Pollinator Paper

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Apis Bee Colony Rentals for Almonds: The Relationship Between Apis Bee Supply, Demand and Rental Price

**Abstract**

The objective of this paper is to analyze changes in almond pollination rental prices in response to changes in the supply of honey bees colonies and the demand for those colonies. Since 1995 almond pollination rental prices have been rising but at a decreasing rate. In recent, we find strong negative correlations between almond pollination rental price and total winter. The correlation between almond pollination rental price and almond bearing acres is strong and positive.

When the quality of a colony is considered, the magnitude the rental price increases become more apparent.

**Introduction**

Honey bees play a vital role in the agricultural economy within the United States and abroad. Farmers use honey bees to pollinate berries, fruits, vegetables, and nut crops adding an estimated $15 billion in crop value within the United States (CCD Steering Committee USDA 2007). Managed bee colonies are particularly important for almond crops because almonds are completely dependent on them for pollination (USDA 2013). In order to obtain bees for pollination, almond farmers rent bee colonies from bee brokers for the almond bloom, which starts in February. The brokers coordinate with beekeepers to obtain an adequate supply of healthy hives to meet the demand of the almond growers. Brokers contract with beekeepers as from all over the country and as far away as Florida to supply bees for the almond pollination.

Bee rental agreements called pollination contracts are structured differently depending on the arrangement between the almond grower and beekeeper. Pollination contracts are set up as early as June. As a result, the rental price is relatively fixed prior to the almond bloom. However, some contracts provide bonuses to beekeepers for providing high quality hives. The Almond Board of California recommends that almond growers provide bonuses for colonies that are graded higher than 8 frames (Ribotto 2010). A good contract specifies the minimum and average number of frames of bees per colony. It also specifies the dates the hives will be brought to and removed from the orchard as well as the placement of the hives within the orchard (Almond Board of California 2012).

The demand for almonds is increasing. In order to meet increasing demand almond growers are expanding their orchards. The number of bearing acres of almonds in California has been nearly doubled in the past 20 years. During the four years of our survey from 2010-2013 the number of bearing acres increased by about 9.5% (United States Department of Agriculture National Agricultural Statistics Service 2013). Brokers recommend that almond growers stock 2 8-frame colonies per bearing acre of almonds (Traynor 2013). Therefore the expansion of bearing almond acreage puts upward pressure on demand for managed bee colonies.

Beekeepers’ ability to meet the demand for bee colonies has been hampered over the last 8 years as many bee colonies have succumb to the new and mysterious ailment, Colony Collapse Disorder (CCD). In 2006, beekeepers lost as many as 30-90% of their colonies, much higher than the 5-10% winter losses experienced prior to 2005. The average lose rate since 2006 has been around 30% with about a third of those losses attributed to CCD (USDA 2013). According to the results of the Bee Informed Partnership Management Survey, 31.1% of managed colonies were lost over the winter ending in 2013 compared to 21.9% in 2012, 30% in 2011 and 34% in 2010 (vanEngelsdorp, et al. 2013). Other bee pests including varroa mite and nosema parasite have caused declines in the supply of honey bees. Concurrently, wild pollinator populations have also declined (Committee on the Status of Pollinators in North America 2007). The reduction in the supply of domestic bees as well a decline in available substitutes has put upward pressure on colony rental prices.

Survey data from the California State Beekeeping Association indicates that the price of renting bees for almond pollination was increasing at a modest rate until 2005 when it increased from $70 to $138 in 2006 (Sumner 2006, Heintz 2012). According the California State Beekeeping survey, the rental price has continued to rise up to $151 in 2010 (Figure 1).

Sumner points out the market forces pushing the rental price upward in the years up to 2006 included a decrease in supply of bees as a result of bee disease and an increase in demand for bees for pollination in almonds as a result of the expansion of the almond market. In addition, Sumner observes that demand for almond pollination is expanding at a faster rate than demand for pollination in other crops and almond nectar does not produce honey that is desirable for human consumption. As a result, beekeepers that supply almond growers with bees require a greater portion of their income from almond pollination rentals to maintain their bees, which puts upward pressure on almond pollination rental fees. Increases in diesel price also put upward pressure on almond pollination fees since transportation is a major component of beekeepers costs particularly for beekeepers who truck their hives for the east cost for the almond bloom (Rucker, Thurman and Burgett 2012).

**Material and Methods**

We use data from a longitudinal sample of 13 honey brokers who completed the Bee Informed Partnership Tier 6 pollinator survey between 2010-2013. The BIP Tier 6 survey was conducted by phone. BIP researchers contacted honey bee brokers know to broker bees for California almond pollination. The estimated number of brokers in this industry is between 30-40. Therefore, the sample of respondents represents approximately 33-43% of the brokers in the industry. Tier 6 data set includes information about the almond pollination rental prices, the quantity of colonies supplied and the grade of those colonies.

We also use California State Beekeepers Association (CSBA) survey data to estimate the historical almond pollination rental prices from 1995-2012. The CSBA collects honey bee rental price data annually through surveys they distribute to their members. The number of respondents varies from year to year from between ???-???. To our knowledge, the CSBA provides the best available historical record of almond pollination price.

In order to estimate supply shocks to the national honey bee supply, we employ winter loss rate data collected by the BIP Winter Loss survey. Reliable winter loss data from BIP dates back to 2007. For approximating changes in demand for almond pollinator units, we utilize USDA data on the number of almond bearing acres from 1995-2013.

*BIP Survey Refinement and Analysis*

In our analysis of the BIP Tier 6 survey, we took a subset of 12 brokers who completed the survey in all 4 years. Using the panel data subsample of the survey we were able to look at fluctuations in supply within the pollination market. For our data summary analysis of the BIP survey responses we used colony-weighted averages. To determine the colony-weighted average, each broker was weighted by the number of colonies he or she placed during the survey year. The colony-weighted average is a more accurate measure of the overall industry average than a simple average since the size the brokers’ operations vary significantly (in 2013 the smallest broker operation in the subsample placed 2,155 colonies while the largest placed 92,000 colonies). The number of colonies placed by a broker is reflective of the broker’s operation size and corresponding market share.

We also created hive quality adjustment measures for our analysis. Colonies are graded based on number of bees in the colony. These grades are calculated in terms of the number of frames the bees that inhabit the hive. We find that the quality of the colonies placed varies over the survey period. The quality variation makes it difficult to compare supply and prices across time periods. We cope with this obstacle by analyzing supply of bees on a frame basis and by creating a quality adjusted colony rental price.

Traditionally the supply of bee is considered at the colony level. This is done for practical purposes because it would be difficult to estimate the number of bees used for pollination. However, most colonies placed for pollination are graded which helps to approximate the number of bees within the colony. Using colony grade in combination with the number of colonies placed, we estimate of the supply of bee that contributes to pollination services by looking at the bee supply on a frame basis. We estimate the total number of frames provided by taking the average grade of the colonies placed by each broker times the number of colonies that the broker and sum the results.

In order to deal with the impact of quality variation on rental price, we created a quality adjusted colony rental price measure. First, we calculated the per frame price by taking each brokers average rental price divided by the average grade of the colonies the broker placed. Then we took the colony weighted average of the per frame price. The quality adjusted colony rental price is simply the colony weighted per frame price times 10. The factor of 10 reflects the average colony grade during the survey period. Using the quality adjusted colony rental price helps us remove price movements that occur as a result of changes in colony quality between years.

*Correlation Analysis: Price, Demand and Supply*

The CSBA reporting method of reporting almond pollination rent varies over the survey period from 1995-2012. Over the report period, the categorical distinction of how the almond pollination fees are calculated has changed. In early years, the almond pollination fees were separated into broker and owner categories. In later years, the almond rental prices were segmented into regionally. For the purposes of this study, we aggregate all the pollination rental price figures into a single category. We do this by taking an average of the almond rental prices weighted by the number of colonies placed in each category.

For the demand and supply analysis, we calculate correlation coefficients between the price of pollinator rental and winter loss, colony grade, and almond bearing acreage. **Results**

*BIP Survey Summary*

In 2013, the number of colonies placed by the 13 brokers surveyed was 262,161 representing about 19% of the estimated 1.4 million colonies used for California almond pollination each year (USDA 2013). Over the period from 2010-2013, the number of colonies placed by the brokers increased by nearly 23,000 (9.6%). For an alternate view of the supply of bees provided for pollination services by the surveyed brokers, we estimated the number of frames of bees the brokers supplied for pollination. (table 1).

**Discussion**

**Acknowledgements**

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| --- | --- | --- | --- | --- | --- |
| **Table 1** | | | | | |
| **Quantity and Quality of Pollinator Units Placed in California Almond** | | | | | |
| Year | Total Number of Placed Colonies | Change in number of colonies placed from previous year | Average Colony Grade | Estimate Total Number of Frames Supplied | Change in the number of frames supplied from previous year |
| Question | 1 |  | 14 | | |
|  |  |  | Average weighted by number of colonies placed | | |
| 2010 | 239,234 | --- | 9.7 | 2,391,218 | --- |
| 2011 | 267,049 | 11.6% | 10.1 | 2,726,848 | 14% |
| 2012 | 261,872 | -1.9% | 10.6 | 2,688,186 | -1% |
| 2013 | 262,161 | 0.1% | 9.3 | 2,185,992 | -19% |
| n=13 | | | | | |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Correlation |  |  |  |  |
|  | BIP Rental Price | CSBA Rental Price | Winter Loss Rate | Almond Acreage |
| BIP Rental Price | 1 |  |  |  |
| CSBA Rental Price | 0.7753 | 1 |  |  |
| Winter Loss Rate | -0.8009 | -0.9991 | 1 |  |
| Almond Acreage | 0.8453 | 0.9928 | -0.9969 | 1 |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Year** | **CSBA Rent** | **BIP Rent** | **BIP Rent Confidence Interval** | **Average Grade** | **Grade Confidence Interval** | **Winter Loss Total** | **Almond Acreage** |
| 2013 |  | $154.60 | (140.07-169.12) | 9.3 | (8.1-10.1) | 31.1% | 810,000 |
| 2012 | $153.42 | $154.16 | (146.54-161.78) | 10.6 | (9.3-11.5) | 21.9% | 790,000 |
| 2011 | $151.56 | $152.80 | (144.38-161.22) | 10.1 | (9.6-10.5) | 30.0% | 760,000 |
| 2010 | $150.79 | $137.77 | (128.44-147.11) | 9.7 | (8.7-10.7) | 34.0% | 740,000 |
| 2009 | $157.03 |  |  |  |  | 29.0% | 720,000 |
| 2008 | $148.50 |  |  |  |  | 36.0% | 680,000 |
| 2007 | $143.35 |  |  |  |  | 32.0% | 640,000 |
| 2006 | $136.08 |  |  |  |  |  | 610,000 |
| 2005 | $72.58 |  |  |  |  |  | 590,000 |
| 2004 | $53.52 |  |  |  |  |  | 570,000 |
| 2003 | $51.99 |  |  |  |  |  | 550,000 |
| 2002 | $45.94 |  |  |  |  |  | 545,000 |
| 2001 | $45.01 |  |  |  |  |  | 530,000 |
| 2000 | $42.37 |  |  |  |  |  | 510,000 |
| 1999 | $41.43 |  |  |  |  |  | 485,000 |
| 1998 | $40.36 |  |  |  |  |  | 460,000 |
| 1997 | $38.59 |  |  |  |  |  | 442,000 |
| 1996 | $36.71 |  |  |  |  |  | 428,000 |
| 1995 | $35.41 |  |  |  |  |  | 418,000 |

Bee Informed Partnership Tier 6 Pollination Survey

1. How many colonies did you place in almond orchards this year?
2. How many colonies did you place in almonds last year?
3. Given an unlimited supply, how many colonies could you have placed in almond orchards this year?
4. If an additional almond orchard with 100 acres needed bees from you this past season, would you have been able to supply those bees?
5. What % of the colonies that you placed in almonds were “field run”?
6. What was the average number of colonies you placed per acre?
7. What was the highest number of colonies you placed per acre?
8. What was the lowest number of colonies you placed per acre?
9. What was the average number of colonies you placed per acre last year?
10. How many different beekeepers (including yourself) did you place colonies for this year?
11. How many different almond growers did you place colonies for this year?
12. How many beekeepers that you broker for (including yourself) had difficulty meeting the number of colonies they committed for pollination?
13. How many colonies, that were committed for pollination, were you and/or those beekeepers you broker for short?
14. What was the average grade of the colonies you placed?
15. What was the average price you received per placed colony?
16. What was the lowest price received?
17. What was the highest price received?
18. What percentage of the hives that you broker for are managed year round in California exclusively?
19. What percentage of the almonds growers that you supplied with bees this year, did you supply bees to last year as well?
20. What percentage of beekeepers that you brokered for did you broker for last year as well?