand- and Supply-Enhancing Programs

U.S. soybean producers have a long history of collectively funding demand- and supply-enhancing activities both in the domestic and international markets in order to increase the health and competitiveness of their industry. Prior to 1991, these efforts were pursued by various voluntary state checkoff programs, who invested in their own programs and also contributed to the American Soybean Association (ASA). However, with the passage of the 1990 Farm Bill, a national mandatory checkoff program was established for U.S. soybean producers. Under the so-called *Soybean Promotion, Research, & Consumer Information Act of 1990*, soybean producers are required to pay 0.5% of the market price of each bushel of soybeans sold to fund demand- and supply-enhancing promotion and research, with 50% of the proceeds funding the United Soybean Board (USB), which is the national soybean organization created to carry out these promotion and research activities. Along with the USB, the other 50% of funds raised by this mandatory checkoff program are used to fund Qualified State Soybean Board organizations (QSSBs).

Under existing agricultural legislation, the USB is required to have an independent analysis of the economic effectiveness of the program conducted at least once every five years. With almost $1 billion spent on checkoff programs each year by U.S. farms and firms, the government requires stakeholders to have independent information on the effectiveness of these programs. Accordingly, the purpose of the research reported here was to conduct such an economic evaluation for the most recent 5-year period of performance for the USB, 2019-23.

Objective and Scope

The primary purpose of this study was to provide an independent economic evaluation of the effectiveness and impacts of the USB marketing and research programs over the past five years, 2019-2023. Specifically, this study had three general objectives:

1. To measure whether the USB and QSSB promotion and research activities increased consumption and production of soybeans and soy products in the United States and foreign markets compared to what would have occurred in the absence of these activities.

2. To measure the benefits of the USB activities in terms of incremental profitability for the entire industry and compare these benefits with the cost of the checkoff to compute a benefit-cost ratio (BCR) of this campaign to its stakeholders.

3. To measure the indirect benefits of the USB to the broader macro-economy.

In this study, the impacts of all factors affecting domestic and foreign soybean and soy product demand ("demand drivers") and supply ("supply drivers") for which data were available were measured statistically. In this way, we could net out the impacts of other demand and supply drivers (e.g., soybean price, exchange rates, consumer income, technology, etc.) besides USB demand- and supply-enhancing activities affecting soybean and soy product demand/supply over time. In addition, the profitability of the incremental sales generated by USB activities was estimated. The benefits (profits) to soybean producers were estimated using a simulation model which enabled computation of a marginal benefit-cost ratio (BCR) for each individual USB/QSSB activity as well as all activities combined. These benefits to soybean producers were compared with the costs associated with the USB and QSSBs. Based on the estimated impacts from the demand models, individual specific activity BCRs and an overall BCR were derived.

This independent evaluation is carried out by Dr. Harry M. Kaiser, who is the Gellert Family Professor of Applied Economics and Management at Cornell University. Dr. Kaiser is a national and internationally renowned expert in the economics of generic advertising and promotion programs. Dr. Kaiser has extensive experience in conducting economic evaluation studies of domestic and international checkoff programs. Dr. Kaiser has written 150 refereed journal articles, five books, 17 book chapters, over 150 research bulletins, and received $8 million in research grants in the area of agricultural marketing with an emphasis on promotion programs.

USB/QSSBs Program Expenditures

The USB was implemented in 1991 as part of the 1990 Farm Bill to "implement a program of promotion, research, consumer information, and industry information designed to strengthen the soybean industry's position in the market place, to maintain and expand existing domestic and foreign markets and uses for soybeans and soybean products and to develop new markets and uses for soybeans and soybean products."[1] Collectively, the USB and QSSBs raised just over $164 million in recent years on an annual basis for both national and international activities.

The USB/QSSBs invest in a variety of activities to accomplish their overall objective of improving the demand for U.S. soybeans and soy products and the efficiency of soybean production. In this report, the promotion and research activities were divided into four categories:

1. Domestic soybean and soy product promotion,
2. Foreign market development (aka export promotion) of U.S. soybean and soy products,
3. Demand-enhancing research for soybeans and soy products,
4. Production-enhancing research for soybeans and soy products.

The first three activities are intended to increase the demand for soybeans and soy products. The goal of these activities is to increase demand, price, and producer profits. Production research is intended to increase the supply of soybeans, improve production efficiency, and reduce producers' costs of production.

Figure 1 presents the domestic promotion expenditures for the USB and QSSBs from 1995 through 2023. Since 1995, there has been a general upward trend in domestic promotion expenditures. While there has been more variation recently in domestic promotion spending, it currently is over six times higher than it was in the mid-1990s.

Figure 2 presents USB spending on demand-enhancing research from 1995 through 2023. Spending for this category of USB activities has generally trended upwards since 1995 with a few fluctuations occurring between 2019 and 2023. Demand-enhancing research has a lagged effect on demand since it takes time for research discovery and bringing new discoveries to market. Indeed, in this study, the finding was that expenditures on demand-enhancing research took about 13 years, on average, before they had an impact on soybean demand.

Figure 3 presents U.S. soybean and soy product export promotion expenditures by the USB and USSEC partnerships (Foreign Agricultural Service (FAS) and QSSB). USSEC receives funding primarily from these three parties (USB, FAS and QSSBs) and cooperating industry to help build a preference for U.S. soybeans and soybean products in foreign markets. U.S. soybean export

[1] Soybean Promotion, Research, and Consumer Information Act, Section 1966(b) (1990) (codified as amended at 7 U.S.C. 6301-6311 (1991)).

promotion has grown considerably over this time period, increasing from just $7 million in 1995 to over $68 million in 2023.

Figure 4 presents the combined spending on production research by USB and state level QSSB organizations from 1995 to 2023. Overall, this category of spending greatly increased considerably between 1995 and 2011. In 2012, it fell considerably, but since then has been trending upward. Similar to demand-enhancing research, production research takes time before its impacts are felt on soybean supply. In this study, the lag was about 11-14 years, on average, before these expenditures had an impact on soybean supply.

Figure 1. USB domestic promotion expenditures, 1995-2023.

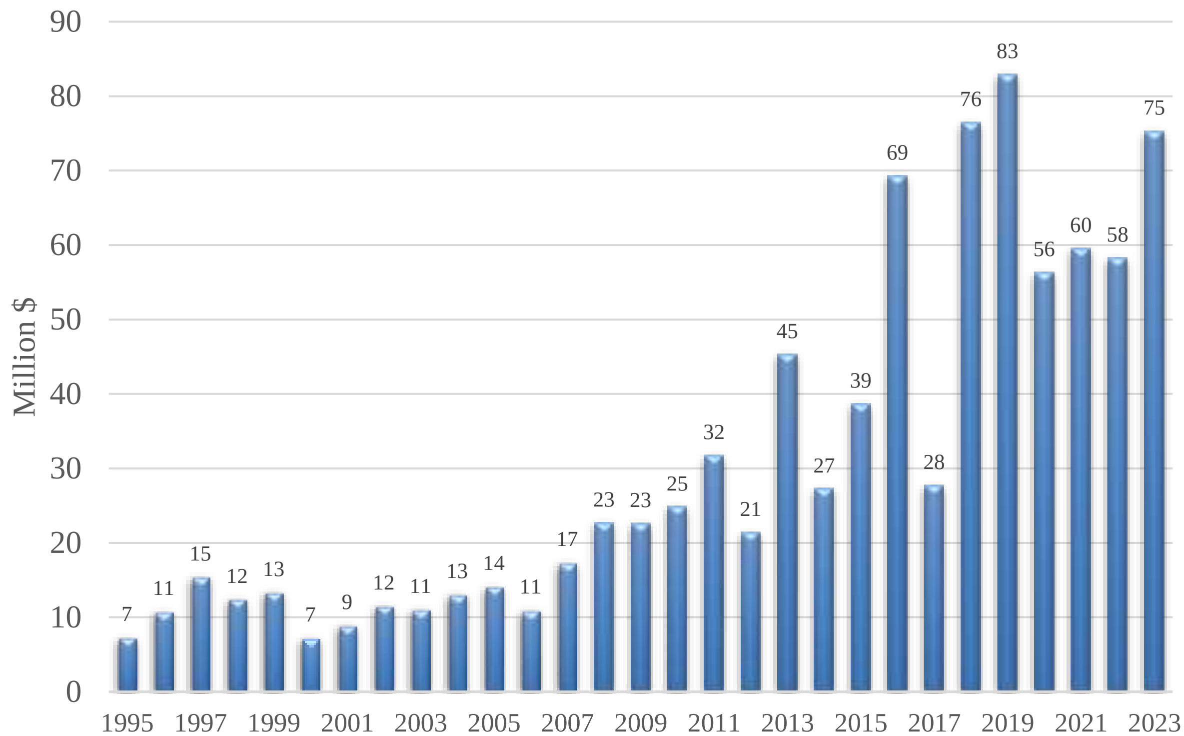


Figure 2. USB demand-enhancing expenditures, 1995-2023.

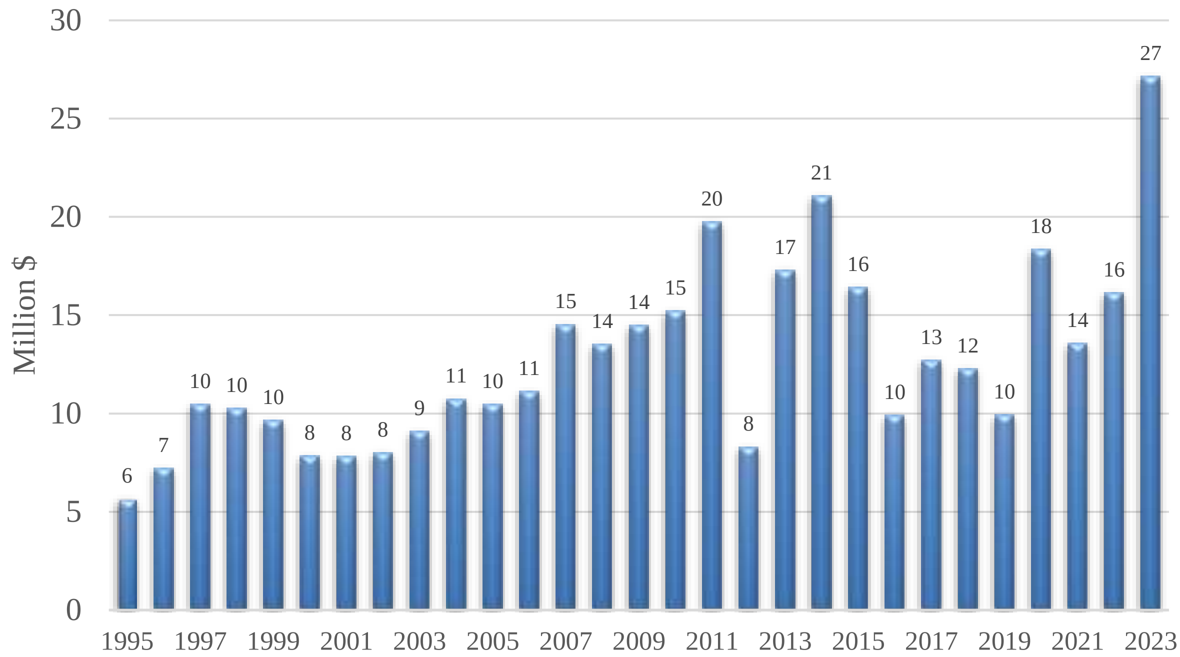


Figure 3. USB and USSEC partnerships (FAS+QSSB) export promotion expenditures, 1995-2023.

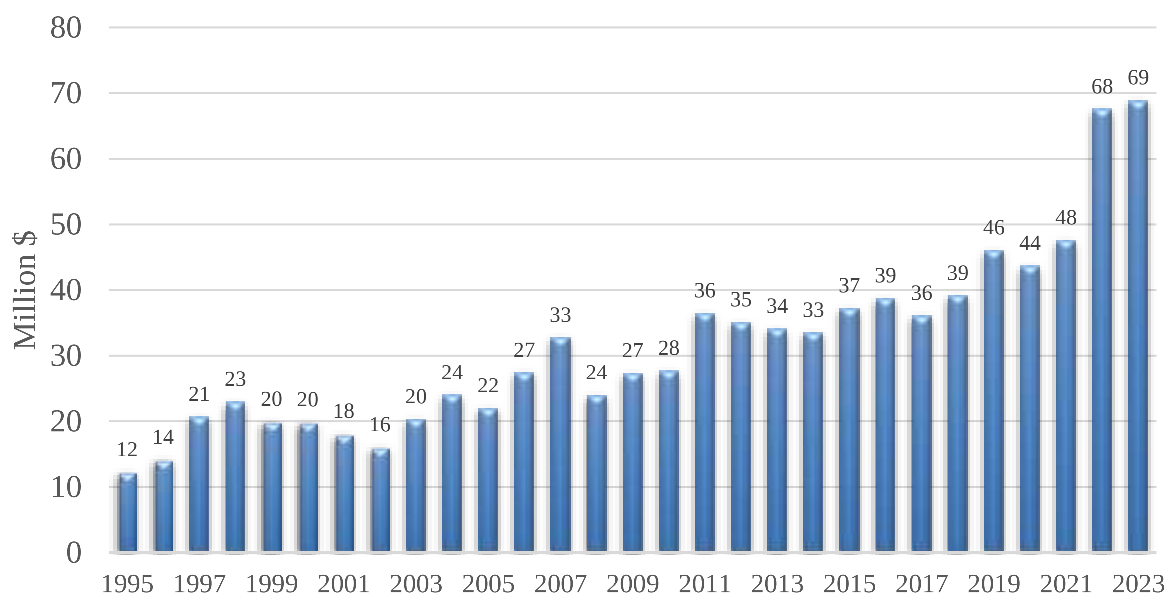
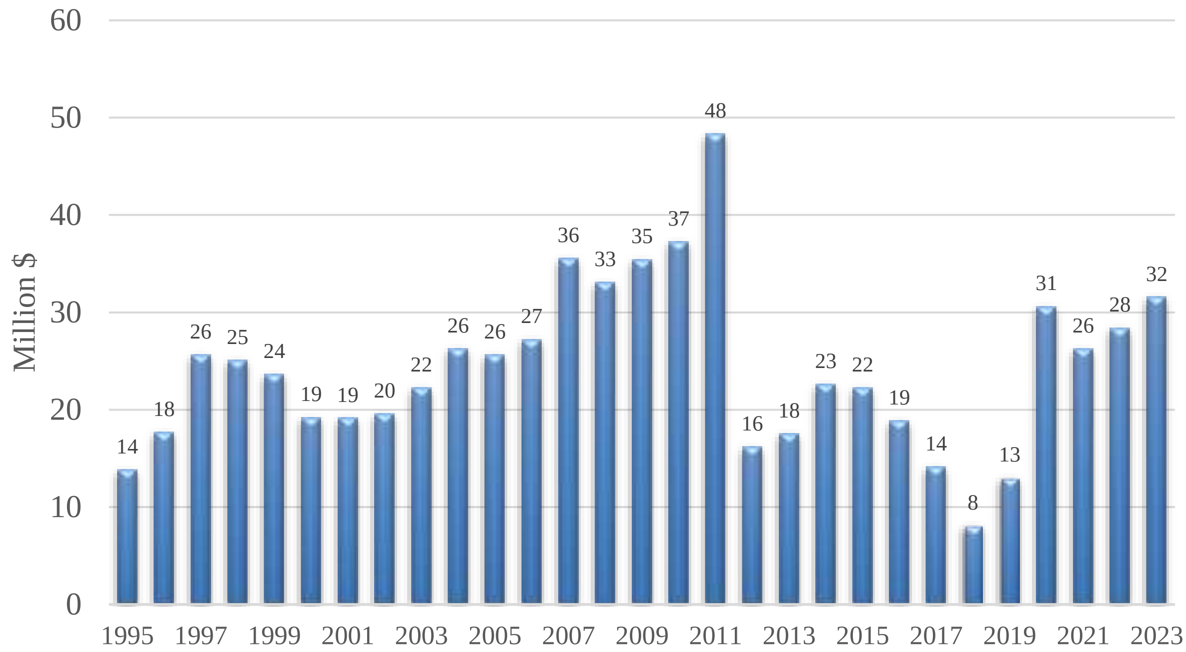


Figure 4. USB production-enhancing expenditures, 1995-2023.



Data Limitations

This analysis was based on secondary data from government sources, private venders, the USB, and researchers at Texas A&M University who conducted previous (2014 and before) USB Return on Investment evaluation studies. The accuracy of the results depended primarily on the quality of this secondary data, the bulk of which mainly measure supply and demand drivers for soybeans and soy products. While these data were judged to be the best available for this economic evaluation, there are errors in data from any data source, including the data used in this study.

There were four potential limitations in the data used in this study, three relating to expenditures by the USB, and the final relating to the lack of data on private firm and federal government spending on research and promotion activities.

The first limitation was that the domestic promotion and demand-enhancing research expenditure data obtained for 2012 through 2023 only included USB funding and did not include funding by the QSSBs. These data were unavailable for this study. However, as a proxy for QSSB contributions to domestic promotion and demand-enhancing research, we increased these expenditures by two-fold for 2012-23 reflecting the fact that USB receives 50% of total assessment funds and the QSSB receive the other 50%. This resulted from discussions with senior USB management who estimate that doubling USB-only expenditures was a reasonable approximation of the true USB and QSSB investment in these two activities.

Relatedly, this study relied on two different sets of data for expenditures on production research, demand-enhancing research, and domestic promotion. The annual data from 1980-2011 came from a previous economic evaluation study of the USB by researchers at Texas A&M[2]. While these researchers very generously shared their data for this study, it was not perfectly comparable to the annual data generated by USB staff for the past 12 years, 2012-2023. For example, the Texas A&M study combined domestic promotion expenditures with demand-enhancing expenditures by the USB, while the more recent data broke the two out separately. Because we wanted to measure the separate impacts of the two activities, we assumed that the average percentage allocation of promotion vs. demand-enhancing research in the past 12 years (2012-23) also held for the 1980-2011 data. For the 2012-23 period, 27.8% of these expenditures were allocated to demand-enhancing research and 72.2% of the expenditures were allocated to domestic promotion. To merge these results with the older data, the same proportions (27.8% and 72.2%) were used to split the 1980-2011 data into demand-enhancing research and domestic promotion expenditures.

The third limitation is that the 1980-2011 production research expenditures included QSSB and USB investments while the 2012-2023 data only included USB expenditures. In this study, we wanted to account for combined QSSB and USB spending on production research in order to get an accurate estimate of the impact of production research on soybean supply. Again, in this case, we doubled the USB-only expenditures for production research for 2012-23 to get an approximation of USB and QSSB total expenditures on production research. Fortunately, this limitation was completely mitigated in this study because the econometric model indicated a 14-

[2] Williams, Capps & Lee (2014) The Return to Soybean Checkoff Investments, Texas A&M University.

year lag in production research, and consequently, the production research expenditures for 2012-2018 were not even considered in the model.

Finally, we did not have access to data on expenditures by private companies nor the federal and state government in promoting and conducting research/development on soybeans and soy products domestically and in the export market. Both industry and government spent a significant amount of money on promoting U.S. soybeans and soy products domestically as well as abroad, and similarly invested in research and development of soybeans and soy products. In addition, the government, e.g., the Agricultural Research Service of the USDA, spent considerable money on research and development that enhanced soybean and soy product production. For this report, we did not have access to annual expenditures by these entities. It is therefore likely that the estimated impacts for USB and its partners' promotion and research activities captured some of these private and government research and promotion activities as well. Accordingly, the estimates reported here were likely upper bounds estimates of USB's impacts.

Methodology

This study quantified the relationship between the various promotion and research activities of the USB and QSSBs and the domestic demand and supply and international demand for U.S. soybeans and soy products. Several econometric models were estimated. The econometric approach quantifies economic relationships using economic theory and statistical procedures with data. It enables one to simultaneously account for the impact of a variety of factors affecting demand and supply for a commodity. By casting the economic evaluation in this type of framework, one can filter out the effect of other factors and, hence, quantify directly the net impact of the USB and QSSB's activities on soybean demand and supply.

The three econometric models that were estimated include: (1) domestic soybean (and soybean meal and soybean oil) demand, (2) domestic soybean farm-level supply, and (3) U.S. soybean (soybean meal and soybean oil) import demand. The first two models were estimated with annual time series data from 1980 through 2023. The third model was estimated with panel data for seven countries/regions and the most recent 10 years of time series data. The three econometric models were used to test whether various activities funded by the USB and QSSBs, such as domestic promotion; demand-enhancing research; production research; and export promotion, had a positive and statistically significant impact on soybean (soybean meal and soybean oil) demand and supply. A detailed discussion of the econometric model and the results is presented in the appendix of this report. Here, we focus on a general overview of the model and a discussion of the results.

To compare the relative importance of each factor on soybean demand and supply, the results from the econometric models were converted into "elasticities." An elasticity measures the percentage change in demand or supply given a 1% change in a specific demand or supply driver, holding all other factors constant. For example, the computed own price elasticity of demand measures the percentage change in soybean quantity demanded given a 1% change in soybean price, holding constant all other soybean demand drivers. Since elasticities were calculated for each demand and supply factor in each model, one can compare them to determine which factors had the largest impact on demand or supply.

Domestic Soybean (Soybean Meal and Soybean Oil) Demand

Three econometric domestic demand equations were separately estimated for (1) whole soybeans, (2) soybean meal, and (3) soybean oil products. The following demand drivers were included to ascertain their impacts on the farm-level demand (measured as U.S. commercial disappearance of soybeans) for whole soybeans:

1. Soybean price in $ per bushel,
2. Farm price index for soybean substitute commodities, including sunflowers, flaxseed, cottonseed, peanuts, corn, and linseed,[3]

[3] More recently, both canola and distillers dried grains with solubles (DDGS) have become important substitutes for soybeans and soy products. Unfortunately, price data on both of these products was difficult to find prior to 1991, and since the data used to estimate the domestic demand models date back to 1980, these two substitutes were not included in the model.

3. U.S. pork, milk, and poultry production,
4. Commercial disappearance of soybeans in the previous year,
5. USB domestic promotion expenditures on whole soybeans, soybean meal, and soybean oil,
6. USB expenditures on demand-enhancing research.

The soybean price was expected to be negatively related to farm-level soybean demand, i.e., a lower price results in higher quantity demanded reflecting the law of demand. The farm price index for soybean substitute commodities was included because they represent the most important substitutes for soybeans. The relationship between soybean demand and this price index was expected to be positive because these commodities are substitutes for soybeans, e.g., an increase in the substitute price index should result in an increase in soybean demand because soybeans would become relatively less expensive. Commercial disappearance of soybeans in the previous year was included to capture habit formation and it provided an explicit dynamic dimension to the model, i.e., demand in the current year was correlated to demand in the previous year.

Finally, and most relevant here, two major USB and QSSB demand-enhancing activities were separately included in the domestic demand model for soybeans. The first was domestic promotion expenditures by the USB and QSSBs that were intended to increase the demand for soybeans and soy products. The second was expenditures on research projects that were intended to increase the demand for soybeans and soy products such as new product development. Since there was a lagged effect between when a research project ultimately impacts demand, various lengths of lags were run for research expenditures, and the lag length that resulted in the best statistical fit (e.g., highest coefficient of determination, best t-values) was selected for the final model. Likewise, some of the promotion activities also had a lag impact on demand, and similar procedures were used for promotion expenditures. All monetary variables in the model were deflated by the Consumer Price Index for all items to remove the effects of inflation.

Similar procedures were used to estimate demand models for soybean meal and soybean oil. The same demand drivers were included in each model as were included for the whole soybean demand model, with one exception. Instead of soybean price, the wholesale soybean meal price was included in the soybean meal demand model and the wholesale soybean oil price was included in the soybean oil demand model. More details are provided on these demand models in the Appendix.

Domestic Soybean Supply

The farm-level soybean supply (measured as U.S. soybean production) model included the following supply drivers:

1. Soybean price in $ per bushel,
2. Corn price in $ per bushel,
3. Index of prices paid by farmers in the crop sector,

4. Linear time trend variable to capture increased efficiency in soybean production due to technological progress and improvements in management ability,
5. Soybean production in the previous year,
6. USB and QSSB expenditures on farm-level supply-enhancing research.

The soybean price was expected to be positively related to farm-level soybean supply, i.e., a higher price resulted in higher quantity supplied reflecting the law of supply. The corn price was included because corn is a competing commodity. The relationship between soybean supply and the corn price was expected to be negative because an increase in the corn price should result in a decrease in soybean supply since soybeans would now be relatively less profitable than corn. The soybean and corn prices were included in the model as the ratio of the soybean to corn price. A distributed lag specification for this price ratio was used as a proxy of soybean producers' price expectations. Various lag lengths were run, and the lag length that resulted in the best statistical fit was used as the final model.

The index of prices paid by farmers was included as a measure of soybean costs, and the relationship was expected to be negative, i.e., as costs increase, soybean supply should decrease. The trend term was included to capture changes in technology and managerial efficiency over time. Soybean production in the previous year was included to capture the dynamic link between production in consecutive years.

Finally, and most relevant here, USB and QSSB production research expenditures were included in the supply model for soybeans. Production research was expected to increase the supply of soybeans. Since there is a lagged effect between when a research project ultimately impacts supply, various lengths of lags were run for research expenditures, and the lag length that resulted in the best statistical fit was selected for the final model.

The following data sources were used for all the variables in the domestic demand and supply models: commercial disappearance, production, price, and cost data came from *Soybeans and Oil Crops* report from the Economic Research Service of the USDA, the Index of Prices Paid by farmers and corn prices came from *Agricultural Prices* published by the National Agricultural Statistics Service of USDA, and USB expenditures on domestic promotion, demand-enhancing research, and production research came from USB and from the Texas A&M previous evaluation study.

U.S. Soybean (Soybean Meal and Soybean Oil) Import Demand

Using panel (both time series and importing region-level) data, an import demand model for U.S. soybean and soy products was estimated. Data on key demand drivers for U.S. soybean and soy product imports to selected regions were collected and used on an annual basis over the period 2014-2023 for the following seven importing regions: Greater China, Northeast Asia, Southeast Asia, Asia Subcontinent, Europe, the Americas, and North Africa.

The import demand equation for U.S. soybeans (soybean meal and soybean oil) was estimated with imports of U.S. soybeans (or soybean meal or soybean oil) as the dependent variable, which was measured on a volume basis for each calendar year for each region. The following import demand drivers were included to ascertain their impacts on import demand for U.S. soybeans (soybean meal and soybean oil):

1. Unit value (price) of annual soybean (soybean meal and soybean oil) imports from the U.S. to each importing region in dollars per pound,
2. Unit value (price) of annual soybean (soybean meal and soybean oil) imports from the rest-of-the-world (ROW) exporters to each importing region in dollars per pound,
3. Average annual GDP for each importing region,
4. Average annual real exchange rate (ER) of each importing region's currency relative to U.S. dollar,
5. Imports of soybeans (soybean meal and soybean oil) in the previous year for each importing region,
6. Trend variable to capture omitted variable effects,
7. Indicator variable to capture impact of US-China tariff increase in 2018,
8. Total annual U.S. soybean and soy product export promotion expenditures by the USB and USSEC partnerships (FAS+QSSB) to each importing region.

Both the U.S. and ROW soybean (soybean meal and soybean oil) prices were computed as the total value of imports divided by the total quantity of imports. Hence, price was computed as a unit value measure. The U.S. price is expected to be negatively related to the volume of imports from the U.S. in each importing region, i.e., a lower price would result in higher U.S. import quantity demanded reflecting the law of demand. The import price of all competing regions was included because these regions are the chief competitors for U.S. soybeans and soy products. The relationship between the ROW price and the import demand for U.S. soybeans and soy products was expected to be positive because ROW soybeans are a close substitute with U.S. soybeans.

The relationship between GDP and the demand for U.S. soybeans (soybean meal and soybean oil) was expected to be positive, i.e., as regions become wealthier, the demand for U.S. soybeans (soybean meal and soybean oil) should increase. The ER has been shown to be an important determinant of the demand for U.S. imports. The relationship between ER and the import demand for U.S. soybeans (soybean meal and soybean oil) was expected to be negative. As the U.S. dollar becomes cheaper, U.S. soybeans (soybean meal and soybean oil) become relatively cheaper and hence import demand increases. Imports in the previous year were included to capture dynamic effects of international trade rigidities, i.e., imports from the U.S. last year should be highly correlated with imports from the U.S. this year. A trend variable was included to capture the net impact of other potential import demand drivers not included in the model. An indicator variable, equal to 1 for China in 2018-23 and zero otherwise, was included to capture the impact of the trade war between China and the U.S. that began in 2018, which dramatically reduced U.S. soybean import volume to China.

U.S. export promotion expenditures in each region were included in the U.S. import demand model for soybeans. These expenditures included funds from three sources: USB, QSSB, and FAS, and were treated as one variable called U.S. soybean/soy product export promotion. U.S. export promotion was expected to increase the import demand of soybeans. All monetary variables in the model were deflated by the Consumer Price Index for all items in each country/region to remove the effects of inflation.

The following data sources were used for the variables in the import demand model: the quantity, value, and therefore price of U.S. and ROW soybean and soy product imports came from the FAS Global Agricultural Trade System (GATS). Importing country GDP, exchange rates, and Consumer Price Indices came from the USDA Economic Research Service’s international macroeconomic data. Annual soybean export promotion expenditures were provided by the USB.

Econometric Results

Domestic Soybean Demand and Supply

The domestic demand and supply models were estimated with annual national data from 1980 through 2023. All equations were estimated using a logarithmic functional form. The detailed econometric results are presented and discussed in the appendix of this report.

Soybean demand. The estimated elasticities for the farm-level soybean demand model are summarized in Table 1 (the full econometric output is listed in the Appendix). The coefficient of variation (R^2) indicates that the explanatory variables explained 95% of the variations in annual farm-level demand for soybeans. The elasticity signs were consistent with economic theory and all estimated coefficients (except for the lagged commercial disappearance and the substitute price index, which were not statistically significant and therefore omitted from the final model) were statistically significant. Several econometric diagnostic tests performed indicated no statistical problems with the model.

Table 1. Soybean demand elasticities.

Demand Factor	Elasticity	95% lower bound conf interval	95% upper bound conf interval
Own price	-0.170	-0.278	-0.081
Pork + milk production	1.273	1.077	1.623
Domestic promotion	0.028	0.015	0.041
Demand-enhancing research (lagged 13 years)	0.067	0.008	0.127

The own price elasticity (all elasticities that follow are based on the average for the entire period, 1980-2023) was negative and equal to -0.17. The interpretation of this is a 1% increase in the farm soybean price, holding all other demand factors constant, resulted in a 0.17% decrease in soybean quantity. Pork plus milk production had a positive elasticity value indicating that as milk and pork production increased so did the demand for soybeans. Specifically, a 1% increase in pork plus milk production, holding all other demand factors constant, increased soybean demand by 1.27%. This was the most important demand driver for soybeans.

Both domestic promotion and demand-enhancing research activities by the USB and QSSBs had a positive and statistically significant impact on U.S. soybean demand. Holding all other demand factors constant, a 1% increase in promotion expenditures increased soybean demand by 0.028%. A 1% increase in lagged demand-enhancing research expenditures by the USB and QSSBs increased soybean demand by 0.067%. The lag length was 13 years on demand-enhancing research, which means that it took 13 years, on average, for such research to have an impact on demand.

Another way to view the estimated elasticities for USB and QSSB promotion and demand-enhancing research is in terms of their total impact on soybean demand. That is, had there not been any domestic promotion, farm-level soybean demand would have been 2.8% (0.028*100 = 2.8%) lower than it actually was over this period.[4] Had there not been any demand-enhancing research, farm-level soybean demand would have been 6.7% (0.067*100 = 6.7%) lower than it actually was over this period. Of course, in this case, it would take 13 years to achieve this increase in demand given the long lag effects of research coming to fruition.

Because there is error inherent in any statistical model, the lower bound of the 95% confidence interval was computed for the demand-enhancing research and promotion elasticities. The lower bound can be interpreted as the lowest value of the estimated elasticity where one can be confident that the true population elasticity would be at or above it 95% of the time. The lower bound of the 95% confidence interval for the promotion elasticity was 0.015. The lower bound of the 95% confidence interval for the demand-enhancing research elasticity was 0.008. In other words, the true promotion elasticity lied at or above 0.015 95% of the time, and the true demand-enhancing research elasticity lied at or above 0.008 95% of the time.

Soybean supply. The estimated elasticities for the soybean supply model are summarized in Table 2. The explanatory variables explained 91% of the variations in annual supply for soybeans. The elasticity signs were consistent with economic theory and all estimated coefficients (except for soybean production in the previous year, which was omitted from the model since it is not significant) were statistically significant. Several econometric diagnostic tests performed indicated no statistical problems with the model.

Table 2. Soybean supply elasticities.

Supply Factor	Elasticity	95% lower bound conf interval	95% upper bound conf interval
Soybean price/farm cost index	0.298	0.047	0.549
Corn price/farm cost index	-0.399	-0.598	-0.200
Time trend	0.534	0.429	0.638
Production research (lagged 11-14 years)	0.095	0.004	0.185

The estimated own price elasticity was positive and equal to 0.298. The polynomial distributed lag model includes the price lag for the three previous years in its formulation. The interpretation of this was a 1% increase in the farm soybean price, holding all other supply

[4] This calculation follows from multiplying the elasticity value by 100% in order to get an estimate of the total impact of the USB and QSSBs. In other words, since an elasticity is a percentage measure of how demand (or supply) changes given a 1% change in an explanatory variable, multiplying the elasticity value by 100% gives an estimate of how demand (or supply) would change given a 100% change in the explanatory variable, holding constant all other factors.

factors constant, led to a 0.298% increase in soybean quantity supplied. The corn price had an elasticity value of -0.399. That is, a 1% increase in the corn price led to a 0.399% decrease in soybean supply, holding all other supply drivers constant. The estimated coefficient on the trend term was positive and statistically significant indicating positive technological improvements over the period 1980-2023.

Production research activities by the USB and QSSBs had a positive and statistically significant impact on U.S. soybean supply. Holding all other demand factors constant, a 1% increase in production research expenditures increased soybean demand by 0.095%. The lag length for production research is 11-14 years.[5] The lower bound of the 95% confidence interval on the production research elasticity was 0.04.

Another way to view the estimated elasticities for USB and QSSB production research is in terms of their total impact on soybean supply. That is, had there not been any USB- and QSSB-sponsored production research, soybean supply would have been 9.5% (0.095*100 = 9.5%) lower than it actually was over this period.

It is quite likely that the estimated elasticity of 0.095 for USB and QSSB production research was biased upwards due to the omission of significant spending by both the federal government and private companies on soybean research and development. While we do not have time series annual data on these expenditures, a recent estimate provided by USB is that the private industry (e.g., Indigo, Benson Hill, Monsanto, Pioneer, Syngenta) spent $775 million annually on soybean and soy product research and development. In addition, the USDA spent about $100 million per year on this, while the soybean checkoffs spent about $26 million annually.

In other words, the soybean checkoffs only made up about 3.3% of the total funding of soybean research and development. As such, the estimated impact of 9.5% likely overstates the contribution of USB and QSSBs. Hence, this important caveat should be noted in interpreting this finding.

Soybean meal demand. The estimated elasticities for the wholesale soybean meal demand model are summarized in Table 3. The explanatory variables explained over 96% of the variations in annual demand for soybean meal. The elasticity signs were consistent with economic theory and all estimated coefficients (except for the substitute price index and lagged

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[5] There is a large body of economic literature measuring the economic returns to agricultural research and development by the government and private industry in the United States. These studies aimed to measure the social and private rate of return on agricultural research, and one of the key issues in doing this was estimating the lag length of time between when research was initiated and when it began to have an impact on agricultural production. An excellent review of this literature is provided by a 2008 publication entitled, "Research Lags Revisited: Concepts and Evidence from U.S. Agriculture," by Julian Alston, Philip Pardey, and Vernon Ruttan. In this paper, the authors reported that about 21% (370 estimates) of all studies found an agriculture research lag length between 0 and 10 years, 28% (490 estimates) found a lag length of 11-20 years, and another 20% (358 estimates) found a lag length of 21-30 years. Therefore, estimates here of 12 years for demand-enhancing research and 11-14 years for production research fell within the range of previous studies. It should be noted that the 12- and 11-14-year lag lengths estimated in this study should be thought of as the average minimum time for soybean research to have an impact, and the impacts last substantially longer than this.

commercial disappearance of soybean meal, which were not significant and therefore omitted from the model) were statistically significant. Several econometric diagnostic tests performed indicate no statistical problems with the model.

The estimated coefficient on lagged soybean meal demand (measured as commercial disappearance) was 0.303, which was statistically significant from zero. This indicated that there was a positive correlation between soybean meal demand in the previous year and current soybean meal demand.

The estimated own price elasticity was negative and equal to -0.157. The interpretation of this was a 1% increase in the wholesale soybean meal price, holding all other demand factors constant, led to a 0.157% decrease in soybean meal quantity demanded. Pork plus milk production had a positive elasticity value indicating that as pork and milk production increased so did the demand for soybean meal. Specifically, a 1% increase in pork plus milk production, holding all other demand factors constant, increased soybean meal demand by 0.552%.

Table 3. Soybean meal demand elasticities.

Demand Factor	Elasticity	95% lower bound conf interval	95% upper bound conf interval
Soybean meal demand in previous year	0.303	0.083	0.523
Own price	-0.157	-0.235	-0.079
Pork + milk production	0.552	0.380	0.724
Domestic promotion + demand enhancing research	0.059	0.034	0.085

Domestic promotion and demand-enhancing research activities[6] by the USB and QSSBs had a positive and statistically significant impact on U.S. soybean meal demand. Holding all other demand factors constant, a 1% increase in promotion and demand-enhancing research expenditures increased soybean meal demand by 0.059%. The lag length was eight years on demand-enhancing research and one year for promotion. Extrapolating these results, had there not been any demand-enhancing research or promotion, soybean meal demand would have been 5.9% lower than it actually was over this period. The lower bound of the 95% confidence interval for promotion and demand-enhancing research was 0.034.

[6] In this specification, rather than including demand research expenditures and domestic promotion expenditures as separate variables, they are combined. This was done for the following statistical reason: including only demand research expenditures (and not promotion expenditures) results in a statistically significant coefficient for demand research. The same is true if promotion expenditures are included without demand research expenditures. However, if both variables are included together as separate variables, one is statistically significant and the other is insignificant which suggests that the two variables are highly correlated and causes a multicollinearity problem. The only way to deal with this is to either omit one of the variables or add them together, which is done here.

Soybean oil demand. The estimated elasticities for the wholesale soybean oil demand model are summarized in Table 4. The R^2 indicates that the explanatory variables explained 94% of the variations in annual demand for soybean oil. The elasticity signs were consistent with economic theory and all estimated coefficients (except for pork plus milk production, which was not and was omitted from the model) were statistically significant. Several econometric diagnostic tests performed indicate no statistical problems with the model.

The estimated coefficient on lagged soybean oil demand (measured as commercial disappearance) was 0.781, which was statistically significant from zero. This indicated that there was a positive correlation between soybean oil demand in the previous year and current soybean oil demand.

Table 4. Soybean oil demand elasticities.

Demand Factor	Elasticity	95% lower bound conf interval	95% upper bound conf interval
Soybean oil demand in previous year	0.781	0.625	0.939
Own price	-0.202	-0.474	-0.070
Domestic soybean oil promotion	0.004	0.0003	0.008
Demand-enhancing research (lagged 8 years)	0.054	0.0005	0.108

The estimated price elasticity was negative and equal to -0.202. The interpretation of this is a 1% increase in the wholesale soybean oil price, holding all other demand factors constant, led to a 0.202% decrease in soybean oil quantity demanded.

Both domestic soybean oil promotion and demand-enhancing research activities by the USB had a positive impact on U.S. soybean oil demand. Holding all other demand factors constant, a 1% increase in promotion expenditures increased soybean oil demand by 0.004%. A 1% increase in lagged demand-enhancing research expenditures increased soybean oil demand by 0.054%. The lag length was 8 years for demand-enhancing research, which meant that it took about 8 years, on average, for such research to have an impact on soybean oil demand. Extrapolating these elasticity results, had there not been any domestic soybean oil promotion by the USB and QSSBs, soybean oil demand would have been 0.4% lower than it actually was over this period. Had there not been any demand-enhancing research, soybean oil demand would have been 5.4% lower than it actually was over this period. The lower bound of the 95% confidence intervals for promotion and demand-enhancing research were 0.0003 and 0.0005, respectively.

Import Soybean (Soybean Meal and Soybean Oil) Demand

The import demand equation for U.S. soybeans (soybean meal and soybean oil) was estimated for the seven regions with time series data from 2014 through 2023. All equations were estimated using a logarithmic functional form. A fixed effect model was estimated with the panel data structure with cross-sectional GLS weights applied.

Soybean import demand. The estimated elasticities for the soybean import demand model are summarized in Table 5. The explanatory variables explained 98% of the variations in U.S. soybean imports to the seven regions over the past 5 years. The elasticity signs were consistent with economic theory and most estimated coefficients (except imports in the previous year, which was omitted from the final model) were statistically significant. Several econometric diagnostic tests performed indicate no statistical problems with the model.

The estimated coefficient on lagged soybean import demand was 0.663, which was statistically significant from zero. This indicated that there was a positive correlation between soybean import demand in the previous year and current soybean import demand. U.S. soybean imports had an own price elasticity of demand of -0.458, which meant a 1% increase in the U.S. price for soybeans would result in a 0.458% decrease in U.S. soybean imports, holding all other import demand drivers constant. The ROW price had a cross-price elasticity of demand equaling 0.262. Specifically, a 1% increase in ROWP would result in a 0.262% increase in U.S. soybean imports, holding constant all other demand drivers. GDP had a small, but significant positive effect on U.S. soybean imports. Holding all other drivers constant, a 1% increase in importing countries' GDP increased U.S. soybean imports by 0.062%.

Table 5. Soybean import demand elasticities.

Import Demand Factor	Elasticity	95% lower bound conf interval	95% upper bound conf interval
Imports in previous year	0.663	0.462	0.865
U.S. price	-0.458	-0.760	-0.157
Rest-of-World price	0.262	0.105	0.420
GDP	0.062	-0.018	0.143
USB, QSSB, USSEC, and FAS export promotion	0.181	0.085	0.276

The export promotion expenditures funded through USSEC partnerships (USB, FAS & QSSB) had a positive and statistically significant impact on U.S. soybean import demand. Holding all other demand factors constant, a 1% increase in combined U.S. export promotion expenditures increased soybean import demand by 0.181%. Again, another way to view the estimated export promotion elasticity is in terms of its total impact on soybean import demand. That is, had there not been any U.S. soybean and soy product export promotion, U.S. soybean exports would have been 18.1% (0.181*100 = 18.1%) lower than they actually were over this period. The lower bound of the 95% confidence interval for export promotion was 0.085.

Soybean meal and soybean oil import demand. The estimated elasticities for the soybean meal and soybean oil import demand models are summarized in Tables 6 and 7. The explanatory variables explained 98% of the variations in U.S. soybean meal and soybean oil imports to the seven regions over the past 5-years. The elasticity signs were consistent with economic theory. For the soybean meal import demand equation, all estimated coefficients (except GDP and exchange rates) were statistically significant. For the soybean oil import demand equation, all estimated coefficients (except GDP and imports in previous year) were statistically significant. Several econometric diagnostic tests performed indicated no statistical problems with the model.

The estimated own price elasticity of U.S. soybean meal was statistically significant. Specifically, a 1% increase in the U.S. soybean meal price, holding all other factors constant, decreased soybean meal import quantity demanded by 0.36%. Competing country soybean meal price had a positive impact on U.S. soybean meal imports; a 1% increase in the ROW price increased U.S. soybean meal imports by 0.36%, holding all other demand drivers constant. The time trend term was negative for soybean meal imports. U.S. export promotion had a positive and statistically significant impact on soybean meal import demand. A 1% increase in soybean (and soy product) export promotion expenditures, holding all other import demand factors constant, increased soybean meal imports by 0.075%. Alternatively, had there not been any U.S. soybean export promotion, U.S. soybean meal imports would have been 7.5% lower than they actually were. The lower bound of the 95% confidence interval for export promotion of soybean meal import demand was 0.032.

The estimated own price elasticity of U.S. soybean oil was statistically significant. Specifically, a 1% increase in the U.S. soybean oil price, holding all other factors constant, decreased soybean oil import quantity demanded by 2.333%. Competing country soybean oil price had a positive impact on U.S. soybean oil imports; a 1% increase in the ROW price increased U.S. soybean oil imports by 0.636%, holding all other demand drivers constant. The U.S. to importing region exchange rate was the most important demand determinant for U.S. soybean oil imports. A 1% increase in the exchange rate reduced U.S. soybean oil import demand by 4.427%. A 1% increase in soybean (and soy product) export promotion expenditures, holding all other import demand factors constant, increased soybean oil imports by 0.401%. Alternatively, had there not been any U.S. soybean export promotion, U.S. soybean oil imports would have been 40% lower than they actually were. However, the lower bound of the 95% confidence interval for export promotion of soybean oil import demand was -0.019.

Table 6. Soybean meal import demand elasticities.

Import Demand Factor	Elasticity	95% lower bound conf interval	95% upper bound conf interval
Soybean meal imports in previous year	0.957	0.925	0.988
U.S. price	-0.360	-0.462	-0.256
Rest-of-World price	0.360	0.256	0. 462
Time trend	-0.096	-0.133	-0.058
USB and USSEC partnerships FAS & QSSB	0.075	0.032	0.117

Table 7. Soybean oil import demand elasticities.

Import Demand Factor	Elasticity	95% lower bound conf interval	95% upper bound conf interval
U.S. price	-2.333	-2.888	-1.580
Rest-of-World price	0.636	0.176	1.095
U.S. to region exchange rate	-4.427	-5.700	-2.986
USB and USSEC partnerships FAS & QSSB	0.401	-0.019	0.820

Simulation Model

The net benefits of each of the four USB activities were measured through simulation of the demand and supply functions estimated above using a marginal benefit-cost (BCR) analysis. That is, the endogenous variables in the model such as prices and quantities were simulated under two scenarios: (1) baseline scenario where all exogenous variables (e.g., USB domestic promotion expenditures) were set equal to historical levels, and (2) counterfactual scenario, where USB expenditures were decreased by 1% below their historical levels. The endogenous variables were then determined under both scenarios to determine the impact of a 1% decrease in expenditure levels on prices, quantities, and industry-wide producer net revenue. Then, a BCR was computed for each USB activity and for the overall effort of the USB. Full details for the simulation model are outlined in the Appendix of this report.

The model was simulated for the most recent 5-year period, 2019-2023. The focus here is on the marginal benefit-cost ratio, which is based on a small change (1%) between two equilibrium levels.

Simulation Results. How did the marginal benefits compare with the marginal costs? To answer this question, the following marginal BCR was computed for each USB activity:

$$BCR = \Delta NR / \Delta Costs$$

where: BCR was the marginal benefit-cost ratio, ΔNR was the change in net revenue (i.e., total soybean revenue minus total costs) associated with the 1% increase in the USB activity, and ΔCost was the respective 1% change in total costs. The interpretation of a marginal BCR is that it measures the net return of an *extra* dollar (i.e., at the margin) invested in promotion or research by the USB.

Table 8 lists the marginal BCRs for each USB (and QSSB, USSEC, and FAS) activity[7]. All activities had BCRs larger than 1.0 indicating the marginal benefits of each activity were larger than their marginal costs.

Domestic promotion had a marginal BCR of 4.50:1. In other words, an extra dollar invested in domestic soybean (soybean meal and soybean oil included) promotion returned $4.50 in net revenue to soybean producers. In the previous evaluation study, the estimated marginal BCR for domestic promotion was very similar at 4.41:1. Domestic expenditures on demand-enhancing activities had the largest impact of all activities. Specifically, this activity had a marginal BCR of 42.88:1. In other words, an extra $1 spent by the USB on demand-enhancing research 13 years ago returned $42.88 in net revenue to soybean producers in the current period. In the previous study, the marginal BCR estimated for demand enhancement research was significantly lower at 18.18:1. Production research had a marginal BCR of 5.78:1. That is, an extra dollar spent on production research 11-14 years ago increased producer net revenue by

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[7] The BCRs reported in Table 8 were not discounted, which was similar to the approach used in the previous evaluation studies. If a 7% discount rate is applied to the benefits and costs over the 5-year period, the BCRs fall by approximately 1.7%, which is not very different from these results. The 7% discount rate is the investment rate that is currently being used in discounted cost-benefit studies.

$5.78. In the previous report, production research had a higher marginal BCR of 9.42:1. U.S. soybean export promotion for soybeans had a marginal BCR of 14.26:1. In other words, an extra dollar invested in U.S. soybean export promotion returned $14.26 in net revenue to soybean producers. This is slightly lower than the marginal BCR in the previous report of 17.95:1. Overall, the combined marginal BCR for all USB/QSSB activities was 12.30:1, i.e., an extra dollar invested in all activities returned $12.30 in net revenue to the soybean industry. This was practically identical to the overall marginal BCR estimated in the previous study (12.34:1).

All these numbers presented were "point estimates," which were estimates rather than exact measures. That is, there is uncertainty about the precision of these estimates and therefore it was useful to construct confidence intervals around these point estimates. It was especially important to estimate the lower bound confidence interval for the BCR. Collectively, the lower bound 95% confidence interval for the marginal BCR was 4.95. In addition, all of the BCRs for the four individual activities are greater than one. Since the lower bound of this estimate was still substantially above one, this provided additional empirical evidence that the Soybean Checkoff Program has been a profitable venture for soybean producers.

Table 8. Marginal BCR for USB, QSSB, USSEC**,** and FAS activities.

USB/QSSB Marketing Activity	BCR 2019-23	95% Confidence Interval Lower Bound	BCR 2014-18
Domestic promotion	4.50	1.81	4.41
Demand-enhancing research	42.88	17.26	18.18
Production research	5.78	2.33	9.42
Foreign market development	14.26	5.74	17.95
All activities combined	12.30	4.95	12.34

How does the estimated overall BCR for the USB compare to that of other promotion checkoff programs? Table 9 lists the estimated BCRs for selected food commodities.[8] The BCRs range in value from a low of 1.7 for California avocados to a high of 32.08 for watermelon promotion. The overall BCR for USB marketing/research of 12.30 was significantly higher than the overall median of all BCRs in Table 9 (7.10).

[8] In this table, some of the BCRs are marginal and some are average. A marginal BCR, which is used in this study, is interpreted as the return at the margin, i.e., the net revenue return on an *extra* dollar invested in the promotion activity. An average BCR gives the return in net revenue, on average, for each dollar invested in promotion.

Table 9. Estimated BCRs for Selected Commodities.

Author(s)		Average BCR	Marginal BCR
Alston et al. (1998)	California Dried Plums	NA	2.70
Crespi and Sexton (2005)	California Almonds	NA	6.20
Kaiser (2022)	Tart Cherries	2.05	NA
Kaiser (2021)	Cranberries	7.70	NA
Schmit et al (1997)	California Eggs	NA	6.90
Carman and Craft (1998)	California Avocados	5.00	1.70
Williams et al. (2004)	Florida Orange Juice	5.00	NA
USDA (2020)	All Dairy	4.78	NA
USDA (2020)	Fluid Milk	3.37	NA
USDA (2020)	Cheese	3.63	NA
USDA (2020)	Butter	15.67	NA
USDA (2020)	Dairy Exports	6.74	NA
Kaiser (2019)	Beef	NA	11.91
Kaiser (2021)	Pork	NA	27.57
Kaiser (2020)	Blueberries	NA	18.74
Murray et al. (2001)	Cotton	4.50	NA
Kaiser (2021)	Walnuts	11.62	NA
Kaiser (2019)	Peanuts	NA	9.74
Kaiser et al. (2012)	Raisins	9.95	NA
Kaiser (2022)	Pears	NA	4.80
Ward (2008)	Honey	6.80	NA
Capps and Williams (2015)	Lamb	NA	7.10
Kaiser (2017)	Watermelons	32.08	NA
Richards and Patterson (2007)	Potatoes	6.50	NA
Kaiser (2019)	Soybeans	NA	12.34
Median		6.50	7.10

U.S. Economy-Wide Input-Output Model

The promotion/research activities conducted by the USB and QSSBs benefited a range of stakeholders beyond soybean producers that fund the activities. For example, local agricultural input suppliers benefited from additional purchases of inputs, and local workers benefited from higher wages and/or more jobs. Federal, state and local governments also benefited from the extra tax revenue associated with soybean producers' incremental earnings due to the Soybean Checkoff Program. To quantify these benefits, an "input-output" model of the U.S. economy was used to simulate the macroeconomic impacts of two scenarios regarding USB and QSSB promotion/research activities: (1) baseline scenario as described above, and (2) a "no Soybean Checkoff Program" scenario, where total soybean producer revenue without the checkoff was simulated. The difference in these two scenarios provided a measure of the total revenue impact of the Soybean Checkoff Program on the soybean sector and its indirect effect on the general economy.

Indirect and Induced Effect Results

What were the total direct impacts of the Soybean Checkoff Program to the soybean industry? We measured this as the total soybean producer revenue accruing to the industry because of the checkoff activities. This can be computed by taking the change in total revenue due to the checkoff:

$$\Delta TR = P(Q - Q'),$$

where P was the soybean price (P), Q was soybean commercial domestic disappearance and exports with the USB and QSSBs from the baseline scenario, and Q´ was simulated soybean commercial disappearance and exports (Q´) for the counterfactual without the USB and QSSBs' promotion and research. Commercial domestic disappearance of soybeans was computed to be 9.2% lower without the Soybean Checkoff Program than it actually was. Exports to the seven countries/regions were computed to be 18.1% lower without the USB/QSSBs (and FAS) than they actually were. Applying these percentages to average commercial disappearance and exports to the seven countries from 2019-23, total revenue to the soybean industry would have been $4.75 billion per year lower had there not been Soybean Checkoff Program in the past 5 years. The $4.75 billion incremental amount due to the checkoff was achieved by higher sales volume domestically (9.5%) and higher export volume (18.1%) due to the USB/QSSB marketing and research activities. This is the *direct effect* of the Soybean Checkoff Program on the soybean sector.

As previously mentioned, USB/QSSB marketing/research activities benefited a range of stakeholders beyond soybean producers that fund these activities, e.g., local input suppliers, seed, fertilizer and pesticide purchases, and local workers benefit from either higher wages or more harvesting and post-harvest processing jobs. Each of these relationships can be summarized in an "input-output model" that contains data on the technical relationships between each input supply industry, the outputs for the industry in question (incremental total revenue due to marketing and research by the Soybean Checkoff Program), and broader macroeconomic outputs such as employment, labor income, value-added, and GDP.

Here we used the most recent version of IMPLAN to simulate the direct and indirect impacts of the USB/QSSB domestic and international activities. The direct domestic impact of the USB/QSSBs was the average annual incremental increase in industry-wide total revenue due to their promotion/research activities. In the simulation results presented above, this amounted to an incremental increase in total revenue of $4.75 billion per year from these activities.

Accordingly, the $4.75 billion was inputted into the IMPLAN model as the direct effect of the USB/QSSBs to compute the broader economy-wide effects in the U.S. Using 2023 as a base year, the IMPLAN model was solved to determine the indirect, induced, and total effects of the combined impact of the USB/QSSBs (and FAS and USSEC) activities. Recall that the "direct" effect is the incremental increase in industry-wide total revenue to soybean producers. The indirect effects are the impacts beyond the direct effect to the general economy, and IMPLAN divides them into two effects: "indirect" and "induced." The indirect effects were changes in inter-industry transactions as supplying industries responded to increased demand from the directly affected industries. For example, the increase in soybean sales volume due to USB/QSSB activities led to increased purchases of inputs and services from soybean producers, and the indirect effect of IMPLAN captured this. The induced effects reflected changes in local spending that result from income changes in the directly and indirectly affected industry sectors. The increase in money circulated to the local community had a multiplier effect that enhanced the local economy.

The results showed that the domestic and export market activities by the USB/QSSBs had substantial impacts on the general economy as illustrated in Table 10. This table displays the detailed impacts of the USB/QSSBs activities on employment numbers, employment income, value added (a measure of the incremental profit generated not only for soybean producers, but for input suppliers, packers, and wage-earners as well), and total economic output (measured as GDP). The direct effect of the USB/QSSBs adding an incremental $4.75 billion to the soybean industry had positive spillover effects to the general economy, including:

- Increasing U.S. employment by almost 30,932 people.
- Increasing U.S. employment income by $2.6 billion.
- Increasing total value added by $5.9 billion in the U.S.
- Increasing U.S. GDP by over $9.8 billion.

In addition, the existence of the USB/QSSBs also increased tax revenue at the federal, state, and local levels. In 2023, this amounted to $36 million in county tax revenue, $244 million in state tax revenue, and $655 million in federal tax revenue for a grand total of a little under $1 billion in total tax revenue.

Table 10. Direct, Indirect, Induced, and Total Effects of all USB/QSSB Activities in the U.S.

Impact Type	Employment (number)	Labor Income (mil $)	Total Value Added (mil $)	GDP (mil $)
Direct Effect	6,849	1,111	3,132	4,750
Indirect Effect	11,788	704	1,303	2,500
Induced Effect	12,295	803	1,462	2,592
Total Effect	30,932	2,618	5,897	9,842

Appendix 1. Econometric Models

This Appendix presents the complete econometric output for all supply and demand models used in this study, describes the simulation model used to compute the average return-on-investment (BCR), and the macroeconomic input-output model. For the domestic demand side, the three econometric equations included: (1) farm-level domestic soybean demand, (2) wholesale soybean meal demand, and (3) wholesale soybean oil demand. On the supply side, a soybean supply function was estimated. In addition, three econometric equations were estimated for U.S. soybean imports from other countries: (1) import demand function for U.S. soybeans, (2) import demand function for U.S. soybean meal, and (3) import demand function for U.S. soybean oil. In the output that follows, LOG is the natural logarithmic operator.

To address the potential problem of price endogeneity, an endogeneity test was performed on the own prices in the demand equations, which consisted of the following. First, the own price was regressed on all other explanatory variables in the demand equation. The residuals from this regression were then included in the original demand equation, and a t-test on the estimated coefficient on this residual term was used to test the null hypothesis that the own price was exogenous. For all cases, the t-value for the coefficient for the residual term was not statistically significant. Therefore, the null hypothesis of exogenous price could not be rejected. Accordingly, ordinary least squares regression was used to estimate all models.

Three different functional forms were estimated: (1) double logarithmic, (2) semi-logarithmic, and (3) linear functional forms. The double logarithmic form fit the data the best and resulted in the most statistical significance for the explanatory variables.

The import demand equations for U.S. whole soybeans, soybean meal, and soybean oil were estimated using country/region fixed effects. This approach was used in the previous evaluation study because it resulted in the best statistical fit of all models estimated.

The following regression outputs list all the estimation results and diagnostics including R-squared, adjusted R-squared, log likelihood, Akaike info criterion, Schwarz criterion, Hannan-Quinn criterion, Durbin-Watson statistic, and Wald F-statistic.

Domestic Soybean Demand

The soybean demand equation is estimated in logarithmic form, with annual data from 1980-2023, and had the following econometric results:

Dependent Variable: LOG(QSB)
HAC standard errors & covariance (Bartlett kernel, Newey-West fixed bandwidth = 4.0000)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CONSTANT	-9.084705	1.307856	-6.946257	0.0000
LOG(PSB/CPI)	-0.170104	0.048368	-3.516872	0.0016
LOG(QPORK+QMILK)	1.272283	0.118039	10.77852	0.0000
LOG(DEMRES(-13)/CPI(-13))	0.067384	0.029036	2.320716	0.0284
PDL01	0.020698	0.004740	4.366176	0.0002

R-squared	0.955446	Mean dependent var	8.067589
Adjusted R-squared	0.948591	S.D. dependent var	0.220163
S.E. of regression	0.049919	Akaike info criterion	-3.010154
Sum squared resid	0.064789	Schwarz criterion	-2.778866
Log likelihood	51.65739	Hannan-Quinn criter.	-2.934760
F-statistic	139.3892	Durbin-Watson stat	1.740200
Prob(F-statistic)	0.000000	Wald F-statistic	251.5544
Prob(Wald F-statistic)	0.000000		

Lag Distribution of LOG(1000+PROMOTOTAL/CPI)	i	Coefficient	Std. Error	t-Statistic
. *|	0	0.01380	0.00316	4.36618
. *|	1	0.01380	0.00316	4.36618
	Sum of Lags	0.02760	0.00632	4.36618

In this table, QSB is domestic commercial disappearance of soybeans in million bushels, PSB is the soybean price per bushel (no endogeneity detected), CPI is the Consumer Price Index for all items, QPORK is U.S. pork production, QMILK is U.S. milk production, DEMRES is USB plus QSSB expenditures on demand-enhancing research, and PROMOTOTAL is USB and QSSB soybean, soybean oil, and soybean meal promotion expenditures. The model with the best result had the following lag structures. For USB promotion, expenditures on current year, one-year lag, and two-year lag had the best fit. For demand-enhancing research, USB expenditures lagged 13 years resulted in the best fit. Since the log of zero is undefined, and there are zero values for some promotion and research years, a small number ($10) is added to these variables.

Soybean Supply

The soybean supply equation was estimated in logarithmic form, with annual data from 1980-2023, and had the following econometric results:

Dependent Variable: LOG(PRODUCTION)
HAC standard errors & covariance (Bartlett kernel, Newey-West fixed bandwidth = 4.0000)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CONSTANT	4.612901	0.464498	9.930940	0.0000
LOG(PCORN(-1)/IPP(-1))	-0.399247	0.096137	-4.152881	0.0004
LOG(TREND)	0.533512	0.050790	10.50418	0.0000
PDL01	0.300673	0.094599	3.178397	0.0040
PDL02	-0.107612	0.037398	-2.877514	0.0083
PDL03	-0.069542	0.063729	-1.091222	0.2860
PDL04	0.036599	0.026025	1.406302	0.1725

R-squared	0.901324	Mean dependent var	8.061426
Adjusted R-squared	0.876655	S.D. dependent var	0.229138
S.E. of regression	0.080475	Akaike info criterion	-2.006070
Sum squared resid	0.155428	Schwarz criterion	-1.682267
Log likelihood	38.09409	Hannan-Quinn criter.	-1.900519
F-statistic	36.53668	Durbin-Watson stat	2.033642
Prob(F-statistic)	0.000000	Wald F-statistic	43.40680
Prob(Wald F-statistic)	0.000000		

Lag Distribution of LOG(PSB(-1)/IPP(-1))	i	Coefficient	Std. Error	t-Statistic
. *|	0	0.19306	0.05784	3.33770
. * |	1	0.17090	0.04646	3.67811
* . |	2	-0.06649	0.06912	-0.96197
	Sum of Lags	0.29747	0.09019	3.29819

Lag Distribution of LOG(PRODRES(-11)/CPI(-11))	i	Coefficient	Std. Error	t-Statistic
* . |	0	-0.03294	0.03792	-0.86875
.* |	1	0.00731	0.02601	0.28107
. *|	2	0.12076	0.04790	2.52099
	Sum of Lags	0.09513	0.04125	2.30643

In the table, PRODUCTION is annual soybean production, PSB(-1) is the soybean price lagged one period, IPP(-1) is the index of prices paid by crop farmers lagged one period, PCORN(-1) is the corn price lagged one period, TREND is a trend term, and PRODRES(-11) is USB and QSSB production research expenditures lagged 11 years. A lag length of 11 years for research expenditures had the best statistical fit. A distributed lag model for the expected soybean to IPP ratio is estimated, and the best lag structure is current, one-year lagged, and two-year lagged price ratios.

Domestic Soybean Meal Demand

The soybean meal demand equation was estimated in logarithmic form, with annual data from 1980-2023, and had the following econometric results:

Dependent Variable: LOG(QMEAL)
Huber-White-Hinkley (HC1) heteroskedasticity consistent standard errors and covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(QMEAL(-1))	0.303095	0.107966	2.807310	0.0084
LOG(PMEAL/CPI)	-0.157347	0.038290	-4.109317	0.0003
LOG(QPORK1+QMILK)	0.551625	0.084404	6.535553	0.0000
LOG((DEMRES(-8)+PROMOTOTAL(-1)+10)/CPI(-8))	0.059331	0.012657	4.687633	0.0000

R-squared	0.966330	Mean dependent var	10.58511
Adjusted R-squared	0.963174	S.D. dependent var	0.196523
S.E. of regression	0.037713	Akaike info criterion	-3.613184
Sum squared resid	0.045513	Schwarz criterion	-3.437238
Log likelihood	69.03732	Hannan-Quinn criter.	-3.551774
Durbin-Watson stat	1.917019		

In the table, QMEAL is annual soybean meal domestic commercial disappearance, QMEAL(-1) is annual soybean meal domestic commercial disappearance in the previous year, PMEAL is the wholesale price for soybean meal (no endogeneity detected), and all other variables are previously defined. USB plus QSSB demand-enhancing research expenditures lagged 8 years had the best statistical fit. USB plus QSSB expenditures for soybean, soybean meal, and soybean oil promotion expenditures lagged one year had the best statistical fit.

Domestic Soybean Oil Demand

The soybean oil demand equation was estimated in logarithmic form, with annual data from 1980-2023, and had the following econometric results:

Dependent Variable: LOG(QOIL)
HAC standard errors & covariance (Bartlett kernel, Newey-West fixed bandwidth = 4.0000)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CONSTANT	1.177640	0.439523	2.679360	0.0117
LOG(QOIL(-1))	0.781478	0.076974	10.15254	0.0000
LOG(POILF/CPI)	-0.201989	0.133253	-1.515833	0.1397
LOG(PROMOOIL+10/CPI)	0.004256	0.001925	2.211289	0.0345
LOG(DEMRES(-8)/CPI(-8))	0.054300	0.026389	2.057672	0.0481

R-squared	0.942710	Mean dependent var	9.850956
Adjusted R-squared	0.935318	S.D. dependent var	0.211177
S.E. of regression	0.053708	Akaike info criterion	-2.882266
Sum squared resid	0.089421	Schwarz criterion	-2.662333
Log likelihood	56.88079	Hannan-Quinn criter.	-2.805504
F-statistic	127.5267	Durbin-Watson stat	2.396977
Prob(F-statistic)	0.000000	Wald F-statistic	400.9854
Prob(Wald F-statistic)	0.000000		

In this table, QOIL is annual soybean oil domestic commercial disappearance, QOIL(-1) is annual soybean oil domestic commercial disappearance in the previous year, POILF is the fitted value of the instrument for the wholesale price for soybean oil, SUNFLOWERP is the sunflower price, FLAXSEEDP is the flaxseed price, and all other variables are previously defined. USB demand-enhancing research expenditures lagged 11 years had the best statistical fit. A distributed lag model for soybean, soybean meal, and soybean oil promotion expenditures with current, one-year lag, and two-year lag had the best statistical fit. Since the log of zero is undefined, and there are zero values for some promotion and research years, a small number ($100) is added to these variables.

Import Demand for U.S. Soybeans

The soybean import demand equation was estimated in linear form, with panel data from 2014-2023 for seven importing regions, and had the following econometric results:

Dependent Variable: LOG(QUSB)
Linear estimation after one-step weighting matrix
White cross-section (period cluster) standard errors & covariance (no d.f. correction)
Standard error and t-statistic probabilities adjusted for clustering

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CONSTANT	2.939657	1.102529	2.666286	0.0285
LOG(QUSB(-1))	0.663223	0.100593	6.593143	0.0002
LOG(PSB/CPI)	-0.458362	0.150730	-3.040948	0.0160
LOG(ROWPSB/CPI)	0.262160	0.078568	3.336721	0.0103
LOG(GDP)	0.062314	0.040143	1.552285	0.1592
LOG((PROMO)/CPI)	0.180518	0.047626	3.790292	0.0053

Weighted Statistics

R-squared	0.771052	Mean dependent var	22.26659
Adjusted R-squared	0.750969	S.D. dependent var	9.339711
S.E. of regression	0.311914	Sum squared resid	5.545554
F-statistic	38.39305	Durbin-Watson stat	1.942065
Prob(F-statistic)	0.000000		

Unweighted Statistics

R-squared	0.691730	Mean dependent var	15.13295
Sum squared resid	7.200288	Durbin-Watson stat	1.464471

In this table, QUSB is import volume of U.S. soybeans to each importing region, QUSB(-1) is import volume of U.S. soybeans to each importing region in previous period, PUSB is the U.S. soybean price, ROWPSB is the rest-of-the-world soybean price, GDP is real Gross Domestic Product in the importing region, PROMO is U.S. soybean export expenditures in the importing region, and CPI is the Consumer Price Index for all items in the importing region.

Import Demand for U.S. Soybean Meal

The soybean meal import demand equation was estimated in logarithmic form, with panel data from 2014-20123 for seven importing regions, and had the following econometric results:

Dependent Variable: LOG(QUSMEAL)
Method: Panel EGLS (Cross-section SUR)
Linear estimation after one-step weighting matrix
White cross-section (period cluster) standard errors & covariance (no d.f. correction)
Standard error and t-statistic probabilities adjusted for clustering

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(QUSMEAL(-1))	0.956479	0.015876	60.24516	0.0000
LOG(PUSMEAL/ROWPMEAL)	-0.358991	0.051585	-6.959266	0.0001
LOG(PROMO/CPI)	0.074625	0.021350	3.495232	0.0081
LOG(TREND)	-0.095481	0.018867	-5.060676	0.0010

Weighted Statistics

R-squared	0.980790	Mean dependent var	121.6137
Adjusted R-squared	0.979814	S.D. dependent var	189.5029
S.E. of regression	1.018582	Sum squared resid	61.21307
Durbin-Watson stat	2.197985		

Unweighted Statistics

R-squared	0.934927	Mean dependent var	13.70897
Sum squared resid	8.239969	Durbin-Watson stat	2.308612

In this table, QUSMEAL is import volume of U.S. soybean meal to each importing region, PUSMEAL is the U.S. soybean meal price, ROWPMEAL is the soybean meal price from the rest-of-the-world, TREND is a trend term, and all other variables are as previously defined.

Import Demand for U.S. Soybean Oil

The soybean oil import demand equation was estimated in logarithmic form, with panel data from 2014-2023 for seven importing regions, and had the following econometric results:

Dependent Variable: LOG(QUSOIL)
Method: Panel EGLS (Cross-section weights)
Linear estimation after one-step weighting matrix
White diagonal standard errors & covariance (no d.f. correction)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CONSTANT	28.07856	3.256519	8.622261	0.0000
LOG(PUSOIL/CPI)	-2.233585	0.327148	-6.827437	0.0000
LOG(ROWPOIL/CPI)	0.635488	0.229853	2.764763	0.0076
LOG(ER)	-4.342622	0.678074	-6.404349	0.0000
LOG(PROMO/CPI)	0.400607	0.209489	1.912309	0.0607

Effects Specification

Cross-section fixed (dummy variables)

Weighted Statistics

R-squared	0.934589	Mean dependent var	15.62976
Adjusted R-squared	0.923502	S.D. dependent var	11.01363
S.E. of regression	1.069707	Sum squared resid	67.51217
F-statistic	84.29887	Durbin-Watson stat	1.768583
Prob(F-statistic)	0.000000		

Unweighted Statistics

R-squared	0.877850	Mean dependent var	9.978567
Sum squared resid	76.41709	Durbin-Watson stat	1.770322

In this table, QUSOIL is import volume of U.S. soybean oil to each importing region, PUSOIL is the U.S. soybean oil price, ROWPOIL is the soybean oil price from the rest-of-the-world, ER is the U.S. to region exchange rate, and all other variables are as previously defined.

Appendix 2. Simulation Models for Average Benefit-Cost Analysis

The simulation model was used to compute a marginal BCR for USB demand- and supply-enhancing activities. In order to evaluate the full effect of the USB's marketing/research programs on quantity and price, we needed to incorporate the supply response of soybeans into the model. To do this, we use the computed own price elasticity of supply from the estimated soybean supply equation, which was equal to 0.30. We then used the demand equation for soybeans domestically and the import demand equation to evaluate foreign market development performance.

The simulation procedure for computing the marginal BCR began on the demand side, where predicted quantities of soybean demand (Q_t^D) were estimated from the soybean demand equation. Then, using a procedure similar to that in Alston et al. (1996), supply was defined in constant elasticity form and equated with the predicted demand quantities. Changes in demand due to USB marketing and research then affected the level of production and the resulting farm price. Specifically, the supply function was defined as:

(1) $Q_t^S = A_t P_t$

where $A_t = Q_t^D / P_t$ and P_t was the farm soybean price. The defined value, A_t, varied by year and ensured that, given the actual values of prices and other variables, the supply equation passed through the quantity defined by Q_t^D. This made possible the combining of the supply response and estimated demand model to simulate past retail prices and quantities.

Given the simulation procedures described above, the change in net economic benefits due to the USB marketing/research was computed for each year from 2019 to 2023 as the difference in net revenue (i.e., net revenue) between the following two scenarios: (1) historic or baseline scenario with USB marketing/research expenditures set to actual levels, and (2) marginally reduced USB scenario, where USB marketing/research expenditures were 1% lower than the actual expenditures. The difference between the baseline and 1% reduced USB expenditures scenarios provided a measure of the marginal impact of the USB marketing-research spending, i.e., how an extra dollar spent impacted the market.

The change in net revenue was computed as follows:

(2) $\Delta NR_t = (P_t Q_t – P'_t Q'_t) M_t$,

where $P_t Q_t$ represented total revenue (soybean price per bushel times quantity sold) to soybean producers for the baseline scenario with 100% USB marketing/research expenditures, $P_t' Q_t'$ represented total revenue to soybean producers for the 1% reduced funding scenario (with USB marketing/research expenditures reduced by 1%), and M_t represents a net margin factor for soybean producers which translated total gross revenue into net revenue (net of all costs). Using USDA costs and returns data for soybeans, the average net margin factor computed for 2013-2022 was 0.0477, i.e., total revenue per acre exceeded total costs by 4.77%, on average, since 1997.

A marginal benefit-cost ratio was computed and was equal to:

(3) $BCR = \Sigma \Delta NR_t / \Sigma \Delta Cost_t$

where: BCR is benefit-cost ratio, ΔNR_t was as defined above and $\Delta Cost_t$ was equal to a 1% change in cost of the USB spending on marketing/research. The change in net revenue and change in costs were summed over the period 2019 through 2023. This computation was done separately for domestic promotion, demand-enhancing research, and production-enhancing research by USB and the QSSBs.

Identical procedures were done for generating the average BCR for foreign market development in the import demand model. Two scenarios were run: (1) baseline with historical spending by USB and FAS, and (2) 1% reduced-export promotion scenario, where export promotion by USB and FAS was reduced by 1%. Unfortunately, there was no available estimate of the U.S. soybean export supply price elasticity. Since a domestic soybean supply function was estimated in this study, the own price elasticity of supply from that equation was used for the export supply response. In this case, the value is 0.3, meaning that an increase in the export price of 1% increased U.S. exports by 0.3%, holding all other factors constant. In addition, since FAS has historically contributed about 25% of total U.S. soybean export promotion expenditures, the costs in the benefit-cost ratio were reduced by 25% to reflect only soybean producer contributions.

Annual Data Used in Domestic Demand and Supply Models

YEAR	CPI ALL ITEMS 1980-82=100	DEMAND RESEARCH $	INDEX PRICES OF PRICES PAID CROP SECTOR 2011=100	CORN PRICE $/BU.	SOY MEAL PRICE $/TON	SOY OIL PRICE $/TON	PORK PRODUCTION MIL. LBS
1980	82.4	1,806,685	36.8	3.11	235.13	22.73	14,699
1981	90.9	2,930,318	39.5	2.50	196.62	18.95	16,006
1982	96.5	2,707,664	40.9	2.55	200.94	20.62	14,422
1983	99.6	2,764,231	40.8	3.21	203.21	30.55	13,223
1984	103.9	3,527,494	41.5	2.63	136.40	29.52	14,331
1985	107.6	2,749,542	40.3	2.23	166.20	18.02	11,779
1986	109.7	3,038,733	38.5	1.50	177.31	15.36	12,688
1987	113.6	2,889,195	39.4	1.94	239.35	22.67	13,248
1988	118.3	3,499,859	42.1	2.54	252.40	21.09	13,393
1989	123.9	2,924,890	44.3	2.36	186.48	22.28	15,451
1990	130.7	3,095,264	45.7	2.28	181.38	20.98	16,617
1991	136.2	3,026,414	47.1	2.37	189.21	19.13	15,873
1992	140.3	2,320,900	48.0	2.07	193.75	21.24	14,229
1993	144.5	2,643,829	48.8	2.50	192.86	26.96	15,199
1994	148.2	3,245,978	50.5	2.26	162.60	27.51	14,812
1995	152.4	5,643,879	52.9	3.24	235.90	24.70	14,807
1996	156.9	7,203,995	55.0	2.71	270.90	22.51	14,063
1997	160.5	10,461,573	56.3	2.43	185.30	25.83	14,374
1998	163.0	10,239,177	55.6	1.94	138.55	19.80	15,684
1999	166.6	9,635,796	55.3	1.82	167.70	15.59	15,813
2000	172.2	7,830,672	57.1	1.85	173.61	14.09	15,354
2001	177.0	7,808,590	58.9	1.97	167.72	16.46	15,999
2002	179.9	7,983,473	59.1	2.32	181.58	22.04	17,233
2003	184.0	9,073,910	61.3	2.42	256.05	29.97	17,088
2004	188.9	10,720,335	64.1	2.06	182.90	23.01	17,696
2005	195.3	10,457,819	68.6	2.00	174.17	23.41	17,849
2006	201.6	11,102,817	73.0	3.04	205.44	31.02	17,118
2007	207.3	14,509,786	78.2	4.20	335.94	52.03	17,274
2008	215.3	13,509,533	90.6	4.06	331.17	32.16	19,010
2009	214.6	14,462,107	88.2	3.55	311.27	35.95	19,308
2010	218.1	15,206,730	91.0	5.18	345.52	53.20	18,952
2011	224.9	19,732,492	100.0	6.22	395.53	51.90	19,162
2012	229.6	8,283,765	102.8	6.89	468.11	47.13	19,685
2013	233.0	17,274,371	104.5	4.46	489.94	38.23	19,966
2014	236.7	21,048,577	108.1	3.70	368.49	31.60	20,529
2015	237.0	16,391,498	109.2	3.61	324.56	29.86	20,704
2016	240.0	9,881,323	106.6	3.36	316.88	32.55	21,074
2017	245.1	12,700,469	108.0	3.36	345.02	30.04	21,962
2018	251.1	12,267,189	110.7	3.61	308.28	28.26	23,367
2019	255.7	9,928,231	111.2	3.56	299.50	29.65	27,616
2020	258.8	18,339,059	111.1	4.53	392.31	56.87	28,303
2021	271.0	13,564,758	119.7	6.00	439.81	72.98	27,675
2022	292.7	16,132,386	139.3	6.54	451.91	65.26	26,996
2023	304.7	27,141,447	138.7	4.80	380.00	51.00	27,011

Annual Data Used in Domestic Demand and Supply Models

YEAR	PRODUCTION RESEARCH EXPENDITURES $	SOYBEAN PRODUCTION MIL. BU.	SOY MEAL PROMOTION $	SOY OIL PROMOTION $	SOYBEAN PROMOTION $	TOTAL SOY PROMOTION $	SOYBEAN PRICE $/BU.
1980	4,423,262	1,798	0	0	0	0	7.60
1981	7,174,226	1,989	0	0	0	0	6.07
1982	6,629,108	2,190	0	0	0	0	5.71
1983	6,767,600	1,636	0	0	0	0	7.83
1984	8,636,277	1,861	0	0	0	0	5.84
1985	6,731,637	2,099	0	0	0	0	5.05
1986	7,439,656	1,943	0	0	0	0	4.78
1987	7,073,547	1,938	0	0	0	0	5.88
1988	8,568,621	1,549	0	0	0	0	7.42
1989	7,160,938	1,924	0	0	0	0	5.69
1990	7,578,059	1,926	0	0	0	0	5.74
1991	7,409,498	1,987	0	0	0	0	5.58
1992	5,682,202	2,190	0	0	0	0	5.56
1993	6,472,822	1,870	0	0	0	0	6.40
1994	7,947,050	2,515	405,700	864,589	0	1,270,289	5.48
1995	13,817,773	2,174	3,203,477	3,886,338	174,877	7,264,693	6.72
1996	17,637,367	2,380	4,172,474	5,851,009	742,244	10,765,727	7.35
1997	25,612,817	2,689	5,882,777	9,313,341	248,916	15,445,033	6.47
1998	25,068,330	2,741	8,509,526	3,679,668	234,581	12,423,775	4.93
1999	23,591,087	2,654	7,249,012	6,019,488	88,619	13,357,119	4.63
2000	19,171,645	2,758	3,455,488	3,724,598	33,115	7,213,201	4.54
2001	19,117,583	2,891	6,427,846	754,174	1,749,205	8,931,225	4.38
2002	19,545,744	2,756	4,822,865	2,216,413	4,494,681	11,533,959	5.53
2003	22,215,434	2,454	5,841,848	4,964,740	251,330	11,057,918	7.34
2004	26,246,338	3,124	7,486,845	3,209,289	2,374,178	13,070,312	5.74
2005	25,603,627	3,068	8,452,670	4,334,584	1,332,422	14,119,676	5.66
2006	27,182,760	3,197	4,708,088	4,330,336	1,911,558	10,949,983	6.43
2007	35,523,958	2,677	7,303,630	6,438,762	3,609,808	17,352,200	10.10
2008	33,075,064	2,967	9,595,046	7,373,331	5,721,706	22,690,083	9.97
2009	35,407,227	3,361	9,605,816	8,158,999	4,847,568	22,612,383	9.59
2010	37,230,271	3,331	11,764,630	9,155,535	3,921,653	24,841,817	11.30
2011	48,310,583	3,097	18,696,884	9,312,677	3,683,773	31,693,334	12.50
2012	16,168,490	3,042	6,845,060	465,130	14,062,838	21,373,028	14.40
2013	17,518,429	3,357	9,232,095	21,669,790	14,418,346	45,320,230	13.00
2014	22,579,431	3,928	5,689,494	16,344,371	5,212,494	27,246,360	10.10
2015	22,225,273	3,927	13,407,142	18,716,036	6,490,843	38,614,021	8.95
2016	18,826,558	4,296	12,201,685	51,402,071	5,656,023	69,259,779	9.47
2017	14,113,340	4,412	8,877,746	17,548,641	1,292,044	27,718,432	9.33
2018	8,073,713	4,428	10,875,660	60,042,038	5,501,184	76,418,882	8.48
2019	12,991,348	3,552	23,517,443	41,272,092	18,117,917	82,907,452	8.57
2020	30,579,759	4,216	13,718,916	24,145,157	18,424,387	56,288,460	10.80
2021	26,211,701	4,464	15,840,697	23,308,106	20,379,928	59,528,731	13.30
2022	28,367,425	4,270	14,278,481	26,044,077	17,954,403	58,276,962	14.20
2023	31,544,026	4,165	12,816,578	24,578,142	37,902,200	75,296,920	12.65

Annual Data Used in Domestic Demand and Supply Models

YEAR	SOYBEAN COMMERCIAL DISAPPEAR MIL. BU.	SOY MEAL COMMERCIAL DISAPPEAR 1000 SHORT TONS	MILK PRODUCTION BIL. LBS.	SOY OIL COM DISAPP 1,000 SHORT TONS	POULTRY PRODUCTION MIL. LBS.	REAL DISPOSABLE INCOME BIL 2017 $	TREND #
1980	1,843	24,375	128,406	10,744	14,155	5,202	1
1981	2,048	24,622	132,770	11,613	14,973	5,322	2
1982	2,100	26,415	135,505	11,882	15,054	5,438	3
1983	1,805	22,975	139,588	11,403	15,453	5,632	4
1984	1,721	24,397	135,351	11,576	16,088	6,009	5
1985	1,880	25,126	143,012	11,311	16,871	6,194	6
1986	2,042	27,730	143,124	12,020	17,929	6,430	7
1987	2,073	28,147	142,709	12,801	19,772	6,548	8
1988	1,673	24,940	145,034	12,252	20,588	6,879	9
1989	1,868	27,610	143,893	13,435	22,039	7,079	10
1990	1,839	28,408	147,721	12,944	23,636	7,225	11
1991	2,040	29,955	147,697	13,892	24,885	7,286	12
1992	2,179	30,484	150,885	14,473	26,398	7,576	13
1993	1,959	30,644	150,636	14,471	27,539	7,699	14
1994	2,395	33,266	153,602	15,597	29,346	7,909	15
1995	2,330	32,638	155,292	14,457	30,644	8,169	16
1996	2,441	34,333	154,006	16,300	32,289	8,423	17
1997	2,626	38,234	156,091	18,341	33,258	8,724	18
1998	2,596	37,796	157,262	18,024	33,667	9,238	19
1999	2,716	37,700	162,589	17,434	35,590	9,537	20
2000	2,804	39,350	167,393	17,719	36,427	10,004	21
2001	2,933	40,583	165,332	19,352	37,343	10,297	22
2002	2,791	38,388	170,063	19,344	38,500	10,614	23
2003	2,525	36,619	170,348	17,802	38,902	10,884	24
2004	2,986	40,902	170,832	18,763	40,022	11,233	25
2005	2,878	41,243	176,931	19,112	41,386	11,365	26
2006	3,081	43,159	181,782	20,451	41,686	11,778	27
2007	3,056	42,474	185,654	21,246	42,608	12,054	28
2008	3,047	39,249	189,978	18,459	43,713	12,244	29
2009	3,363	41,800	189,202	19,173	41,674	12,273	30
2010	3,282	39,382	192,877	19,777	43,058	12,505	31
2011	3,159	41,302	196,255	19,974	43,514	12,775	32
2012	3,111	40,145	200,642	20,951	43,523	13,126	33
2013	3,477	41,092	201,260	20,785	44,159	12,937	34
2014	3,863	45,384	206,048	20,974	44,842	13,384	35
2015	3,944	45,063	208,508	22,405	46,197	13,908	36
2016	4,214	44,995	212,451	22,418	47,226	14,172	37
2017	4,297	49,554	215,527	23,823	48,178	14,614	38
2018	3,971	49,650	217,568	24,815	49,018	15,144	39
2019	3,952	51,800	218,441	25,154	50,251	15,609	40
2020	4,504	51,350	223,309	25,046	50,876	16,603	41
2021	4,464	52,499	226,293	24,827	50,995	17,123	42
2022	4,270	53,065	226,416	26,614	51,428	16,117	43
2023	4,165	54,725	226,551	27,200	51,838	16,796	44

Panel Data Used in Import Demand Models

REGION	YEAR	CHINA TARIFF 0 OR 1	COVID19 0 OR 1	CPI FOR ALL ITEMS 2015=100	REAL EXCHANGE RATE	GDP 2017 $ BIL.	US PRICE SOY MEAL $/TON
GREATER CHINA China + Taiwan	2014	0	0	98.6	6.6	10,861	528.37
	2015	0	0	100.0	6.7	11,596	405.86
	2016	0	0	102.0	7.0	12,365	379.93
	2017	0	0	103.6	7.1	13,204	355.94
	2018	1	0	105.7	7.0	14,073	379.11
	2019	1	0	108.8	7.3	14,913	350.03
	2020	1	1	111.3	7.2	15,250	361.93
	2021	1	1	112.4	6.9	16,527	454.09
	2022	1	1	114.6	7.7	17,019	510.41
	2023	1	1	115.3	8.0	17,930	522.53
NORTHEAST ASIA Japan + South Korea	2014	0	0	99.2	106.7	5,762	639.76
	2015	0	0	100.0	121.0	5,855	542.52
	2016	0	0	100.2	110.3	5,921	537.70
	2017	0	0	101.1	115.6	6,065	451.23
	2018	0	0	102.2	115.4	6,121	460.12
	2019	0	0	102.7	115.5	6,183	454.14
	2020	0	1	102.9	114.6	5,974	456.32
	2021	0	1	103.5	123.6	6,139	622.85
	2022	0	1	106.9	155.8	6,228	612.09
	2023	0	1	110.1	159.7	6,303	575.99
SE ASIA	2014	0	0	97.5	95.1	2,372	563.26
	2015	0	0	100.0	100.0	2,484	428.99
	2016	0	0	102.0	101.5	2,605	376.86
	2017	0	0	104.8	102.6	2,743	360.74
	2018	0	0	107.6	103.3	2,883	399.79
	2019	0	0	109.9	102.6	3,006	360.99
	2020	0	1	111.2	102.5	2,894	385.90
	2021	0	1	113.6	104.3	2,992	465.10
	2022	0	1	119.6	113.6	3,157	540.20
	2023	0	1	124.1	114.2	3,292	505.82
EUROPE	2014	0	0	99.8	85.5	17,235	530.15
	2015	0	0	100.0	100.0	17,636	434.30
	2016	0	0	100.4	103.6	17,990	421.88
	2017	0	0	102.0	103.4	18,448	401.43
	2018	0	0	103.9	99.9	18,822	403.32
	2019	0	0	105.3	105.5	19,100	362.81
	2020	0	1	105.9	104.5	17,871	391.91
	2021	0	1	108.7	101.9	18,887	466.09
	2022	0	1	118.0	113.2	19,572	522.24
	2023	0	1	125.2	107.7	19,705	507.96
AMERICAS Columbia+ Mexico	2014	0	0	94.3	89.1	5,994	528.37
	2015	0	0	100.0	100.0	6,044	405.86
	2016	0	0	108.3	106.0	6,059	379.93

	2017	0	0	115.0	102.8	6,173	355.94
	2018	0	0	123.8	103.7	6,280	379.11
	2019	0	0	138.3	107.1	6,336	350.03
	2020	0	1	155.0	116.0	5,906	361.93
	2021	0	1	184.5	124.4	6,348	454.09
	2022	0	1	245.9	125.9	6,593	510.41
	2023	0	1	394.2	122.0	6,708	522.53
MENA Tunisa Egypt Moracco	2014	0	0	93.2	96.1	649	587.54
	2015	0	0	100.0	100.0	671	445.59
	2016	0	0	110.0	109.2	691	372.44
	2017	0	0	130.0	135.5	721	365.22
	2018	0	0	143.4	125.8	752	403.31
	2019	0	0	152.0	117.8	778	349.62
	2020	0	1	158.0	110.5	761	341.33
	2021	0	1	166.1	116.5	798	467.23
	2022	0	1	185.3	132.4	833	533.57
	2023	0	1	230.6	164.4	864	523.57
ASIA SUB-CONTINENT Pakistan India Bangladesh Nigeria	2014	0	0	95.5	100.9	2,508	590.01
	2015	0	0	100.0	100.0	2,693	481.87
	2016	0	0	104.9	100.2	2,900	389.57
	2017	0	0	108.8	97.4	3,097	364.34
	2018	0	0	113.2	102.3	3,286	419.43
	2019	0	0	118.4	106.0	3,444	385.72
	2020	0	1	126.5	105.1	3,283	396.82
	2021	0	1	133.7	104.1	3,555	510.62
	2022	0	1	147.0	113.8	3,770	561.87
	2023	0	1	159.6	121.1	3,943	552.16

Panel Data Used in Import Demand Models

REGION	YEAR	US PRICE SOY OIL $/TON	US SOYBEAN EXPORT PROMO $	US PRICE SOYBEANS $/TON	IMPORTS OF US SOY MEAL TONS	IMPORTS OF US SOY OIL TONS
GREATER CHINA China + Taiwan	2014	912.33	8,574,029	507.30	5,009,957	612,410
	2015	848.32	9,152,302	396.59	6,176,755	717,556
	2016	842.39	8,883,274	400.62	6,085,453	654,848
	2017	834.56	8,758,501	399.93	5,695,374	678,907
	2018	797.71	8,990,994	371.62	6,288,595	739,312
	2019	775.81	8,496,625	359.60	6,592,190	542,777
	2020	805.92	7,934,645	381.95	7,281,173	693,612
	2021	1,247.24	7,824,574	536.61	7,262,888	425,320
	2022	1,591.08	8,282,823	618.08	7,506,002	392,940
	2023	1,599.97	8,147,171	584.79	7,198,086	113,073
NORTHEAST ASIA Japan + South Korea	2014	916.45	3,659,308	539.11	239,096	40,560
	2015	840.95	3,554,454	440.23	104,763	51,436
	2016	853.38	3,286,191	426.70	119,966	84,103
	2017	800.03	3,161,284	426.39	180,878	267,238
	2018	757.80	3,936,539	404.10	205,506	283,704
	2019	724.77	4,396,103	387.14	182,583	359,195
	2020	750.39	5,032,721	424.82	168,617	316,644
	2021	1,148.64	4,848,125	560.79	134,204	162,934
	2022	1,566.18	7,053,657	637.13	192,218	93,040
	2023	1,822.30	6,322,510	607.64	137,304	274
SE ASIA	2014	1,053.57	8,065,754	520.44	818,690	5,749
	2015	1,778.70	8,107,991	412.98	1,285,110	837
	2016	1,825.94	7,277,643	394.00	1,298,007	1,003
	2017	1,467.28	7,612,878	388.48	1,361,304	680
	2018	805.84	8,485,190	378.07	1,894,713	5,074
	2019	1,381.73	10,369,237	364.11	1,189,596	668
	2020	1,285.26	8,814,831	395.28	851,919	99
	2021	611.13	10,833,102	522.30	780,827	6,382
	2022	2,279.12	14,895,888	624.62	803,860	106
	2023	2,232.01	15,168,407	601.36	714,102	386
EUROPE	2014	1,721.93	2,186,709	461.40	1,084,010	217
	2015	3,849.31	5,161,687	384.46	821,843	85
	2016	1,352.66	5,904,292	390.79	214,182	580
	2017	1,715.06	4,070,307	381.00	333,074	297
	2018	1,659.29	4,748,334	353.20	844,269	816
	2019	1,487.14	5,518,975	349.08	550,662	507
	2020	1,545.43	5,103,513	389.43	532,543	392
	2021	1,415.94	4,070,435	502.38	566,861	136
	2022	2,350.91	6,260,015	595.96	376,317	582
	2023	1,047.55	6,697,015	576.09	932,738	20,536
AMERICAS Columbia+	2014	912.33	7,281,316	507.30	5,009,957	612,410
	2015	848.32	7,323,405	396.59	6,176,755	717,556

Mexico	2016	842.39	10,143,686	400.62	6,085,453	654,848
	2017	834.56	6,461,292	399.93	5,695,374	678,907
	2018	797.71	7,570,850	371.62	6,288,595	739,312
	2019	775.81	8,414,864	359.60	6,592,190	542,777
	2020	805.92	7,146,581	381.95	7,281,173	693,612
	2021	1,247.24	8,321,805	536.61	7,262,888	425,320
	2022	1,591.08	15,029,420	618.08	7,506,002	392,940
	2023	1,599.97	12,168,713	584.79	7,198,086	113,073
MENA Tunisa Egypt Moracco	2014	866.45	2,906,133	499.87	385,198	59,408
	2015	785.31	2,107,189	365.37	508,227	138,543
	2016	749.99	935,301	394.74	502,732	61,436
	2017	835.52	3,767,221	369.89	583,542	54,154
	2018	935.79	2,428,771	362.64	719,727	24,669
	2019	1,081.70	4,260,747	356.04	516,593	18,159
	2020	762.69	3,634,601	370.04	711,905	155,311
	2021	1,475.68	4,350,536	504.69	456,185	31,760
	2022	2,320.80	7,186,229	624.61	486,634	7,353
	2023	2,043.16	7,938,539	581.36	620,284	6,315
ASIA SUB-CONTINENT Pakistan India Bangladesh Nigeria	2014	1,375.10	71,116	502.35	74,715	593
	2015	772.48	1,661,142	394.57	199,382	13,136
	2016	805.70	2,271,316	391.41	212,924	7,812
	2017	665.13	2,073,728	373.55	358,286	7,720
	2018	699.07	3,106,115	359.94	186,994	11,527
	2019	772.30	4,502,951	343.70	255,574	13,173
	2020	940.79	5,976,812	383.33	212,249	36,141
	2021	1,396.28	7,229,752	492.50	228,980	59,632
	2022	1,560.48	8,794,789	597.70	185,930	133,057
	2023	3,600.20	12,346,726	562.19	184,272	25

Panel Data Used in Import Demand Models

REGION	YEAR	IMPORTS OF US SOYBEANS TONS	ROW PRICE SOY MEAL $/TON	ROW PRICE SOY OIL $/TON	ROW PRICE SOYBEANS $/TON	TIME TREND #
GREATER CHINA China + Taiwan	2014	4,479,243	503.88	854.16	508.77	1
	2015	4,961,755	572.53	677.59	381.57	2
	2016	5,023,343	445.26	701.03	370.56	3
	2017	5,466,386	376.40	736.74	376.03	4
	2018	7,226,552	423.09	697.46	396.60	5
	2019	7,103,047	336.46	634.15	350.58	6
	2020	6,390,977	363.15	688.99	344.59	7
	2021	6,255,745	666.26	1,089.96	453.65	8
	2022	7,448,090	964.52	1,419.35	592.45	9
	2023	5,471,176	589.13	1,030.59	522.94	10
NORTHEAST ASIA Japan + South Korea	2014	2,537,633	469.23	848.12	512.23	1
	2015	2,900,462	362.51	668.29	385.43	2
	2016	2,882,228	332.48	720.14	377.71	3
	2017	2,979,612	320.34	747.61	376.94	4
	2018	3,110,071	371.54	6,872.73	403.97	5
	2019	3,532,696	328.96	55,200.00	345.06	6
	2020	3,121,580	324.04	47,025.00	343.69	7
	2021	2,970,322	409.94	1,239.50	411.85	8
	2022	3,599,932	488.62	1,443.80	592.29	9
	2023	2,356,391	497.80	1,010.55	525.82	10
SE ASIA	2014	3,533,515	383.50	829.90	337.01	1
	2015	3,528,164	275.30	670.37	383.92	2
	2016	4,989,823	238.07	740.43	372.94	3
	2017	5,037,412	240.87	753.38	376.76	4
	2018	6,315,433	296.37	768.02	393.23	5
	2019	5,458,410	225.96	684.79	354.27	6
	2020	5,576,034	233.48	610.15	344.83	7
	2021	4,457,333	251.01	1,338.40	143.21	8
	2022	3,599,622	299.02	1,512.07	174.52	9
	2023	3,018,661	299.44	1,006.24	150.92	10
EUROPE	2014	4,824,135	316.66	797.60	388.85	1
	2015	5,497,489	234.25	1,179.12	387.28	2
	2016	5,071,427	350.34	724.74	375.16	3
	2017	4,782,869	336.06	1,243.25	374.89	4
	2018	8,979,763	398.36	1,488.95	394.32	5
	2019	5,658,187	344.74	1,244.68	346.64	6
	2020	5,134,558	349.26	1,724.11	340.98	7
	2021	5,127,015	423.38	1,385.09	359.18	8
	2022	5,058,399	505.53	2,018.37	476.19	9
	2023	5,613,071	512.20	988.73	527.71	10
AMERICAS Columbia+ Mexico	2014	4,479,243	489.30	901.07	491.50	1
	2015	4,961,755	412.33	741.32	368.29	2
	2016	5,023,343	401.28	786.27	381.52	3

	2017	5,466,386	377.61	793.89	365.21	4
	2018	7,226,552	451.25	747.93	396.36	5
	2019	7,103,047	460.01	702.25	343.44	6
	2020	6,390,977	445.63	832.52	342.93	7
	2021	6,255,745	445.94	1,354.93	455.95	8
	2022	7,448,090	569.67	1,625.24	586.02	9
	2023	5,471,176	548.45	1,200.86	516.37	10
MENA	2014	1,245,817	490.26	839.06	510.38	1
Tunisa	2015	960,428	362.37	661.61	380.36	2
Egypt	2016	1,012,170	340.56	698.55	362.21	3
Moracco	2017	1,591,162	320.68	747.58	366.12	4
	2018	4,255,230	374.64	707.76	393.53	5
	2019	3,489,302	318.24	640.44	335.83	6
	2020	5,145,480	334.21	659.73	338.05	7
	2021	3,634,878	426.30	1,188.37	462.07	8
	2022	4,112,931	481.50	1,578.88	581.56	9
	2023	1,242,069	498.55	1,038.03	522.28	10
ASIA	2014	328,421	492.58	842.65	508.19	1
SUB-	2015	1,145,530	365.80	673.31	375.09	2
CONTINENT	2016	967,044	332.04	699.77	385.37	3
Pakistan	2017	2,191,837	323.07	743.95	374.89	4
India	2018	2,981,631	400.32	700.63	399.17	5
Bangladesh	2019	2,446,987	327.12	646.44	348.32	6
Nigeria	2020	2,507,900	504.81	698.70	339.91	7
	2021	1,738,687	417.20	1,163.09	413.12	8
	2022	1,141,233	473.54	1,471.07	586.46	9
	2023	491,590	491.08	1,062.74	524.89	10