

# Driving the U.S. Demand for Honey: Estimated Economic Impact of the National Honey Board



An Evaluation Report  
to the National Honey Board  
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## **Preface**

The following research was completed solely by the author independent of any influence from the National Honey Board except for data assistance and clarification from the National Honey Board staff. All statistical and econometric analyses including the computer programming were directly a product of the author. The scope of the report has been limited to measuring the demand for honey and the impact of the National Honey Board programs on that demand. The honey industry continues to experience considerable production issues associated with the Colony Collapse Disorder (CCD) and this report only documents the colony change but does not deal with the CCD issues in terms of the science or solutions. All demand models are based on both economic theory and scientifically accepted econometric methods. As will be shown, the demand results are both theoretically and empirically revealing. Any omissions or errors are the responsibility of the author.

Appreciation is extended to the staff of the National Honey Board for being totally responsive to data needs and for providing materials relating to specific promotion programs. Margaret Lombard always immediately responded to my research requests.

Ronald W. Ward

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## **Introduction**

Do commodity promotions impact the demand for those food groups involved in the generic promotion of their commodities? That is a fundamental question since generic promotions are generally funded through a mandatory assessment on producers and/or first handlers. It is essential that those paying the assessments know if their generic programs, designed to enhance demand, were beneficial in terms of a Return-on-Investment (ROI). That is, does the benefit exceed the cost? Generic promotions have become a popular marketing tool for many commodity groups since it is often difficult for an individual producer/handler to promote his/her own commodity while reaping the full benefits. Given the generic nature of many commodities, there would likely be other producers who realize benefits but not subject to the underlying cost, thus implying a potential *free-rider* problem. By definition, generic promotion is the cooperation among a group of producers/handlers of a homogeneous product for the purpose of disseminating information to enhance the demand for the good. An effective program leads to benefits through positive changes in demand. If the product is nearly homogeneous, then all producers/handlers share in the gains. Yet without an organized program for generic promotions, free-riders will assuredly occur.

Where there is a need for disseminating information for a fairly homogeneous good, organized generic programs with legal standing can be a marketing solution for those producers. That legal authority is most often referred to as a *commodity checkoff* program. The term comes from the condition that those producing the commodity, within the definition of the checkoff, are subject to a mandatory assessment to underwrite the program. Legal

authority is either from state or national laws. Those programs covering the entire nation come under the regulatory control of the U.S. Department of Agriculture. All programs under the auspice of the U.S. Secretary of Agriculture are required to have a periodic independent evaluation of their programs in order for the Secretary to judge if the programs are indeed a benefit to the specific commodity group.

Four basic components for all commodity checkoff programs include (1) organizing an *administrative* structure and representation; (2) *messaging* and delivery; (3) *evaluation*; and (4) *equity* with the distribution of any benefits. All details of the enabling legislation and/or approval process are documented for each stand-alone commodity checkoff program. While the government provides rigorous oversight, it is usually the industry's responsibility to administer and deliver the messages all subject to the government's regulatory oversight. Since the industry is given the assessment authority, that must come with strong government oversight and representation by members from within the industry. Evaluation is a key to objectively determining the economic impact of the demand enhancing efforts, hence a requirement for an independent evaluation is clear. Equity issues are usually handled through legal challenges via USDA oversight, court systems or call for a referendum to vote on the continuation of a program. A program can be terminated by the Secretary of Agriculture, the courts, and by producers/handlers. Such decisions need to be based, at least partially, on the scientific evidence from measuring the demand enhancing success of a specific program (Ward, 2006).

With this brief background we now turn to the focus of this report, the economic



impact of the National Honey Board or for convenience NHB. This program has been active since its start in 1996 (Federal Register) and was last evaluated in 2012 (Ward, 2014). Over the years, normal transitions within the Board members, staff, and facilities have occurred while maintaining the program focus on enhancing the demand for honey. Those administrative type changes will not be part of the evaluation since they are continuously monitored and approved by the Agricultural Marketing Service (AMS) agency within the USDA. Such administrative and regulatory changes are an on-going AMS oversight responsibility and somewhat secondary to measuring the programs' impact on the U.S. demand for honey. Thus, this report will be limited to the third component of the National Honey Board programs (i.e., the independent evaluation.)

Among the wide range of commodities entering the food chain, honey is quite unique in that honey is a by-product of the pollination process. For some plants, honey from the pollination services is in high demand and hence valuable in-and-of itself. Of other plants such as almonds, any collected honey is less valuable for human consumption mostly due to the less desirable honey flavors and related attributes. Underlying the bee industry is an economic system of compensation for using honeybees for the pollination services and the harvesting of marketable honey. Establishing the value of the pollination services is beyond the scope of this report since the NHB's mandate is to enhance the demand for marketable honey. Clearly, enhancing honey demand is a direct way to provide a benefit for the pollination services essential to U.S. agriculture.

Demand is a concept everyone uses with some level of understanding. Honey demand

can be easily divided into three distinct categories of use: (1) table honey; (2) honey for manufacturing; and (3) honey for storage. Honey has a long storage life, yet there is always a cost of commercial storage and convenient storage for at-home use. Table honey is what most consumers are use to seeing on the grocery shelf where the product identity is easily observed. Honey for manufacturing may be hidden within the ingredient mix and/or may be promoted and more visible in some manufactured product. For example, “Honey-Oat” energy bars or honey-coated cereal displaced on the cereal box include honey as an ingredient while keeping the honey identity. In the broadest sense, there are unique demands for honey when viewing the manufacturing sector versus the retail table honey. As such, the impact of the NHB must be viewed as two-separated honey markets, manufacturing and table use.

All evaluations are looking backward to see what has happened with demand and if the program of interest had a statistically significant positive impact on demand. For honey, was the NHB programs a demand driver and, if so, by how much? Three importance dimensions to determining the statistical properties are: (1) understanding the underlying economic structure of the industry; (2) having the necessary data to measure demand; and (3) using the appropriate statistical procedures for measuring the demand drivers. Market data are usually classed as aggregate data collected over time or dis-aggregated data collected cross-sectionally and over time. Cross-sectional data may be collected at points of purchase or by the purchaser such as a household. Cross-sectional time series data have an advantage that it may contain more information about the buyer but may be volatile. Aggregated data averages out much of the noise and is usually more available as well as being directly accessible through public

sources.

For the honey evaluation, we will turn to the aggregated data mostly reported by the USDA National Statistical Reporting Service since it is consistently reported, accessible and provides a way to account for both uses of honey. To avoid issues with storage modeling, we turn to annual data that are directly accessible. With the data in place, then econometric models are specified to represent the demand for honey within the U.S. marketplace.

The report will first set the stage by tracking the availability and uses of honey along with establishing the economic value on an annual basis. Second, demand enhancing activities by the National Honey Board will be detailed. Third, demand models for both the Table and Manufacturing sectors are estimated and interpreted. Finally, using the demand models the impacts of the NHB are presented concluding with estimated Returns-on-Investment (ROI) for both sectors and marginal rates-of-return. While the econometric procedures are technical in nature, every effort is made to first show the statistics and then provide an intuitive interpretation of the results.

## **The Honey Industry in Transition**

Foods do not just automatically show up on the grocery aisles and shelves. There is always a complex supply chain linking the product origin to the product(s) availability to shoppers. That supply chain is usually not transparent to the potential buyer and very often those same shoppers expect the desired food to be there in all the varieties, quality and packaging. The word “desired” is used since some foods are a staple part of the daily diet and

purchased routinely. While purchases of others foods may required the potential shopper to have a little nudge when pondering the buying decision. That nudge frequently comes through the distribution of information through a wide range of media from “on-package” to “social media.” Information content and media use depend on the shoppers, the food product, and the frequency of buying.

Honey is no exception. It is almost always available in “table form” and as an ingredient in many processed foods such as cereals. Honey has a long shelf life and is familiar to most shoppers. As a natural sweetener, honey has a myriad of uses on the table and in food products purchased frequently. Natural sweetener versus artificial sweetener raises complex questions about sweetener substitution and the underlying supply chain for sweeteners in general. Likewise, information about honey natural sweeteners and its use suggest the potential for letting shoppers know and/or remind them about the attributes of honey. That in turn has lead to the role of “generic promotions” as a tool for disseminating information about the attributes and uses of honey. Generic promotions, just like the supply chain, require an underlying structure (i.e., the National Honey Board) to provide those promotion services.

In this section, the intent is to give an overview for those structures that assure the flow of honey through the distribution channels while keeping the potential shopper informed. Of particular importance are the major changes that potentially impacted the overall honey market in the U.S.

### ***Production and Imports***

At the heart of the U.S. honey industry are the bee colonies with some regionally

stationary while most are moved throughout the U.S. as part of the pollination of crops. Honey is a by-product of pollination with the honey value directly related to the nectar source or type of crop. Honey varieties depend on the flowering source and for a few crops, such as almonds, the honey is less desirable for table consumption because the attributes of that particular crop. Others such as orange blossom produce a highly desirable honey. Structurally, the honey attributes (i.e., flavor, color, etc.) are uniquely tied to the crops and all of the underlying conditions among those crops. As a practical example in Florida, in 2000 there were 78.7 million bearing orange trees and by 2017 that number dropped to 50.1 million bearing trees or 63.6% of the 2000 numbers. Clearly for this particular regional crop, the pollination services and resulting orange blossom honey had to be impacted because of changes external to the honey industry. Any impact may have been lessened somewhat because of the storable nature of honey. Yet the point is that major changes in a particular crop can have direct impacts on the honey sources. One can cite other external events, yet those details are beyond the scope of this report while recognizing the link between honey and each major crop within the U.S. supply chain. This is not pursued further because of the unique mandate of the National Honey Board to promote all honey in the U.S. and not just one variety. To do otherwise, equity issues among honey varieties could occur since all sources are subject to the honey checkoff assessment. This will be explained in detail later.

In 1965 there were 4.718 million bee colonies producing most of the U.S. honey supply used for both table honey and honey for manufacturing. In Figure 1, dramatic collapses in the U.S. bee colonies show that by 2017 total colonies declined to 2.669 million colonies. The

primary reasons for the colony collapse are documented in *Colony Collapse Disorder (CCD) Progress Report* (USDA CCD Steering Committee, June 2009). Those details are not part of this report.

The lower portion of Figure 1 illustrates the overall negative trend in the colony supply and the major drop starting in the mid-80s. The low point was in 2008 with 2.342 million colonies (50% of the 1965 level) and since then the numbers have generally leveled out or slightly increased. CCD has been a dramatic structural change for the U.S. honey production sector. An obvious questions is what about the productive per colony?

Between 1965 to 1985, the average colony produced 48.75 pounds of honey per colony

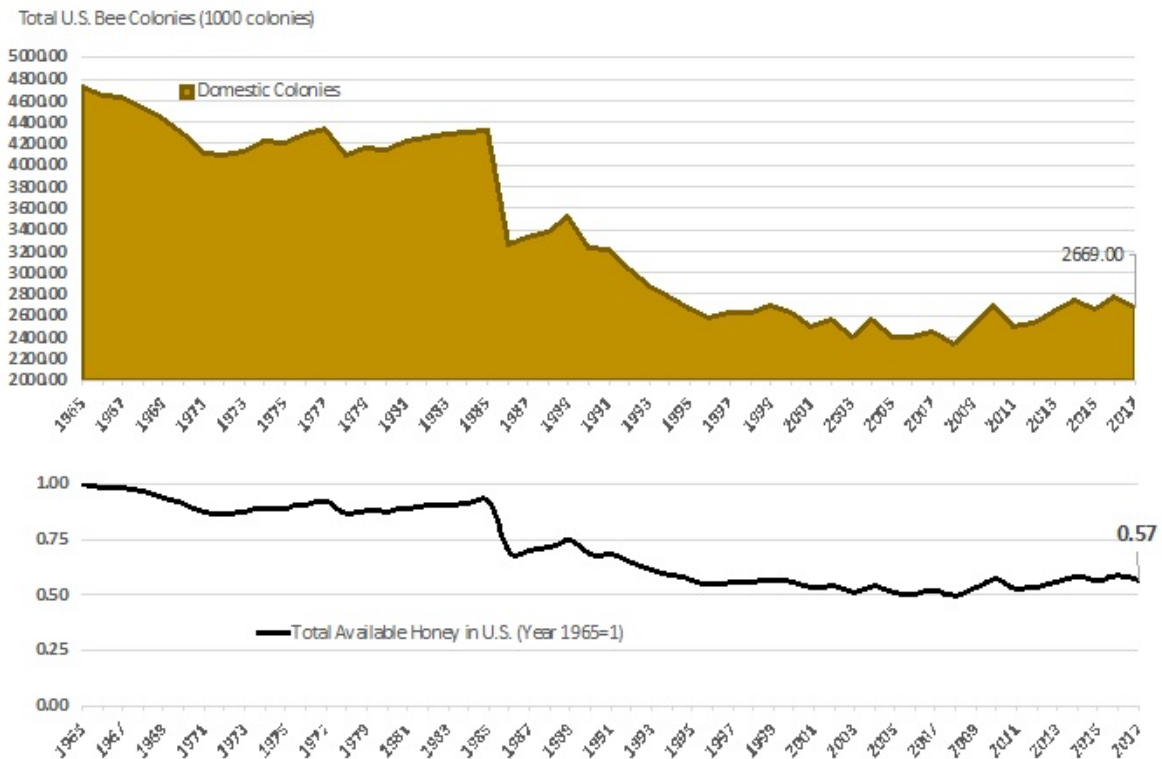


Figure 1. U.S. bee colonies over the years since 1965.

while between 1986-2009 that number increased to 70.74 pounds. For much of the CCD periods the colony productivity did increase within these two ranges but with year-to-year normal variations. The pounds per colony dropped to an average of 59.42 pounds from 2010 through 2017 with 2017 yielding 55.30 pounds per colony. Colony  $\times$  Yield = (U.S. Honey Production) and by 2017 the U.S. total stood at 147.638 million pounds contrasted with 241.849 million pounds in 1965. By 2017, U.S. production was just 61% of the 1965 level. The peak production was in 1969 with 267.485 million pounds giving a difference of almost 119.847 million pounds between 1969 and 2017. That translates into a 45% loss in U.S. honey production from its peak year. For any food source, that is a major structural change within an industry.

In 1965 total U.S. production along with a small level of imports stood at 255.15 million pounds with the U.S. contributing 95% of the total honey supplies and imports, close to 5%. Beyond the colony collapse, growth in honey imports has been the most dramatic change in the honey supply chain over the last four decades. From an import share of around 5% to nearly a 75% share in 2017 clearly reflects this structural change.

Figure 2 depicts this dramatic change year-to-year since 1965 with a steady growth in annual imports of honey into the U.S. marketplace. By 2017, total honey supplies (U.S. production plus imports) totaled 595.33 million pounds giving a 2.33 factor increase in total available honey since 1965. As shown in the lower half of Figure 2, by 2017 U.S. honey production accounted for 24.8% of the total. That is a drop from 95.0% to 24.8% in four decades requiring a major re-structuring of the honey supply chain. Imports come from a

number of countries-of-origin but are not documented in this report since again, the National Honey Board’s goals is to enhance the demand for honey in the U.S. marketplace without differentiation to source. Since all domestic and imports are subject to the same NHB assessments, the Board must not differentiate among the sources. That is, the Board must assure that equity exist in both assessments and realized benefits.

Another way to view current supply trends would be to express both domestic and imports relative to a more recent period such as 2000. Setting 2000=1, then total imports were 2.25 times the 2000 level while domestic production continue to decline to .67 level of the 2000 domestic honey. Combined, imports and domestic honey was 1.42 times the 2000 level, again clearly pointing to the dominance of the imports.

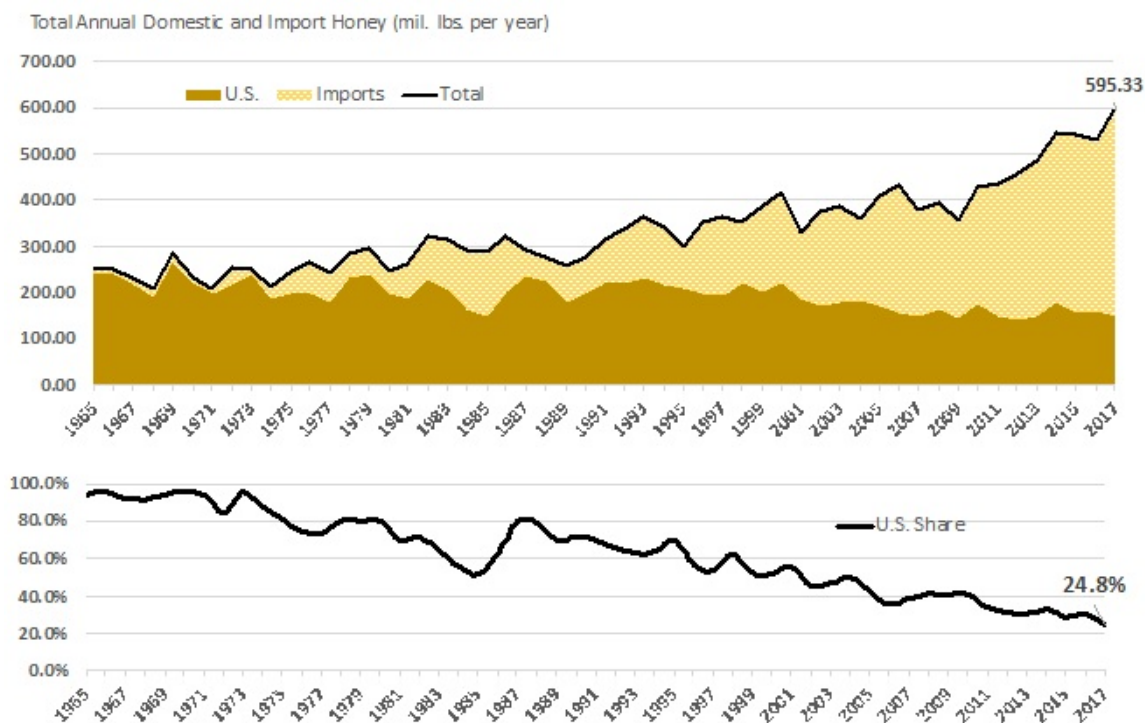


Figure 2. Domestic production and imports of honey into the U.S. market.



In additions to those numbers in Figure 2, the market always have a supply of honey -on-hand (e.g., storage). Over the years starting with 1965, honey in storage has represented about 13% of the total. That percent has continued to decline where by 2017, honey in storage represented about 5% of the supply. Obviously there is always a cost-of-storage but at the same time necessary to meet supply chain demands. This part of the honey industry is mentioned since knowing honey-in-storage is essential when figuring out the utilization (demand) of honey. On average from 1965-2000, U.S. production accounted for 62% of the supply; imports, 25%; and net stocks, 13%. For the years 2001-2017 these percentages shifted with U.S. production, 34%; imports, 57%; and stocks, 9%. Comparing these two periods clearly illustrates the structural change in the industry with almost a flip in the domestic versus import percentages.

### ***U.S. Utilization of Honey***

Existing data do not provide a complete tracking for all of the uses of honey and particularly the non-food uses such as for cosmetics and health applications. One can, however, trace the uses of honey for manufacturing and table honey. Table honey is what is commonly seen on the grocery shelves while manufacturing covers the wide range of baking and beverage production requiring sweeteners and flavoring.

Figure 3 captures the year-to-year use of honey as reflected with four categories: honey for food manufacturing, table honey, exports, and storage. In 2017 the total equaled 625.9 million pounds and that level exceeds the level 586.2 million pounds in Figure 2 since the utilization includes the net-honey in storage. Nearly 75% of all honey went to manufacturing

in 2017. As shown in the bottom portion of Figure 3, manufacturing utilization accounted for the majority of honey demand, ranging from 60% to 80% depending on the year. Since the mid-2000s, the manufacturing share of honey utilization trended upward however slightly. For comparison, honey for table use generally ranged around 20% of the total utilization.

To understand and measure the demand for honey, one has to rely on the allocations in Figure 3 and particularly honey for manufacturing and honey for table consumption. Those uses are so distinctly different that separate demand models are required as developed later in this report. The National Honey Board’s activities have been in the more recent years, so it is worth noting the utilizations for more recent years, say 2000-2017. For those years, the averages were 69% for manufacturing; 19% going to table use; 2% for exports; and 10%

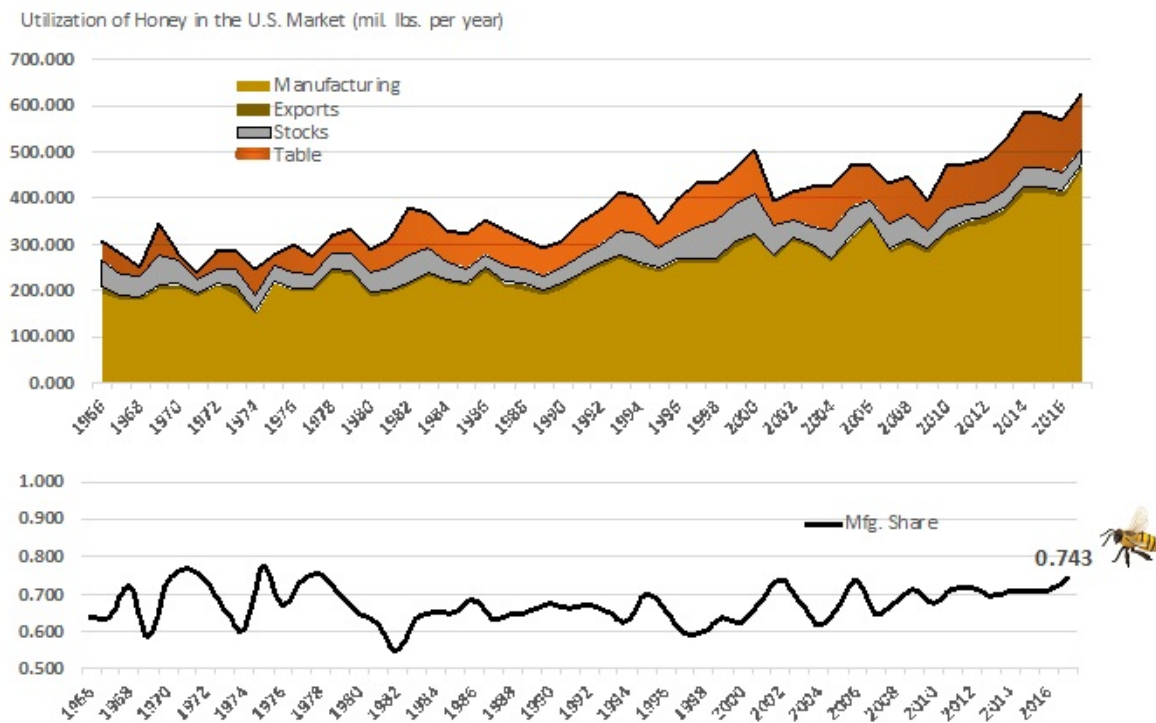


Figure 3. Utilization of honey within the U.S. marketplace.

allocated to storage.

Figures 2 and 3 trace the production and utilization but do not show utilization by honey source. It is nearly impossible to separate out how much of the domestic supply goes to table versus manufacturing and similarly for imports. Tracing the use-source is not necessary because the NHB does not differentiate between the sources (except for organic honey) when collecting assessments. Honey is treated equally when applying the honey checkoff assessments with all based on the pounds of honey (or honey equivalent).

### ***Honey Prices***

Retail honey price, producer price, import price and a weighted average producer/import price series are the four basic measures of the value of the honey market.

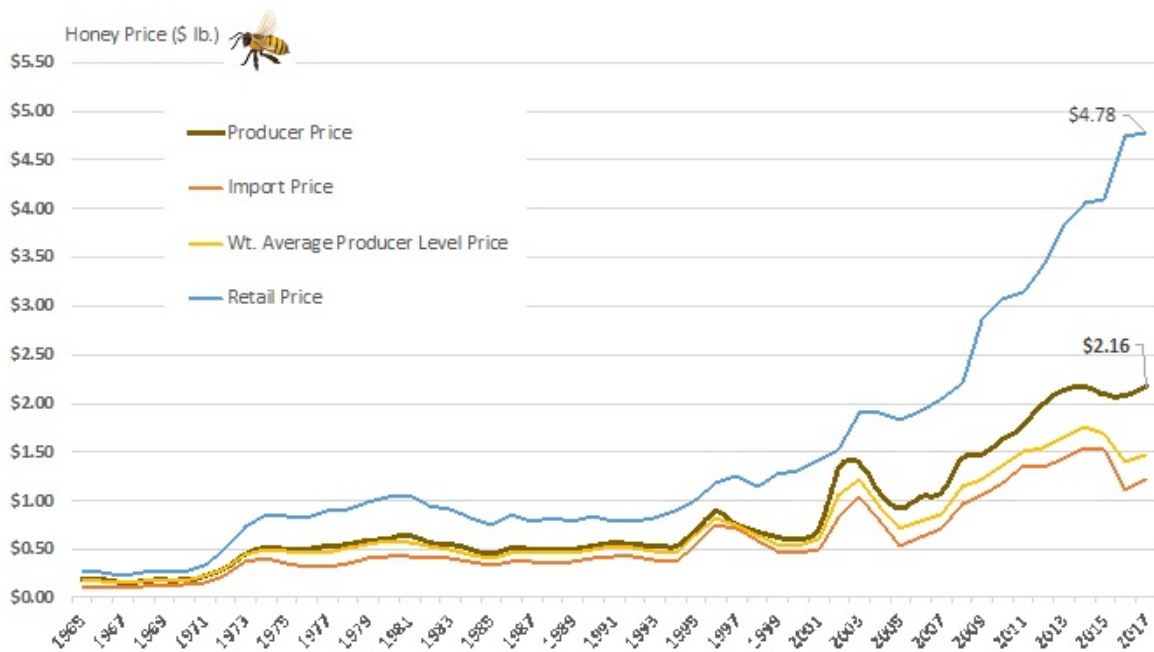


Figure 4. Honey prices within the U.S. marketplace.

Each price is plotted in Figure 4 and the major price increases over time clearly capture an underlying change in the value of honey over the past four decades.

In the 1960's retail honey prices were around \$0.25 to \$0.30 per pound then from the 70's to mid-90's honey prices ranged from \$0.75 to nearly a \$1.00 per pound of honey. By 2017, retail honey prices averaged \$4.78 per pound of table honey. That increase to 2017 represented a 17.8 factor increase from the 1965 retail price. Over the same decades, producer prices increased from \$0.178 to \$2.16 per pound or a 12.1 factor increase at the U.S. producer level.

From 1965 through 2017, the retail and U.S. honey producer prices in Figure 4 showed a correlation of .976 and the correlation between domestic producer price with honey import prices was .980. Without implying causality, the linkage via prices in the supply chain for honey in the U.S. marketplace is extremely strong. Even when comparing the same correlations for more recent years (e.g., 2000 to 2017) the correlations remain high with .948 for the retail/producer prices and .930 for the producer/import prices. These strong correlations are important when later modeling the table and manufacturing sectors and then expressing the values at different points in the supply chain. Such strong correlations would generally be expected since much of the same honey can be used for manufacturing or table honey with much of the movement depending on the supply chain arrangements.

For a simple guideline (see Appendix A.1) based on regressing domestic honey prices against the retail price suggests that a 10 cent increase (or decrease) in retail prices translates into a 4.85 cent increase in the domestic producer price based on the full data range in Figure

4. A 10 cent increase in the U.S. producer price generally translates into a 6.51 cent increase in the import price. With the existing data limitations relating to the flow of honey by variety and/or color, we do know that there is a strong price correlations across the three basic classes of honey (i.e., white honey, XL amber honey, and amber honey) where all correlations are between .98 to .99 values (see Appendix A.2). This is mentioned just to emphasize the extremely strong linkage (and substitution) within the supply chain among the honey varieties. Again, in the modeling sections all honey sources are group into the honey as a class of foods both because the honey data by variety are not available and, more importantly, the National Honey Board's mandate is to enhance the demand for honey and not just one variety of honey. This avoids any possibility of creating equity issues within the industry in terms of benefits accruing to one sector of the industry.

### ***Honey Value***

Figure 2 shows both domestic production and imports while Figure 4 gives the prices at the producer and import points in the supply chain. Total value of the honey industry within the U.S. marketplace is then a product of the price times production from the two honey sources (i.e., U.S colonies and imports). Changes in both the price and supply levels obviously lead to fluctuations in the total dollar value during any one year. In 1965 the total honey industry within the U.S. stood at \$44.34 million and by 2017 that number increased to \$865.94 million, giving a 19.5 factor increase. As plotted in Figure 5, the peak value was \$946.41 million in 2014.

Around 2007 the domestic and import values were almost equal then from that point

forward the import value exceeded the domestic production value. By 2017 U.S. colony production accounted for about 37% of total honey value entering the U.S. honey market. That decline in domestic share of the total value is illustrated in the lower graph of Figure 5 with the nearly 50/50 share seen in 2007-2009. Most of the relative import value gain since then is attributed to the growth in imports seen in Figure 2. The import growth percentage is greater than the value percentage simply because of the stronger domestic price compared to the import price. Note above that a 10 cent increase in domestic prices translates into a 6.5 cent increase in the import price (again, see Appendix A.1).

At this point the supply, utilization, price and value of honey have been established

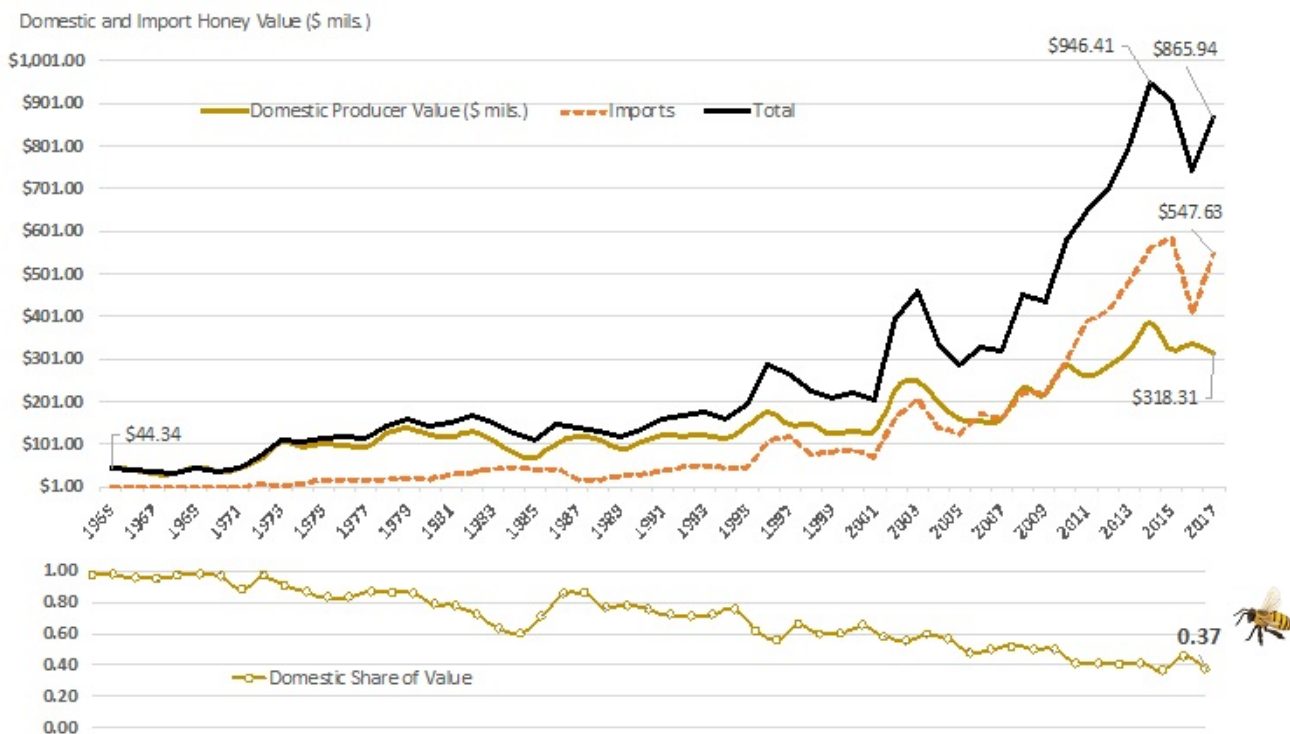


Figure 5. Total, domestic and import value of honey entering the U.S. marketplace.

extending back several decades. Price, value, supplies and utilizations are driven by many factors ranging from demand drivers and conditions impacting domestic production. As noted from the outset, the primary focus of this report is to determine the impact of the National Honey Board's programs within the whole distribution system. Ultimately the question is what would have been the value of the honey industry without the honey checkoff program or compared to earlier periods? Before addressing that specific paramount question, one must first identify those programs and the efforts of the National Honey Board to move the demand needle for honey within the U.S. market.

### **National Honey Board**

The National Honey Board exist under the authority of the United States Commodity Promotion, Research, and Information Act of 1996 (Federal Register, 1996). This Act was passed as an umbrella legislation to facilitate commodity sectors seeking the establishment of a commodity promotion program. Prior to the 1996 Act, each commodity had to receive separate congressional authority to start a national checkoff program. Dairy and Beef are two example with programs started prior to the 1996 Act. The Act was established as an effective way to accommodate various commodity groups considering generic promotions while providing oversight through the Secretary of Agriculture. Standards and procedures were set in place that included procedural steps, funding, enforcement, federal oversight, evaluation, administrative guidelines, and Board representation and referendums (i.e. voting). These standards were essential because each approved checkoff Board was given mandatory

assessment authority and thus had to be accountable to those paying the checkoff assessments. All programs approved through the 1996 Act were expected to strengthen the position of agricultural commodity industries; maintain and/or expand domestic and foreign demand for agricultural goods; develop new markets; and assist producers in meeting their conservation objectives. All of the rules and structural requirements for a national checkoff are found in the Act ((Pub. Law 104-127, Title V, 1996; Forker and Ward, 1992).

Pollination is essential to agriculture and honey is a by-product of that service. Hence, it is of no surprise that honey has a long history of support at the federal level as an indirect way to assist with pollination. *“Honey price support program was first created by the Agricultural Act of 1949 (P.L. 81-439) to provide market price stability for honey producers and to encourage maintenance of sufficient bee populations for pollination (Canada, 2004)”*. An alternative to price supports would be to institute a system where producers could jointly promote their honey through generic promotion programs with the goal of producer funded promotion programs instead of government substitutes. Movement away from price supports is the initial reason for a consideration of the honey checkoff program leading up to the Honey Packers and Importers Research, Promotion, Consumer Education and Industry Information Order under the auspice of the United States Commodity Promotion, Research, and Information Act of 1996. Carol Canada’s report “Farm Commodity Programs: Honey” provides excellent insight into that history so will not be repeated in this report (C. Canada, 2004).



### ***National Honey Board (NHB) Legal Authority***

The NHB was authorized through the 1996 Act and had one major revision since its first approval. The Federal Register/Vol 73, No. 99 (2008) provides a good summary of the initial authorizations and is repeated here under the titled Establishment of Honey Packers and Imports Research, Promotion, Consumer Education and Industry Information Order and Suspension of Assessments Under the Honey Research, Promotion, and Consumer Information Order” . . .

*“This final rule establishes the Honey Packers and Importers Research, Promotion, Consumer Education and Industry Information Order (Packers Order). The Packers Order is authorized under the Commodity Promotion, Research, and Information Act of 1996 (1996 Act). Under the Packers Order, first handlers and importers will pay an assessment of \$0.01 per pound on honey and honey products. First handlers and importers of less than 250,000 pounds of honey and honey products annually will be exempt from the assessment. The assessments will be remitted to the Honey Packers and Importers Board (Board) to conduct a generic program of promotion, research, consumer education, and industry information to maintain and expand markets for honey and honey products. A referendum was conducted among honey first handlers and importers between April 2 and April 16, 2008. Seventy-eight percent of those covered under the Packers Order—representing ninety-two percent of the volume of those voting in the referendum—favored implementation of the program. This rule also suspends the requirement of the existing Honey Research, Promotion, and Consumer Information Order (Current Order) and regulations authorized under the Honey Research, Promotion, and Consumer Information Act (Honey Act) that honey producers and importers pay to the National Honey Board (Current Board) an assessment in the amount of \$0.01 per pound on honey and honey products. The provisions of the Current Order and regulations issued thereunder will be terminated at a later date” (Federal Register, May 21, 2008).*

With the structural changes noted in the earlier section, a subsequent proposal to change the assessment rate was partitioned for consideration. In Federal Register Vol.79, No. 22, November 18, 2014 a summary of the proposed rate change was published as reproduced below . . .

*“This proposed rule invites comments on amending the Honey Packers and Importers Research, Promotion, Consumer Education and Information Order (Order) to increase the assessment rate from \$0.01 per pound to \$0.015 per pound on honey and honey products, over a two-year period. The Order limits an increase in the assessment rate to no more than one-quarter cent per year. Thus, the rate would increase to \$0.0125 per pound for the period January 1 through December 31, 2015, and to \$0.015 per pound on and after January 1, 2016. The Order is administered by the Honey Packers and Importers Board (Board) with oversight by the U.S. Department of Agriculture (USDA). Under the program, assessments are collected from first handlers (packers) and importers and used for research and promotion projects designed to maintain and expand the market for honey and honey products in the United States and abroad. Additional funds would allow the Board to expand its production research activities and promotional efforts. The Board’s production research focuses on maintaining the health of honey bee colonies. Increasing demand for honey and honey products would benefit the honey industry as a whole. This action also makes three additional changes to: Clarify that the assessment rate applies not only to the Harmonized Tariff Schedule numbers but to any other numbers used to identify honey; change the length of time that books and records are to be held; and change the exemption requirements” (Federal Register, Vol. 79, No.222, Nov. 18, 2014).*

As noted in the USDA-AMS website the key components for current honey program is that . . . *“the assessment rate is \$0.015 per pound and is collected on domestic honey and honey products from first handlers or packers and on imported honey or honey products by the U.S. Department of Homeland Security’s Customs and Border Protection. Packers and importers marketing less than 250,000 pounds of honey per year are exempt from paying assessments” (USDA-AMS, 2018).*

### ***National Honey Board Programs***

The NHB website provides clear insight into the breath of programs and the target audience. A selection from the dynamic pages is shown in Figure 6 on the next page. Across the top are listed sections starting with **HOME | ABOUT HONEY | BEES & SUSTAINABILITY | RECIPES | LOCATOR | INDUSTRY & PARTNERS**. The sections are generally self explanatory and provide educational materials about bees, honey and hundreds for ways to use honey. The honey locator is a tool for potential honey buyers and sellers to connect through the **LOCATOR** tab. Note that the NHB is not in the business of

buying and selling but this tab does provide an efficient way for searching out potential suppliers and buyers. Clicking the far right tab (**INDUSTRY & PARTNERS**) takes one to the five basic focus areas of the National Honey Board: Consumers, Food Processors, Food Services, Retail, and Industry. The **CONSUMER** section focuses on educating and informing consumers about the creative ways to use honey basically as table honey alone and complements to foods from breakfast to dinner and anything between. For the **FOOD PROCESSORS**, the emphasis is on honey is the perfect ingredient in bakery and snack foods using industry news, trends and the latest technical info with the natural sweetener attributes of honey. For the away-from-home market, the **FOOD SERVICE** is a source of information for menus, creative food dishes and beverages all incorporating honey. The **RETAIL** section is about presentation and partnering with retail food stores to maximum exposure for table

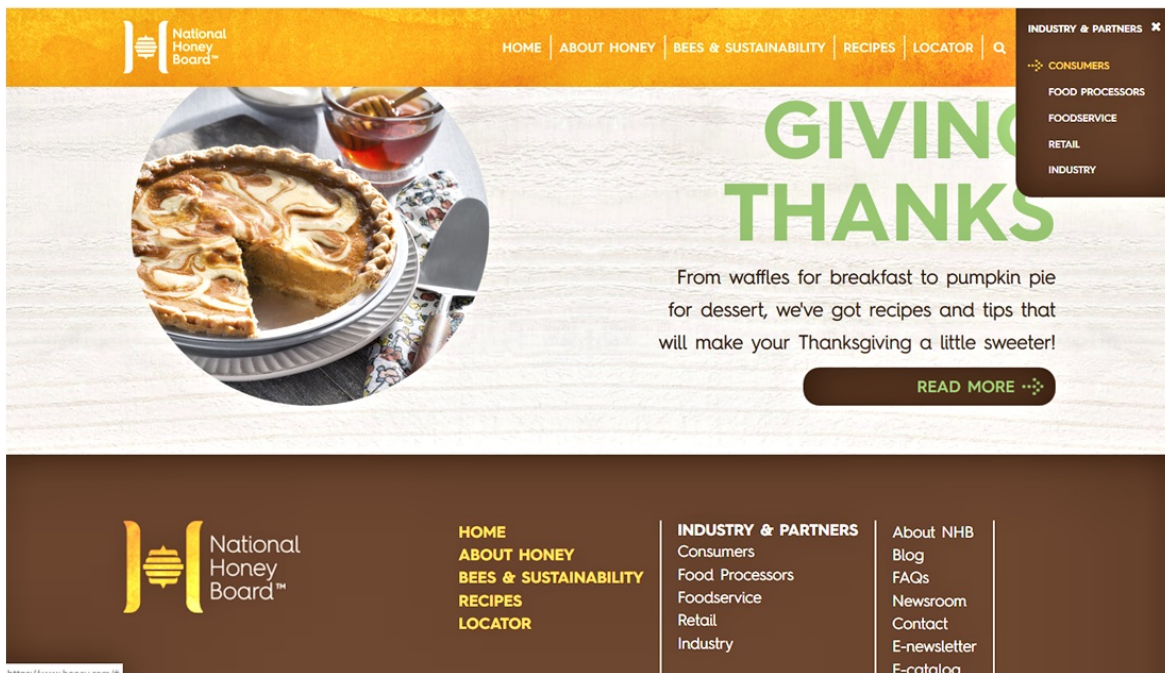


Figure 6. The National Honey Board website (www.honey.com).

honey and processed foods that have visible package of honey as an ingredient (e.g., honey coated cereal). Finally, **INDUSTRY** is designed to keep the industry informed about the NHB programs and helping suppliers, handlers, and stores utilize the materials available through the NHB. Direct contact with the NHB can be made through Blog, FAQ, Newsroom, E-newsletter, E-catalog, and E-mails. Many recipe and educational brochures, hangtags, stickers, magnets, and more are available to members of the honey industry to use in educating and informing consumers in their area about honey and its many uses. Each section noted above stands alone but are all designed to enhance the demand for honey in the U.S. marketplace. Interest readers need to go to the website to visit each section since the details are far too large to include in this report. As already stated many times, the foremost question is if all of these programs combined enhanced the demand for honey within the U.S. marketplace?

### ***National Honey Board Assessments and Expenditures***

A fundamental dimension of program evaluation is to have reliable measures of the Board's program activities. Most evaluations involving analytical procedures (e.g., econometrics) turn to the market enhancing expenditures by the boards. Frequently, the expenditures across activities within a Board's programs are correlated enough that one can use the total expenditures instead of just the marketing dollars. Program expenditures are a direct measure of the promotion intensity and have proven to be a reliable measure particularly when using aggregated market data such as the annual data used in this honey evaluation. For some commodities such as citrus (ERD-FDOC, 2018) and mangos (Ward, 2018), data from self reporting by households have been used with the inclusion of questions about the

awareness of generic promotions. Promotion awareness is a direct response by the potential buyer and has proven very useful when such data are available. Consistent household honey consumption data are not available and that is one reason for using annual honey data for modeling purposes and the Board's program expenditures. There is nothing wrong using aggregate data but one has to recognize both the benefits and limitations associated with aggregations over buyers and time. Aggregated data remove a lot of noise that often cannot be explained, yet the aggregation removes details about who does and does not buy a particular product and prevents measuring market penetration (who buys) and market intensity (how much among buyers). Ward's mango study provides insight into market penetration and market intensity (Ward, 2018).

Honey promotion expenditures can be documented back for many years even prior to the official establishment of the National Honey Board. Those expenditures are shown in Appendix A.3 while the more recent assessments and expenditures are plotted in Figure 7 starting with 2006. In 2017, there were \$9.9 million available funds of which \$7.75 was from assessments in that current year. With the increase in assessments for \$0.01 to \$0.015 shown in the previous section, total available funds increased consistently starting with 2014. For most of the years from 2006 to 2014, the available funds averaged \$5.192 million and since then averaged \$8.515 million with the peak of \$9.9 million in Figure 7. In 2006 the carryover accounted for 26.1% and since then the carryover percentage consistently declined until 2017 with a 16.4% level of available funds. Those yearly percentages are included in Appendix A.3.

The right portion of Figure 7 gives the percentage distribution of those expenditures reflected in the bars in the left part of this figure. Those expenditures by program area and operations are also included in Appendix A.3. Overall from 2006 through 2017, 74% of the expenditures went directly to marketing and industry services, all focusing on enhancing the demand for honey. Supporting research and emerging opportunities accounted for 13% and Board/Federal administrative stood at 4%. And the total administrative (office and staff) equaled 9% over the 12 years starting with 2006. In 2017 that same administrative cost dropped to 6.13% and continued to decline in the administrative percentage since 2014 (i.e., 10.41% in 2014; 8.19% in 2015; 8.13% in 2016 and 6.13% in 2017). As assessments increased, a greater share of the added dollar went directly to programs.

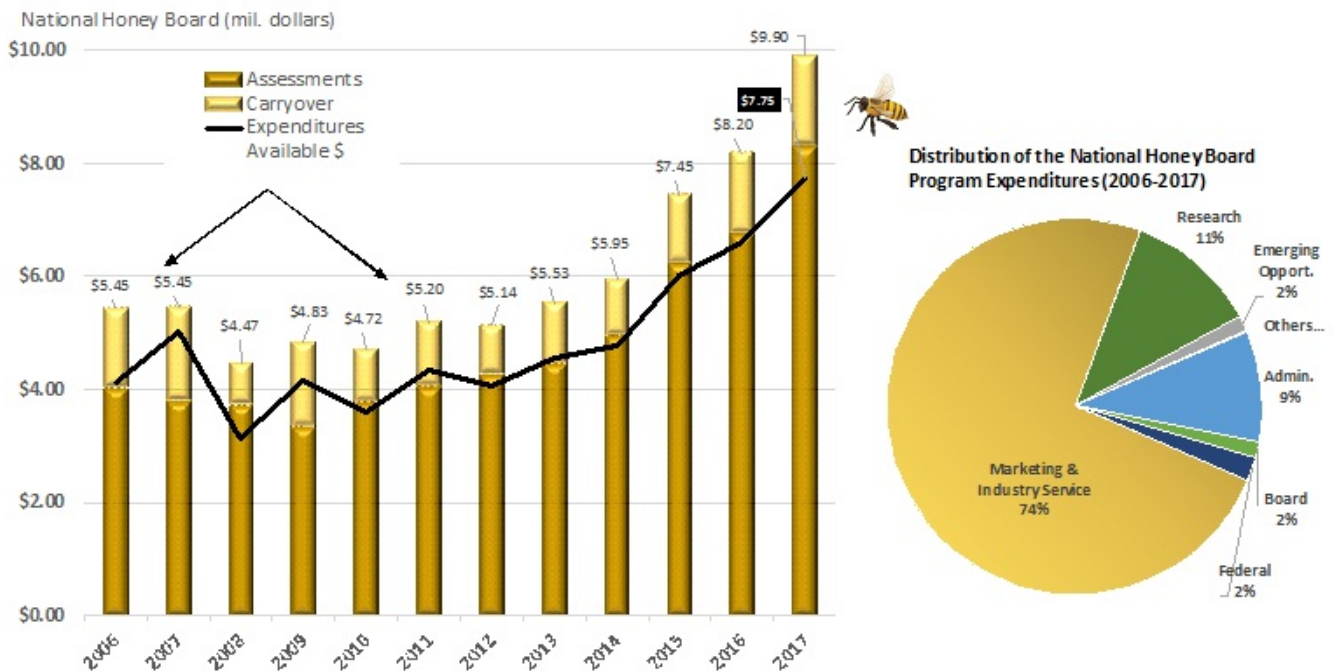


Figure 7. National Honey Board assessments and program expenditures.

As with all checkoff programs, it is not possible to implement checkoff programs without that underlying administrative costs. Yet when one sees the administrative efficiency with larger programs, that is a positive sign in the evaluation process. An opposing trend would be troubling for programs that have been ongoing for several years and that is clearly not the case of the National Honey Board.

As a quick check of the assessment dollars in Figure 7, one can take the new assessment rate times the domestic and import honey pounds to calculate the total assessments. Since there can be lags in the flow of monies and that some reported honey may not be subject to the assessments because of organic and volume rules, the actual assessments in Figure 7 could differ from the calculated. For 2015, 2016 and 2017 the new assessments of \$0.015 were in place and total reported domestic production and import pounds was 1.667 billion pounds for those three years. Total reported assessments for those three years was \$21.259, thus implying 1.417 billion pounds were assessed over those years. A ratio of  $1.417 \div 1.667 = .85$  or equivalently 15% of the honey was not subject to the assessments. This difference could be timing, organics not subject to the assessment, and production size. Using FAS numbers, 8.82% of the imports were organic and exempt from the assessments. Subtracting 8.82% of the imports from the import total then gives 1.561 billion pounds of imports potentially subject to the assessments. Dividing 1.417 by 1.564 gives 92.15% or approximately 92% of all honey (domestic and imports) entering the U.S. market place was subject to the checkoff assessment, implying that most producer/supplier who could benefit from the checkoff were also paying the assessment excepting the organic producers. That is, a potential

“free-rider” problem does not appear to be major issue. The main reason for just including the years 2015-2017 is because of the consistency in the rate level over those years.

At this juncture, we have documented the honey supply chain through volume, value and utilization. Then the checkoff monies spent to enhance the demand for honey were shown. Combining the market data and the NHB efforts, then what impacts have those checkoff programs had on the demand for honey in the U.S. market? Those impacts are the subject of the next several sections.

## **The Theory of Honey Demand**

Demand is a reflection of consumers willingness to purchase a good given a prevailing price, purchasing power, and state of knowledge. Some goods keep much of their identity through the supply chain and are recognizable at the point of purchase. Fluid milk or beef are good examples. Other goods becoming mostly ingredients are not easily recognized by the potential buyer. Table honey is easily recognized and frequently honey in manufacturing is recognized. Yet in manufacturing using honey as a sweetener may not be so visible, often depending on the manufactured food. As guidelines for developing demand models for honey, one can set forth a few principles for developing conceptual honey demand models:

- *Honey is a well known food viewed as a natural sweetener with very few, if any, negative attributes.*
- *With a long self life, households may need to be reminded about using honey since it may not be purchased as frequently as more perishable foods.*
- *Honey has a range of uses as a stand-alone food good, complements to other foods, and as an ingredient in the production of other foods.*



- *There will be a demand for honey in the absence of promotions.*
- *Varieties and forms of honey are substitutable enough to expect the law of one price to prevail. That is, one can talk about honey as a food category and hence talk about the demand for honey. The strong correlation among honey prices across colors and over the supply chain all point to the law of one price.*

These guidelines suggest the need to separate demand into two major categories: (a) table honey as a stand alone food; and (b) honey used in manufacturing for a sweetener ingredient. Then if the law-of-one price stands, prices can be linked through fairly simple equations. The second point above implies that potential and even existing buyers need to be reminded or even nudged to make a purchase, yet some level of demand will exist without any nudging. This last point has important implications when including the checkoff efforts in a demand model.

### ***Modeling Table Use of Honey***

Table honey represents honey typical in visual containers ready for sell in various consumer type outlets such a retail food chain, farmers market, etc. An interested shopper can identify the product in all of the forms and packages. Yet it is still honey within the context of the law-of-one price (e.g. all forms fit within one food category). There is an underlying demand for the product with that demand being a function of all factors influencing demand. In Figure 8 the lower curve labeled  $D_0$  depicts the relationship between quantity of honey and its price. The location of the curve depends on all of the demand drivers at a point in time. Assuming for the moment that no honey promotions existed for the coordinates along  $D_0$ , the fact that the demand curve as drawn is not at the origin in the figure implies that there is a

demand for honey even in absence of the generic promotions. This concept is true for all commodities and the question is what would the demand be if generic promotions existed?

In the upper curve with the dash line, demand has now shifted upward to  $D_1$  assuming the checkoff dollars are now positive (i.e.,  $ck > 0$ ). The positive shift denotes that generic promotions have in fact had a positive impact on consumer with the amount of the impact depending on the intensity and effectiveness of the promotions. Quite obvious, if  $D_1$  just overlaid  $D_0$  the generic efforts had no impact. It becomes an empirical question as to the location of  $D_1$  relative to  $D_0$  and that question is precisely why one must turn to statistical

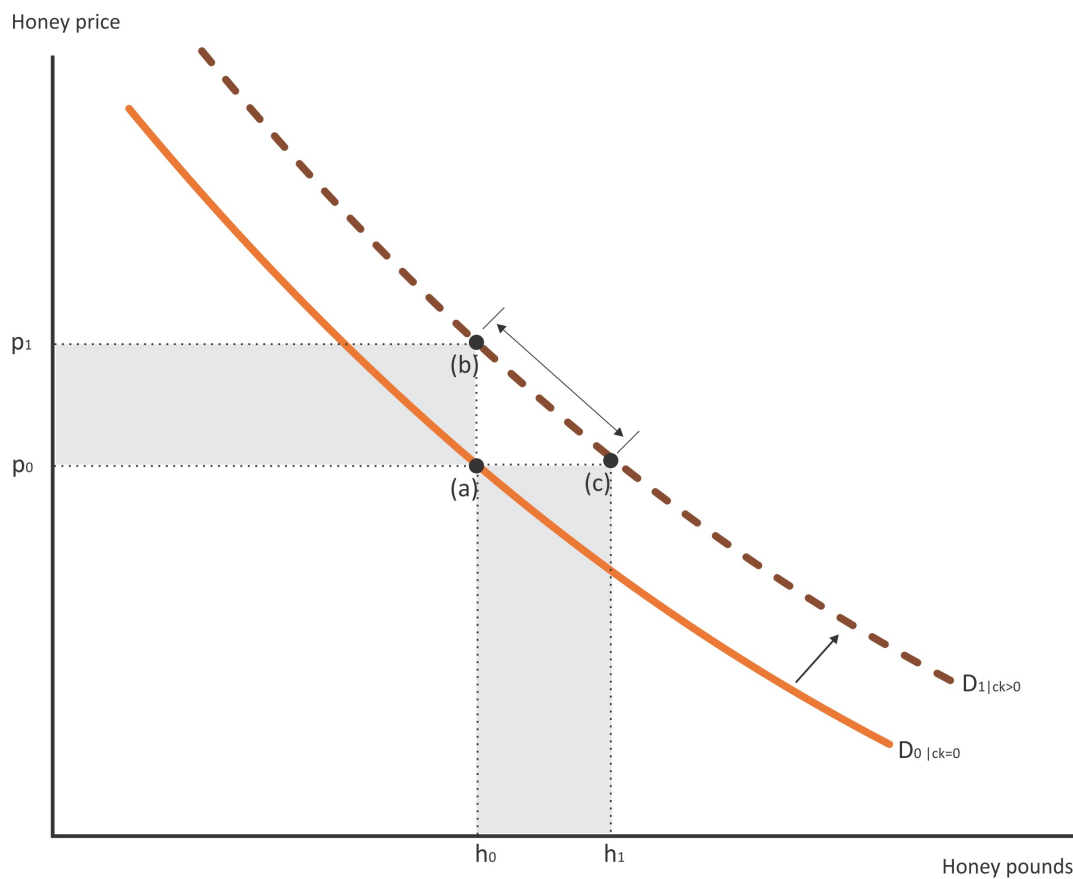


Figure 8. Conceptual demand for table honey.

modeling to determine the distance between  $D_1$  and  $D_0$  and how much it cost to achieve the resulting shift in demand. Any shift from  $D_0$  to  $D_1$  is a product of changes in market penetration and market intensity and the higher those numbers for a give commodity, the more difficult it is to achieve a significant difference between  $D_0$  and  $D_1$ .

If the available honey is fixed for a specific time, then honey prices increase from  $p_0$  to  $p_1$  in Figure 8. If supplies could increase without constrain, prices could remain the same but the quantity purchased increases from  $h_0$  to  $h_1$ . The final equilibrium is in the range from (b) to (c) in Figure 8 and depends on the slopes of the demand and supply curves. With a fixed supply, the *value gain* attributed to the checkoff program would be  $[p_1-p_0] \times h_0$  and the net benefit would be the return to what it cost to achieve that value gain. Similarly for a perfectly elastic supply, the gain would be  $[h_1-h_0] \times p_0$ . The concept here is quit basic but getting the empirical counterpart to Figure 8 can be more challenging.

The shift in Figure 8 is for a fixed amount of promotions and with more promotions the amount of gains may be smaller. Demand shifts with more and more promotions traces out what is typically called an *advertising response curve*. From that curve one can also estimate the marginal gains for incremental increases in the checkoff dollars spent. Showing *marginal gains* and *value gains* are typically two ways for measuring the impact of various commodity checkoff programs.

### ***Modeling Manufacturing Use of Honey***

There are multiple uses of honey beyond the table honey that mostly involve using honey as an ingredient in food manufacturing and particularly for baking and beverages.

Honey used for cosmetics and medical purposes exist but data on those uses are limited and most likely quite small relative to the food ingredient market. Unlike table honey, demand for honey in manufacturing is closely tied to ingredient formulas for sweeteners used in baking and beverage manufacturing. Sugars are a primary ingredient in all baking and beverages with a strong linkage between the end food product and the use of sugars. In the lower part of Figure 9 that linkage is suggested with the theoretical line showing the use of sugar as the volume of baking and beverage production increases. Note that there is no scale in the chart and the linkage is illustrated with a line just to indicate the concept. While somewhat simplistic, the lower graph illustrate the tie between the food manufacturing sector and the demand for sweeteners on the horizontal axis.

Honey account for a very small portion of the sweeteners entering the food manufacturing sector. Likewise as drawn with the solid line labeled Honey-Sugar formula, the use of honey as part of the sweetener mix is almost a linear relationship with the demand for sugar for manufacturing. Honey for manufacturing rises in some portion to the increase in uses of sugar and that will be shown later. One of the attributes of honey in manufacturing is that honey sweetener can be presented on the package of many processed food products such as honey coated cereals, honey covered candies, etc. all with an emphasis on the natural sweetener attributes of honey contrasted with artificial sweeteners.

In Figure 6 we showed the NHB focus on food processing and in Figure 9 the conceptual impact is drawn. Without any focus on the food processing, there will be some linkage between the uses of sugar and mix with honey sweetener, all suggested with  $M_0$ . With

generic promotion programs and product research, it is theoretical plausible that  $M_0$  could be rotated upward to say  $M_1$ . In the figure, a formula rotation leads to an increase in the use of honey from  $h_0$  to  $h_1$  for the same baking/beverage levels. Determining to what extent (b) differs from (a) in Figure 9 is the empirical challenge of measuring the impact of the NHB programs on the manufacturing sector.

We will see later that the mix of sugar sources on the horizontal axis can impact the

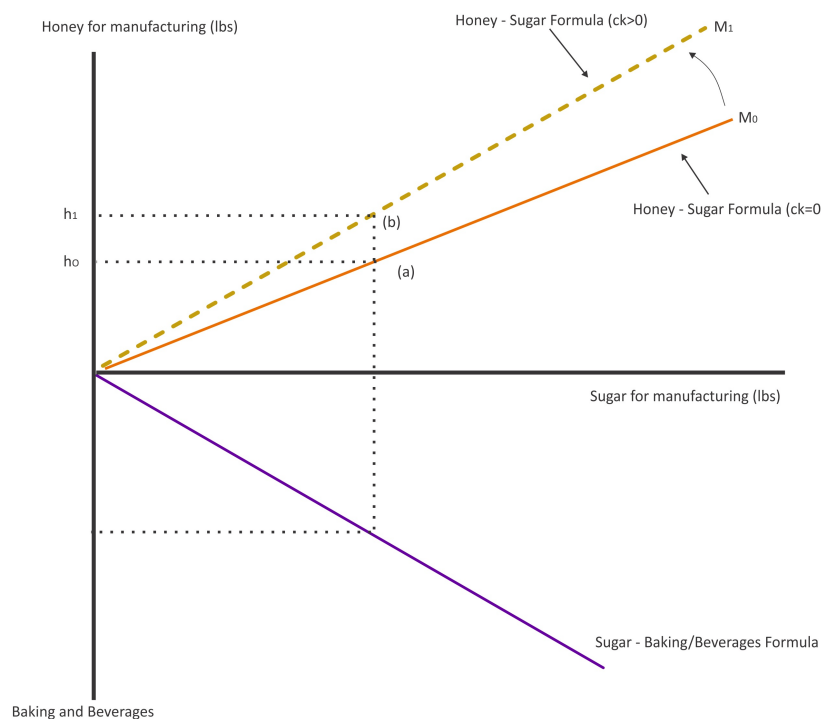


Figure 9. Conceptual demand for honey in food manufacturing.

adoption of honey. One of those sugars is High Fructose Corn Syrup that has encountered a lot of health concern issues, hence consumer concerns about its use in food manufacturing. The honey industry is expected to benefit from the change in the sugar mix as a result of the

HFCS issues. This will be shown in the manufacturing model estimation.

## **Econometric Models of Honey Demand**

Econometrics is the merging of economic theory, statistics and data for the purpose of quantifying relationships among variables of interest. For this report, it is the tool used to determine empirically if the National Honey Board's programs shifted the demand for honey as suggested in Figures 8 and 9. The tool provides the empirical responses and the ability to draw inferences about the honey checkoff impacts on demand and level of statistical confidence in those inferences. Availability and type of data dictate the type of econometrics to use. Namely, for this evaluation the data used are annual time series contrasted with having household or individual consumer data points and the necessary time series econometric methods are used. Actual estimations require adoption of computer packages with many having slightly different coding but get to the same point in estimation. Appendix B.1 provides the detailed coding using TSP, a well known statistical package. As a behind the scene check, many of the same estimates were also completed using STATA, another widely used statistical package. Those comparisons are not included except to note that the estimates were identical between the two packages.

### ***Table Honey Estimated Model***

All variables used in the analysis are defined in Appendix B.1 and for notational convenience, those definitions are repeated as the model is specified:

HDQT0	'DOMESTIC PRODUCTION (1000 LBS)';
HDPRO	'DOMESTIC PRICE (\$/LBS)';

HSTK0	'HONEY STOCKS (1000 LBS)';
HIQT0	'HONEY IMPORTS QUANTITIES (1000 LBS)';
HSPRO	'HONEY SUPPORT PRICE (\$/LBS)';
HEQT0	'HONEY EXPORTS QUANTITIES (1000 LBS)';
DPI	'REAL DISPOSABLES PERSONAL INCOME'
CPI	'CONSUMER PRICE INDEX '
SUP	'HONEY PRICE SUPPORT '
HPG	'NHB PROGRAM EXPENDITURES (MIL \$)'

Define:

PDOM = HDPRO as the U.S. domestic producer honey price (\$/lb)  
 QDOM = HDQT0/1000 as the U.S. domestic production (mil. lbs.)  
 QSTK = HSTK0/1000 as honey storage (mil. lbs.)  
 QIMP = HIQT0/1000 as honey imports (mil. lbs.)  
 QEXP = HEQT0/1000 as U.S. exports (mil. lbs.)  
 QDKE = QDOM + QSTK - QEXP as domestic honey net of exports

Allowing for potential non-linear models suggested with Figure 8 and the role of the National Honey Board, equation (1) provides a reasonable mathematical specification of the table honey demand. First the model is specified and then discussed before actually estimating the parameters while letting the “t” subscript denote the year. Eq. (1) first shows the non-linear form but the model is intrinsically linear in that all coefficients (excepting  $\eta$  and  $\tau$ ) can be estimated after making the log transformation that is a standard accepted procedure.

$$PDOM_t = (QDKE_t^{\beta_1}) (DPI_t^{\beta_2}) \exp^{\beta_0 + \beta_3 SUP_t + \delta \sqrt{(\eta_1 HPG_t + (1 - \eta_1) HPG_{t-1})}} \quad (1)$$

Eq. (1) is a standard specification except for the way the checkoff dollars enter the model. First, the link between price and quantity is capture with  $\beta_1$  where if  $|\beta_1|$  differs from one, the model set forth in Figure 8 is a curve relationship or non-linear. Honey Board program annual expenditures enter the model through  $NHB_t$  and  $NHB_{t-1}$  with t being the current year and t-1

for the previous year. Drawing from the 2012 honey evaluation, the specification in (1) proved useful with the parameters  $\delta$ ,  $\eta$  and the  $\tau$  root function and the properties in (1) for the checkoff effect are highly desirable. If  $HPG_t$  and  $HPG_{t-1}$  are both zero (i.e, no checkoff expenditures) the demand function collapses to all the terms to the left of the checkoff function. There will be a demand for honey even in the absence of the honey checkoff as re-stated with eq. (2) and mentioned in the prior section.

$$\log(PDOM_t) = \beta_1 \log(QDKE_t) + \beta_2 \log(DPI_t) + \beta_0 + \beta_3 SUP_t \quad (2)$$

If either  $HPG_t$  and  $HPG_{t-1}$  is positive, the impact on table honey demand depends on the magnitude of  $\delta$  in eq. (1). If  $\delta > 0$ , demand shifts upward and the degree of that shift depends on the size of NHB and the  $\delta$  positive value. If  $\delta$  increased over time, that would indicate gains in effectiveness for the same expenditures. Likewise, a decline in  $\delta$  would point to the programs becoming less efficient over time. Clearly, a key element in the evaluation of the table honey demand is estimating  $\delta$ .

Both  $HPG_t$  and  $HPG_{t-1}$  enter the demand equation (1), implying that current and the previous year's NHB programs impact the current demand. Inclusion of  $HPG_{t-1}$  in some form represent a typical promotion carryover effect. That is, the full impact of demand enhancing programs are not realize immediately but carried into the next year. A one year lagged effect is not atypical when using annual data. The approach expressed in eq. (1) using  $\eta_1$  to weight the current and one year lag in NHB program expenditures. Letting  $0 \leq \eta_1 \leq 1$ , then if  $\eta_1 = 1$  only the programs in the current year impact the demand for table honey. With  $\eta_1 = 0$ , the current expenditures have no impact and only the previous year's efforts impact the current year



demand for table honey (see Ward and Boynton, 2010). If  $0 > \eta_1 < 1$  both the current year and last year's Board expenditures impact current demand. In the previous evaluation of the honey programs (Ward, 2012),  $\eta_1$  was estimated to be .6 or sixty percent of the promotion impact was realized in the same year. Through 2017,  $\eta_1 = .20$  or 80 percent of the Board's impact is delayed one year. This is discussed in more detail below.

In Table 1 the estimates for eq. (1) are shown with the far left column (Col 1 and Col 2) corresponding to the notation and parameters in the table honey demand model. Given the annual data and delaying stock share, the model explicitly assumes that producer domestic honey prices are driven by domestic supplies or prices are dependent of supplies with  $\beta_1$  expected to be negative since the demand curve must be (see Figure 8) is negative based on demand theory. All variables in the model are statistically significant except for the support variable. With additional years of data, the price support variable should become less and less important. SUP was included since the model was estimated starting with year 1991 when the support programs played a larger role. In the previous evaluation, the support variable was positive and statistically significant but with the data through 2017, that particular variable is of less importance.

In Col 3,  $\beta_1 = -1.35$  and is statistically different from zero. In the previous report, the estimated coefficient was -1.30. This parameter is capturing the slope of the demand curve in Figure 8 and is shown again at the bottom of Table 1 just to illustrate mathematically.  $\beta_1$  is the price flexibility where, for example, each 10% increase (or decrease) in domestic supplies, producer honey prices would decline (or increase) by 13.5%. Table honey is very

price flexible. While not precisely correct, often one takes the reciprocal of the price flexibility to approximate a price elasticity since price elasticity is more frequently referenced in general discussions. The approximate price elasticity is -.74 or for each 10% increase (or decline) in honey prices, table honey demand would decline (or increase) by 7.4%. Honey

Table 1. Estimated demand for table honey.

Dependent variable: log(PDOM)  
 Current sample: 1991 to 2017  
 Number of observations: 27

Mean of dep. var. = .072591      LM het. test = 1.91760 [.166]  
 Std. dev. of dep. var. = .508359      Durbin-Watson = 1.09680 [.000,.054]  
 Sum of squared residuals = .692061      Jarque-Bera test = 2.17759 [.337]  
 Variance of residuals = .031457      Ramsey's RESET2 = 2.28546 [.145]  
 Std. error of regression = .177362      F (zero slopes) = 47.8990 [.000]  
 R-squared = .897002      Schwarz B.I.C. = -2.91196  
 Adjusted R-squared = .878275      Log likelihood = 11.1516

Variable	Notation	Parameter Estimate	t-value	Significance (P-value)
Col 1	Col 2	Col 3	Col 3	Col 4
Intercept	$\beta_0$	10.9442	4.59388	.000
log(QDFKE)	$\beta_1$	-1.35533	-2.88219	.009
log(DPI)	$\beta_2$	3.40249	1.85493	.077
SUP	$\beta_3$	-3.29884	-1.69443	.104
HPG <sub>t</sub>	$\delta$	.12190	2.27139	.033
HPG <sub>t-1</sub>	$\delta$	.12190	2.27139	.033
Weight	$\eta_1$	.20		
Root	$\tau$	1.00		

$$PDOM_t = (QDKE_t^{-1.355}) (DPI_t^{3.402}) \exp^{10.944 - 3.2988SUP_t + .1219(\delta_1 HPG_t + \delta_2 HPG_{t-1})}$$

demand is price inelastic but on the higher end of the price inelastic scale. As a general rule, the fewer the number of substitutes for a good, the closer the reciprocal rule is to reality.

Since the main focus of this evaluation is on the National Honey Board's impact, discussion of the HPG parameters is of utmost importance. First,  $\delta = .1219$  and is statistically different from zero with a 96% confidence level. That is, there is less than a 4% change that we find the impact statistically significant when it is not based on a two-tail test. With a one-tail test, the confidence level rises to 98% thus showing that the empirical evidence is that the National Honey Board programs have had a positive and statistically significant impact on the demand for table honey. In Figure 8, the illustrated shift in demand is positive and statistically significant. Also, the model as specified in eq. (1) was estimated stopping with year 2012, 2013, 2014, 2015, 2016 and 2017 to compare any changes in the  $\delta$  value. The coefficients cannot be compared year to year without standardizing them since the data change with additional years. A standardized  $\delta$  is simply taking the estimated  $\delta$  times the standard deviation of the independent variable (i.e., checkoff variable specification) divided by the standard deviation of the dependent variable. Those standardized  $\delta$ 's are in Appendix B.2 starting with the 1991-2012 years through 1991-2017 where the standardized  $\delta$ 's generally increased over the selected periods except for the last period 1991-2017 where the coefficient was slightly larger than the 1991-2012 period (again see Appendix B.2). From the 1991-2016 to 1991-2017, the standardized coefficients dropped from 0.25577 to 0.20639 suggesting a slight decline in the productivity of the expenditures. This may be an aberration with the addition of 2017 but still needs to be monitored over subsequent years.

In equation (1) the functional form  $\delta \sqrt{(\eta_1 HPG_t + (1 - \eta_1) HPG_{t-1})}$  was finally selected after exploring alternative specification such as using polynomial lags instead of  $\eta_1$  and different roots. All of those alternatives are not including in this report due to volume of effort. Yet the results were very robust across the root specification leading to the final  $\tau=1$  in eq. (1). Similarly, maximum likelihood procedures were used to determine the  $\eta_1$  value in Table 1. Again, there results were robust over slight changes in the  $\eta_1$  value. With these two caveats, the final model presented in Table 1 was deems the most appropriate.

Other statistics supporting the table honey model are shown in Table 1. Among those the  $R^2$  is among the more important in that it gives insight into how well the model explained the actual dependent variables, i.e., domestic honey prices. Almost 90% of the variation in honey prices are explained with the model and other statistics are within reasonable ranges. Figure 10 shows actual producer prices since 1991 with a solid line along with a dotted line giving the models ability to predict those prices based on eq. (1) and the year-to-year value of the right-hand side variables.

Predicted values are a product of the coefficients times the variable values after conversion from the non-linear to liner specification (i.e., eq. (1)). One can take the same model and instead of estimating the price, simulate how the demand would change if conditions such as no National Honey Board had existed. Similarly, simulate the impact of either increases or decreases in the promotion expenditures and calculate the difference between the predicted and simulated values. This gives the gains suggested in Figure 8 between the demand  $D_0$  and  $D_1$ . Those calculations follow in the Return-on-Investment

Section.

***Estimated Model for Honey Used in Food Manufacturing***

Unlike the table honey demand, honey going into manufacturing is closely tied to the demand for the manufactured food most for baking and beverages. Figure 9 presented the demand concept linking honey for food manufacturing to the use of sugar for baking and beverages. Each food product likely requires unique ratios of sugar to other ingredients but in total one could expect general formulas for sugar entering all aspects of the food manufacturing industry, all with some level of flexibility in the volume and sweetener mix. Over the decades since 2000, honey accounted for .81% of the sweetener market; cane/beets at 48.05%; and artificial sweeteners, 50.64% of which High Fructose Corn syrup (HFCS) was

$$QMFG_t = \lambda_0 + (TSWE_t) \left[ \lambda_1 + \lambda_2 \sqrt{NHB_t} + \lambda_3 \left( \frac{HFCS_t}{TSWE_t} \right) \right] \quad (3)$$

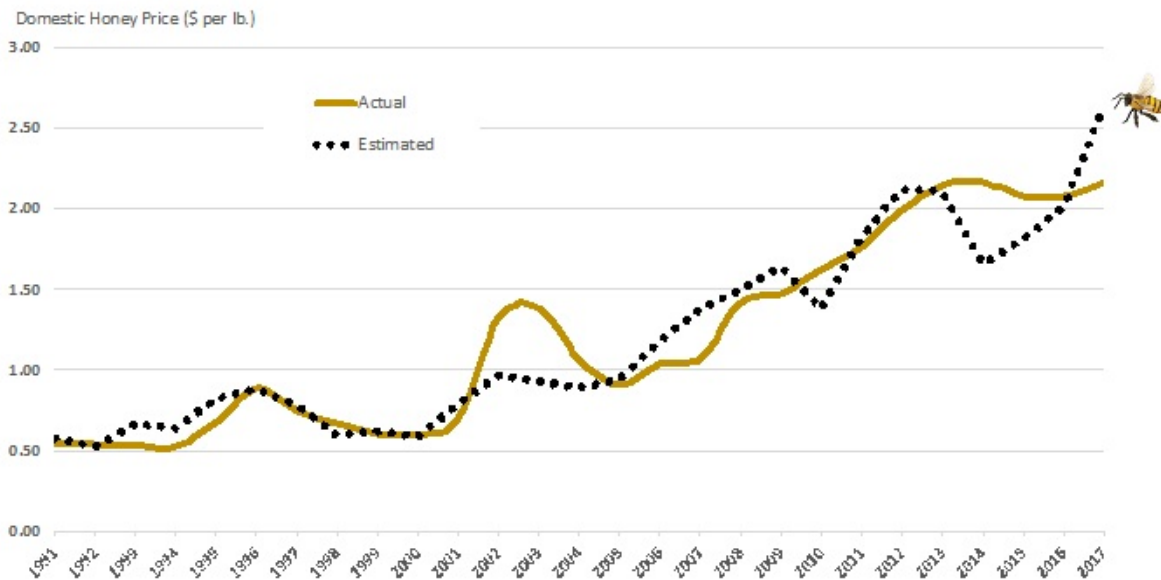


Figure 10. Actual and estimated producer prices based on the table honey demand model.

38.37%. Honey is a natural sweetener and HFCS is an artificial sweetener that in recent years has experience considerable negative press relating primary to health concerns. Given the small share the sweetener market for honey, an expectation is that some substitution of artificial for natural sweetener could occur. If HFCS share of the sugar market mix were to decline, an expectation could be for the use of more honey natural sweetener. In fact, in HFCS share of sugars consistently declined from 62.64% in 2000 to 39.76% by 2017. See the chart in Appendix C.1. Such a change in the sugar mix should have some positive impact on the use of honey for food manufacturing since honey is considered a natural sweetener. Given the fundamental attributes of honey versus HFCS and that honey prices are generally 7 times that of HFCS, one would never expect a one-to-substitute of these two sweeteners. Yet, the relative use of HFCS in baking and drinks has declined relative to cane and beef sugar.

A basic premise from Figure 9 is the relationship between the use of sugar in manufacturing and the use of honey could change if the sweetener mix between cane/beefs and artificial sweeteners changed. For the manufacturing use of honey it is not necessary to know why the mix change between cane/beef and the corn syrup but that the change occurred and that such mix be included in the honey model.

Define the following:

HSWE0	'HONEY SWEETNERS (LBS/CAPITA)'
CSWE0	'CALORIC SWEETNERS (LBS/CAPITA)'
HSWE1	'HONEY SWEETNERS (MILLIONS LBS)'
HMANF	'HONEY MANUFACTURING (1000 LBS)'
RSUGAR	'REFINED SUGAR (LBS/CAPITA)'
HFCS	'HIGH FRUCTOSE CORN SWEETNER (LBS/CAPITA)'
CRGLUC	'CORN SWEETNER - GLUCOSE (LBS/CAPITA)'
CRDEXT	'CORN SWEETNER - DEXTROSE (LBS/CAPITA)'

TCORN            'CORN SWEETNER - TOTAL (LBS/CAPITA)'  
 ESYRUP        'EDIBLE SYRUPS (LBS/CAPITA)'  
 SWTOTL        'TOTAL SWEETNERS (MILLIONS LBS)'

The let:

QMFG = HSWE0 as honey to food manufacturing (mil. lbs.)

TSWE = (RSUGAR + TCORN + ESYRUP) as the total sweetener net of honey (mil. lbs.)

Equation (3) is the model specification corresponding to Figure 9. If  $\lambda_2 = 0$  there is no impact from the NHB programs on the use of honey for manufacturing (i.e., line  $M_0$  does not rotate)

and the slope of  $M_0$  is  $\left[ \lambda_1 + \lambda_3 \left( \frac{HFCS_t}{TSWE_t} \right) \right]$ . Likewise this slope is the same without the

NHB dollars simply meaning that there will be honey used in manufacturing without the NHB programs. The value of  $\lambda_2$  determines how much more honey goes to manufacturing with the inclusion of the generic demand enhancing programs.

Equation (3) has been estimated and the results are reported in Table 2 and the manufacturing demand for honey shown at the bottom of the table. In Table 2,  $\lambda_1 = .02484$  with a t-value of 5.48, giving a 99% confidence level that the coefficient is statistically different from zero. The relationship between sugars in food manufacturing and the need for honey is established with statistical confidence.

For the impact of the National Honey Board programs on manufacturing use of honey, the estimate for  $\lambda_2$  is positive and statistically different from zero with at least a 95% confidence level and even higher with a one-tail test. Again,  $\lambda_2$  shows the positive rotation in  $M_0$  (see Figure 9) with the NHB program expenditures. Finally, the negative size for the

relative levels of HFCS in the sweeteners establishes that as the share of sugars from HFCS declines, the use of honey in manufacturing increases. The exact responses will be addressed in the next major section dealing with returns on the investment.

Note in Table 2 the explanatory power of the model is relatively high with the  $R^2=.86$ . That is, the model explains 86% of the variation in demand for honey in manufacturing. The solid line in Figure 11 corresponds to the use of honey for manufacturing

Table 2. Estimated model for honey used in food manufacturing.

Dependent variable: QMFG  
 Current sample: 1991 to 2017  
 Number of observations: 27

Mean of dep. var. = 309.340      LM het. test = .562304 [.453]  
 Std. dev. of dep. var. = 60.4243      Durbin-Watson = 1.81819 [.118,.581]  
 Sum of squared residuals = 13347.2      Jarque-Bera test = 1.70161 [.427]  
 Variance of residuals = 580.312      Ramsey's RESET2 = 3.81851 [.064]  
 Std. error of regression = 24.0897      F (zero slopes) = 46.8606 [.000]  
 R-squared = .859398      Schwarz B.I.C. = 128.647  
 Adjusted R-squared = .841058      Log likelihood = -122.055

Variable Col 1	Notation Col 2	Coefficients Col 3	t-value Col 4	Significance Col 5
Intercept	$\lambda_0$	-194.1120	-2.7965	.010
Sweeteners (TSWE)	$\lambda_1$	.020484	5.4892	.000
NHB	$\lambda_2$	.001274	2.0047	.057
HFCS/TSWE	$\lambda_3$	-.026091	-5.4223	.000

$$QMFG_t = -194.112 + (TSWE_t) \left[ .02048 + .00127 \sqrt{NHB_t} - .02609 \left( \frac{HFCS_t}{TSWE_t} \right) \right]$$



first presented in Figure 3 while the dotted line shows the model’s ability to explain that use over the years since 1991. Major growth and turning points are captured but does over and under state uses in selected years. The purpose of the model is not necessarily for predicting but is intended to capture the impact of the National Honey Board programs. In the next major section, this model will be used to show manufacturing demand over a range of NHB expenditures compared to the estimated demand plotted (dotted line) in Figure 11.

***Indirect Effects of the Honey Programs***

Equations (1) and (3) ( Tables 1 and 2) show the direct effect of the National Honey Board on the U.S. demand for honey. Two indirect linkages need to also considered, namely the price linkage between import prices with domestic honey prices and imports linked with the demand for honey used in manufacturing. While a complex system of equations could

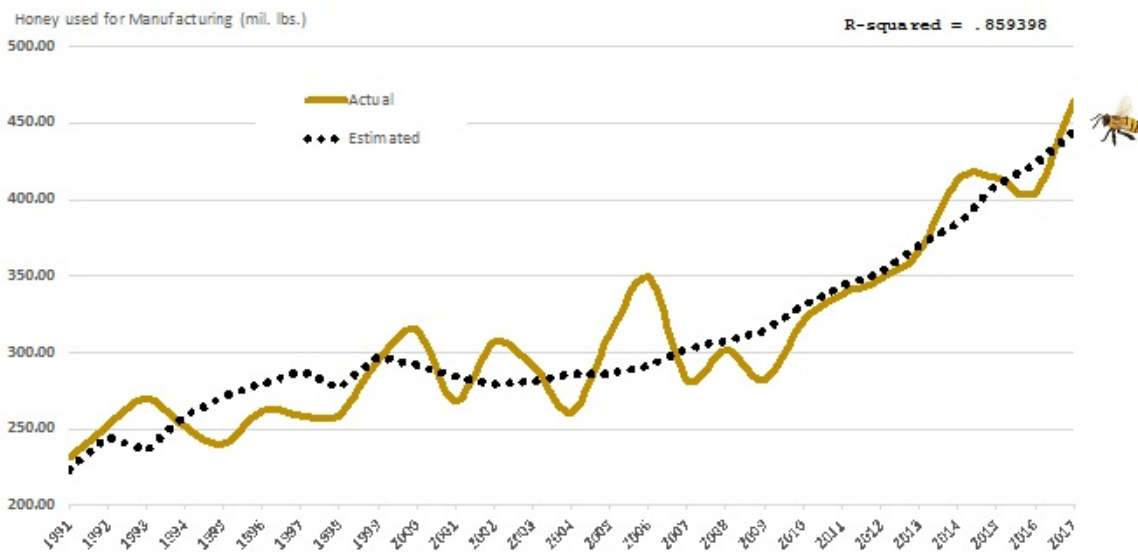


Figure 11. Predicting the demand for honey used in food manufacturing.

be developed to express these direct and indirect effects, they can fairly easily be captured with two additional equations since all honey prices are linked to some degree and most of the imports likely flow to the food processing sectors. That flow, however, cannot be precisely quantified.

Define PIMP as the import price based on FAS data (\$ lb) and PDOM as the domestic price as already defined in the table honey demand section (see Eq. (1)). Allowing for a non-linear relationship between the two prices and that the domestic price is the driver, then a quick estimation was completed assuming:  $PIMP = PDOM^{\gamma_1} (\exp^{\gamma_0})$  thus giving

$PIMP = PDOM^{.876} (\exp^{-.334})$  with the  $R^2=.94$ . With the  $\gamma_1=.876$  indicates that with a 10% increase (or decrease) in the producer price leads to a 8.76% increase in the import price. In Eq. (1) the NHB programs impact producer prices that in turn impact the import price.

Secondly, QMFG or honey for manufacturing is related to the NHB with Eq. (3). Since in total the expectation is that honey for manufacturing is closely tied to import, there should be a close empirical linkage between the two quantities where:  $QIMP = \xi_0 + \xi_1 QMGF$  or empirically,  $QIMP = -277.152 + 1.6208 QMG$ . The t-value for  $\xi_1$  is 17.83 and the  $R^2=.88$ .

## **Return-on-Investment to the National Honey Board**

The last evaluation of the National Honey Board was completed using data through 2012. In the earlier evaluation, the gains were based on comparing demand with actual NHB expenditures with and without the generic promotion programs. Given the structural changes in the industry and the new assessment rates, an alternative approach would be to compare the gains since 2012 or for the years 2013 through 2017. Average annual NHB expenditures for the 2013-2017 was \$5.94 million and from 1991-2012 the average equaled \$3.17 million. The early dollars were about 50% of the current dollars. Given this appropriate percentage difference for 50%, an approach closer to the more current activities could be to estimate the demand for honey in the U.S. market place with the programs and then what those gains in the 2013-2017 years would have been if expenditures in those years were only 50% of the actual. This is closer to the marginal approach to estimating the impact but slightly different in that we are comparing 100% activities against 50% of the activities. The semi-marginal approach is useful also because there were never experiences of zero programs so with the larger current programs compare to no programs run the risk of overstating the potential gains. This method will be applied to both the table honey model and the honey model for food processing.

### ***NHB Impact on Table Honey***

The model first presented in eq. (1) and Figure 8 provides the foundation for estimating the impact on table honey demand. Basically, one estimates honey producer prices (PDOM) with the actual program dollars spent (e.g., HPG in eq. (1)). Then using the

same model, estimate the domestic prices for the years 2013 through 2017 but assuming that expenditures were only 50% of the 2013-2107 level. That gives expenditures on average close to the 1991-2013 average expenditures. Figure 12 shows those estimated domestic prices with the NHB dollars and then with 50% of those dollars. The difference in the two prices is the gain in price attributed to the Board since 2012 and earlier years.

Over those year since 2012, the price difference on average is close to \$0.52 per pound with the increase over the 50% level of the prior years. The price would have been around 75% of the actual if those additional expenditures had not taken place. Taking those prices times the actual table honey sold gives a quick way to show the value chain for the table honey sector. Total table honey gains are the differences between the two prices times the honey for table use as presented in Table 3.

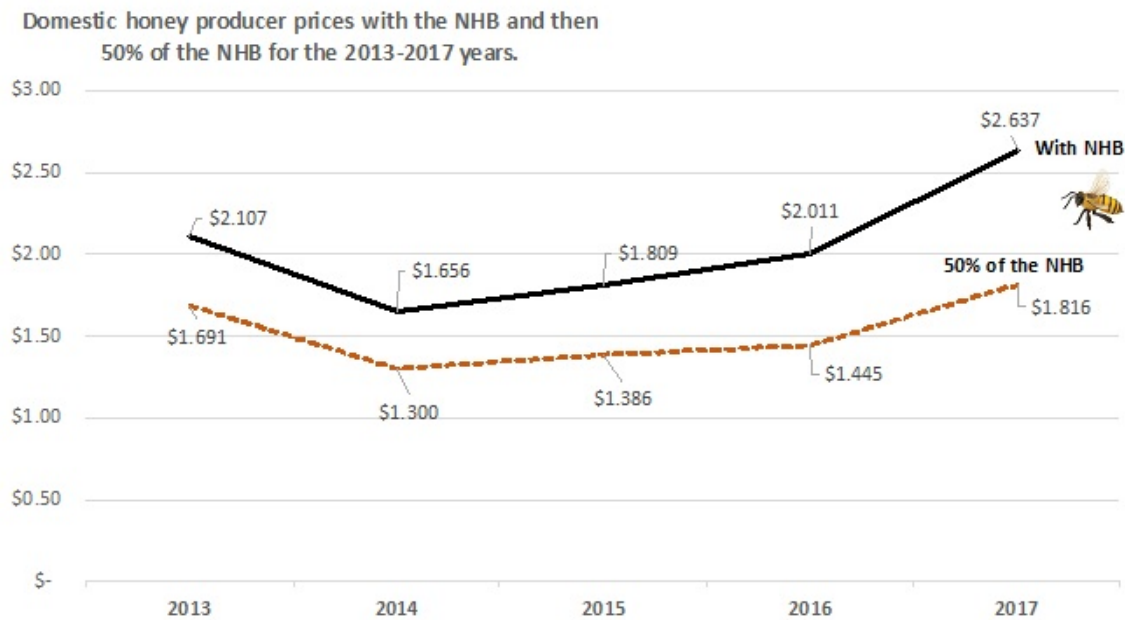


Figure 12. Estimated gain in honey prices with the NHB versus 50% of the dollars for the years 2013-2017.

Table 3. Estimated gains from enhancing the demand for table honey for the 2013-2017 years.

Year	Producer Price with NHB (\$/lb)	Producer Price with 50% of the NHB (\$/lb)	Table Honey (mil. lb)	Value With (mil. \$)	Value with 50% of NHB (mil. \$)
2013	\$2.107	\$1.691	147.616	\$310.960	\$249.670
2014	\$1.656	\$1.300	160.778	\$266.220	\$209.035
2015	\$1.809	\$1.386	159.935	\$289.245	\$221.641
2016	\$2.011	\$1.445	154.445	\$310.599	\$223.132
2017	\$2.637	\$1.816	151.046	\$398.312	\$274.340
Total Value	----	----	----	\$1,575.336	\$1,177.818
Gains	----	----	----	\$397.518	----
net NHB \$ 2013-2017	----	----	----	\$33.33 × .50 = \$16.67	----
ROI to Table Honey	----	----	----	<b>23.85</b>	----

Table 3 gives the year-by-year estimates then the total dollars with the programs and with 50% of those programs, again the 50% appropriates what would have existing with the programs had remained near the 1991-2012 average. The Board dollars are for the 2013

years forward using the allocation procedures discussed with  $HPG_t$  and  $HPG_{t-1}$  in the discussion of eq. (1). Note that the ROI is only part of the full impact since it is the gains only to the table honey use. Next those gains from the manufacturing use are estimated in a similar way.

Since half of the \$33.33 million by the NHB would have existed under the above calculations, the incremental gains must be expressed relative to half of the dollars spend. That is, in Table 3 the \$397 million are the gains from the actual less what would have existed at the 50% level or \$16.67 million in additional generic expenditures. Dividing \$397 by 16.67 yields an ROI of 23.85. This ROI to the table side is significantly larger than seen in the early study. Also, the gains are attributed to the upward shift in demand leading to major increases in honey prices. Momentarily, this same ROI will be calculated in a different way.

An important caveat is that all of the measured shift is attributed to the Honey Board. If honey brands increased their promotions in parallel with the generic efforts, then the ROI of 23.85 may be overstated. Data on the brands were not available but even if all brands equaled the same of the National Honey Boards programs, the programs returns would still be substantial in comparisons to many other commodity boards.

With the price increases attributed to the Board, one could also ask how much additional table volume would be required to force the price down the demand curve to the point that price remain the same while volume increase. Appendix D.1 outlines the methods and used later.

### ***NHB Impact on Honey for Manufacturing***

Now turning to the manufacturing use of honey, two factors must be considered to estimate the value of honey for manufacturing with and with 50% of the NHB dollars. First the manufacturing honey model shows the link between baking/beverage use of sugar and the demand for honey as an added sweetener. Second to determine the value of the added manufacturing demand the gain in pounds must be multiplied by a price. Since the expectation is that most of the manufacturing use of honey comes from imports, the price of imports should be a good indicator to the pound value at the FOB (or import) level. Earlier import prices were linked to domestic producer prices (i.e., see the section following Figure 11.)

We know from the manufacturing section that honey promotions significantly impacted the use of honey as documented in Table 2. Likewise the import price per pound was linked to the domestic price. Thus there is a manufacturing demand with actual and a 50% level of board programs and there is an indirect effect through the price linkage. Figure 13 shows both of these values then in Table 4 the actual calculations are presented.

In Figure 13, the difference in use of honey for manufacturing with actual and 50% of actual NHB programs clearly shows the impact of the manufacturing sector. With the actual Board dollars, total honey flowing into the manufacturing sector from 2013-2017 totaled an estimated 2.030 billion pounds and imports equaled 1.904 billion. If all imports went into manufacturing, some of the domestic production also had to go to manufacturing since the manufacturing total exceeded the report imports. Adding the yearly pounds in

Figure 13 shows that with 50% of the NHB dollars, manufacturing equaled 1.856 billion pounds. The difference of 173.348 million pounds is attributed to the additional board dollars above what would have been the expected level of board expenditures based on the earlier expenditures (i.e., the 50% level). The difference represents about 8.5% of the manufacturing use of honey directly attributed to the added expenditures since 2013 through 2017.

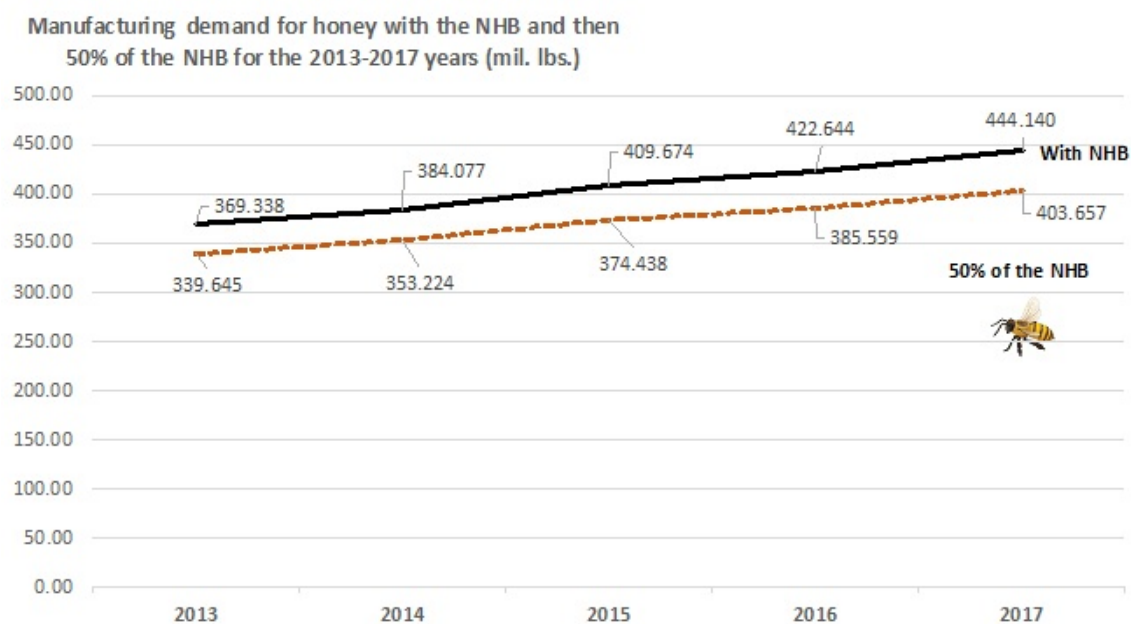


Figure 13. Estimated manufacturing use of honey with the NHB and 50% of the NHB.

Figuring the value of those pound gains becomes complicated. The gains in Figure 13 are the direct impacts. Yet we know that there is a link between the domestic price and the FOB or import price. There are two approaches and they give substantially different values. First, let QMFG1 equal the estimated manufacturing as estimated with the manufacturing model and PIMP1 is the estimated import price based on actual generic efforts. Then using



the 50% assumption, QMFG2 equals the estimated manufacturing demand at the 50% level and PIMP2 is the estimated import value given the indirect effect of PDOM1 on import prices. Using the PIMP1 as the honey value per pound, the gain (see Table 4) is \$234.30 million dollars directed attributed to the marginal dollars added over the 2013-2017 years. That is,  $PIMP1 \times (QMFG1 - QMFG2)$  is the gain in the honey value for manufacturing. Alternatively, with the link between domestic and import prices, at the lower expenditure level of 50%, the models would price the import price to be PIMP2 that for the years in Table 4 is on average 22.5% less than with the full NHB efforts. Clearly the change in the pound value far exceeds the change in actual pounds. These calculations are more easily

Table 4. Estimated value of honey with manufacturing with the NHB and the 50% level.

Year	PIMP1 (\$/lb)	PIMP2 (\$/lb)	QMFG1 (mil. Lbs.)	QMFG2 (mil. Lbs.)	VAL11 (mil. \$)	VAL21 (mil. \$)	VAL22 (mil. \$)
2013	\$1.375	\$1.134	369.338	339.645	\$507.83	\$467.00	\$385.31
2014	\$1.114	\$0.901	384.077	353.224	\$427.68	\$393.33	\$318.24
2015	\$1.203	\$0.953	409.674	374.438	\$492.83	\$450.44	\$356.75
2016	\$1.320	\$0.988	422.644	385.559	\$557.98	\$509.02	\$380.99
2017	\$1.674	\$1.208	444.140	403.657	\$743.47	\$675.70	\$487.42
Total	---	---	2029.872	1856.524	\$2,729.80	\$2,495.50	\$1,928.70
Avg.	\$1.337	\$1.037	---	---	---	---	---
Gain (11_21)	---	---	---	---	---	\$234.30	---
Gain (11_22)	---	---	---	---	---	---	\$801.10
50% of NHB	---	---	---	---	---	29.69 × .50= \$14.84	---
ROI <sub>mfg</sub>	---	---	---	---	---	<b>15.78</b>	---

seen in the table.

In Table 4, QMFG1 are the pounds of honey for manufacturing for each year starting with 2013. Then QMFG2 are those pounds under the assumption that the NHB dollars would have been 50% of the actual for those years 2013-2017, again giving expenditures close to the levels prior to 2013. Assuming the import price is still PIMP1, then  $PIMP1 \times (QMFG1 - QMFG2) = \$234.30$  million for the most recent five years. Total NHB equaled \$29.69 million for those years (i.e.,  $NHB_t$  in Table 2). Note that the program dollars in the table honey slightly different from those for the manufacturing since the table model includes a weight of the current and prior year expenditures while the manufacturing is for the year hence giving the reason for the two notations,  $HPG_t$  in the table model and  $NHB_t$  in the manufacturing model.

Taking the gains for the import price PIMP1 and dividing by the 50% of the NHB expenditures for those years gives an estimate of the ROI for the manufacturing sector or  $ROI_{mfg} = 15.78$  from the gains in using of honey in manufacturing attributed to the generic promotions. This is the most conservative approach to estimating the honey-for-manufacturing ROI since the indirect effect from changing the import price though the link between import and domestic price is not used.

In the manufacturing model honey use was linked to sugar use in food manufacturing without considering the relative prices of honey compared with sugar prices. An argument would be that if honey was becoming relatively more expensive than sugar, as is the case, one would expect the use of honey in manufacturing to decline. In Appendix D.2 the ratio

of honey-to-sugar prices has been added to the manufacturing model to test for a possible impact of the relative prices. The relative prices are also plotted in Appendix D.2.

For the manufacturing model in D.2, the estimated coefficient for PDOM/PSUG is the wrong sign and statistically no different from zero. That is, there is not statistical evidence that the relative honey prices impact the inclusion (or exclusion) of honey in the manufacturing sector. At the same time we do know that the generic efforts did positively impact the use of honey for food manufacturing.

#### ***Approximating the total ROI for 2013-2017***

To combined the total gains from both markets for honey, it is important to calculate the value using the same price assumptions. In Table 4 the manufacture value was based on the actual import prices and not that which would have been with 50% of the NHB. One can estimate the table honey value under the same assumptions. This can best be explain with the aid of Figure 14 for the table honey demand. Domestic producer prices (PDOM) are on the left vertical axis and the table honey pounds on the bottom horizontal axis. The solid curve labeled D100% is the table honey demand based on the actual NHB expenditures for the calendar years 2013 through 2017. Actual weighted average domestic producer honey price was shown to be \$2.036 for those years and the price flexibility coefficient was shown to be -1.355 (see Table 1).

Point (a) in Figure 14 is the table honey equilibrium point giving at total honey table volume of 773.82 million pounds for the five-year period at the average weighted price. Total revenues would be  $\$2.036 \times 773.82$  but in the actual calculations the price times the

pounds for each year was used instead of the average price. Next, since the price flexibility is known with statistical confidence, one can easily appropriate a price elasticity to be  $-.738$ . With this elasticity, it is a straight forward calculation to determine the loss in table honey demand if the NHB dollar were only 50% of the actual for the five years. To emphasize again, the 50% is close to the dollars before 2013 and used as the reference base. That is, what would have been the checkoff gains with the added dollars over the 50% base? For the same actual price but 50% level generic dollars, table honey demand would have to have been 632.45 million

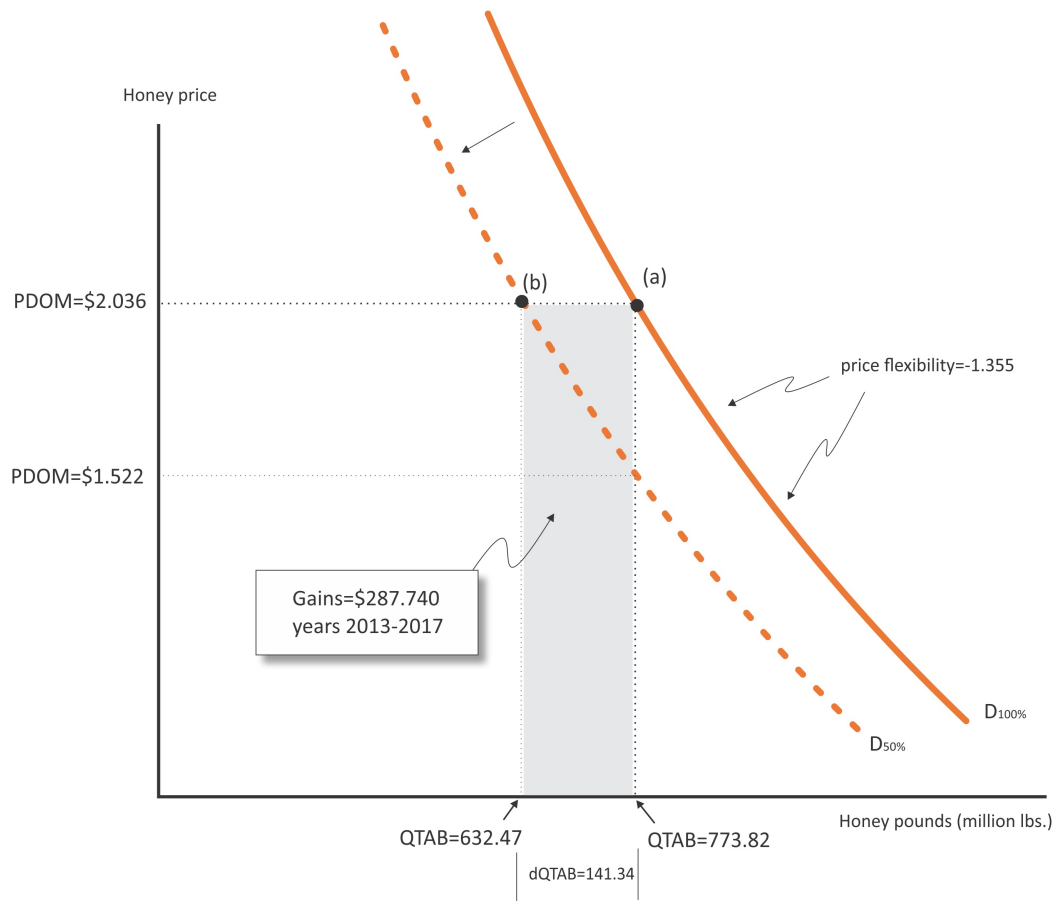


Figure 14. Gains in table honey demand attributed to the National Honey Board.

pounds to have the same producer price of \$2.036. Stated differently, if demand had been along D50% the quantity demand would be 632.47 million pounds over the 2013-2017 years at the \$2.036 price. Whereas, with the positive shift in demand attributed to the honey programs, total pounds of table honey would be 773.82 million pounds for the same price. That difference in expenditures from the actual down to the 50% level created a 22.34% increase in the pounds of honey demanded. Totals value gains at the producer level is estimated to be \$287.74 million dollar using the procedure expressed with Figure 14. This is contrasted with Table 4 where the gains were based on price changes holding the pounds fixed. The difference in gains is due to the nature of the price flexibility coefficient. This

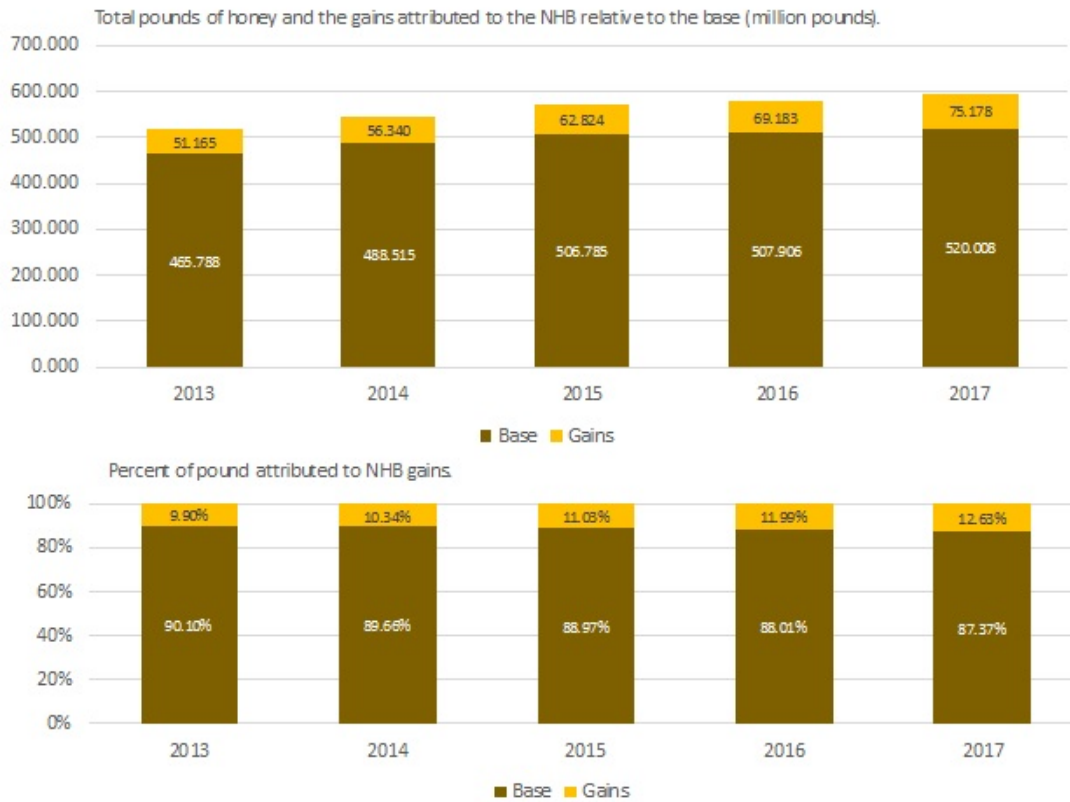


Figure 15. Estimated gains in demand for honey for the 2013-2017 years.

latter method is more desirable since the gains with table and manufacturing uses are based on holding prices fixed and allowing pounds to change. Manufacturing gains were always in pounds and with Figure 15, the table gains are now in pounds of honey. Table pounds were 22.3% greater and manufacturing pounds, 8.5% more.

Adding the columns in Figure 15 gives the total pounds for the five years of which 314.69 million pounds were attributed to the added checkoff dollars from 2013 through 2017 with 141.34 ( 44.9%) from table honey and 173.35 million pounds (55.1%) from manufacturing gains in pound equivalent increase in demand . The lower chart in Figure 15 gives the share of total pounds attributed to the honey checkoff for each of the years and the average is 11.2%. Relative to the base of 2.5 billions, the additional 314.69 million pounds represent a 12.6% growth directly attributed to the honey programs. Multiplying these gains times the appropriate prices (i.e., table and manufacturing prices) then yields the value of those shifts in demand for honey and ultimately an overall ROI to the industry.

Table 5 provides the final calculation using the actual National Honey Board expenditures compared with the 50% allocations assumption for the years 2013-2017. To repeat, the 50% assumption was used since major changes were made in the Honey Board and that rule facilitated estimating the gains relative to a base closely tied to the expenditures prior to 2013. Col (1) breaks the gains down by table and manufacturing uses of honey and then the total. Cols (2) and (3) give the gains in pounds and dollar value. Finally, the most important number of the full report is Col. (4), the return-on-investment.

Table honey demand shifted as a direct impact of the National Honey Board. As

illustrated in Figure 14, the gain is 141.34 pounds on the table use honey and 173.35 million pounds for honey used in manufacturing. Table honey accounted for 44.9% of the total poundage gain as estimated. For the value, table honey gains equaled \$287.74 million dollars and manufacturing, \$234.29 million. While the pound gains were greater for manufacturing, the price for pound for manufacturing was less than for table use as first shown in Figure 4 and that is why the dollar gains to manufacturing are only 44.9% to the

Table 5. Estimated Return-on-Investment to the National Honey Board.

	2013-2017	Gain in Millions Lbs.	Gain in Millions \$	ROI
	Col (1)	Col (2)	Col (3)	Col (4)
Row (1)	Table Honey	141.340 (44.9%)	\$287.740 (55.1%)	17.26 (55.6%)
Row (2)	Manufacturing Use	173.348 (55.1%)	\$234.296 (44.9%)	14.06 (44.4%)
Row (3)	Total	314.689	\$522.036	<b>31.32</b> (100%)
Row (4)	NHB\$=\$33.34 mil. 50% factor= \$16.667 mil.			

dollar gain. Clearly, the table honey gains exceeded the manufacturing even though manufacturing accounts for nearly 74% of the utilization of honey. Domestic honey benefits slightly more than the imported honey percentage wise.

Recall in the table honey model there was a lag effect in the impact of the honey programs (i.e., see eq. (1)) and it was shown that  $\eta_1$  equaled 80%. So fully expressing the dollars spent, the NHB dollars for the years 2013 through 2017 were added to 80% of the 2012 year giving a total of \$33.34 million in expenditures. With the 50% assumption, that gives \$16.667 million added dollars over what is assumed would have occurred. Then a practical estimate of the ROI's is simply to divide the value gains (Col. (3)) by the \$16.668 million. Col. (4) gives those estimates. Demand enhancement efforts by the National Honey Board generated an ROI of 17.26 for table honey and 14.06 for manufacturing use of honey. Combined, the estimated ROI is **31.32** over the five year span starting with 2013. This is a marginal gain representative of the more recent years and, hence, more relevant the current programs. A quick comparison to the 2014 report (or study ending with 2013 data), there has been a substantial increase in the effectiveness of the National Honey Board.

### **Summary and Conclusions**

Generic promotions of commodities are specifically intended to enhance the demand for the commodity fitting into a class of goods that have little differentiation among those producing and/or supplying the good. That is, the good is nearly homogenous in terms of the underlying attributes and characteristics. The greater the differentiation, the less likely the success of a generic effort and even the less likely that such a differentiated product



would even have an mandatory program approved at the Federal level. Commodity checkoff's existence is a product of producers/suppliers wanting a voice in the marketing process when individually that voice could not be heard because of producer size, resources, and the inability to fully capture the benefit even if a single producer promoted his or her good. The collective voice via generic advertising and promotions of the commodity is the alternative when the goods are basically non-differentiated and the need to prevent free-riders within the industry. Mandatory assessments is the mechanism to underwrite the generic program. With the authority to assess comes the responsibility to make sure the program(s) work. That is equally true for the National Honey Board where the Board has the authority to assess producers/suppliers to fund generic programs to enhance the demand for honey produced in the U.S. or entering the U.S. via imports. As part of the responsibility one has to have objective scientific measures of performance showing movement in the demand curve for honey. That scientific measurement has been the focus of this report. So what do we now know about the economic impact of the generic promotion of honey? Below are several bullet points highlighting the inferences found within this report.

- The honey industry in the U.S. has experienced considerable structural change on both the marketing and production sides. Imports have become the majority supplier accounting for nearly 75% of the honey in the U.S. marketplace. Over the same data periods, honey prices have increased by a factor of 12 or more, depending on the points in the supply chain.
- Demand for honey can be classed into two broad categories, table honey and honey going into manufacturing. In 2017, 74.3% of the utilization was for honey used in

food manufacturing. There are two distinct demands, one for table and one for manufacturing.

- The National Honey Board programs focus on both markets as is clearly documented in the content of their website.
- Assessments were raised from \$0.01 to \$0.015 per pound and that along with greater imports have generated major additional funds for underwriting the honey checkoff programs. In 2017, checkoff funds totaled \$9.9 million compared to \$4.47 million in 2008. With the growth in funds, a larger percentage of the funds were dedicated to demand enhancing programs. In 2014, 10.4% of the dollars covered administrative costs and by 2017 that administrative costs dropped to 6.13%.
- Excluding organic honey from assessments, the data suggest that only 8% of the honey was not assessed. In turn, that generally indicates minimal problems with free-rider issues (see page 25).
- Estimated demand models for both table honey and honey for manufacturing show strong statistically significant impacts of the NHB programs on both demands.
- For table honey, price elasticity of demand is estimated to be  $-0.743$  or the price flexibility estimate is  $-1.35$ . That is, for table honey consumer demand is inelastic but on the high end of the inelastic scale. This elasticity was important to calculating the return-on-investment to the National Honey Board. The 2012 study gave a similar price flexibility of  $-1.30$ .
- Positive shifts in honey demand were estimated, pointing to about a 22% (see page 55) increase in table demand compared to if the programs were funded at the levels prior to the assessment rate changes. Similarly, a 12.6% growth is seen for manufacturing honey use (see page 56).
- To estimate the Return-on-Investments, the gains were estimated with actual program

expenditures and then to expenditures set to 50% of the actual. The 50% rate basically set the expenditures to levels prior to the new assessment rates and changes in the staffing/facilities.

- Using the estimated demand models and the 50% level comparison, ROI's (Return-on-Investment) were estimated. Returns to the Table Honey side gave an ROI of 17.26 and for the Manufacturing side, the ROI=14.06. Combined, the estimated ROI=31.32 (see Table 5). This is a large return relative to many other generic programs and nearly double the values estimated for the 2012 study.
- There are obviously many uses of honey in brands and honey identity in manufactured foods such as cereals where honey is clearly identified. It is impossible to know those non-generic efforts and the costs. Possibly the NHB could be picking up some of those benefits but also the generic programs could be a catalyst for including honey on food packaging covers as one example. Even with non-generic efforts, the generic returns are so high that one cannot assume all of the gains were from non-generic programs.

The overall conclusion is that the results for the National Honey Board is that the programs have enhanced the U.S. demand for honey for both table and honey for manufacturing. The gains to the table side were stronger than found for the manufacturing side of the demand equations. This is difference than seen in the earlier study where manufacturing ROI exceeded the table honey ROI.

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## Appendices

### Appendix A.1: Price linkages

```

HDPRO      ='DOMESTIC PRICE ($/LBS)';
HRPRO      ='RETAIL PRICE - ALL HONEY ($/LBS)';
HIPRO_FOB='HONEY IMPORTS FOB PRICE ($/LBS)';
  
```

Dependent variable: HDPRO  
 Current sample: 1966 to 2017  
 Number of observations: 52

Mean of dep. var. = .838986  
 Std. dev. of dep. var. = .589673  
 Sum of squared residuals = .844427  
 Variance of residuals = .016889  
 F (zero slopes) = 1000.03 [.000]  
 R-squared = .952382

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	.124216	.028908	4.29697	[.000]
HRPRO	.484742	.015329	31.6232	[.000]

$$\frac{\partial HDPRO}{\partial HRPRO} = .485$$

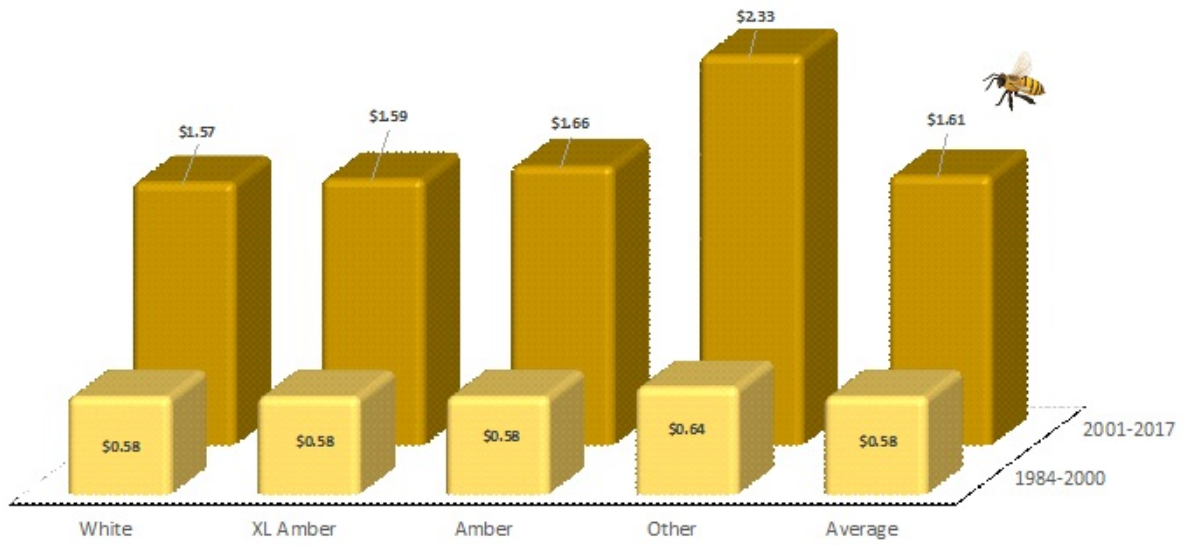
Dependent variable: HIPRO\_FOB  
 Current sample: 1966 to 2017  
 Number of observations: 52

Mean of dep. var. = .582761  
 Std. dev. of dep. var. = .391730  
 Sum of squared residuals = .314458  
 F (zero slopes) = 1194.38 [.000]  
 R-squared = .959819

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	.036720	.019251	1.90747	[.062]
HDPRO	.650834	.018832	34.5597	[.000]

$$\frac{\partial HIPRO\_FOB}{\partial HDPRO} = .651$$

Appendix A.2: Honey prices (\$/lb) by color.



Appendix A.3. National Honey Board Expenditures.

Year	Total Honey Programs
1990	\$3,912,539.00
1991	\$2,942,666.00
1992	\$3,589,921.00
1993	\$2,628,928.00
1994	\$3,471,634.00
1995	\$3,616,796.00
1996	\$3,679,183.00
1997	\$3,863,456.00
1998	\$3,081,252.00
1999	\$3,871,021.00
2000	\$3,897,055.00
2001	\$3,702,163.30
2002	\$3,580,777.93
2003	\$4,403,253.66
2004	\$3,836,794.78
2005	\$3,059,335.23
2006	\$4,118,733.00
2007	\$5,045,942.59
2008	\$3,132,405.78
2009	\$4,157,249.98
2010	\$3,593,463.07
2011	\$4,328,503.25
2012	\$4,082,752.93
2013	\$4,556,490.00
2014	\$4,776,016.00
2015	\$6,009,300.00
2016	\$6,595,655.00
2017	\$7,750,974.00



## Appendix B.1. TSP honey demand modeling program statements.

```

OPTIONS MEM=1000;
TITLE 'NATIONAL HONEY BOARD - 2018 EVALUATION';
FREQ A;
SMPL 1965,2017;
IN 'G:\ZHoney\Honey2018\HoneyTSP\NHB2018.TLB';

LIST ZVARZ Year COLNY YIELD HDQT0 HDPR0 HDVA0 HSTK0 HIQT0 HEQT0
HIQT0FAS HEQT0FAS HDIQT0 HIPRO_FOB HIPRO_CIF HEPRO HIVA0_FOB
HIVA0_CIF HIVA1_FOB HIVA0_CIF HEVA0 HEVA1 HSPRO HPARITY HCPR1 HCPR2
HCPR3 HCPR4 HCPR0 HRPR1 HRPR2 HRPR3 HRPR4 HRPR0 HAPR1
HAPR2 HAPR3 HAPR4 HAPR0 POP HSWE0 CSWE0 HSWE1 HMANF RSUGAR HFCS CRGLUC
CRDEXT TCORN ESYRUP SWTOTL MFG01 MGF02 MGF03 MGF04
MGF05 MGF06 MGF07 MGF08 MGF09 MGF10 MGF11 MGF12 MGF13 MGF14 DPI CPI GDP
IXYR HBEXP_PRG HBEXP_ADV HBPER_ADV HBEXP_ADM9
HBEXP_BRD2 HBEXP_FED HBEXP_ADM11 HBEXP_CAP HBADM_CAP HBADMPER
HBEXP_TOT10 HBPER_PRG HBASSEMT HBINCOME;

? doc Year 'CALENDAR YEAR';
? doc COLNY 'COLONIES (1,000)';
? doc YIELD 'POUNDS PER COLONY (LBS)';
? doc HDQT0 'DOMESTIC PRODUCTION (1000 LBS)';
? doc HDPR0 'DOMESTIC PRICE ($/LBS)';
? doc HDVA0 'DOMESTIC VALUE ($1000)';
? doc HSTK0 'HONEY STOCKS (1000 LBS)';
? doc HIQT0 'HONEY IMPORTS QUANTITIES (1000 LBS)';
? doc HEQT0 'HONEY EXPORTS QUANTITIES (1000 LBS)';
? doc HIQT0FAS 'HONEY IMPORTS FAS QUANTITIES (1000 LBS)';
? doc HEQT0FAS 'HONEY EXPORTS FAS QUANTITIES (1000 LBS)';
? doc HDIQT0 'HONEY DOMESTIC & IMPORTS QUANTITIES (1000 LBS)';
? doc HIPRO_FOB 'HONEY IMPORTS FOB PRICE ($/LBS)';
? doc HIPRO_CIF 'HONEY IMPORTS CIF PRICE ($/LBS)';
? doc HEPRO 'HONEY EXPORTS PRICE ($/LBS)';
? doc HIVA0_FOB 'HONEY IMPORTS FOB VALUE ($1,000)';
? doc HIVA0_CIF 'HONEY IMPORTS CIF VALUE ($1,000)';
? doc HIVA1_FOB 'HONEY IMPORTS FAS FOB VALUE ($1,000)';
? doc HIVA0_CIF 'HONEY IMPORTS FAS CIF VALUE ($1,000)';
? doc HEVA0 'HONEY EXPORTS VALUE ($1,000)';
? doc HEVA1 'HONEY EXPORTS FAS VALUE ($1,000)';
? doc HSPRO 'HONEY SUPPORT PRICE ($/LBS)';
? doc HPARITY 'PARITY ADJUSTMETN FACTOR';
? doc HCPR1 'COOP/PRIVATE PRICE - WHITE HONEY ($/LBS)';
? doc HCPR2 'COOP/PRIVATE PRICE - XL AMBER HONEY ($/LBS)';
? doc HCPR3 'COOP/PRIVATE PRICE - AMBER HONEY ($/LBS)';
? doc HCPR4 'COOP/PRIVATE PRICE - OTHER HONEY ($/LBS)';
? doc HCPR0 'COOP/PRIVATE PRICE - ALL HONEY ($/LBS)';
? doc HRPR1 'RETAIL PRICE - WHITE HONEY ($/LBS)';
? doc HRPR2 'RETAIL PRICE - XL AMBER HONEY ($/LBS)';
? doc HRPR3 'RETAIL PRICE - AMBER HONEY ($/LBS)';
? doc HRPR4 'RETAIL PRICE - OTHER HONEY ($/LBS)';
? doc HRPR0 'RETAIL PRICE - ALL HONEY ($/LBS)';
? doc HAPR1 'AVERAGE PRICE - WHITE HONEY ($/LBS)';
? doc HAPR2 'AVERAGE PRICE - XL AMBER HONEY ($/LBS)';
? doc HAPR3 'AVERAGE PRICE - AMBER HONEY ($/LBS)';

```

? doc HAPR4 'AVERAGE PRICE - OTHER HONEY (\$/LBS)';  
 ? doc HAPR0 'AVERAGE PRICE - ALL HONEY (\$/LBS)';  
 ? doc POP 'US POPULATION (MILLIONS)';  
 ? doc HSWE0 'HONEY SWEETNERS (LBS/CAPITA)';  
 ? doc CSWE0 'CALORIC SWEETNERS (LBS/CAPITA)';  
 ? doc HSWE1 'HONEY SWEETNERS (MILLIONS LBS)';  
 ? doc HMANF 'HONEY MANUFACTURING (1000 LBS)';  
 ? doc RSUGAR 'REFINED SUGAR (LBS/CAPITA)';  
 ? doc HFCS 'HIGH FRUCTOSE CORN SWEETNER (LBS/CAPITA)';  
 ? doc CRGLUC 'CORN SWEETNER - GLUCOSE (LBS/CAPITA)';  
 ? doc CRDEXT 'CORN SWEETNER - DEXTROSE (LBS/CAPITA)';  
 ? doc TCORN 'CORN SWEETNER - TOTAL (LBS/CAPITA)';  
 ? doc ESYRUP 'EDIBLE SYRUPS (LBS/CAPITA)';  
 ? doc SWTOTL 'TOTAL SWEETNERS (MILLIONS LBS)';  
 ? doc MFG01 'BAKERY, CEREALS AND ALLIED PRODUCTS (MIL LBS)';  
 ? doc MGF02 'CONFECTIONERY AND RELATED PRODUCTS (MIL LBS)';  
 ? doc MGF03 'ICE CREAM AND DAIRY PRODUCTS (MIL LBS)';  
 ? doc MGF04 'BEVERAGES (MIL LBS)';  
 ? doc MGF05 'CANNED, BOTTLED & FROZEN FOOD (MIL LBS)';  
 ? doc MGF06 'ALL OTHER FOOD USE (MIL LBS)';  
 ? doc MGF07 'NON-FOOD USE (MIL LBS)';  
 ? doc MGF08 'SUBTOTAL INDUSTRIAL (MIL LBS)';  
 ? doc MGF09 'HOTELS, RESTAURANTS, AND INST. (MIL LBS)';  
 ? doc MGF10 'WHOLESALE GROCERS, JOBBERS, SUGAR DEALERS (MIL  
 LBS)';  
 ? doc MGF11 'RETAIL GROCERS, CHAIN STORES (MIL LBS)';  
 ? doc MGF12 'ALL OTHER DELIVERIES (MIL LBS)';  
 ? doc MGF13 'SUBTOTAL NON-INDUSTRIAL (MIL LBS)';  
 ? doc MGF14 'TOTAL U.S. (MIL LBS)';  
 ? doc DPI 'DISPOSAL PERSONAL INCOME';  
 ? doc CPI 'CONSUMER PRICE INDEX';  
 ? doc GDP 'GROSS DOMESTIC PRODUCT';  
 ? doc IXYR 'YEAR';  
 ? doc HBEXP\_PRG 'HONEY BOARD EXPENDITURES - DEMAND ENHANCING  
 PROGRAMS (\$)';  
 ? doc HBEXP\_ADV 'HONEY BOARD EXPENDITURES - ADVERTISING AND FOOD  
 SERVICES (\$)';  
 ? doc HBPER\_ADV 'HONEY BOARD EXPENDITURES - PERCENT ADVERTISING  
 AND FOOD SERVICES (%)';  
 ? doc HBEXP\_ADM9 'HONEY BOARD EXPENDITURES - TOTAL ADMINISTRATION  
 (\$)';  
 ? doc HBEXP\_BRD2 'HONEY BOARD EXPENDITURES - BOARD MEETINGS (\$)';  
 ? doc HBEXP\_FED 'HONEY BOARD EXPENDITURES - FEDERAL OVERSIGHT  
 (\$)';  
 ? doc HBEXP\_ADM11 'HONEY BOARD EXPENDITURES - ADMINISTRATION/FEDERAL  
 (\$)';  
 ? doc HBEXP\_CAP 'HONEY BOARD EXPENDITURES - CAPITAL IMPROVEMENTS  
 (\$)';  
 ? doc HBADM\_CAP 'HONEY BOARD EXPENDITURES - TOTAL PROGRAM  
 EXPENDITURES (\$)';  
 ? doc HBADM 'HONEY BOARD EXPENDITURES - PROGRAM SHARE OF TOTAL  
 EXPENDITURES (%)';  
 ? doc HBEXP\_TOT10 'HONEY BOARD EXPENDITURES - TOTAL EXPENDITURES  
 (\$)';  
 ? doc HBPER\_PRG 'HONEY BOARD EXPENDITURES - SHARE OF TOTAL  
 EXPENDITURES (%)';  
 ? doc HBASSEM 'HONEY BOARD EXPENDITURES - ASSESSMENTS';

```

? doc HBINCOME          'HONEY BOARD EXPENDITURES - ALL INCOMES';

PRINT YEAR HSWE0;

?=====;
? PRICE CORRELATIONS          ;
?=====;
CORR HDPR0 HIPR0_FOB;      ? DOMESTIC PRICE ($/LBS)and HONEY IMPORTS FOB
PRICE ($/LBS);
LHDPR0=HDPR0(-1);
CORR HDPR0 HRPR0;          ? DOMESTIC PRICE ($/LBS)and RETAIL PRICE - ALL
HONEY ($/LBS);
SELECT LHDPR0>0;
CORR HRPR0 LHDPR0;
OLSQ HIPR0_FOB C HDPR0;

OLSQ HDPR0 C HRPR0;

CORR HAPR1 HAPR2 HAPR3 HAPR4 HAPR0;

SELECT YEAR>1999;

CORR HDPR0 HIPR0_FOB;      ? DOMESTIC PRICE ($/LBS)and HONEY IMPORTS FOB
PRICE ($/LBS);
LHDPR0=HDPR0(-1);
CORR HDPR0 HRPR0;          ? DOMESTIC PRICE ($/LBS)and RETAIL PRICE - ALL
HONEY ($/LBS);
SELECT LHDPR0>0;
CORR HRPR0 LHDPR0;
OLSQ HIPR0_FOB C HDPR0;

OLSQ HDPR0 C HRPR0;

SELECT 1;

?=====;
? HONEY FOR MANUFACTURING          ;
? RELATING TO INDUSTRY PROMOTIONS  ;
?=====;
?HSWE1                          'HONEY SWEETNERS (MILLIONS LBS)';
?SWTOTL                          'TOTAL SWEETNERS (MILLIONS LBS)';
NCSWE1=(SWTOTL - HSWE1); ? TOTAL SWEETENERS LESS THE USE OF HONEY;
SWEET_PC=NCSWE1/POP;           ? SWEETENERS PER CAPITA;
RHFCS=HFCS/SWEET_PC;          ? HFCS RELATIVE TO SWEETENERS NET OF HONEY;
PRINT YEAR RHFCS;

SELECT 1;

?=====;
=====;
? EXPRESSING ALL HONEY BOARD PROGRAMS IN TERMS OF MILLIONS OF DOLLARS
PER YEAR          ;
?=====;
=====;
DHBEXP_PRG = (HBEXP_PRG)/1000000; ? DEMAND ENHANCING PROGRAMS WITH
INDUSTRY AND ADVERTISING COMBINED ($ MIL)

```

```

DHBEXP_TOT10 = HBEXP_TOT10/1000000; ? TOTAL EXPENDITURES ($ MIL);

?=====
=====;
? HONEY MODEL FOR USE IN MANUFACTURING
? HONEY FOR MGF IS RELATED TO NON-HONEY SWEETNERS WITH ADJUSTMENTS
;
?=====
=====;
      OLSQ(ROBUST) HSWE1 C NCSWE1 DHBEXP_PRG(-1);

SELECT 1;
?=====;
? HONEY FOR TABLE USE ;
? RELATING TO PROMOTION PROGRAMS ;
?=====;
? HDIQT0      'HONEY DOMESTIC & IMPORTS QUANTITIES (1000 LBS)';
? HEQT0       'HONEY EXPORTS QUANTITIES (1000 LBS)';
? DPIHOME     'FOOD EXPENDITURES - AT HOME ($ BILLIONS)';
? HDQT0       'DOMESTIC PRODUCTION (1000 LBS)';
? HDPRO       'DOMESTIC PRICE ($/LBS)';
? HSTK0       'HONEY STOCKS (1000 LBS)';
? HIQT0       'HONEY IMPORTS QUANTITIES (1000 LBS)';
? HEQT0       'HONEY EXPORTS QUANTITIES (1000 LBS)';

PDOM=HDPRO;           ? DOMESTIC PRICE ($/LBS);
PIMP=HIPRO_FOB;       ? IMPORT PRICE ($/LBS);
DPDOM=( PDOM - PDOM(-1) ); ? CHANGE IN PRICE FROM PREVIOUS YEAR;
QDOM=HDQT0/1000;      ? DOMESTIC PRODUCTION (MIL LBS);
QSTK=HSTK0/1000;     ? HONEY STOCKS (MIL LBS);
SELECT QSTK=0; QSTK=@MISS;
SELECT 1;
QEXP=HEQT0/1000;      ? HONEY EXPORTS (MIL LBS);
QIMP=HIQT0/1000;     ? HONEY IMPORTS (MIL LBS);
QMFG=HSWE1;          ? HONEY SWEETENERS (MIL LBS);
QMFG_NET=QMFG-QIMP;  ? NET DOMESTIC DEMAND FOR HONEY FOR
MANUFACTURING (ASSUMES IMPORTS MOSTLY GO TO MFG.);
QTOT=QDOM+QIMP+QSTK;
PRINT YEAR QTOT QMFG QEXP QSTK QIMP;
TREND=1;
TREND=(YEAR<2010)*1 + (YEAR>=2010)*(TREND(-1)+1);
PRINT YEAR TREND;

?=====;
? STOCK EQUATION AND FILLING MISSING VALUES FOR 1982-1985 ;
? THIS IS NO LONGER USED SINCE THE VALUES ARE NOW KNOWN ;
?=====;
?      OLSQ QSTK C DPDOM QSTK(-1);
?      SET B0=@COEF(1); SET B1=@COEF(2); SET B2=@COEF(3);
?      SELECT YEAR=1982; QSTK=B0 + B1*DPDOM + B2*QSTK(-1);
?      SELECT YEAR=1983; QSTK=B0 + B1*DPDOM + B2*QSTK(-1);
?      SELECT YEAR=1984; QSTK=B0 + B1*DPDOM + B2*QSTK(-1);
?      SELECT YEAR=1985; QSTK=B0 + B1*DPDOM + B2*QSTK(-1);
?      SELECT 1;
?      PRINT QSTK;
?=====

```

```

=====;
? HONEY EQUATION FOR MANUFACTURING THEN RELATING IMPORTS TO THE HONEY
FOR MANUFACTURING;
? MODEL ALLOWS THE SLOPE BETWEEN SWEETENER AND USE OF HONEY TO CHANGE
WITH PROMOTIONS ;
?=====
=====;
?NCSWE1 TOTAL SWEETNERS NET OF HONEY USE;
TITLE 'HONEY MODEL FOR MANUFACTURING';
MFORM(TYPE=GEN,NROW=800,NCOL=22) ZMFGZ=0;
SET I=0;

DO K=2017 TO 2017; ?RECURSIVE MODEL;
DO ROOT=.50 TO .50 ;

HNCSWE0=NCSWE1*[ (DHBEXP_PRG )**ROOT ]; ? INTERACTION TERM BETWEEN
NON-HONEY SWEETNERS AND PROMOTIONS;
HNCSWE1=NCSWE1*[ (DHBEXP_PRG(-1) )**ROOT ]; ? INTERACTION TERM BETWEEN
NON-HONEY SWEETNERS AND PROMOTIONS;
HNCSWE2=NCSWE1*RHFCS;
? MODEL 3 - HONEY FOR MANUFACTURING;
? QMFG - HONEY SWEETENERS (MIL LBS);
DOT QMFG NCSWE1 TREND; L.=LOG(.); ENDDOT;
LHNCSWE0=LNCSWE1*( (DHBEXP_PRG )**ROOT);
LHNCSWE1=LNCSWE1*( (DHBEXP_PRG(-1) )**ROOT);
LHNCSWE2=LNCSWE1*RHFCS; ? RHFCS = share of sugar from High Fructose
Corn Syrup
CORR NCSWE1 QMFG;
CORR C NCSWE1 HNCSWE0 HNCSWE1 HNCSWE2;

SELECT (YEAR>1990) & (YEAR<=K); ? 1990 WAS THE FIRST YEAR WITH NHB
DATA;
? OLSQ(ROBUST) QMFG C LNCSWE1 LHNCSWE0; ? <=== SLOPES
CHANGES RECURSIVELY FROM 2012 THROUGH 2017;
? OLSQ(ROBUST) QMFG C LNCSWE1 LHNCSWE0 LHNCSWE1; ? <=== SLOPES
CHANGES RECURSIVELY FROM 2012 THROUGH 2017;
OLSQ(ROBUST) QMFG C LNCSWE1 LHNCSWE1 LHNCSWE2; ? <===
SLOPES CHANGES RECURSIVELY FROM 2012 THROUGH 2017;
OLSQ(ROBUST) QMFG C LNCSWE1 LHNCSWE0 LHNCSWE2; ? <===
SLOPES CHANGES RECURSIVELY FROM 2012 THROUGH 2017;
OLSQ(ROBUST) QMFG C LNCSWE1 LHNCSWE0 LHNCSWE1 LHNCSWE2; ? CURRENT AND
LAG NHB AND HFCS SHARE;
OLSQ(ROBUST) QMFG C NCSWE1 HNCSWE0 HNCSWE2; ? CURRENT AND LAG
NHB AND HFCS SHARE -LINEAR MODEL;
OLSQ(ROBUST) QMFG C NCSWE1 HNCSWE1 HNCSWE2; ? CURRENT AND LAG
NHB AND HFCS SHARE -LINEAR MODEL;
OLSQ(ROBUST) QMFG C NCSWE1 HNCSWE0 HNCSWE1 HNCSWE2; ? CURRENT AND
LAG NHB AND HFCS SHARE -LINEAR MODEL;
? OLSQ(ROBUST) QMFG C LNCSWE1 LHNCSWE1; ? <=== SLOPES
CHANGES RECURSIVELY FROM 2012 THROUGH 2017;

OLSQ(ROBUST) QMFG C NCSWE1 HNCSWE0 HNCSWE2; ? CURRENT AND LAG
NHB AND HFCS SHARE -LINEAR MODEL;
BM0=@COEF(1); BM1=@COEF(2); BM2=@COEF(3); BM3=@COEF(4);

SET I=I+1;
SET ZMFGZ(I,1)=K;

```

```

SET ZMFGZ (I,2)=ROOT;
SET ZMFGZ (I,3)=@LOGL;
SET ZMFGZ (I,4)=@RSQ;
SET ZMFGZ (I,5)=@COEF(1);
SET ZMFGZ (I,6)=@COEF(2);
SET ZMFGZ (I,7)=@COEF(3);
SET ZMFGZ (I,8)=@COEF(4);
SET ZMFGZ (I,9)=0;
SET ZMFGZ (I,10)=@T(1);
SET ZMFGZ (I,11)=@T(2);
SET ZMFGZ (I,12)=@T(3);
SET ZMFGZ (I,13)=@T(4);
SET ZMFGZ (I,14)=0;

ENDDO;                                ? LOOPING FOR THE YEAR - NOW THROUGH
2017 AND BACKWARD;
ENDDO;                                ? LOOPING FOR THE ROOT-

?=====
;
? NOW RUNNING THE MANUFACTURING DEMAND FOR HONEY USING KALMAN
FILTERING;
? MUST ESTABLISH THE ROOT BEFORE RUNNING THE KALMAN FILER
;
?=====
;

SELECT [YEAR>=1991] & [YEAR<=2017];

OLSQ(ROBUST) QMFG C NCSWE1 HNCWE0 HNCWE2;
WRITE(FORMAT=EXCEL, FILE='G:\ZHONEY\HONEY2018\HONEYTSP\HONEYMFG.XLS')
ZMFGZ;

SELECT 1;
TITLE 'HONEY MODEL FOR MANUFACTURING';

SELECT 1;
SELECT YEAR>1990;
QMFG0=QMFG;                                ?
<== ACTUAL MANUFACTURING USE OF HONEY;
QMFG1=(BM0 + BM1*NCSWE1 + BM2*HNCWE0 + BM3*HNCWE2);    ? <== ACTUAL
MANUFACTURING USE OF HONEY;
HBINDNONE=0;
SELECT YEAR>1990;
RH = RHFCS*(YEAR<2010) + 0.37083*(YEAR>=2010);    ? NOW CONTROLLING THE
SHARE OF HFCS IN THE SWEETENER PART;
QMFG2=(BM0 + BM1*NCSWE1 + BM2*HBINDNONE + BM3*HNCWE2);    ? <== ACTUAL
MANUFACTURING USE OF HONEY WITHOUT HONEY PROMOTIONS;
QMFG3=(BM0 + BM1*NCSWE1 + BM2*HNCWE0 + BM3*NCSWE1*RH);    ? KEEPING
HFCS AT THE HIGH LEVEL;
QMFG4=(BM0 + BM1*NCSWE1 + BM2*HBINDNONE + BM3*NCSWE1*RH);    ? NO
PROMOTIONS AND HIGH HFCS;

SET ZADJ=.50; HBIND50=NCSWE1*((DHBEXP_PRG * ZADJ)**ROOT);    ? REDUCING
EXPENDITURES BY 50% THROUGHOUT;
SET ZADJ=.25; HBIND25=NCSWE1*((DHBEXP_PRG * ZADJ)**ROOT);    ? REDUCING

```

```

EXPENDITURES BY 25% THROUGHOUT;
QMFG5=(BM0 + BM1*NCSWE1 + BM2*HBIND50 + BM3*HNCSWE2);           ? REDUCING
NHB $ BY 50%
QMFG6=(BM0 + BM1*NCSWE1 + BM2*HBIND25 + BM3*HNCSWE2);           ? REDUCING
NHB $ BY 25%

WRITE (FORMAT=EXCEL, FILE='G:\ZHONEY\HONEY2018\HONEYTSP\SIMMFG.XLS') YEAR
BM0 BM1 BM2 BM3 QMFG0 QMFG1 QMFG2 QMFG3 QMFG4
  QMFG5 QMFG6  DHBEXP_PRG  DHBEXP_TOT10;

?=====;
? MODEL 4 - HONEY IMPORTS;
?=====;
OLSQ(ROBUST) QIMP C QMFG1;
QIMP0=QIMP;
QIMP1=@FIT;
? FORCST(DEPVAR=QMFG,STATIC) QMFG2 C NCSWE1 HBINDNONE HNCSWE2;
FORCST(DEPVAR=QIMP,STATIC) QIMP2 C QMFG2;           ? FORECASTING
IMPORTS WITHOUT THE PROMOTIONS;
? PRINT YEAR QMFG0 QMFG1 QMFG2 NCSWE1 DHBEXP_PRG;
DQMFG1=QMFG1-QMFG2;           ? MANUFACTURING
DEMAND FOR HONEY WITH AND WITHOUT THE HONEY BOARD;
PRINT YEAR QMFG0 QMFG1 QMFG2 DQMFG1 DHBEXP_PRG;
PRINT YEAR QIMP0 QIMP1 QIMP2;

SELECT 1;

?=====;
? HONEY PRICE RELATED TO TABLE HONEY SUPPLIES           ;
?=====;
? PROMOTIONS NOW IN MILLIONS $;
QTAB=(QDOM+QSTK-QEXP - (QMFG-QIMP) );
NMFG=QMFG-QIMP;
QSUP=(QDOM+QSTK+QIMP);           ? SUPPLIES WITH IMPORTS;
QDOK= QDOM+QSTK;           ? SUPPLIES WITHOUT IMPORTS;

QDKE= QDOM+QSTK-QEXP;           ? SUPPLIES NET OF EXPORTS;
DMFG=QMFG/(QSUP);           ? MANUFACTURING SHARE OF HONEY USE;
SELECT YEAR<=2017;   ? <=====?

MSD DMFG;
SELECT 1;
IXTAB=QTAB/QMFG;           ? TABLE HONEY RELATIVE TO HONEY FOR
MANUFACTURING
PRINT DMFG IXTAB;

?=====;
?=====;
? HONEY SUPPORT PROGRAM CHANGED FROM PRICE SUPPORT TO NON-RECOURSE
LOANS WITH BASE=60 CENTS;
?=====;
?=====;
SUPPORT=(YEAR<1993)*HSPR0 + (YEAR>=1993)*.60;           ? CHANGE IN THE
SUPPORT PROGRAM;

```

```

?=====;
? HONEY PRICE MODEL WITH LAGGED WEIGHTS - AR1 ;
?=====;
MFORM(TYPE=GEN,NROW=1000,NCOL=21) LIKE=0;
SET I=I+1;

? CHANGING THE WEIGHTS FOR THE AVERAGE HONEY PROGRAM EFFORTS;
CPI=CPI/100;
PRINT YEAR POP CPI DPI;
DPI_PC=DPI/POP;
RDPI_PC=( DPI_PC/CPI );
LRDPI_PC=LOG(RDPI_PC); ? LOG OF REAL PER CAPITA DISPOSAL INCOME;

DHBEXP_PRG0=DHBEXP_PRG;
DHBEXP_PRG=DHBEXP_PRG;
MSD DHBEXP_PRG;
PRINT DHBEXP_PRG0;
DO K=2012 TO 2017;
DO ZROOTZ=1 TO 1 BY .10;
? DO ZROOTZ=.5 TO .5 BY .10;
DO N1 = 0.2 TO .2 BY .10;

HBPRG=[ (DHBEXP_PRG)*N1 + (DHBEXP_PRG(-1))*(1-N1) ]**ZROOTZ; ?
ADVERTISING CURRENT AND ONE YEAR LAG;
DHBPRG=[ ((DHBEXP_PRG/CPI)**ZROOTZ)*N1 +
((DHBEXP_PRG(-1)/CPI(-1))**ZROOTZ)*(1-N1) ]; ? ADVERTISING CURRENT
AND ONE YEAR LAG;
ZHBPRG=HBPRG;
ZDHBPRG=DHBEXP_PRG**ZROOTZ;
ZDHBPRG1=DHBEXP_PRG;
DOT PDOM QDOK QTAB QDKE HBPRG DPI CPI; I.=1/.; L.=LOG(.); R.=.**.5;
ENDDOT; ? CREATING THE LOGS FOR CONSIDERATION;
DFLPDOM=LPDOM-LCPI;
DLDP1 = LDPI-LCPI;
ZHBPRG1=ZDHBPRG(-1); ? THIS IS EQUIVALENT TO N1=0;
SET I=I+1;
SELECT YEAR>=1991 & YEAR<=K;
PRINT YEAR N1 ZROOTZ;
PRINT QTAB QDKE;

PRINT ZROOTZ N1;
PRINT CPI HBPRG;
? OLSQ(ROBUSTSE) LPDOM C LQDKE SUPPORT LRDPI_PC ZHBPRG(2,4,NONE);
? SUPPLIES NET OF EXPORTS;
? OLSQ(ROBUSTSE) LPDOM C LQDKE SUPPORT LRDPI_PC
ZHBPRG1(2,4,NONE); ? SUPPLIES NET OF EXPORTS;
? OLSQ(ROBUSTSE) PDOM C QDKE SUPPORT LRDPI_PC ZHBPRG(2,4,NONE);
? SUPPLIES NET OF EXPORTS;
? OLSQ(ROBUSTSE) PDOM C QDKE SUPPORT LRDPI_PC ;
? SUPPLIES NET OF EXPORTS;
? OLSQ(ROBUSTSE) PDOM C QDKE SUPPORT LRDPI_PC
ZHBPRG1(2,4,NONE); ? SUPPLIES NET OF EXPORTS;

```



```

OLSQ(ROBUSTSE)      LPDOM C LQDKE SUPPORT LRDPI_PC ZHBPRG; ? SUPPLIES
NET OF EXPORTS <== FINAL MODEL;;
SET ZMFGZ(I,2)=ZROOTZ;
SET ZMFGZ(I,3)=N1;
SET ZMFGZ(I,4)=@LOGL;
SET ZMFGZ(I,1)=K;
SET ZMFGZ(I,5)=@COEF(1);
SET ZMFGZ(I,6)=@COEF(2);
SET ZMFGZ(I,7)=@COEF(3);
SET ZMFGZ(I,8)=@COEF(4);
SET ZMFGZ(I,9)=@COEF(5);
? SET ZMFGZ(I,10)=@COEF(6);
SET ZMFGZ(I,11)=@RSQ;
? SET ZMFGZ(I,12)=@COEF(8);
SET ZMFGZ(I,13)=@T(1);
SET ZMFGZ(I,14)=@T(2);
SET ZMFGZ(I,15)=@T(3);
SET ZMFGZ(I,16)=@T(4);
SET ZMFGZ(I,17)=@T(5);
? SET ZMFGZ(I,18)=@T(6);
? SET ZMFGZ(I,19)=@T(7);
? SET ZMFGZ(I,20)=@T(8);

ENDDO;
ENDDO;
ENDDO;

WRITE(FORMAT=EXCEL,FILE='g:\ZHONEY\HONEY2018\HONEYTSP\HONEYMFG.XLS')
ZMFGZ;
MFORM(TYPE=GEN,NROW=410,NCOL=6) MLIKEM=0;
SET I=0;

?=====;
SELECT YEAR>=1991 & YEAR<=K; ? K=2017;
?=====;
? HONEY PRICE MODEL SIMULATION WITH HBPRG=0 -
?=====;
corr LPDOM LQDKE SUPPORT DLDPI ZHBPRG1;
? OLSQ(ROBUSTSE)      LPDOM C LQDKE SUPPORT LRDPI_PC ZHBPRG1(2,4,NONE);
? OLSQ(ROBUSTSE)      LPDOM C LQDKE SUPPORT LRDPI_PC ZHBPRG1(2,4,NONE);
? OLSQ(ROBUSTSE)      LPDOM C LQDKE SUPPORT LRDPI_PC;
? PDOM11=EXP(@FIT);

? OLSQ(ROBUSTSE)      PDOM C QDKE SUPPORT LRDPI_PC
; ? SUPPLIES NET OF EXPORTS;
? OLSQ(ROBUSTSE)      PDOM C QDKE SUPPORT LRDPI_PC ZHBPRG1;
?(2,4,NONE); ? SUPPLIES NET OF EXPORTS;
? KPDOM=@FIT;
? KPDOM1=@COEF(1) + QDKE*@COEF(2) + SUPPORT*@COEF(3) +
LRDPI_PC*@COEF(4);

? ZROOTZ=.50; N1=.20;
? OLSQ(ROBUSTSE)      DFLPDOM C LQDKE SUPPORT LRDPI_PC ZHBPRG; ?
SUPPLIES NET OF EXPORTS;
? FIT01=EXP(@FIT)*CPI;
? OLSQ(ROBUSTSE)      DFLPDOM C LQDKE SUPPORT LRDPI_PC DHBPRG; ?

```

```

SUPPLIES NET OF EXPORTS;
? SQDHBPRG=DHBPRG**2;
? OLSQ(ROBUSTSE) DFLPDOM C LQDKE SUPPORT LRDPI_PC DHBPRG; ?
SUPPLIES NET OF EXPORTS;
? FIT02=EXP(@FIT)*CPI;
? NONE=0;
? FORCST DFLPDOM00 C LQDKE SUPPORT LRDPI_PC NONE;
? FIT03=EXP(DFLPDOM00)*CPI;
?
? PRINT YEAR PDOM FIT01 FIT02 FIT03;
DDD=(YEAR=2013) + (YEAR=2014)*2 + (YEAR=2015)*3 + (YEAR=2016)*4 +
(YEAR=2017)*5;
DDDZHBPRG=ZHBPRG*DDD;

OLSQ(ROBUSTSE) L PDOM C LQDKE SUPPORT LRDPI_PC ZHBPRG; ? SUPPLIES
NET OF EXPORTS;
PRINT @COEF @LOGL;
FORCST H PDOM;

SET ZADJ=1.0;
ADJ_HBPRG=[ ( (ZADJ*DHBEXP_PRG))*N1 + ((ZADJ*DHBEXP_PRG(-1)))*(1-N1)
]**ZROOTZ; ? ADVERTISING CURRENT AND ONE YEAR LAG;
PDOM_100= EXP[ @COEF(1) + LQDKE*@COEF(2) + SUPPORT*@COEF(3) +
LRDPI_PC*@COEF(4) + ADJ_HBPRG*@COEF(5)];
SET ZADJ=.75;
ADJ_HBPRG=[ ( (ZADJ*DHBEXP_PRG))*N1 + ((ZADJ*DHBEXP_PRG(-1)))*(1-N1)
]**ZROOTZ; ? ADVERTISING CURRENT AND ONE YEAR LAG;
PDOM_75= EXP[ @COEF(1) + LQDKE*@COEF(2) + SUPPORT*@COEF(3) +
LRDPI_PC*@COEF(4) + ADJ_HBPRG*@COEF(5)];
SET ZADJ=.50;
ADJ_HBPRG=[ ( (ZADJ*DHBEXP_PRG))*N1 + ((ZADJ*DHBEXP_PRG(-1)))*(1-N1)
]**ZROOTZ; ? ADVERTISING CURRENT AND ONE YEAR LAG;
PDOM_50= EXP[ @COEF(1) + LQDKE*@COEF(2) + SUPPORT*@COEF(3) +
LRDPI_PC*@COEF(4) + ADJ_HBPRG*@COEF(5)];
SET ZADJ=.25;
ADJ_HBPRG=[ ( (ZADJ*DHBEXP_PRG))*N1 + ((ZADJ*DHBEXP_PRG(-1)))*(1-N1)
]**ZROOTZ; ? ADVERTISING CURRENT AND ONE YEAR LAG;
PDOM_25= EXP[ @COEF(1) + LQDKE*@COEF(2) + SUPPORT*@COEF(3) +
LRDPI_PC*@COEF(4) + ADJ_HBPRG*@COEF(5)];
SET ZADJ=.05;
ADJ_HBPRG=[ ( (ZADJ*DHBEXP_PRG))*N1 + ((ZADJ*DHBEXP_PRG(-1)))*(1-N1)
]**ZROOTZ; ? ADVERTISING CURRENT AND ONE YEAR LAG;
PDOM_05= EXP[ @COEF(1) + LQDKE*@COEF(2) + SUPPORT*@COEF(3) +
LRDPI_PC*@COEF(4) + ADJ_HBPRG*@COEF(5)];
SET ZADJ=.00;
ADJ_HBPRG=[ ( (ZADJ*DHBEXP_PRG))*N1 + ((ZADJ*DHBEXP_PRG(-1)))*(1-N1)
]**ZROOTZ; ? ADVERTISING CURRENT AND ONE YEAR LAG;
PDOM_00= EXP[ @COEF(1) + LQDKE*@COEF(2) + SUPPORT*@COEF(3) +
LRDPI_PC*@COEF(4) + ADJ_HBPRG*@COEF(5)];

PDOM_HAT=EXP(HPDOM);

PRINT PDOM PDOM_HAT PDOM_100 PDOM_75 PDOM_50 PDOM_25 PDOM_05 PDOM_00
DHBEXP_PRG DHBEXP_TOT10;
PRINT LQDKE SUPPORT LRDPI_PC ZHBPRG ;

```

```

?=====;
?  MODEL 2 - IMPORT PRICE;
?=====;
OLSQ PIMP C PDOM;
PRINT @COEF @T;
LPDOM=LOG(PDOM);
LPIMP=LOG(PIMP);
OLSQ LPIMP C LPDOM;
PRINT @COEF @T;
PIMP0=PIMP;
LPDOM1=LOG(PDOM_HAT); ? ESTIMATED PRODUCER PRICE WITH PROMOTIONS;
LPDOM2=LOG(PDOM_00); ? ESTIMATED PRODUCER PRICE WITH PROMOTIONS;
FORCST(DEPVAR=PIMP,STATIC) LPIMP1 C LPDOM1;
FORCST(DEPVAR=PIMP,STATIC) LPIMP2 C LPDOM2;
PIMP1=EXP(LPIMP1); ? IMPORT PRICE WITH PROMOTIONS;
PIMP2=EXP(LPIMP2); ? IMPORT PRICE WITHOUT PROMOTIONS;
PRINT YEAR PIMP0 PIMP1 PIMP2;

?=====;
? REVENUES AND GAINS FROM DOMESTIC PRODUCTION ;
?=====;
HDVA1= QDOM*PDOM_100; ? DOMESTIC WITH PROMOTIONS;
HDVA2= QDOM*PDOM_00; ? DOMESTIC WITHOUT PROMOTIONS;
HDVA00= HDVA0/1000; ? DOMESTIC ACTUAL;
PRINT YEAR QDOM PDOM_100 PDOM_00;
PRINT YEAR HDVA0 HDVA1 HDVA2;

HIVA1= QIMP1*PIMP1; ? IMPORT VALUE WITH PROMOTIONS;
HIVA2= QIMP2*PIMP2; ? IMPORT VALUE WITHOUT PROMOTIONS;
PRINT YEAR HIVA1 QIMP1 PIMP1 HIVA2 QIMP2 PIMP2;

HIVA3= QIMP1*PIMP2; ? IMPORT VALUES CHANGING ONLY WITH THE PRICE
CHANGE;
HIVA4= QIMP2*PIMP1; ? IMPORT VALUES WITH CHANGES IN THE QUANTITIES BUT
NOT PRICE CHANGES;
DQMF1=QMF1-QMF2; ? CHANGE IN THE USE OF HONEY FOR MANUFACTURING
ATTRIBUTED TO THE INDUSTRY SERVICES;
DQIMP1=QIMP1-QIMP2; ? CHANGE IN THE USE OF HONEY IMPORTS ASSOCIATED
WITH MANUFACTURING;

HMVA1= QMF1*PIMP1; ? MANUFACTURING VALUE WITH PROMOTIONS;

HMVA2= QMF2*PIMP2; ? MANUFACTURING VALUE WITHOUT PROMOTIONS;

HMVA3= QMF1*PIMP2; ? MANUFACTURING VALUES CHANGING ONLY WITH THE PRICE
CHANGE;
HMVA4= QMF2*PIMP1; ? MANUFACTURING VALUES WITH CHANGES IN THE
QUANTITIES BUT NOT PRICE CHANGES;
? PRINT YEAR QMF1 QMF2 DQMF1 QMF2;
HBTOT0=HBEXP_TOT10/1000000;

MSD HDVA00 HDVA1 HDVA2 HBPRG DHBEXP_PRG HIVA1 HIVA2 HIVA3 HIVA4
DQMF1 DQIMP1 HMVA1 HMVA2 HMVA3 HMVA4 HBTOT0; ?

```

```

HBTOT0 = HBEXP_TOT10 OR TOTAL BOARD EXPENDITURES;

? 1 2 3   4 5   6 7 8 9   10 11   12 13 14 15 16 ;

? HBPRG IS THE WEIGHTED HONEY BOARD PROGRAMS
?=====;
? DOMESTIC SIDE;
?=====;
SET HDREV0=@SUM(1);
SET HDREV1=@SUM(2);
SET HDREV2=@SUM(3);
SET DGAIN12=HDREV1-HDREV2;

SET HBPROM1 =@SUM(4);
SET HBPROM2= @SUM(5);

SET ROI1=DGAIN12/HBPROM1; ? GAINS NET OF IMPORT CHANGES ;

?=====;
? IMPORT SIDE;
?=====;
SET HIREV1=@SUM(6); ? PREDICTED IMPORT REVENUES WITH PROGRAMS;
SET HIREV2=@SUM(7); ? PREDICTUED IMPORT REVENUE WITHOUT THE PROGRAMS;
SET HIREV3=@SUM(8); ? PREDICTED IMPORT REVENUE WITH JUST THE CHANGES IN
THE HONEY FOR MANUFACTURING, NOT PRICE CHANGES;
SET HIREV4=@SUM(9); ? QUANTITY BUT NO PRICE CHANGE ATTRIBUTED TO THE
PROMOTIONS;

SET DQMGF12=@SUM(10);
SET DQIMP12=@SUM(11);

SET HMREV1=@SUM(12);
SET HMREV2=@SUM(13);
SET HMREV3=@SUM(14);
SET HMREV4=@SUM(15);
SET HONEYBD=@SUM(16);

SET IGAIN12=HIREV1 - HIREV2;
SET IGAIN13=HIREV1 - HIREV3;
SET IGAIN14=HIREV1 - HIREV4;

SET MGAIN12=HMREV1 - HMREV2;
SET MGAIN13=HMREV1 - HMREV3;
SET MGAIN14=HMREV1 - HMREV4;

SET ROI2 = (DGAIN12 + MGAIN12)/HBPROM1;
SET ROI3 = (DGAIN12 + MGAIN13)/HBPROM1;
SET ROI4 = (DGAIN12 + MGAIN14)/HBPROM1;

SET NETROI1 = DGAIN12/HONEYBD; ? DOMESTIC GAINS;
SET NETROI2 = (DGAIN12 + MGAIN12)/HONEYBD; ? DOMESTIC AND
MANUFACTURING GAINS;
SET NETROI3 = (DGAIN12 + MGAIN13)/HONEYBD;
SET NETROI4 = (DGAIN12 + MGAIN14)/HONEYBD;

```

```

SET SHROI12=ROI1/ROI2;
SET SHROI13=ROI1/ROI3;
SET SHROI14=ROI1/ROI4;

MMAKE MN1M0 N1 HDREV0 HDREV1 HDREV2 DGAIN12
HIREV1 HIREV2 HIREV3 HIREV4
HMREV1 HMREV2 HMREV3 HMREV4
IGAIN12 IGAIN13 IGAIN14
MGAIN12 MGAIN13 MGAIN14
HBPROM1 HBPROM2
ROI1 ROI2 ROI3 ROI4 SHROI12
NETROI1 NETROI2 NETROI3 NETROI4
SHROI13 SHROI14
DQMFG12 DQIMP12;
MAT MN1M2=MN1M0;
print MN1M2;

WRITE (FORMAT=EXCEL, FILE='g:\ZHONEY\HONEY2018\HONEYTSP\HBMN1M.XLS')
MN1M2;

PRINT YEAR QDKE;

WRITE (FORMAT=EXCEL, FILE='g:\ZHONEY\HONEY2018\HONEYTSP\HBROI [N1=20] .XLS'
)
YEAR QDOM PDOM PDOM_100 PDOM_00 HDVA0 HDVA1 HDVA2
HIVA1 QIMP1 PIMP PIMP1 HIVA2 QIMP2 PIMP2
HIVA3 QIMP QIMP0 QIMP1 QIMP2 QIMP1 PIMP2
HIVA4 QIMP2 PIMP1
DQMFG1 QMFG NET QMFG QMFG1 QMFG2 SUPPORT
DQIMP1 QIMP1 QIMP2
HMVA1 QMFG1 PIMP1
HMVA2 QMFG2 PIMP2
HMVA3 QMFG1 PIMP2
HMVA4 QMFG2 PIMP1
HBTOT0 HBPRG DHBEXP_PRG
POP DPI CPI QTAB DPI_PC QDOM QSTK QDKE QEXP QMFG QIMP PDOM HRPR0;

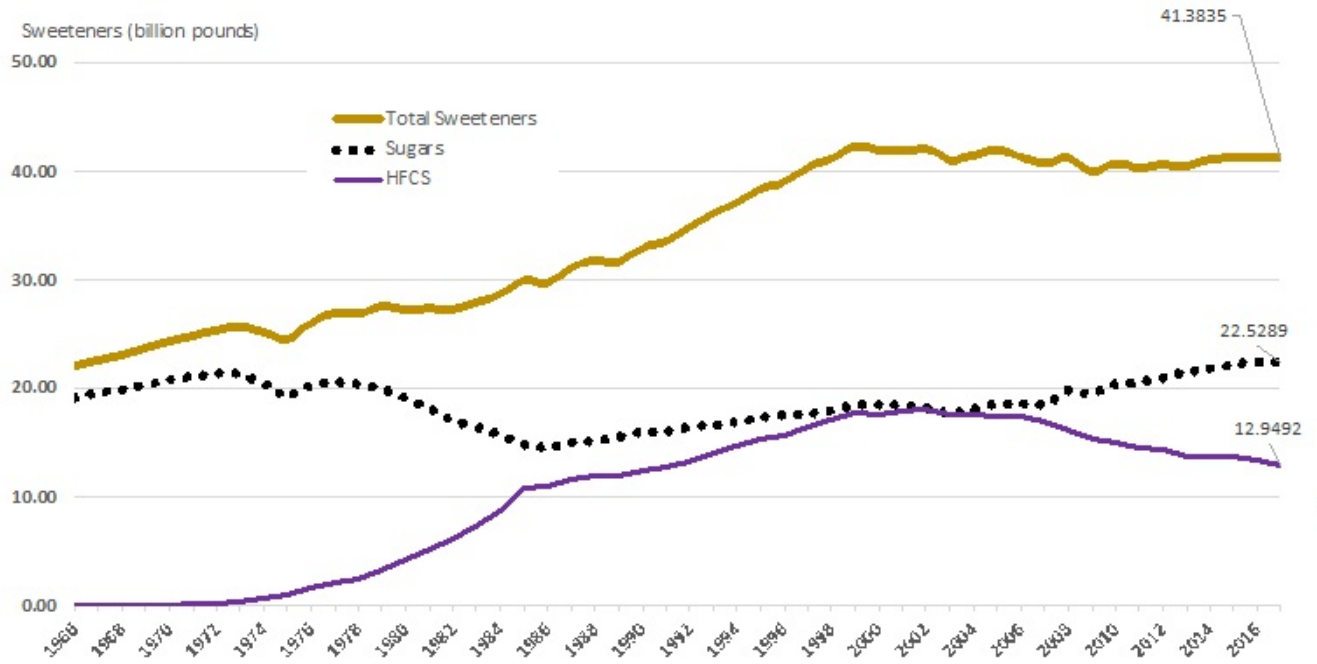
END;

```

Appendix B.2 Standardized honey checkoff coefficients ( $\delta$ ).

Years	Std $\delta$	$\delta$	StDev(NHB)	StDev(PDOM)
1991-2012	0.19769	0.19611	0.43324	0.42977
1991-2013	0.18857	0.19590	0.43818	0.45521
1991-2014	0.22489	0.22984	0.46510	0.47534
1991-2015	0.25187	0.23698	0.51932	0.48861
1991-2016	0.25577	0.18910	0.67448	0.49866
1991-2017	0.20639	0.12191	0.86067	0.50836

Appendix C.1. Relative use of HFCS in the sweetener market.



Appendix D.1. Equivalent change in table honey demand with prices fixed at the no program levels (i.e., NHB=0). In the final table honey model  $\tau=1$ .

The original table honey demand is:

$$PDOM_t = (QDKE_t^{\beta_1}) (DPI_t^{\beta_2}) \exp^{\beta_0 + \beta_3 SUP_t + \delta \sqrt[3]{(\eta_1 HPG_t + (1-\eta_1) HPG_{t-1})}}$$

Then if  $dPDOM=0$  it follows that:

$$dPDOM = 0 = (QDKE_t^{\beta_1}) (DPI_t^{\beta_2}) \exp^{\beta_0 + \beta_3 SUP_t + \delta \sqrt[3]{(\eta_1 HPG_t + (1-\eta_1) HPG_{t-1})}} - (QDKE_t^{\beta_1}) (DPI_t^{\beta_2}) e (DPI_t^{\beta_2}) \exp^{\beta_0 + \beta_3 SUP_t}$$

hence:

$$(QDKE_t^1)^{\beta_1} \exp^{\delta \sqrt[3]{(\eta_1 HPG_t + (1-\eta_1) HPG_{t-1})}} - (QDKE_t^0)^{\beta_1} = 0$$

or

$$\left( \frac{QDKE_t^1}{QDKE_t^0} \times QDKE_t^0 \right)^{\beta_1} \exp^{\delta \sqrt[3]{(\eta_1 HPG_t + (1-\eta_1) HPG_{t-1})}} - (QDKE_t^0)^{\beta_1} = 0$$

where  $\frac{QDKE_t^1}{QDKE_t^0}$  is the percentage increase in table honey demand holding prices fixed

and the honey program at some positive levels.

$$\log \left( \frac{QDKE_t^1}{QDKE_t^0} \right) = -\frac{\delta}{\beta_1} \sqrt[3]{(\eta_1 HPG_t + (1-\eta_1) HPG_{t-1})} = \frac{\delta}{|\beta_1|} \sqrt[3]{(\eta_1 HPG_t + (1-\eta_1) HPG_{t-1})}$$

This then shows the equivalent relative increase in table honey for fixed honey prices and positive level of honey board programs plotted in Figure xx (page xx).

$$PDOM_t = (QDKE_t^{\beta_1}) (DPI_t^{\beta_2}) \exp^{\beta_0 + \beta_3 SUP_t + \delta \sqrt[3]{(\eta_1 HPG_t + (1-\eta_1) HPG_{t-1})}}$$

or

$$\begin{aligned} \log(PDOM_t) &= \beta_1 \log(QDKE_t) + \beta_2 \log(DPI_t) \\ &\quad + \beta_0 + \beta_3 SUP_t + \delta \sqrt[3]{(\eta_1 HPG_t + (1-\eta_1) HPG_{t-1})} \end{aligned} \tag{18}$$



$$\left(\frac{QDKE_t^1}{QDKE_t^0}\right) = \exp^{\frac{\delta}{|\beta_1|} \sqrt{(\eta HPG_t + (1-\eta) HPG_{t-1})}} \quad (D.1)$$

## D.2. Potential for honey prices to impact the demand for honey in manufacturing.

Dependent variable: QMFG  
 Current sample: 1991 to 2017  
 Number of observations: 27

Mean of dep. var. = 309.340  
 LM het. test = .378956 [.538]  
 Std. dev. of dep. var. = 60.4243  
 Durbin-Watson = 1.84287 [.082,.703]  
 Sum of squared residuals = 13049.0  
 Jarque-Bera test = 1.53042 [.465]  
 Variance of residuals = 593.135  
 Ramsey's RESET2 = 4.75407 [.041]  
 Std. error of regression = 24.3544  
 F (zero slopes) = 34.5114 [.000]  
 R-squared = .862539  
 Schwarz B.I.C. = 129.989  
 Adjusted R-squared = .837546  
 Log likelihood = -121.750

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	-159.168	72.4370	-2.19733	[.039]
NCSWE1	.018505	.397168E-02	4.65921	[.000]
HNCSWE0	.121447E-02	.677743E-03	1.79193	[.087]
HNCSWE2	-.023816	.522202E-02	-4.56061	[.000]
PDOM_PSUG	2.51601	2.85387	.881613	[.388]

Standard Errors are heteroskedastic-consistent (HCTYPE=2).

