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# The Fable of the Bees Revisited: Causes and Consequences of the U.S. Honey Program

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Abstract: In his 1973 paper, Steven Cheung discredited the “fable of the bees” by demonstrating that markets for beekeeping services exist and that they function well. Although economists heeded Cheung’s lessons, policy makers did not. The honey program—the stated purpose of which was to promote the availability of pollination services—operated for almost 50 years, supporting the price of honey through a variety of mechanisms. Its effects were minor before the 1980s but then became important with annual government expenditures near $100 million for several years. Reforms of the program in the late 1980s reduced its market effects and budget costs, returning it to its original role as a minor commodity program. The 1996 Farm Bill formally eliminated the honey program, which redirected lobbying efforts toward enacting trade restrictions and obtaining annual relief through the appropriations process. We measure the historical welfare effects of the program during its various incarnations, examine its frequently stated public interest rationale—the encouragement of honeybee pollination, and interpret its history in light of economic theories of regulation.

# The Fable of the Bees Revisited: Causes and Consequences of the U.S. Honey Program

*"It has been said that if one dies and goes to heaven and wants to come back to Earth and have eternal life, come back as a federal program"*

*Rep. Harris W. Fawell (R-Ill, House of Representatives, August 6, 1993)*.

## I. Introduction

In 1973, Steven Cheung recounted the history to that time of what he termed "the fable of the bees" in economic thought.[1] Earlier writers (Meade, 1952; Bator, 1958) had used beekeeping and apple farming as examples of reciprocal externalities: apple blossom nectar provides food for bees and the foraging activity of bees pollinates apple blossoms. By stipulating that apple farmers and beekeepers do not transact, Meade and Bator inferred that the pair of externalities resulted in an underprovision of both apples and honey.

Cheung's central point was that the stipulated facts of Meade and Bator's story, and therefore the claim of externalities, are fictional—there are well-developed markets in which beekeepers and growers of crops transact regularly. Arguably, his most persuasive piece of evidence that interdependencies have been internalized through market transactions is his observation that one needs only open the Yellow Pages of the phone book in certain Washington towns and find listings there for pollination services. He went on to analyze data from a small number of beekeepers and concluded that the markets for pollination services function well: that observed fees reflect both the pollination value of the bees' activities and the nectar value of the pollinated crop.

[1]The term "fable of the bees" refers to earlier work by Mandeville (1705), which was not connected with externalities.

While Cheung's analysis of Washington beekeeping did not disprove the existence of externalities in other situations, it did sound a caution against the use of blackboard economics for policy analysis. He illustrated a central point of Coase's celebrated 1960 paper: that the transaction costs of market exchange determine the existence and extent of externalities and that to understand transaction costs (hence externalities) one must understand the institutional details of the market under consideration.

However, while Cheung may have discredited the bees-and-apples example to the satisfaction of certain academic economists, his influence did not spread to policy makers. At the time Cheung wrote, there existed a real policy counterpart to the externality argument, namely the U.S. honey price support program. Its specific purpose, according to its legislative history, was to promote the production of pollination on the grounds that markets underprovide such services. (Interestingly, pollination services were not subsidized, as one might propose from the blackboard. Rather, the price of its complementary output—honey—was supported.) Cheung was aware of the program and correctly argued that it had minimal influence at the time. In the 30 years since he wrote, however, the honey program has had major effects in honey and pollination markets and, for a relatively minor commodity, has generated substantial government expenses. Largely as a result of these expenses, the honey program was eliminated in the 1996 Farm Bill. Since then, honey producers have successfully lobbied for other forms of support through trade restrictions and through the annual appropriations process.

An analysis of this program—its causes and effects from cradle to grave and beyond—is the focus of our paper. With respect to the causes of the honey program, the fact that it has gone through a complete birth-to-death cycle makes it relatively unique among long-lived U.S.

commodity programs. Lessons learned from it should prove useful for understanding aspects of other programs. With respect to its effects, we find the usual commodity program distortions in the honey market—taxpayers lose and a relatively small number of commercial beekeepers obtain substantial gains (between $10,000 and $20,000 annually per participating producer) for a brief period in the 1980s. Interestingly, we find that domestic consumers also benefitted from the program.[2]

Widely accepted economic models of regulators' behavior hold that for a given industry, a political equilibrium will be established that balances at the margin the competing interests of consumers, producers, and taxpayers.[3] Shocks to the industry of various sorts can induce adjustments to a new political equilibrium. Below we recount and interpret the history of the honey program from the perspective of such a political economic model. We conclude that the underlying political equilibrium of support for beekeeping is a stable one. The post-World War II history of the industry is characterized by short periods of out-of-equilibrium levels of support, followed by the re-institution in various guises of a modest subsidy.

The paper proceeds as follows. In Section II, a model of the honey program is presented in which the history of the support program is interpreted. A welfare accounting follows, considering the effects of policy on both honey and pollination markets. Section III examines the political economy of the program. In Section IV, we summarize our findings and draw a

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[2]Previous work has addressed aspects of the honey program. Willett and French (1991) and Smargiassi and Willett (1989) considered the effects of the support program on honey producers, but neither measured explicitly the program's welfare effects or studied its political economy. Our analysis, which extends work by Chuang (1992), does both.

[3]For seminal articles in this literature, see Stigler (1971), Peltzman (1976), and Becker (1983). For applications to farm subsidies, see Gardner (1987) and Rucker and Thurman (1990).

connection between the political economy literature and work by Barzel that accentuates the seemingly limitless number of margins for adjustment to changing conditions in non-political market settings.

## I. The Honey Program: History and Economic Effects

We first develop a model of the U.S. honey market, recounting the effects of the honey support program from 1952 through 1993. We then use the framework for estimating consumer and producer benefits and taxpayer expenses and consider the indirect effects of the honey program on markets for pollination.

### II.A. A Model of the Honey Program's Effects on Honey Markets

The methods by which honey producers participated in the honey support program evolved over time. We represent the three primary regimes in figure 1.[4] During the first, from 1952 to 1979, the honey program was a standard commodity price support program (see Pasour, 1990). Producers could place their honey under loan at a support price and then either forfeit the honey to the government, keeping the original loan proceeds, or redeem the honey to sell it on the market (paying back the loan plus interest). During this time the world price of honey, $P_W$ (assumed here to be exogenous), was above the support price, $P_S$. Producers had no incentive to forfeit their honey, and the government costs of running the program amounted to administration costs and an interest rate subsidy.

In 1980, the parity-linked support price rose above the world market price as shown in the second panel of figure 1. Producers could obtain a better price by putting their honey under loan

[4]See Hoff and Willett (1994) for a detailed description of the program and its history. A packer purchase program that operated in 1950 and 1951 is not shown here, but we describe its operation in Section III.

and subsequently forfeiting it than by selling it on the market. In 1985, the year in which the program had its greatest effects, the support price represented a full 37 percent premium over the market price. Because the Commodity Credit Corporation (CCC) was required not to sell forfeited honey for less than 110 percent of the support price, the government distributed it through domestic food programs (Hoff and Phillips, 1989). Domestic demand was met with imports, $Q_I$. In this stylized representation, government costs became the entire shaded area, $P_S \cdot Q^S_{dom}$, plus the costs of administering the program and of processing and distributing the forfeited honey through the Temporary Emergency Food Assistance Program (TEFAP) and the school lunch program. In 1985, the program had its largest effects. Ninety-six percent of honey pledged as loan collateral was forfeited, and approximately half of domestic consumption was imported.

Another program effect, difficult to depict in figure 1, is the benefit from government honey distributions. The size of the benefit depends on the market price of honey and the distribution of reservation prices of recipients. If all the CCC honey were distributed to consumers with reservation prices below the retail market price ($P_W$ plus processing and transportation costs) and if resale were effectively prohibited, then there would be no market effects of the distributions, only benefits to recipients (equal to the value they place on the honey, which is necessarily less than the retail price per pound). At the other extreme, if all distribution recipients (or consumers to whom they resold) had reservation prices at or above the retail price, the distributions would displace market sales and imports would be reduced. The value of such distributions to their recipients would be the retail price per pound—the savings from replacing market purchases with distributions. But further, some or even all of the value to recipients can be dissipated by the process of distribution. If distribution of free honey entails queuing, then a portion of the value of the distributed honey will be dissipated and waiting time costs should be counted among the resource costs of the program (see Barzel, 1974 and 1989, ch. 2). In what follows, and due to the absence of appropriate data, we assume that queuing costs are zero and base our welfare change estimates on that assumption, recognizing that this biases downward our estimates of the program's costs.[5]

The large market effects in the early 1980s were addressed by legislative modifications to the program. Beginning with the 1986 crop year, Congress altered the honey program by dropping the parity-based formula, setting a sequence of progressively lower support prices, and allowing for a marketing loan option. In the third panel of figure 1, producers placed their honey under loan at the support price, $P_S$, and later redeemed it at the repayment rate, $P_R$, in order to sell it at the world price, $P_W$. Producers who sold their honey on the market at $P_W$ received a subsidy equal to the difference between the support price and the repayment rate. The per pound subsidy,

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[5]Depending on the mechanisms by which free honey was distributed, the dissipation of the value of the free good, and hence the welfare costs of the program, could be substantially understated. Systematic information on honey distribution procedures is hard to come by because free food distribution programs were administered locally. A 1988 article from the *Los Angeles Times* gives an anecdotal account of the costs of free food distribution. The article describes how the San Diego Food Bank distributed limited supplies of federal food—cheese, butter, dry milk, cornmeal, flour, and rice—in addition to honey:

> "At one distribution site Friday, more than 400 people picked up allotments of butter, flour, milk and cornmeal.... Some arrived as early as 6 a.m. to be among the first in line for an 8 a.m. opening at Our Lady of Mt. Caramel Church in Rancho Penasquitos.
>
> Debbie Johnston, a housewife and mother of three children, said she doesn't mind standing in line so long before the distribution site opens each month if it means she can pick up items her family might otherwise have to do without ... With two of her children in tow, Johnston was one of the first people in line, which stretched midway into the church's parking lot at one point. As she made her way through the church doors, picked up her family's allocation of commodities—estimated to be worth about $10 at market value—and headed to her car, hundreds of other people waited for their turn." ("Shortages Hit Distribution of Surplus Foods," *Los Angeles Times*, San Diego County Edition, 9/28/88) Note that if Ms. Johnston's opportunity cost of time were $5 per hour, the value of her allocation was totally dissipated.

$P_S - P_R$, ranged from a high of 23 cents in 1986 to a low of 5.9 cents in 1991. Government costs under the 1986 revisions are represented by the shaded area $(P_S - P_R) \cdot Q^S_{dom}$. In addition, the government costs of processing and distributing forfeited honey were reduced because producers forfeited less honey. Although it appears that producers had little incentive to forfeit honey pledged as loan collateral, many continued to do so, especially for the first couple of years after the program was altered. However, by 1992 only 2.8 percent of honey pledged as collateral was forfeited. Further alterations in the program for 1991 through 1993 allowed producers to receive a direct subsidy equal to $P_S - P_R$ without the pretense of putting their honey under loan. These subsidies are also represented in the third panel of figure 1.

In late 1993, Congress reauthorized the program through 1998, but the 1994 and 1995 Appropriations Acts eliminated government expenditures for each of those fiscal years (see Hoff, 1995). When the Appropriations Committee chose not to fund the honey support program for 1994 and 1995, it no longer was possible for producers to forfeit honey pledged as collateral or to receive payments of the difference between the support price and the repayment rate. During these years, honey loans were loans in the ordinary sense; producers had to repay the loan proceeds with accrued interest, and the honey program had little effect.

The honey program was eliminated in the 1996 Farm Bill. Since then, the domestic subsidy to honey production has consisted largely of loans made to beekeepers at below-market interest rates. Trade actions against honey imports from China, however, have also borne fruit. Most recently, the essence of the early 1990's honey program was revived when appropriations were made for marketing assistance loans and loan deficiency payments for the year 2000 crop of honey.[6]

II.B. Welfare Accounting in Honey Markets

Effects on Beekeepers

To estimate the effects of the honey program on beekeepers, we model the supply of honey in the United States assuming that the stock of colonies maintained by U.S. beekeepers is affected by the expected price of honey, other input costs associated with honey production, and costs of adjustment represented by lagged colonies.[7] We then estimate the hypothetical quantity of honey that would have been supplied without the honey support program.

Expected honey producer prices will be influenced by government policy, which we address econometrically by estimating expected honey prices differently for each of the phases of the honey support program. For 1951 through 1980, we generate one-year-ahead expected honey prices from an autoregressive (AR2) process in first differences. Beginning with 1981 and through the period of large program effects, we assume that producers based their colony decisions on the support price, which was known prior to the crop year. For 1986 through 1991,

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[6]See Public Law 106-387, Section 812. These relief tools are essentially the same as those used for the honey program between 1990 and 1993. A notable distinction is that the 2000 legislation only specifies payments for one year.

[7]Arguably, the price of the other primary beekeeping output, pollination services, should also be included in a colony response equation. We do not include such an effect for two reasons. First, pollination fees vary greatly by location and crop. Unlike honey, for which a national market exists, pollination fee data are intrinsically local and no suitable national series exists. Second, we do not want to measure the welfare effects of changes in honey prices with pollination fees held constant. Instead, we would like to measure the effects to all beneficiaries of a honey price increase. If, as we argue later, honey price support lowers equilibrium pollination fees, then the beneficiaries include farmers who purchase pollination services. If variations in honey price are econometrically exogenous in our honey supply equation, then the equation has a general equilibrium interpretation. Measured producer surplus changes include welfare gains to the beneficiaries of lower pollination fees (see Harberger, 1971, and Thurman, 1991).

we calculate the expected honey price as the support price plus the average producer price–repayment rate differential. The input cost index included in the supply response equation is a weighted average of the wage component of prices paid by farmers and the fuel and container components of the producer price index.

Estimation of the colony response equation is complicated by two limitations to the official USDA data. The first is that colony numbers were not recorded during the years 1982 to 1985, although price and cost data are available. The second limitation is that when the National Agricultural Statistics Service (NASS) began again to collect colony data, it changed its method of data collection. In the official estimates, the number of colonies dropped dramatically in 1986 by 1 million colonies, from a prior level of approximately 4 million colonies. Conversations with USDA–NASS employees confirm that changes were made in how the data are collected. Hoff and Phillips (1989) state that while earlier estimates included colony counts from all beekeepers, the later years included counts only from those beekeepers who maintained at least five colonies. In the Appendix, we describe a maximum likelihood estimation method that enables us to account for the hiatus in data collection in the early 1980s and to parsimoniously estimate the effects of the change in survey methods. Our estimation strategy parameterizes the change in methods as a one-time reduction in the number of colonies counted. Our estimate of that reduction is 863,000 colonies with a standard error of 195,000 colonies. In the welfare accounting that we present in tables 2 and 3, we adjust the official numbers with our estimated undercount.

The results of the maximum likelihood estimation of the colony supply equation are presented in table 1. We include the expected honey price and the input cost index in ratio form to impose homogeneity. The estimated coefficient of 394.3 implies a short-run price elasticity of colony supply, evaluated at the means of the data, of 0.052 and a long-run price elasticity of 2.01. These estimates can be compared to the short-run and long-run elasticities of 0.024 and 0.242 reported by Willett and French (1991). The estimates imply that beekeepers adjust the number of colonies slowly in response to changes in expected producer prices.

To measure the effects of the program on producers, we determine first the level of colony investment without price support and then multiply the number of predicted colonies by average colony yields as reported by the USDA to obtain estimates of the hypothetical level of honey production without the program. The table 1 estimates allow us to generate a dynamic prediction of the change in colonies due to removing the honey price support.[8] In figure 1, the level of production without the support program corresponds to finding the point where the U.S. supply of honey intersects $P_W$ (point d in the center panel of figure 1 and point i in the right panel of figure 1). The net benefits to producers from the program are represented by area abcd for the years 1980 through 1985 and area fghi for the years 1986 through 1993.

In table 2, the predicted reductions in colony populations range from about 6,000 colonies in 1981 (a 0.1 percent reduction) to 451,000 colonies in 1993 (a 12 percent reduction). The associated predicted reductions in honey production range from 0.3 to 26.9 million pounds.

Table 3 presents the net producer benefits. For 1981 through 1985, we calculate gross producer benefits by multiplying honey forfeitures by the difference between the support price and

[8]For each year, we obtain the predicted difference in colony populations from the contemporaneous price effect and a lagged colony effect. We calculate the contemporaneous price effect by multiplying the price coefficient of the colony supply equation (394.3) by the difference between the support price and the expected producer price. Next, we calculate the lagged colony effect by multiplying the lagged colony coefficient (0.97) by the previous year's predicted change in colony population. Because of the lagged colony effect, table 3 shows quantity supplied effects tailing off in 1994 and 1995, but we calculate no producer welfare effects in those years because the program had no effect on price.

the producer price. For 1986 through 1990, we add to the value of forfeitures the direct subsidies paid on honey that was placed under loan and then redeemed. For 1991 through 1993, we include all of the above plus the value of direct subsidies paid on honey that was not placed under loan. We also subtract a newly instituted Agricultural Stabilization and Conservation Service (ASCS) assessment of 1 percent of the support price. To obtain the estimates of net producer benefits presented in table 3, we subtract the deadweight loss triangles, shown in figure 1, which we calculated using the predicted reductions in production without the support program from table 2. Based on these calculations, net producer benefits range from $0.3 million in 1981 to a peak of $40.3 million in 1987.[9]

Effects on Honey Consumers

Under the assumption that variations in net U.S. imports did not influence the world price, consumers were affected by the honey program only through the distribution of CCC honey stocks. Consumers who would have purchased honey on the market but instead receive free honey distributions receive a benefit. Recipients who would not have purchased honey also receive a positive, but smaller, benefit. Measurement of the welfare effect on consumers depends on measuring this displacement (see also footnote 7 on the dissipation of value through queuing).

To measure the displacement, we hypothesize that domestic consumption of honey is directly affected by the quantity of CCC distributions and a linear and quadratic time trend. We found in alternative specifications that the price of honey, the price of its closest substitute

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[9]In figure 1, we portray the supply of honey to the United States as perfectly elastic, but our estimates of domestic producer benefits do not depend on this assumption. For the 1981 through 1985 period, the import elasticity is irrelevant because producers received the fixed support price. For the 1986 through 1993 period, producers received the support price plus the differential between the world price and the loan repayment rate. Because the repayment rate was adjusted in response to changes in the world price, the differential was relatively constant and the price received by producers did not depend upon the world price.

(sugar), and income had statistically insignificant effects and, importantly, their inclusion did not significantly alter the values of the other estimated coefficients.[10] The results of OLS estimation of the consumption equation are presented in table 1. Of relevance to welfare measurement, CCC honey distributions had a significant and substantial negative effect on honey consumption. Each additional pound of honey distributed by the CCC is estimated to decrease per capita consumption of honey at the retail level by 0.76 of a pound. CCC distributions did not offset per capita retail purchases pound for pound because some recipients would not otherwise have purchased honey. (However, the CCC distributions coefficient is not significantly different from –1 at conventional levels.) The linear and quadratic trend coefficients are also significant and indicate a decreasing trend in honey consumption through 1982 and an increasing trend thereafter. This trend roughly corresponds with the increased use of honey in processed food products and, later, promotional efforts by the National Honey Board.

We use the estimated effect of CCC distributions on honey consumption to estimate the benefit to consumers from the honey support program. We assume that the proportion of each pound of CCC-distributed honey that offsets honey consumption from market sources is valued by consumers at the retail price of honey. The remaining proportion of each pound—which goes to consumers who would not otherwise have purchased this honey—we assume is valued at the lower retail price of sugar as an approximation. The difference between the retail price of honey and the retail price of sugar for these consumers represents a deadweight loss to society from

[10]Because a retail honey price was not published for the years 1980 to 1986, we constructed those prices based on the observed relationship between the producer price and the retail price for the years 1950 through 1979 and 1987 through 1992.

CCC distributions.[11] As shown in table 3, net consumer benefits reached a peak of $78 million in 1983 but declined to less than $1 million by 1990.[12]

Effects on Taxpayers and Net Benefits to Society

Taxpayers pay the cost of subsidizing beekeepers and distributing donated honey, including the costs of storage, processing, handling, and transportation. One way to estimate distribution costs is to use the markup between the retail honey price and the producer price, which was on average 31.2 cents per pound over the 1981 to 1995 period. We estimate the distribution cost component of taxpayer expense as the product of the average markup and the number of pounds of honey forfeited by producers. For 1981 through 1985, taxpayer expenses are these distribution costs plus the amount paid to honey producers for forfeited honey. The cost of forfeited honey is represented by area bclk in the middle panel of figure 1. For 1986 through 1990, taxpayer expenses are the sum of (1) the support price–repayment rate differential for each

[11]To make the calculations of benefits consistent for producers and consumers, we base the actual consumer benefit calculations on forfeitures rather than on CCC distributions of honey. Because honey can be stored for a few years, CCC distributions lagged forfeitures.

[12]The calculations of consumer benefits assume that the supply of honey to the United States is perfectly elastic. One justification for this is that the United States imports only about 10 percent of world production. If, however, the supply of honey is upward sloping, our calculations may overstate the benefits to consumers between 1980 and 1985 and understate the benefits after 1985. In the 1980 to 1985 period, imports of honey into the United States increased greatly as producers forfeited greater quantities of honey. This effectively shifted out the excess demand for honey by the United States. With an upward sloping excess supply curve, this would result in a higher world price for honey, which would translate into a higher retail price and a loss of surplus to those consumers who would have purchased honey. In addition, the U.S. support program would then have effects on foreign consumers and producers. Foreign consumers would suffer a loss in surplus and foreign producers would net a gain in surplus as a result of the higher world price.

From 1986 on the situation is reversed. The relevant supply price to U.S. producers under this regime of the support program is the world price plus the support price-repayment rate differential. In this case, more honey is marketed by U.S. producers and the excess demand for honey by the United States pivots in at the support price. With an upward sloping excess supply curve, the resulting equilibrium world price would decrease. Hence, domestic consumers who purchase honey on the market would gain in surplus relative to our calculations. Foreign producers would suffer a loss in surplus and foreign consumer surplus would increase.

pound of honey bought back from the CCC, and (2) the distribution costs and producer receipts for forfeited honey. For 1991 through 1993, taxpayer expenses are the costs associated with all of these components, plus the direct subsidy payments of the support price–repayment rate differential collected on honey not put under loan, and less the 1 percent ASCS assessment.

The resulting calculated taxpayer expenses are presented in table 3. The deadweight loss as a result of the program, calculated as net consumer benefits plus net producer benefits minus taxpayer expenses, also is reported in the last column of table 3. The years with the highest taxpayer expenses in the early 1980s are associated with the largest net social losses. Alterations in the program as of 1986 reduced both taxpayer expenses and the net social loss. By the late 1980s, the benefits to consumers and honey producers nearly offset the taxpayer expenses of the honey program.

II.C. The Effects of the Honey Subsidy on Pollination

The effects of the honey program in the honey market are relatively straightforward. Consumers and producers trade in well-defined markets, and the welfare effects of market interventions are, in principle, measurable. Less straightforward are the effects of the honey program on consumers and producers of pollination services.

There are two types of beekeeping situations. There are those where the welfare gains from contracting between beekeepers and farmers are less than the transaction costs. These are markets with “pollination externalities”—markets in which increases in pollination services would generate net welfare gains (ignoring the transaction costs of effecting the increase). The other situations are those studied by Cheung: markets in which transaction costs are low enough that farmers and beekeepers contract for pollination services.

If a honey subsidy induced more pollination in the externality situations, then economic efficiency could increase. On the other hand, inducing more pollination in situations with contracts would result in the usual efficiency losses from a subsidy. A complete accounting of the effects of the honey subsidy in the two situations is beyond the scope of the present paper. However, we are able to address the question of whether a link exists between the price of honey and the price of pollination services and can estimate the size of such an effect. Thus, we can examine the main argument of the proponents of the honey program (see Section III) that subsidizing honey induces more pollination.

An indirect empirical method for determining the effects of the honey program on pollination is to analyze pollination fees, paid by farmers, for evidence of variation due to honey prices. If honey and pollination are complementary outputs, then increases in the supported price of honey should reduce equilibrium pollination fees. With this objective in mind, we obtained information on pollination fees from Professor Michael Burgett of the Department of Entomology at Oregon State University. He annually conducts surveys of beekeepers in Oregon. The data set we have constructed includes information on average annual pollination fees received by the survey respondents for the years 1987 to 1995, broken down by crop. We augment the survey data with annual data from other sources on Oregon crop prices and Oregon honey prices.

A natural empirical specification is

(1) $\text{Pollination Fee}_{it} = f\left(\text{Crop Price}_{it}, \text{Honey Price}_{it}\right)$,

where for crop i in year t, $\text{Pollination Fee}_{it}$ is the average pollination fee (in dollars per colony) reported in the survey; $\text{Crop Price}_{it}$ is the average crop price in Oregon (in dollars per pound); and

Honey $\text{Price}_{it}$ is the average price of honey received by producers in Oregon (in dollars per pound).[13]

The expected sign of the coefficient on Crop Price is positive—an increase in the price of a pollinated crop increases the VMP of pollination services, which should increase pollination fees in equilibrium. We assume an upward sloping supply of bee colonies for annual variations in price. The sign of the estimated coefficient on Honey Price is *a priori* ambiguous but is interesting as it provides insights into the validity of the arguments made by proponents of the honey program. A negative sign is consistent with the argument that an increase in honey prices increases the number of bees available for pollination and that this increase in supply of pollination services reduces pollination fees. A positive sign suggests that an increase in honey prices causes beekeepers to shift more of their colonies from providing pollination services to producing honey, thereby reducing the supply of pollination services and increasing pollination fees.

Beekeepers and landowners agree on pollination fees at the time colonies are placed in orchards and fields, typically in the spring or early summer months. Because the fees are determined prior to the time that actual crop prices for the year are known, fees must be based on expectations of what crop prices will be. We use as a proxy for the expected crop price the crop price from the previous year. Similarly, Oregon honey prices for year t are determined after pollination fees are specified. In the presence of the honey price support program, however, each year's honey price support level was known at the time that pollination fees were specified. Accordingly, we use the honey price for year t when the program was in effect (until 1993), and

[13]Pollination fees, crop prices, and honey prices are deflated (base year = 1991) for the empirical analysis.

thereafter we use the honey price in year t − 1 as a proxy for the expected honey price at the time pollination fees were specified.[14]

Our data set includes 88 observations on crop-average pollination fees from the surveys. The data span the years 1987 to 1995 and include information on 11 crops.[15] The dependent variable, $Fee_{it}$, is measured in dollars per colony, whereas the units for crop prices and honey prices are dollars per pound. Because of differences in crop yields and bee colony placement densities, there is no reason to believe that a given change in crop prices will have the same effect on pollination fees for all crops. Similarly, because of differences in the characteristics and volume of honey produced from different crops, there is no reason to believe that a given change in the price of honey will have the same effects on fees for all crops. A semi-log empirical specification that accounts for the heterogeneity in these effects is

$$\text{(2)} \quad \begin{aligned} \text{Fee}_{it} = {} & \beta_0 + \beta_1 \ln\left( \frac{\text{Crop Price}_{it} \cdot \text{Crop Yield}_i}{\text{Placement Density}_i} \right) \\ & + \beta_2 \ln(\text{Honey Price}_t \cdot \text{Honey Yield}_i \cdot \text{Discount}_i) \\ & + \beta_3 \text{Crop Dummy}_i + \epsilon_{it}. \end{aligned}$$

It can be seen that the units of the adjusted crop price are \$/colony = [(\$/lb)(lb/acre)]/(colonies/acre). Similarly, the units of the adjusted honey price are \$/colony =

[14]Note that we use the actual average honey price rather than the support price. Given that there were different support prices for different grades of honey and given that support prices were binding during the period of our analysis, we assume that the observed average honey price was an appropriately weighted average of the various support prices.

[15]The survey responses do not include fee information for all of the 11 crops for every year. Our data set is comprised of the following: 9 observations on pears, sweet cherries, apples, cucumbers, blueberries, and radish seed; 8 observations on vetch seed; 7 observations on crimson clover seed and squash; and 6 observations on red clover seed and cranberries.

(\$/lb)(lb/colony).[16] The transformation for crop prices adjusts for crop yields and bee colony placement densities, while the transformation for honey prices adjusts for honey quality and honey yield per colony. Crop dummies (0–1 variables) are included to account for any additional fixed effects across crops.

Noting that two of the three terms in the expressions for the adjusted crop and honey prices vary only across crops, equation (2) can be rewritten as a semi-log-linear model:

$$(3)\qquad \begin{aligned} Fee_{it} &= \beta_0 + \beta_1 \ln(\text{Crop Price}_{it} \cdot k_i) + \beta_2 \ln(\text{Honey Price}_t \cdot m_i) \\ &\quad + \beta_3 \text{Crop Dummy}_i + \epsilon_{it} \\ &= \beta_0 + \beta_1 \ln(\text{Crop Price}_{it}) + \beta_2 \ln(\text{Honey Price}_t) \\ &\quad + (\beta_1 \ln k_i + \beta_2 \ln m_i + \beta_3 \text{Crop Dummy}_i) + \epsilon_{it} \\ &= \beta_0 + \beta_1 \ln(\text{Crop Price}_{it}) + \beta_2 \ln(\text{Honey Price}_t) + \beta_3^* D_i + \epsilon_{it}, \end{aligned}$$

where $D_i$ is a crop-specific dummy variable that subsumes the impacts of the separate crop-specific effects discussed above.

OLS estimates of equation (3) and two variants are presented in table 4. Regression 1 includes the crop price, the price of honey, and 10 individual crop dummy variables. Although the estimated coefficient on Crop Price is positive, it is not significantly different from zero. The estimated coefficient on honey price is negative and significant, which supports the primary argument in favor of honey price support: that an increase in the price of honey increases the

[16]Here, the variable Discount is a unitless measure of the proportionate discount or premium in the price of honey from the ith crop relative to the price of honey from some base crop.

availability of pollination services, thereby driving down pollination fees. The crop dummy variables are jointly significant.[17]

With a full set of crop dummies, the crop price variable represents only the effects from time series price variation. It cannot represent the possible effects of inter-crop variation in value. To examine such an effect, regression 2 replaces the individual crop dummy variables with a 0–1 dummy variable that is assigned a value of one if honey typically is produced when colonies are placed with the crop.[18] Because beekeepers earn revenues from the honey produced, the fees charged for placing colonies with these crops are predicted to be less than for crops that yield no income to the beekeeper. Thus, we predict a negative estimated coefficient for the Honey Crop variable. As can be seen from table 4, this prediction is borne out by the highly significant coefficient on this variable. Further, the estimated coefficient on the Crop Price variable becomes positive and significant, and the coefficient on Honey Price remains negative and significant. The coefficient on the Honey Crop variable suggests that the pollination fee for crops that produce honey is about $17 per colony less than for crops that produce no honey.[19] The results also suggest that a 10 percent increase in average honey prices causes a decrease in pollination fees of about $2.50 per colony and that a 10 percent increase in crop prices causes an increase in pollination fees of about $0.40 per colony.

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[17]The only three crop dummy variables whose estimated coefficients are individually significantly different from zero are those for red and crimson clover seed and vetch seed. The estimated coefficients for all three of these are negative. Squash is the omitted category.

[18]Crops that are designated as honey producing crops are vegetable seed, red clover seed, crimson clover seed, vetch seed, raspberries, blueberries, and radish seed.

[19]Across all crops and years, the average pollination fee is $17.66. For crops that do not produce honey, the average fee is $22.96, compared to $11.00 for crops that do produce honey.

In our data set, the price of honey is constant across all crops for each year. Therefore, the honey price variable may also be picking up the effects of other (non-honey price) factors that are correlated with honey price. If so, then the effects of other factors may be confounding our estimates of the impacts of changes in crop prices on pollination fees. Regression 3 accounts for this possible source of bias by replacing the honey price variable in regression 2 with annual dummy variables. As can be seen, the year dummy variables are jointly significant. Further, neither the crop price nor the honey crop variable is much affected—either in terms of statistical significance or the value of the estimated coefficient.

The empirical results presented in table 4 support the argument, first advanced by Cheung, that there is a well-developed market for beekeepers' services. As predicted by a competitive model, increases in crop prices tend to increase pollination fees, and pollination fees for honey crops are less than for crops that do not yield marketable honey to beekeepers. Finally, our results imply that an increase in honey prices results in a reduction in pollination fees. Insofar as the honey program successfully maintained the price of honey above levels that would otherwise have been observed, elimination of the program resulted in a reduction in the availability of pollination services and an increase in pollination fees.

Consider, finally, more aggregate impacts of the honey program on markets for pollination services. Here, we attempt only to provide crude estimates of the effects on the provision of pollination services by invoking the (no doubt unrealistic) assumption that pollination and honey are produced in fixed proportions and that any increase in bee colonies increases the output of the two in equal proportions.

Table 3 reports our econometric estimates of the year-by-year changes in bee colonies induced by honey price support. Due mainly to lagged adjustment, the largest absolute and proportionate predicted changes occur late in our simulation period of 1981 to 1991. In 1981, our counterfactual predicted decline in colony numbers absent the honey program is only one-tenth of a percent. By 1991, our predicted decline is over 6 percent. The fixed proportion assumption implies then that, absent the honey program, pollination services would have been below actual levels by the same percentages. Further, in 1991 the program raised the price of honey by 11 percent (see table 2). The pollination fee regressions in table 4 imply that without the program, pollination fees would have been about $3 higher.

## II. The Political Economy of the Honey Program

Economic models of regulation suggest that for a given industry, a political equilibrium will be established that balances at the margin competing interests of consumers, producers, and taxpayers.[20] Shocks to the industry result in adjustments to a new political equilibrium. Below we recount and interpret the history of the honey program from the perspective of such a model.

To date, there have been four life stages to the honey program. The birth of the program in the early 1950s established a political equilibrium in which unrealized public pollination benefits were used to justify the establishment of a relatively modest subsidy. The second stage was the mid-life crisis in the 1980s in which events exogenous to the honey industry threw the political market out of equilibrium. The market was re-equilibrated fairly quickly with subsequent changes to the program. The death of the program came when the modest size of the beekeeping and honey industries, coupled with the quaint public image of beekeeping, made the honey program a

[20]For seminal articles in this literature, see Stigler (1971), Peltzman (1976), and Becker (1983).

vulnerable political target. Important factors in the demise of the program included a political climate critical of costly agricultural programs and the geographic diversity of honey producers—they likely comprised an important constituent in few, if any, politicians' districts. Gardner (1987) argues that geographic concentration leads to greater political support. The fourth (and current) stage of the honey program is the re-establishment of the modest equilibrium level of support that prevailed from 1950 to 1980 but in the form of trade restrictions and, most recently, marketing assistance loans and loan deficiency payments for the year 2000 crop.

Stage 1: Birth and Modest Support

The impetus for lobbying for honey price supports in the late 1940s came from two sources. First, following the end of World War II there was a decline in the demand for honey that caused honey prices to fall and, it was claimed, threatened to drive beekeepers out of business. Second, there was a problem producing sufficient legume seed to meet the increased demand for cover crops as farmers attempted to replenish soil nitrogen levels following World War II. Elaboration on each of these factors follows.

During World War II, a high national priority was placed on the production of honey (as a substitute for sugar) and beeswax (which was used for waterproofing military equipment) and also on assuring an ample stock of bees for pollination of agricultural crops (U.S. Congress, House, 1949, p. 2). Following the war, with the increased availability and falling price of sugar, the demand for honey fell and the price of honey decreased dramatically between 1947 and 1949 (figure 2).[21]

[21]In nominal terms, the average honey price (a weighted average of prices received by producers in wholesale and retail sales) fell by about 35 percent, while the honey producer price (the price received by producers for honey in 60-pound containers) appears to have fallen by about 50 percent (see table 5). Prices in 1949 were still

Pleas for government price supports at a subcommittee hearing in April 1949 were based in part on the hardships being borne by beekeepers who claimed to be unable to sell their honey for a price that covered their costs of production. To a much greater extent, however, the pleas for support were based on the damage to agriculture that would result from reductions in the pollination services if substantial numbers of beekeepers failed. Experts who were asked to make the comparison all claimed that the pollination services were much more valuable than the honey produced.[22]

At the time, soil nitrogen levels were widely depleted because during WWII farmers had plowed up fields of nitrogen-replacing crops (clover, vetch, and alfalfa) to replace them with more profitable nitrogen-depleting crops (tomatoes, sugar beets, corn, and cotton). After the war, farmers looking to replenish their soil nitrogen levels found that legume seeds were in short supply. The supply of imports was low because of high post-war demand in Europe. Further, although legume seed prices were relatively high, yields were not high enough to make significant expanded domestic seed production profitable.

The limited supply of legume seeds also resulted from a reduction in wild bee populations, which was attributable to the use of new insecticides, the destruction of wild bee habitat, and the drainage and burning of fence rows as new lands were brought into production. Because wild bees had previously performed the pollination task with no involvement from farmers, farmers did not immediately appreciate the importance of the decline.

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considerably higher than they had been prior to the war.

[22]Statements in the 1949 subcommittee hearings regarding the importance of pollination and the role of honeybees included claims that 80 percent of pollination was accomplished by honeybees (pp. 2, 6, 10, 11, 14, 16), that more than 50 agricultural crops relied on pollination (p. 6), and that the value of pollination was 10 to 50 times the value of honey (p. 16).

Research in California in the late 1940s and early 1950s alleviated the dearth of legume seeds. Prior to this time, the potential contribution of honeybees to seed production had not been realized, and it appears that farmers were generally not willing to pay pollination fees for legume seeds. In 1949, however, an innovative beekeeper and an adventuresome farmer—with support from researchers at the University of California–Davis—demonstrated that intensive use of bees (five hives, rather than one or two, per acre) increased yields dramatically (roughly 1,000 pounds per acre compared to state average yields of about 220 pounds). Contemporary accounts of these events (Whitcombe, 1955), as well as more recent academic research (Olmstead and Wooten, 1987), indicate that although both the innovative beekeeper and farmer made short-run rents, markets adjusted very quickly to this news. The supply of pollination services increased quickly, pollination fees rapidly adjusted to a competitive level, and legume seed prices fell. Thus, it appears that legislative testimony in the late 1940s was largely accurate regarding shortages of seed supplies, unwillingness of farmers to pay pollination fees for legume seed production, and falling honey prices.

Given that the major focus of legislative testimony was on problems of pollination, a natural question is why discussion centered on supporting the price of honey rather than on directly subsidizing pollination services. While most testimony concerned honey supports, there was some discussion in the April 1949 hearings of possible pollination subsidy programs.[23] Problems with pilot programs in Ohio and Arkansas concerned the issue of whether to pay the subsidy to the landowner or to the beekeeper and how to assure that the services claimed had

[23] See, for example, the testimony of J. H. Davis from Arkansas and W. T. Gran from Ohio (U.S. Congress, 1949).

indeed been provided. Another problem concerned the source of funding for pollination-subsidizing programs. Fred Ritchie, speaking on behalf of the USDA Production and Marketing Association, indicated that his agency did not feel it would be appropriate to provide such funding under the auspices of the Conservation Reserve Program.[24]

The honey program was created in 1950. In 1950 and 1951, a packer purchase program was in effect.[25] In this program, packers who purchased eligible honey from beekeepers at announced support prices were guaranteed a price equal to the support price plus an allowance for processing, handling, and storage. During the 2 years the program was in effect, the CCC acquired about 25 million pounds of honey. As a result of industry dissatisfaction with the packer purchase program, the nonrecourse loan program was initiated in 1952.[26] There was virtually no honey forfeited to the CCC during the period 1952 to 1980 (table 5), and the program was essentially unchanged until 1985.[27]

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[24]There are few examples of government programs that provide farmers with direct per unit subsidy payments for their production activities. A plausible explanation that has been offered for not observing simple direct subsidy payments is that the transfer to farmers and the costs to taxpayers/consumers is too apparent (see Tullock, 1989; Magee, Brock, and Young, 1989; Antle and Johnson, 1990; Rucker, 1995). With price supports, quotas, and target price programs, the actual magnitude of the transfer to producers is more difficult to evaluate. The direct lump sum subsidy payments implemented in the 1996 Farm Bill present a puzzle in this context.

[25]Hoff and Willett (1994, pp. 56-57) is the primary source of information on the early years of the honey program. The honey program also included export payments and payments for diverting honey to new uses in the early years. Exports averaged about 20 million pounds annually for the 5 years the export payments were in effect. The diversion component of the program had little impact and was abandoned in 1954.

[26]Dissatisfaction on the part of beekeepers apparently developed in part because in some regions packers did not enter into the program. In those regions, packers were under no obligation to pay beekeepers the support price.

[27]During some years, the honey program has also included a purchase option under which the producer could simply sell honey to the CCC at the support price. In 1975 and 1976, for example, the program included a purchase agreement program but no loan program.

An important question for understanding the political economy of the honey program is "Why did honey producers settle for a support price in the early 1950s that was set at levels that remained below the market price for 30 years?" As indicated above, there was substantial discussion in the late 1940s of providing beekeepers with support because of falling honey prices. Figure 2 provides insights into the expectations of beekeepers at the time of subcommittee hearings in 1949. Based on the dramatic decline in honey prices between 1947 and 1949, a reasonable prediction as of 1949 would be that honey prices would continue to fall.[28] Producers therefore settled for a support price of 9 to 10 cents per pound, a price that was considerably higher than prices prior to World War II. When prices leveled off at roughly the 1949 price, it turned out that the support price was slightly below the market price and—with very few exceptions—remained below market levels for 30 years (see table 5, columns 3 and 5). Without an industry-wide crisis to motivate changes in the program, beekeepers apparently did not have the political clout to go back to Congress and obtain a higher support price.

Stage 2: Mid-Life Crisis and Adjustments

From 1981 to 1988, CCC takeovers increased dramatically, with takeovers for the period 1983 to 1985 averaging over 100 million pounds annually. The cause of this increase in CCC takeovers was an increase in the support price to levels that exceeded the honey price received by producers (table 5, columns 3 and 5). Producers placed their honey under loan, received the loan rate, and then forfeited on the loan when market prices stayed below the loan rate. With no restrictions on imports, little domestic honey was purchased, imports increased dramatically, and

[28]In fact, farm prices in general were following a clear downward trend during the late 1940s and early 1950s (see Orden, Paarlberg, and Roe, 1999, figure 3, p. 25).

the CCC was faced with the problem of how to dispose of large amounts of honey. Large Treasury costs resulted, and by the early 1990s changes (described in Section II) had been made to the program to decrease those costs. Testimony presented in 1992 and 1993 indicated that forecasts of costs of the honey program for the foreseeable future were less than $10 million and declining.

Why did the support price increase to levels greater than the market price in the early 1980s, and what changes were made in response to the resulting increased Treasury costs? To answer these questions, it is important to know whether price supports increased in response to lobbying by beekeepers or as a result of factors exogenous to the honey industry. Nominal and real honey price series are shown in table 5. In nominal terms, the support price more than tripled between 1974 and 1984, while the producer price was roughly the same in those two years. In real terms, the support price increased by about 33 percent during this period and the producer price fell by about 50 percent. The reduction in the real producer price appears to be due to substantial shifts in the total supply of honey—world production during the years 1986 to 1988 was more than 40 percent greater than during the years 1973 to 1975.[29] Moreover, the concomitant increase in the support price was not due to lobbying efforts by beekeepers. Rather, support prices increased as a result of the legislated formula for calculating parity prices. During this period, the honey support price was legislated to be set by the Secretary of Agriculture at levels between 60 and 90 percent of the parity price. In fact, for the entire period from 1973 to 1985, the support price was set at the minimum of 60 percent of parity.[30]

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[29]FAO Production Yearbooks, various issues.

[30]See Hoff (1995) and Comptroller General (1985).

Parity prices were calculated using an index of prices paid by farmers (both for production and consumption) and in the inflationary late 1970s and early 1980s, these costs increased substantially, thereby driving up the parity price for honey.[31] Because the honey support price was already being set at the minimum allowable level (60 percent of parity), honey support prices increased rapidly. In the face of (roughly) constant nominal—and declining real—market prices, the rising support prices soon exceeded market prices, thereby causing increased forfeitures, imports, and Treasury costs. The problems faced by the honey program in the early 1980s thus appear to have resulted from events beyond the control of beekeepers and other supporters of the honey program.

The honey program had a relatively small and dispersed constituent base. Supporters of the program realized that it could not survive politically with huge stocks of honey and treasury costs in the range of $80 to $100 million per year and reacted quickly to correct the program's problems. Proposals by critics in Congress and the administration to discontinue the program in the 1985 Farm Bill were successfully fended off by program supporters. A compromise was reached in which the use of parity prices was discontinued and support prices were reduced incrementally from 65.8 cents per pound in 1984 to 50 cents per pound in 1994. In addition, marketing loans were implemented that allowed producers to buy back their honey at prices less than the loan rate (see Section II). Under the 1990 Farm Bill, loan deficiency payments were implemented that allowed producers to receive the difference between the loan rate and repayment rate without putting their honey under loan.

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[31]For information on the technical details of the calculation of parity prices during this period, see USDA's Agricultural Handbook No. 365 (1970).

The net effects of these changes were to dramatically reduce forfeitures, imports, and Treasury costs (see table 5). In subcommittee hearings in 1992, a spokesman for the USDA testified that according to their forecasts the Treasury costs of the honey program would fall below $10 million by 1995 and would remain below that level for the foreseeable future (U.S. House Subcommittee on Livestock, Dairy, and Poultry of the Committee on Agriculture, 1992). As in the late 1940s, a primary argument made repeatedly in defense of the honey program was that without a support price for honey, beekeepers would fail and huge costs would be borne by U.S. agriculture through adverse impacts on pollination activities. An estimate of the value of pollination services that was cited repeatedly was $9.3 billion.[32] Frequently in the discussions in these hearings it was implicitly assumed (and in some cases explicitly asserted) that eliminating the honey program would result in the elimination of pollination services and that the resulting costs would be the full $9.3 billion.[33]

In subcommittee hearings held in 1993, the primary industry concerns were rapidly increasing imports of low-priced Chinese honey and the newly empowered Clinton administration's aversion to the honey program. Suggestions made to correct the industry's problems included placing restrictions and tariffs on Chinese honey imports and changing the program back to a simple loan program (with no low repayment rate provisions). Following these

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[32]The source of this estimate was a study by a group of Cornell entomologists (see Robinson, Nowogrodzki, and Morse, 1989). Morse and Calderone (2000) recently updated the estimates from the 1989 study and determined that the more recent value of pollination services is $14.6 billion. For a compelling criticism of the methodology used in that study, see Muth and Thurman (1995), who argue that an estimate of $9.3 billion greatly overstates the value of pollination services and that more plausible estimates are in the range of $600 million per year.

[33]For an instance in which this claim was made explicitly, see the response of Richard Adee, President of the American Honey Growers Association, to questions from the subcommittee (U.S. House Subcommittee on Specialty Crops and Natural Resources, 1993, p. 12).

deliberations, the Omnibus Budget Reconciliation Act of 1993 was enacted with the honey program still intact. A schedule for minimum honey loan rates was set forth out to the 1998 honey crop, at which time the minimum loan rate was to be 47 cents (Hoff and Willett, 1994, p. 58). The market loan and loan deficiency payment options remained in effect, and declining loan payment limits to individual beekeepers were specified for the period 1994 to 1998.

Stage 3: The Death of the Honey Program

In October 1993, appropriations were denied for the honey program (P.L. 103-111). In June 1994, the GAO submitted an update of their 1985 report on the program to the House and Senate subcommittees (Harman, 1994). The report concluded that "a price support for honey is not needed for ensuring a supply of honeybees for pollination" (p. 9), that pollination markets were not fully developed, and that the elimination of the price support for honey may result in the development of a market for pollination services that "recognizes their full value to crop producers" (p. 10). The honey program was eliminated under the 1996 Farm Bill.

Why was the honey program eliminated in the 1990s? The impetus for the denial of appropriations in 1993 appears to have come from two sources.[34] The first was a bipartisan Congressional coalition comprised of conservative urban Republicans from the Rust Belt and Democrats from the Northeast. An objective of this coalition was to take on agricultural interests and to eliminate costly agricultural commodity programs. The honey, wool and mohair, peanut, and sugar programs all attracted the attention of the coalition. The honey program was their

[34]Sources for the following include two industry observers (a staffer for a member of the House of Representatives and the current Executive Director of an active national association of beekeepers) who are familiar with relevant political events, as well as subcommittee hearings and contemporary newspaper articles.

trophy, even though by the time they succeeded in seeing it eliminated, the costs associated with the program were trivial compared with many other programs.[35]

The second important source of pressure for the elimination of the honey program was the Clinton administration. Early in his presidential campaign, "candidate Clinton, looking for one non-defense program he could oppose without wincing" (Will, 1994) ridiculed the honey program as wasteful and promised to eliminate it if elected. After taking office, President Clinton and his administration continued their efforts to eliminate the program.[36] These two sources of opposition, executive and legislative, succeeded in cutting off funding for the program. The industry did not regroup and there appears to have been virtually no discussion of the program in the hearings or debates for the 1996 Farm Bill. The fact that the honey lobby was relatively weak and that both current and expected future benefits were small proved to be important factors in the demise of the federal honey program. Another important factor—that alternative methods of industry support were being pursued—is discussed below.[37]

[35]For contemporary observers' comments on the smallness of the savings associated with eliminating the honey program, see, for example, "That Buzzing Sound," *The Washington Post*, August 16, 1993 and Passell, "Economics Scene: Special Interests...," *The New York Times*, February 3, 1994. Direct payments under the wool and mohair program were also phased out at this time.

[36]For indications of the Clinton administration's efforts to eliminate the program, see *The Washington Post*, November 24, 1992 and August 31, 1993 and Risen, "Is U.S. Stuck with Honey Subsidies?" the *Los Angeles Times*, March 21, 1993. See also U.S. Congress, House, April 1994 for repeated concerns regarding the Clinton administration's intentions to eliminate the program.

[37]Another factor that influenced public opinion regarding the honey program was its susceptibility to puns and jokes (e.g., sweet deals that stung the taxpayer, government can't keep its sticky fingers out of honey; Congress' attack on the honey pot, etc.). Johnson (2000) discusses a subsidy program for gum naval stores that survived for many years after its political support seems to have disappeared. Thus, although subsidy programs may persist on their own inertia, the case of honey illustrates that they can also be vulnerable for idiosyncratic reasons.

Stage 4: After-Life and Re-equilibration

What has been the regulatory response to the elimination of the honey program? The farm spending bill that banned payments to honey producers for fiscal year 1993-1994 passed the Senate on September 23, 1993 and the House on September 30, 1993. Pressure from the honey lobby for substitute measures was being applied even before these were signed. On September 20, 1993, President Clinton wrote a letter to the Chairman of the House Agriculture Committee, Kiki de La Garza (who was a supporter of the honey program), apparently to make amends for the impending elimination of funding for the program. In the letter, President Clinton acknowledged the concerns of the industry regarding Chinese honey imports and invited an investigation of the impacts of these imports.[38]

In January 1994, the International Trade Commission (ITC) issued a report recommending that beekeepers be given relief, in the form of tariffs on imported Chinese honey, under a Cold War statute that allowed protection against imports of goods from Communist countries that disrupted U.S. markets.[39] Despite his letter inviting the investigation, President Clinton rejected the recommendation of the ITC in April 1994.[40] The honey lobby took another tack in a suit filed in October 1994, this time claiming that China was selling honey in the U.S. market for less than fair market value. Both the ITC and the Commerce Department made preliminary rulings in favor

[38]See Passell, "Economics Scene: Special Interests ...," *The New York Times*, February 3, 1994.

[39]See Honey from China, U.S. International Trade Commission Pub. 2715, January 1994. Investigation TA-406-13. The specific recommendation was for a 3-year tariff-rate quota: a quarterly quota of 12.5 million pounds of imports from China to be assessed a 25 percent tariff. Imports in a quarter greater than 12.5 million pounds were to be assessed a 50 percent tariff.

[40]See Passell, "Economics Scene: Battered but not Broken...," *The New York Times*, April 13, 1995.

of domestic honey growers and recommended that punitive tariffs of 150 percent be imposed on Chinese honey imports.

The ITC's antidumping investigation of these issues was suspended in August 1995 when an agreement was reached between the United States and the People's Republic of China that called for (1) a restriction on annual honey shipments to the United States to 43.925 million pounds (plus or minus a maximum of 6 percent per year based upon U.S. honey market growth), and (2) a requirement that China's price to U.S. importers could be no less than 92 percent of a reference price, which was to be the value-weighted average of import prices from all other countries. The reference price was to be recalculated quarterly and constructed from the most recent 6 months of shipments. No antidumping tariffs were imposed.

Table 6 indicates that Chinese imports have been limited to levels below the quota in each year since the agreement was signed.[41] Table 6 also shows that imports from Argentina have more than offset the reduction in Chinese imports. In 1998, an amendment to the China–United States agreement was adopted in response to concerns from the Chinese that during periods when the world honey price was falling, the reference price—which was calculated for the most recent 6 months—was often high enough that the Chinese could not sell their quota of honey in the United States. The agreement was modified so that the reference price was calculated over the last 3 months of sales data. This modification may be partly responsible for the increase in Chinese imports in 1999.

[41]In 3 of the 5 years since the quota was implemented, Chinese imports were considerably less than the quota, likely suggesting that the reference price floor was high enough to reduce U.S. demand for Chinese honey to levels less than the import quota.

The agreement with China expired in August 2000. But new trade cases were brought almost immediately against China and Argentina by, among others, the American Honey Producers Association. They allege dumping by China and Argentina and the provision of export subsidies by the government of Argentina. The ITC made a preliminary finding of material injury in the countervailing duty case (USITC, November 2000), and the Department of Commerce held that countervailable subsidies have been provided to Argentine honey producers by the government of Argentina (see Department of Commerce, March 13, 2001). A duty rate of 6.55 percent on Argentine honey has been approved.

The most recent form of subsidy has been appropriation for marketing assistance loans and loan deficiency payments for the 2000 year honey crop. At this writing, these payments appear to amount to a considerable 14 cents per pound, which may prove to be inconsistent with long-run equilibrium levels of political support.[42]

What has happened in the honey and beekeeping industries since the elimination of funding for the honey program in 1993? Table 5 indicates that nominal honey prices rose for a period and have recently fallen back to earlier levels.[43] Real honey prices currently are lower than they have been at any time since the 1950s. The number of colonies is about 10 percent lower than in the early 1990s but appears to have stabilized. There has been no clear trend in the amount of honey produced domestically since 1993, and the level of net imports appears to be continuing to increase.

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[42]Earlier, a recourse loan rate was in effect in 1994, 1995, and 1998-2000. The costs and impacts of these loan rates (which require repayment of loans) have been quite small, both because participation has been limited and because the only subsidy involved has been a below market interest rate on the loan amounts.

[43]Industry sources and available data indicate that the increase in U.S. honey prices in 1996 likely resulted from both a reduction in world production of honey and the restriction on imports of Chinese honey.

## IV. Conclusion

During its first 30 years, the honey support program had little effect on honey markets. But in the early 1980s, falling world prices and rising support prices combined to generate substantial effects. As it became more profitable for producers to forfeit honey used as collateral for nonrecourse loans than to sell their honey on the market, the government accumulated large quantities of honey, which subsequently were donated to consumers. Our empirical analysis of honey markets suggests that each pound of donated honey offset market sales of honey by about three quarters of a pound. In addition, higher prices to producers increased annual production of honey by up to 27 million pounds, or 12 percent of actual production. Benefits to consumers and producers came at an annual taxpayer expense of up to $103 million with annual deadweight losses of up to $13 million. Effects in closely related markets for pollination services are illuminated by our empirical analysis of pollination fees. In addition to showing that economic factors affect pollination fees in predictable ways, we find that increases in honey prices result in reduced pollination fees. This finding is consistent with the arguments made by lobbyists in support of the honey program.

With the 1996 Farm Bill, it appeared that the honey program was breathing its last. But the honey lobby remained active, succeeding in August 1995 in obtaining price and quantity restrictions on Chinese imports. Annual authority also was granted for recourse loans in several years after 1993, although these likely had little effect on honey producers. Most recently, in October 2000, appropriations were made to re-institute support mechanisms for the 2000 crop year honey that were in effect in the early 1990s.

Beyond the calculations of welfare effects lie questions of political economy. Theories of Stigler, Peltzman, and Becker suggest that political equilibria are established that equate at the margin the competing interests of consumers, producers, and taxpayers. Exogenous shocks to an industry can disrupt the equilibrium, setting in motion forces to establish a new equilibrium. In a different context, Barzel argues that the margins for adjustment in competing for and specifying property rights in ordinary (nonpolitical) markets are virtually countless. Our interpretation of the honey program provides a link between these literatures. We document a series of political responses to exogenous shocks that, in each case, restored the honey market to what appears to be its long-run equilibrium level of subsidy. The context of these adjustments from 1952 through 1993 was the U.S. honey program. When the modest level of support for the beekeeping industry through the honey program was terminated in 1993, a different policy margin became active—trade restrictions. At the time of this writing, trade actions against Argentina have received preliminary approval and others against China and Argentina are pending. Further, appropriations for supporting beekeeper incomes for the 2000 crop year have been made. We predict that some form of subsidy will survive, consistent with the apparent long-run equilibrium level of support. Given the virtually countless number of margins for adjustments in political markets, however, we offer no predictions regarding the forms of future subsidies.

What lessons useful for understanding other programs might be learned from the honey program? We believe that the broad history of agricultural subsidies is illuminated by the two ideas of equilibrium in political markets and the limitless number of margins for adjustment in the political definitions of property rights. The history of farm subsidies (see Luttrell, 1989, and Pasour, 1990) is not one of stability but rather of continual shifts in the use of various policy tools (acreage restrictions, production controls, price subsidies, and others) to establish and re-establish political equilibria. One can usefully focus on the determinants of static political equilibria, as does Gardner (1987), but still recognize that history matters—that policy options foreclosed by previous experience give way to new, hard to predict, policy margins along which new equilibria are sought. The honey program is a case in point.

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**Table 1.** **Bee Colony Response and Honey Consumption Equation Estimates, 1950-1995**

*Bee Colony Response:*

Maximum Likelihood Estimates

Model: $$y_t^* = \alpha + \gamma y_{t-1}^* + \beta p_t + \varepsilon_t,$$

$$y_t = y_t^*, \quad t = 55, \ldots, 81,$$

$$y_t = y_t^* - A, \quad t = 82, \ldots, 95.$$

$y_t$ is the number of bee colonies as reported by USDA; $p_t$ is the ratio of expected honey price to an index of production costs; A is the adjustment for undercounting post 1981. Data on $y_t$ are missing for the years 1982-1985. See the Appendix for model and estimation details.

| Parameter: | *Coefficient* | *(Standard Error)* |
|---|---|---|
| $\alpha$ | –160.8 | (121.6) |
| $\gamma$ | 0.974 | (0.024) |
| $\beta$ | 394.3 | (100.4) |
| A | 862.9 | (195.1) |

| | |
|---|---|
| 1st-order residual autocorrelation coefficient | –0.28 |
| R-squared (1-SSE/SST) | 0.983 |

*Honey Consumption:*

Ordinary Least Squares Estimates

Dependent Variable: Per Capita Honey Consumption

| *Regressors:* | *Coefficient* | *(Standard Error)* |
|---|---|---|
| Intercept | 1.6271 | (0.0443) |
| Per Capita CCC Distributions | –0.7648 | (0.1337) |
| Year | –0.0326 | (0.0042) |
| $(\text{Year})^2$ | 0.0005 | (0.0001) |

| | |
|---|---|
| Durbin-Watson | 1.412 |
| Adjusted $R^2$ | 0.8059 |

**Table 2. Supply Effects of the Honey Support Program, 1981-1995**

| | | | Colonies | | | Production | |
|---|---|---|---|---|---|---|---|
| Year | Expected Producer Price Without Program ($/lb) | Expected Producer Price With Program ($/lb) | Actual Level[a] (1000s) | Predicted Change Due to Program (1000s) | Actual Average Yield Per Colony (lbs) | Actual Level[b] (mil lbs) | Predicted Change Due to Program (mil lbs) |
| 1981 | 0.560 | 0.574 | 4,213 | 6 | 44.1 | 185.8 | 0.3 |
| 1982 | 0.576 | 0.604 | 4,182 | 17 | 43.0 | 179.8 | 0.7 |
| 1983 | 0.575 | 0.622 | 4,156 | 35 | 43.0 | 178.7 | 1.5 |
| 1984 | 0.538 | 0.658 | 4,141 | 81 | 43.0 | 178.1 | 3.5 |
| 1985 | 0.482 | 0.653 | 4,122 | 145 | 43.0 | 177.2 | 6.2 |
| 1986 | 0.489 | 0.709 | 4,068 | 227 | 41.9 | 170.4 | 9.5 |
| 1987 | 0.554 | 0.679 | 4,053 | 268 | 50.4 | 204.3 | 13.5 |
| 1988 | 0.431 | 0.660 | 4,049 | 346 | 45.5 | 184.2 | 15.7 |
| 1989 | 0.482 | 0.633 | 4,163 | 388 | 30.6 | 127.4 | 11.9 |
| 1990 | 0.478 | 0.607 | 4,073 | 421 | 41.1 | 167.4 | 17.3 |
| 1991 | 0.544 | 0.607 | 4,044 | 430 | 48.2 | 194.9 | 20.7 |
| 1992 | 0.552 | 0.607 | 3,893 | 436 | 52.2 | 203.2 | 22.8 |
| 1993 | 0.522 | 0.607 | 3,739 | 451 | 59.6 | 222.8 | 26.9 |
| 1994 | 0.514 | 0.514 | 3,633 | 439 | 57.8 | 210.0 | 25.3 |
| 1995 | 0.511 | 0.511 | 3,511 | 427 | 58.9 | 206.8 | 25.1 |

[a]Colony numbers are adjusted by adding 863,000 to the USDA-NASS estimates for 1982 through 1995 to reflect changes in data collection by the USDA. See Appendix for detail.
[b]We calculated "Actual Level of Production" by multiplying colony populations by average yields.

**Table 3. Welfare Effects of the Honey Support Program, 1981-1995**

| Year | Retail Honey Price[a] ($/lb) | Support Price ($/lb) | Repayment Rate ($/lb) | Producer Price ($/lb) | Forfeitures (mil lbs) | Quantity Bought Back (mil lbs) | Quantity Directly Subsidized (mil lbs) | Net Producer Benefits (mil $) | Net Consumer Benefits (mil $) | Taxpayer Expenses (mil $) | Deadweight Loss (mil $) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1981 | 0.883 | 0.574 | | 0.566 | 35.2 | 20.0 | | 0.3 | 27.1 | 31.2 | 3.8 |
| 1982 | 0.886 | 0.604 | | 0.568 | 74.5 | 13.9 | | 2.7 | 56.5 | 68.2 | 9.1 |
| 1983 | 0.852 | 0.622 | | 0.544 | 106.4 | 7.2 | | 8.2 | 78.4 | 99.4 | 12.8 |
| 1984 | 0.782 | 0.658 | | 0.495 | 105.8 | 1.7 | | 17.0 | 72.3 | 102.6 | 13.3 |
| 1985 | 0.754 | 0.653 | | 0.475 | 98.0 | 4.0 | | 16.9 | 64.6 | 94.6 | 13.0 |
| 1986 | 0.808 | 0.640 | 0.410 | 0.513 | 41.0 | 139.4 | | 36.2 | 28.7 | 71.1 | 6.2 |
| 1987 | 0.791 | 0.610 | 0.404 | 0.465 | 52.7 | 165.3 | | 40.3 | 36.3 | 82.6 | 6.1 |
| 1988 | 0.813 | 0.591 | 0.384 | 0.459 | 32.0 | 177.5 | | 39.3 | 22.7 | 65.6 | 3.6 |
| 1989 | 0.793 | 0.564 | 0.384 | 0.463 | 2.8 | 158.9 | | 27.8 | 2.0 | 31.1 | 1.3 |
| 1990 | 0.839 | 0.538 | 0.432 | 0.507 | 1.1 | 182.5 | | 18.5 | 0.8 | 20.3 | 1.0 |
| 1991 | 0.789 | 0.538 | 0.479 | 0.538 | 3.2 | 109.7 | 85.7 | 9.8 | 2.3 | 13.2 | 1.1 |
| 1992 | 0.787 | 0.538 | 0.474 | 0.529 | 4.1 | 118.6 | 74.4 | 10.6 | 2.9 | 14.8 | 1.3 |
| 1993 | 0.813 | 0.538 | 0.470 | 0.512 | 16.4 | 120.4 | 77.0 | 11.8 | 11.8 | 26.2 | 2.7 |
| 1994 | 0.891 | 0.500[b] | 0.000 | 0.502 | 0.0 | 73.4 | | 0.0 | 0.0 | 0.0 | 0.0 |
| 1995 | 1.000 | 0.500[b] | 0.000 | 0.664 | 0.0 | 64.4 | | 0.0 | 0.0 | 0.0 | 0.0 |

[a]We constructed retail honey prices for 1981 through 1986 based on the observed relationship between the retail price and the producer price over 1950-1979 and 1987-1992.

[b]The support price in 1994 and 1995 was not a true support price because the loan program became a recourse loan program. That is, producers who took out loans at 50 cents per pound were required to pay the loans back with interest.

**Table 4. Regression Results: Determinants of Pollination Fees**

Dependent Variable: Pollination Fee ($/colony)

| Variable | Regression 1 Coefficient (t-value) | Regression 2 Coefficient (t-value) | Regression 3 Coefficient (t-value) |
|---|---|---|---|
| Constant | 8.51<br>(1.13) | 15.29<br>(2.01)** | 29.33<br>(10.84)** |
| log of Crop Price | 1.17<br>(0.48) | 3.78<br>(3.43)** | 4.14<br>(3.92)** |
| log of Honey Price | –28.16<br>(–3.32)** | –24.70<br>(–1.93)* | — |
| Honey Crop | — | –17.25<br>(–8.43)** | –17.37<br>(–8.84)** |
| Crop Dummy Variables[a] | 33.20** | — | — |
| Year Dummy Variables[a] | — | — | 2.51** |
| F Value | 31.75 | 29.92 | 11.52 |
| Adjusted $R^2$ | 0.809 | 0.499 | 0.547 |
| No. of observations | 88 | 88 | 88 |

[a]Number displayed is value of F-statistic for joint significance of the respective groups of dummy variables.

*Significant at 0.05 level; **Significant at 0.10 level (one-tailed test significance for Crop Price, Honey Crop, and Pollination Index; two-tailed for others).

**Table 5. Honey Markets and Government Activities, 1939-1999**

| Year | Total Colonies (1000s) (1) | Honey Production (mil lbs) (2) | Honey Producer Price ($/lb)[a] (3) | | Average Honey Price ($/lb)[a] (4) | | Average Honey Support Price ($/lb)[a] (5) | | CPI (82-84=100) (6) | Net Imports (mil lbs) (7) | CCC Take Over (mil lbs) (8) | Treasury Costs ($ mil) (9) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1939 | | | 0.019 | 0.137 | 0.067 | 0.428 | | | 13.9 | | | |
| 1940 | | | 0.013 | 0.093 | 0.061 | 0.436 | | | 14.0 | | | |
| 1941 | | | 0.024 | 0.163 | 0.072 | 0.490 | | | 14.7 | | | |
| 1942 | | | 0.092 | 0.564 | 0.138 | 0.847 | | | 16.3 | | | |
| 1943 | | | 0.123 | 0.711 | 0.168 | 0.971 | | | 17.3 | | | |
| 1944 | | | 0.132 | 0.750 | 0.177 | 1.006 | | | 17.6 | | | |
| 1945 | | | 0.142 | 0.789 | 0.186 | 1.033 | | | 18.0 | | | |
| 1946 | | | 0.202 | 1.036 | 0.244 | 1.251 | | | 19.5 | | | |
| 1947 | | | 0.207 | 0.928 | 0.249 | 1.117 | | | 22.3 | | | |
| 1948 | | | 0.134 | 0.556 | 0.179 | 0.743 | | | 24.1 | | | |
| 1949 | | | 0.104 | 0.437 | 0.150 | 0.630 | | | 23.8 | | | |
| 1950 | 5,612 | 233.0 | 0.102 | 0.423 | 0.153 | 0.635 | 0.090 | 0.373 | 24.1 | 2.9 | 7.4 | NA[b] |
| 1951 | 5,559 | 258.1 | 0.103 | 0.396 | 0.160 | 0.615 | 0.101 | 0.388 | 26.0 | –4.5 | 17.8 | NA[b] |
| 1952 | 5,493 | 272.0 | 0.114 | 0.430 | 0.162 | 0.611 | 0.114 | 0.430 | 26.5 | –14.9 | 7.0 | NA[b] |
| 1953 | 5,520 | 223.8 | 0.115 | 0.431 | 0.165 | 0.618 | 0.105 | 0.393 | 26.7 | –23 | 0.5 | NA[b] |
| 1954 | 5,451 | 216.4 | 0.118 | 0.439 | 0.170 | 0.632 | 0.102 | 0.379 | 26.9 | –15.1 | 0.0 | NA[b] |
| 1955 | 5,252 | 255.2 | 0.129 | 0.481 | 0.178 | 0.664 | 0.099 | 0.369 | 26.8 | –10.6 | 0.0 | NA[b] |
| 1956 | 5,195 | 214.0 | 0.136 | 0.500 | 0.190 | 0.699 | 0.097 | 0.357 | 27.2 | –13.4 | 0.0 | NA[b] |
| 1957 | 5,199 | 241.2 | 0.134 | 0.477 | 0.187 | 0.665 | 0.097 | 0.345 | 28.1 | –15 | 0.1 | NA[b] |
| 1958 | 5,152 | 260.5 | 0.120 | 0.415 | 0.174 | 0.602 | 0.096 | 0.332 | 28.9 | –18.5 | 2.0 | NA[b] |
| 1959 | 5,109 | 236.6 | 0.122 | 0.419 | 0.170 | 0.584 | 0.083 | 0.285 | 29.1 | –8 | 0.0 | NA[b] |
| 1960 | 5,005 | 242.8 | 0.129 | 0.436 | 0.179 | 0.605 | 0.086 | 0.291 | 29.6 | 3 | 0.0 | NA[b] |
| 1961 | 4,992 | 255.9 | 0.132 | 0.441 | 0.180 | 0.602 | 0.112 | 0.375 | 29.9 | 1.8 | 1.1 | 0.0 |
| 1962 | 4,900 | 249.6 | 0.128 | 0.424 | 0.174 | 0.576 | 0.112 | 0.371 | 30.2 | –5.9 | 0.0 | 0.1 |
| 1963 | 4,849 | 266.8 | 0.142 | 0.464 | 0.180 | 0.588 | 0.112 | 0.366 | 30.6 | –22.5 | 0.0 | –0.1 |
| 1964 | 4,840 | 251.2 | 0.138 | 0.445 | 0.186 | 0.600 | 0.112 | 0.361 | 31.0 | –4 | 2.2 | 0.0 |
| 1965 | 4,718 | 241.8 | 0.132 | 0.419 | 0.178 | 0.565 | 0.112 | 0.356 | 31.5 | –0.5 | 3.3 | 0.7 |
| 1966 | 4,646 | 241.6 | 0.131 | 0.404 | 0.174 | 0.537 | 0.114 | 0.352 | 32.4 | –4.9 | 4.1 | 0.1 |
| 1967 | 4,635 | 215.8 | 0.124 | 0.371 | 0.156 | 0.467 | 0.125 | 0.374 | 33.4 | 5.1 | 5.4 | –0.1 |

(continued)

**Table 5. Honey Markets and Government Activities, 1939-1999 (continued)**

| Year | Total Colonies (1000s) (1) | Honey Production (mil lbs) (2) | Honey Producer Price ($/lb)[a] (3) | | Average Honey Price ($/lb)[a] (4) | | Average Honey Support Price ($/lb)[a] (5) | | CPI (82-84=100) (6) | Net Imports (mil lbs) (7) | CCC Take Over (mil lbs) (8) | Treasury Costs ($ mil) (9) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1968 | 4,539 | 191.4 | 0.129 | 0.371 | 0.169 | 0.486 | 0.125 | 0.359 | 34.8 | 8.8 | 0.1 | 0.4 |
| 1969 | 4,433 | 267.5 | 0.136 | 0.371 | 0.175 | 0.477 | 0.130 | 0.354 | 36.7 | 4.8 | 3.5 | –0.9 |
| 1970 | 4,285 | 221.7 | 0.142 | 0.366 | 0.174 | 0.448 | 0.130 | 0.335 | 38.8 | 0.8 | 0.0 | 0.8 |
| 1971 | 4,107 | 197.8 | 0.180 | 0.444 | 0.218 | 0.538 | 0.140 | 0.346 | 40.5 | 3.8 | 0.0 | –0.9 |
| 1972 | 4,085 | 215.6 | 0.270 | 0.646 | 0.302 | 0.722 | 0.140 | 0.335 | 41.8 | 34.9 | 0.0 | 0.0 |
| 1973 | 4,124 | 239.1 | 0.421 | 0.948 | 0.444 | 1.000 | 0.161 | 0.363 | 44.4 | –6.9 | 0.0 | 0.0 |
| 1974 | 4,210 | 187.9 | 0.477 | 0.968 | 0.510 | 1.034 | 0.206 | 0.418 | 49.3 | 21.4 | 0.0 | 0.3 |
| 1975 | 4,206 | 199.2 | 0.457 | 0.849 | 0.505 | 0.939 | 0.255 | 0.474 | 53.8 | 42.4 | 0.0 | –0.3 |
| 1976 | 4,269 | 198.0 | 0.450 | 0.791 | 0.499 | 0.877 | 0.294 | 0.517 | 56.9 | 61.8 | 0.0 | –0.2 |
| 1977 | 4,323 | 178.1 | 0.469 | 0.774 | 0.529 | 0.873 | 0.327 | 0.540 | 60.6 | 58.4 | 0.0 | 1.5 |
| 1978 | 4,090 | 231.5 | 0.483 | 0.741 | 0.545 | 0.836 | 0.368 | 0.564 | 65.2 | 48 | 0.0 | 3.5 |
| 1979 | 4,163 | 238.7 | 0.531 | 0.731 | 0.590 | 0.813 | 0.439 | 0.605 | 72.6 | 49.8 | 0.0 | –1.7 |
| 1980 | 4,141 | 199.8 | 0.553 | 0.671 | 0.614 | 0.745 | 0.503 | 0.610 | 82.4 | 40.5 | 6.0 | 8.7 |
| 1981 | 4,213 | 185.9 | 0.566 | 0.623 | 0.632 | 0.695 | 0.574 | 0.631 | 90.9 | 68.1 | 35.2 | 8.4 |
| 1982 | 4,182 | 230.0 | 0.568 | 0.589 | 0.568 | 0.589 | 0.604 | 0.626 | 96.5 | 83.5 | 74.5 | 27.4 |
| 1983 | 4,156 | 205.0 | 0.544 | 0.546 | 0.544 | 0.546 | 0.622 | 0.624 | 99.6 | 102.3 | 106.4 | 48.0 |
| 1984 | 4,141 | 165.1 | 0.495 | 0.476 | 0.500 | 0.481 | 0.658 | 0.633 | 103.9 | 121.2 | 105.8 | 90.2 |
| 1985 | 4,122 | 150.1 | 0.475 | 0.441 | 0.475 | 0.441 | 0.653 | 0.607 | 107.6 | 131.7 | 98.0 | 80.8 |
| 1986 | 4,068 | 200.4 | 0.513 | 0.468 | 0.513 | 0.468 | 0.640 | 0.584 | 109.6 | 110.8 | 41.0 | 89.4 |
| 1987 | 4,053 | 226.8 | 0.465 | 0.409 | 0.503 | 0.443 | 0.610 | 0.537 | 113.6 | 45.9 | 52.7 | 72.6 |
| 1988 | 4,049 | 214.1 | 0.459 | 0.388 | 0.500 | 0.423 | 0.591 | 0.500 | 118.3 | 42 | 32.0 | 100.1 |
| 1989 | 4,163 | 177.0 | 0.463 | 0.373 | 0.498 | 0.402 | 0.564 | 0.455 | 124.0 | 67.4 | 2.8 | 41.7 |
| 1990 | 4,073 | 197.8 | 0.507 | 0.388 | 0.537 | 0.411 | 0.538 | 0.412 | 130.7 | 64.6 | 1.1 | 46.7 |
| 1991 | 4,044 | 219.2 | 0.538 | 0.395 | 0.556 | 0.408 | 0.538 | 0.395 | 136.2 | 82.6 | 3.2 | 18.6 |
| 1992 | 3,893 | 221.7 | 0.529 | 0.377 | 0.550 | 0.398 | 0.538 | 0.383 | 140.3 | 104.2 | 4.1 | 16.6 |
| 1993 | 3,739 | 230.6 | 0.512 | 0.354 | 0.539 | 0.373 | 0.538 | 0.372 | 144.5 | 117.1 | 16.4 | 22.1 |
| 1994 | 3,633 | 218.2 | 0.502 | 0.339 | 0.528 | 0.356 | 0.500 | 0.337 | 148.2 | 114.9 | 0.0 | –0.2 |
| 1995 | 3,511 | 211.1 | 0.664 | 0.436 | 0.685 | 0.449 | 0.500 | 0.328 | 152.4 | 79.3 | 0.0 | –9.3 |

(continued)

**Table 5. Honey Markets and Government Activities, 1939-1999 (continued)**

| Year | Total Colonies (1000s) (1) | Honey Production (mil lbs) (2) | Honey Producer Price ($/lb)[a] (3) | | Average Honey Price ($/lb)[a] (4) | | Average Honey Support Price ($/lb)[a] (5) | | CPI (82-84=100) (6) | Net Imports (mil lbs) (7) | CCC Take Over (mil lbs) (8) | Treasury Costs ($ mil) (9) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1996 | 3,427 | 199.5 | 0.864 | 0.551 | 0.888 | 0.566 | NA[c] | NA[c] | 156.9 | 140.7 | 0.0 | –14.0 |
| 1997 | 3,494 | 196.5 | 0.722 | 0.450 | 0.752 | 0.469 | NA[c] | NA[c] | 160.5 | 158.5 | 0.0 | –1.5 |
| 1998 | 3,496 | 220.3 | 0.629 | 0.386 | 0.655 | 0.402 | NA[c] | NA[c] | 163 | 122.0 | 0.0 | 0.0 |
| 1999 | 3,551 | 205.2 | 0.561 | 0.337 | 0.599 | 0.360 | NA[c] | NA[c] | 166.6 | 161.0 | 0.0 | 2.4 |

[a] First price listed is the nominal price. Second price listed is the real price (1982-84=100).
[b] Data not available.
[c] Not applicable; no price supports during these years.

**Sources:**

**Total Colonies:** 1950-1987: Hoff and Phillips, 1990 (1988-1992: USDA, ERS Honey Background for 1995 Farm Legislation. 1993-1996: NASS, "Honey" annual issues 1995, 1996, 1997). To account for changes in USDA data collection procedures, we added 863,000 to the official estimates from 1992 to 1999 (see appendix).

**Honey Production:** 1950-1991: Honey: Background for 1995 Farm Legislation by Frederic L. Hoff. 1992-1999: 2000 Agricultural Statistics (http://www.usda.gov/nass/pubs/agstats.htm).

**Honey Producer Price (60 pound containers):** 1939-1949: Estimates obtained using Average Honey Price (Producer Price = -.0504 + 1.0323 · Average Honey Price, $R^2$=.99. 1950-1959: ASCS Commodity Fact Sheet, June 1987. 1960-1986: ASCS Commodity Fact Sheet, October 1991. 1987-1999: NASS, "Honey," annual issues.

**Average Honey Price**: 1939-1949: Agricultural Statistics, 1954, p. 90. 1950-1987: Hoff and Phillips, 1990. 1987-1991: NASS, "Honey," annual issues. 1992-1999: 2000 Agricultural Statistics (http://www.usda.gov/nass/pubs/agstats.htm). Average Honey Price is a weighted average of prices received by producers in wholesale and retail sales. Average Honey Price and Producer Price coincide 1982 to 1986 because data on retail sales were not collected.

**Average Honey Support Price:** 1950-1988: Hoff and Phillips, 1990. 1988-1995: USDA/ERS Sugar and Sweetener, Situation and Outlook Yearbook 1996. No support prices were in effect after 1995.

**CPI:** Bureau of Labor Statistics Data (http://146.4.24/cgi-bin/surveymost).

**Net Imports:** 1950-1993: Honey: Background for 1995 Farm Legislation by Frederic L. Hoff. 1994-1999: Sugar: World Markets and Trade, USDA, FAS, annual issues (http://www.fas.usda.gov/htp2/sugar/1999/november/toc.html).

**CCC Take Over:** 1950-1984: Hoff and Phillips, 1990. 1985-1995: USDA Sugar and Sweetener, Situation and Outlook Yearbook 1996.

**Treasury Costs:** 1961-1984: Honey: Background for 1995 Farm Legislation by Frederic L. Hoff. Fiscal Year values. 1985-1995: Sugar and Sweetener, Situation and Outlook Yearbook, December 1996. 1996-1999: History of Budgetary Expenditures of the Commodity Credit Corporation (http://www.fsa.usda.gov/dam/bud/indexccc.htm).

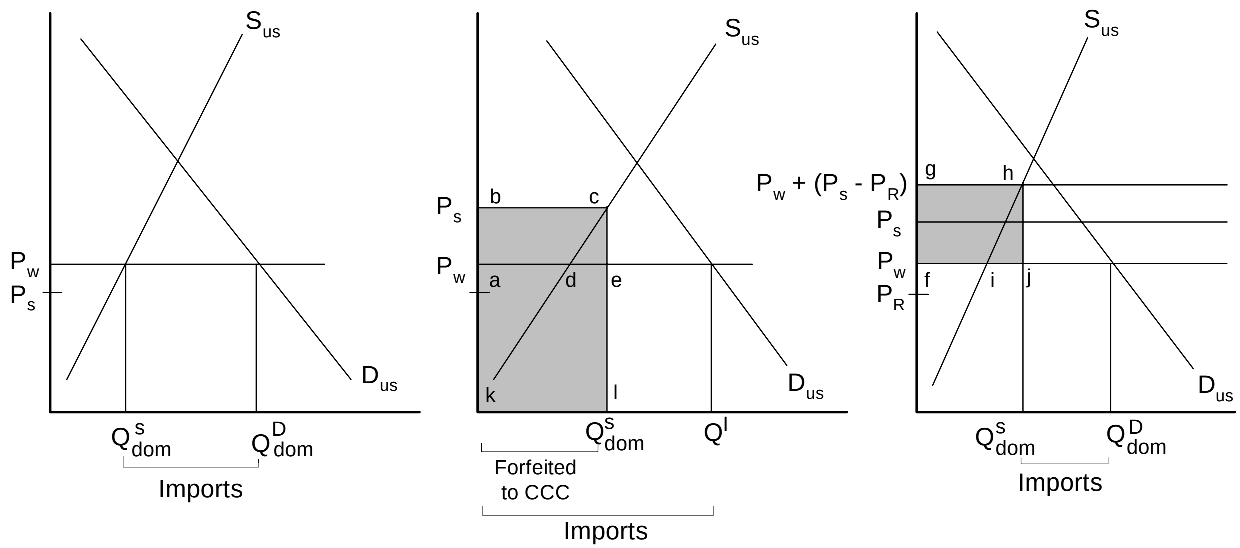
**Table 6. U.S. Imports of Honey from China and Argentina, 1992-1999**

| | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 |
|---|---|---|---|---|---|---|---|---|
| China | 60.0 | 76.6 | 64.5 | 27.5 | 42.7 | 25.2 | 26.9 | 47.9 |
| Argentina | 31.1 | 35.9 | 40.2 | 27.6 | 68.2 | 106.9 | 76.2 | 86.2 |
| Total U.S. Imports | 114.4 | 133.3 | 123.0 | 88.4 | 148.5 | 165.3 | 132.4 | 169.8[a] |

[a]Forecast

Source: USDA Agriculture Statistics and National Honey Board Statistics (http://www.nhb.org/intl/INTL_4 Country1.gif and http://www.nhb.org/intl/SupplyProps2.gif).

**Figure 1. The U.S. Honey Industry Under Three Different Honey Support Program Regimes**




**1952-1979:**
**Minimal Market Effects**

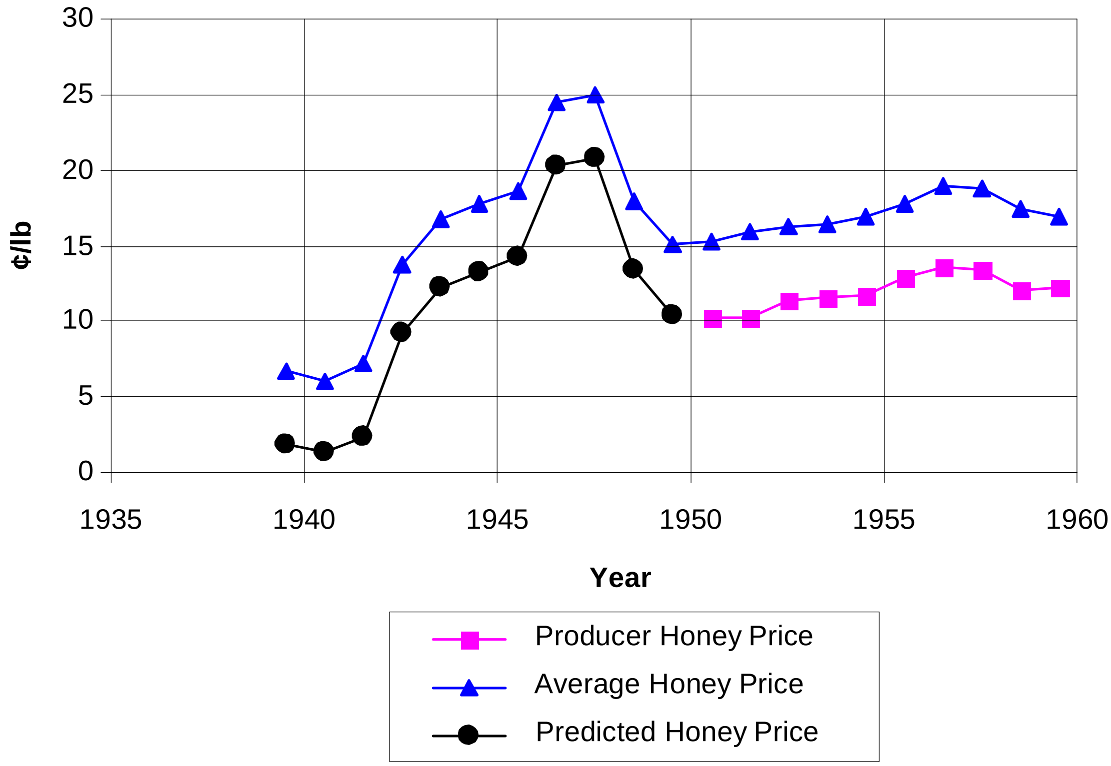
**1980-1985:**
**Large Program Effects**

**1986-1993:**
**Return to Modest Support**

**Key**

| | |
|---|---|
| $S_{us}$: | US supply of honey |
| $D_{us}$: | US demand for honey |
| $Q^{S}_{dom}$: | Quantity supplied by domestic producers |
| $Q^{D}_{dom}$: | Quantity demanded by domestic consumers |
| $Q^{I}$: | Quantity of honey imported |
| $P_W$: | World price for honey |
| $P_S$: | Support price for honey |
| $P_R$: | Repayment price for honey |
| $P_W + (P_S - P_R)$: | Per pound receipts if $P_W \neq P_R$ |

**Figure 2. Nominal Honey Prices, 1939-1959**



**Appendix: Maximum Likelihood Estimation of the Colony Response Equation**

We posit a partial adjustment model for the colony supply decision. This implies that the current number of bee colonies is related to last year's number of colonies and the current year's ratio of honey price to an index of production costs. The model is:

$$\text{(A1)} \qquad y_t^* = \alpha + \gamma y_{t-1}^* + \beta p_t + \epsilon_t, \qquad t = 51, \ldots, 95,$$

where the $\epsilon_t$ are i.i.d. with Var($\epsilon_t$)= $\sigma^2$. In (A1) $y_t^*$ denotes the true number of honeybee colonies and $p_t$ denotes the price/cost ratio. The time index denotes year: "51" stands for "1951."

Estimation of (A1) is complicated by the fact that colony numbers were not recorded for the four years of 1982-1985. Prices and costs were recorded but there is no way to recover the information on the dependent variable for the lost years. Further, because of the absence of $y_{85}^*$, the observation for 1986 would need to be dropped in order to maintain the structure of a linear regression. However, repeated back substitution of (A1) for the 1986 observation yields the following expression, nonlinear in the parameters:

$$\text{(A2)} \qquad y_{86}^* = \alpha(1+\gamma+\gamma^2+\gamma^3+\gamma^4) + \gamma^5 y_{81}^* + \beta(p_{86} + \gamma p_{85} + \gamma^2 p_{84} + \gamma^3 p_{83} + \gamma^4 p_{82})$$
$$+ (\epsilon_{86} + \gamma\epsilon_{85} + \gamma^2\epsilon_{84} + \gamma^3\epsilon_{83} + \gamma^4\epsilon_{82}).$$

A second complication arises in trying to estimate the structural parameters from the observed data. When the counting of honeybee colonies resumed in 1986, a change in data collection methods resulted in (at least) a level change in the number of colonies counted. It is reported in USDA publications that small beekeepers were not surveyed under the new scheme. We model this change in survey techniques as a fixed constant, A, by which post-1981 colony estimates understate the true number of colonies:

(A3) $$y_t = y_t^* - A, \quad t = 82, \ldots, 95,$$

where $y_t$ denotes the recorded colony count. Prior to 1982, we assume that $y_t = y_t^*$.

Substituting from (A3) into (A2) gives the following nonlinear regression model:

(A4) $$\tilde{y}_t(\gamma, A) = \alpha\, \tilde{d}_t(\gamma) + \beta\, \tilde{p}_t(\gamma) + u_t, \quad t = 51, \ldots, 81, 86, \ldots, 95,$$

where

$$\tilde{y}_t(\gamma, A) = y_t - \gamma y_{t-1}, \quad t = 51, \ldots, 81$$

$$= \frac{y_t - \gamma^5 y_{t-1} + A}{(1 + \gamma^2 + \gamma^4 + \gamma^6 + \gamma^8)^{1/2}}, \quad t = 86$$

$$= y_t - \gamma y_{t-1} + A(1 - \gamma), \quad t = 87, \ldots, 95,$$

$$\tilde{p}_t(\gamma) = p_t, \quad t \neq 86,$$

$$= \frac{p_{86} + \gamma p_{85} + \gamma^2 p_{84} + \gamma^3 p_{83} + \gamma^4 p_{82}}{(1 + \gamma^2 + \gamma^4 + \gamma^6 + \gamma^8)^{1/2}}, \quad t = 86.$$

$$\tilde{d}_t(\gamma) = 1, \quad t \neq 86,$$

$$= \frac{1 + \gamma + \gamma^2 + \gamma^3 + \gamma^4}{(1 + \gamma^2 + \gamma^4 + \gamma^6 + \gamma^8)^{1/2}}, \quad t = 86.$$

The disturbance is i.i.d. with $\mathrm{Var}(u_t) = \sigma^2$.

If the $u_t$ are assumed to be normally distributed, and if the nuisance parameter, $\sigma^2$, is concentrated out, the log-likelihood function for the model is:

$$\ln L(\gamma, A, \alpha, \beta) = -\frac{T}{2}\ln(2\pi + 1) - \ln\hat{\sigma}^2(\gamma, A, \alpha, \beta),$$

where $\hat{\sigma}^2(\gamma, A, \alpha, \beta) = \frac{1}{T}\Sigma(\tilde{y}_t - \alpha\tilde{d}_t - \beta\tilde{p}_t)^2$ .

The last expression shows that maximum likelihood is equivalent to nonlinear least squares. The ML estimate of the colony response equation is shown in table 1.