ABSTRACT

YANG, HAOSHI. Three Essays on the Economics of the International Honey Trade and Beekeeping. (Under the direction of Walter Thurman.)

Trade restrictions have been imposed on U.S. honey imports from Argentina and China since 1995. Because the effects of such restrictions on domestic consumers and producers depend on the substitutability in demand between imports from restricted sources and imports from non-restricted sources, trade policy evaluation requires reliable estimates of import demand. Towards this end, a U.S. honey import demand system is estimated in Chapter 1. The study utilizes an AIDS model where honey is distinguished by place of production. Monthly data (1995-2013) from the USDA Foreign Agricultural Service are used for estimation. Choke prices (the price at which quantity demanded is zero) are estimated. Price and expenditure elasticities are calculated and interpreted.

After the 1995 trade restrictions on honey were imposed, several countries (e.g., India and Vietnam) increased honey exports to the United States, likely due in part to the transshipment of honey from China. Specifically, honey from China may have been transshipped through third countries to the United States to avoid the tariffs and restrictions mentioned above. This gives rise to a broad set of issues that has not been examined in the literature. The possible subsequent re-routing of honey through other countries may or may not have significant impacts on U.S. consumers and producers. To understand these effects, Chapter 2 develops a conceptual three-county trade model allowing for goods being transshipped through a third country. The comparative statics demonstrates the effects of changes in tariff under different configurations of trade flows.

Chapter 3 diverges from honey trade and considers markets for pollination services, the other valuable product of beekeeping. The market for honey bee pollination services operates extensively in the United States, but the situation seems different in other areas. Migratory beekeeping is widely practiced in China as in the United States; but Chinese beekeepers’ migration focuses primarily on honey and is not necessarily associated with pollination services. Bee-hive-renting pollination in China is rare and human pollination by hand is still important in some areas. Chapter 3 reports the results of interviews with a sample of Chinese beekeepers, characterizes the travel patterns of Chinese beekeepers, and sheds lights on the general issue of human and bee pollination in order to understand the institutional details of the market for pollination services in China. The study aims to come to an understanding of the transaction costs involved in contracting for pollination services in China, with particular attention paid to the socio-economic factors that promote and discourage migratory beekeeping and pollination.
services, and come to a similar understanding of the substitution between human and bee pollination, and substitution between pollinator-dependent and less-pollinator-dependent crops in farmers’ land allocation decisions.
Three Essays on the Economics of the International Honey Trade and Beekeeping

by
Haoshi Yang

A dissertation submitted to the Graduate Faculty of
North Carolina State University
in partial fulfillment of the
requirements for the Degree of
Doctor of Philosophy

Economics

Raleigh, North Carolina
2016

APPROVED BY:

Kathryn Boys
Stephen Margolis

Xiaoyong Zheng
Walter Thurman
Chair of Advisory Committee
BIOGRAPHY

• Personal Information
  – Name: Haoshi Yang 杨浩石
  – Date of Birth: 1988-06-02
  – Hometown: Shijiazhuang (石家庄), Hebei (河北), China
  – Email: hyang10@ncsu.edu, yanghaoshi@hotmail.com
  – Website: http://www4.ncsu.edu/~hyang10/
  – Address (office): 3337 Nelson Hall, 2801 Founders Drive, Raleigh, NC 27695.

• Education
  – 2011.08 - 2016.05, Ph.D. in Economics, North Carolina State University, Raleigh, NC, USA;
  – 2007.09 - 2011.06, B.S. in Economics, Hebei University 河北大学, Baoding (保定), Hebei (河北), China.

• Areas of Specialization: Agricultural Economics, Applied Microeconomics, Applied Econometrics.

• Dissertation committee: Walter N. Thurman (Dissertation Committee Chair), Kathryn A. Boys, Stephen E. Margolis, Xiaoyong Zheng.

• Teaching
  – Independent Instructor: EC 201 Principles of Microeconomics, Fall 2014 (004, 007) and Fall 2015 (009, 010);
  – TA and Lab Instructor: EC 202 Principles of Macroeconomics, Spring 2016 (210, 211, 212), Spring 2015 (201, 203, 205); EC 205 Fundamentals of Economics, Spring 2014 (202, 209, 211), Fall 2013 (206, 207, 209); ECG 705 Macroeconomic Theory II (Ph.D. level), Spring 2013;
  – Grader: ECG 751 Econometric Methods (Ph.D. level), Fall 2012.

• Languages: English (fluent), Chinese Mandarin (native), Chinese Cantonese (fluent), German (reading), Ancient Greek (advanced), Latin (advanced), Sanskrit (elementary), Georgian (elementary).

• Hobbies: Piano, Classical Studies (Greek and Latin, Award for Outstanding Achievement, 2013-2016)
# TABLE OF CONTENTS

**LIST OF TABLES** .......................................................... v

**LIST OF FIGURES** .......................................................... vi

**Chapter 1** U.S. Honey Import Demand Under Trade Restrictions ............ 1

  1.1 Introduction .......................................................... 1

  1.1.1 Background and History of Trade Restrictions on Honey .............. 6

  1.1.2 A Demand System ................................................. 9

  1.2 Data ............................................................... 9

  1.3 Model ............................................................... 13

  1.4 Results ............................................................ 14

  1.5 Conclusions ........................................................ 17

**Chapter 2** A Model of Transshipment Under Trade Restrictions ............ 18

  2.1 Introduction ........................................................ 18

  2.1.1 Background ...................................................... 18

  2.1.2 The Transshipment Issue ....................................... 20

  2.2 A 3-country Trade Model .......................................... 21

  2.2.1 Triangle Trade: Three Countries with Three Trade Flows .......... 23

  2.2.2 Mono-directional Trade: Three countries with two Trade Flows .... 27

  2.2.3 Bilateral Trade: Two Countries with One Trade Flow .............. 29

  2.3 Conclusion .......................................................... 30

**Chapter 3** Migratory Beekeeping and Pollination Services in China ........ 32

  3.1 Introduction ........................................................ 32

  3.2 Migratory Beekeeping .............................................. 36

  3.3 Pollination Services and Transactions ................................ 49

  3.3.1 Pollination Services Provided by Migratory Beekeepers .......... 51

  3.3.2 Hainan Province ............................................... 55

  3.3.3 Pollination of Apples in Sichuan Province ...................... 57

  3.3.4 Bumble Bee Pollination in Hebei Province ...................... 59

  3.4 Conclusions .......................................................... 63

**References** .......................................................................... 64

**Appendices** ......................................................................... 69

  Appendix A Special Cases in Chapter 2 .................................. 70

  A.1 Triangle Trade: Special Case with $\epsilon_1 = 0$ .................... 70

  A.2 Bilateral Trade: Two Countries with One Trade Flow and Constant Transportation Cost ............................................. 72

  Appendix B Interviews with Beekeepers in China ....................... 73

  B.1 Preface ................................................................. 73

  B.2 Questions Asked .................................................... 74
B.3 Interviews

<table>
<thead>
<tr>
<th>Informant</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>WJS</td>
<td>74</td>
</tr>
<tr>
<td>LM</td>
<td>78</td>
</tr>
<tr>
<td>ZSL</td>
<td>80</td>
</tr>
<tr>
<td>YHC</td>
<td>82</td>
</tr>
<tr>
<td>YJL</td>
<td>88</td>
</tr>
<tr>
<td>LXC</td>
<td>91</td>
</tr>
<tr>
<td>WC</td>
<td>93</td>
</tr>
<tr>
<td>LSJ</td>
<td>96</td>
</tr>
<tr>
<td>QHS</td>
<td>99</td>
</tr>
<tr>
<td>LXS</td>
<td>101</td>
</tr>
</tbody>
</table>

Appendix C The Map of China 104
LIST OF TABLES

Table 1.1 U.S. Honey Production, Consumption and Trade .................................. 3
Table 1.2 U.S. Honey Consumption and Imports .................................................. 11
Table 1.3 US Honey Imports Market Share by Source ......................................... 12
Table 1.4 Choke Prices Estimation for Argentina and Vietnam .............................. 14
Table 1.5 Own-price and Expenditure Elasticities .................................................. 15
Table 1.6 Matrix of Own-price and Cross-price Elasticities ................................... 16
Table 2.1 Vietnam: Honey Production and Trade, Metric tons. Source: FAOSTAT ....... 22
Table 3.1 Number of Bee Hives and Honey Production in China, Source: Chen [1993b]
   (1949-1990) and FAOSTAT (1991-2013) ...................................................... 35
Table 3.2 WJS: Travel ......................................................................................... 38
Table 3.3 Rapeseed in China: Area Harvested, Hectare. Source: FAOSTAT .......... 39
Table 3.4 Quantities and Prices Reported by WJS ................................................. 40
Table 3.5 YHC: Travel ....................................................................................... 42
Table 3.6 ZSL: Travel ......................................................................................... 43
Table 3.7 Average Age of Beekeepers. Source: Luo et al. [2014] .......................... 46
Table 3.8 YJL’s Travel Pattern ............................................................................. 47
Table 3.9 Quantity and price reported by YJL ....................................................... 48
Table 3.10 Fruit Production in Aba Tibetan and Qiang Autonomous Prefecture and
   Sichuan Province, Metric Tons. Source: Sichuan Statistical Yearbook .............. 58
Table 3.11 Pollination Fees .................................................................................. 62
LIST OF FIGURES

Figure 1.1 U.S. Honey Production and Consumption (millions of pounds), 1980–2013 . . . 2
Figure 1.2 U.S. Honey Imports, Exports and Net Imports, 1980–2013 . . . . . . . . . . . . 6
Figure 1.3 Share of U.S. Honey Import by Source . . . . . . . . . . . . . . . . . . . . . . . 7
Figure 2.1 Share of U.S. Honey Import by Source . . . . . . . . . . . . . . . . . . . . . . . 19
Figure 2.2 Triangle Trade . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 23
Figure 2.3 Three Countries with Two Trade Flows . . . . . . . . . . . . . . . . . . . . . . 28
Figure 2.4 Two Countries with One Trade Flows . . . . . . . . . . . . . . . . . . . . . . . 30
Figure 3.1 East, Middle and West . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 37
Figure 3.2 South . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 37
Figure 3.3 WJS’s Travel Pattern . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 38
Figure 3.4 YHC’s Travel Pattern . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 41
Figure 3.5 ZSL’s Travel Pattern . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 43
Figure 3.6 LM’s Travel Pattern . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 43
Figure 3.7 WC’s Travel Pattern . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 45
Figure 3.8 LXC’s Travel Pattern . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 45
Figure 3.9 YANG Jianlong . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 48
Figure 3.10 LXS’s \textit{xiao zhuandi} (short-distance migration) . . . . . . . . . . . . . . . 50
Figure 3.11 Hainan Daily . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 56
Figure 3.12 Tomatoes. Left: Malformation caused by improper use of spray pollination. 
Right: Bumble bee pollination. . . . . . . . . . . . . . . . . . . . . . . . . . 59
Figure 3.13 Bumblebee Production . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 60
Figure 3.14 Flier of the Company . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 60

Figure C.1 Political Map of China. Source: National Bureau of Surveying and Mapping . 105
Chapter 1

U.S. Honey Import Demand Under Trade Restrictions

1.1 Introduction

Honey, an important sweetener with a long history, is made by honey bees using nectar from flowers. According to the USDA National Agricultural Statistics Service, U.S. honey production in 2014 from producers with five or more colonies totaled 178 million pounds, up 19 percent from 149.5 million pounds in 2013, and honey prices increased to a record high during 2014 of $2.16 per pound, up 1 percent from $2.14 per pound in 2013. Table 1.1 presents historical data on variables associated with U.S. honey production, consumption and trade.

The United States imports honey from around the world and the quantity imported has increased from 10 million pounds in 1950 to 350 million pounds in 2013. The quantity exported is generally small, even negligible, compared with imports (Figure 1.2). At the same time, domestic honey production has been relatively stable and has shown a slight decreasing trend during the past three decades. Growing honey demand was met mainly by an increase in honey from foreign countries.

Total U.S. honey consumption, which has been increasing during recent decades, is estimated to have reached 355 million pounds in 2013, with per capita consumption of honey being around 1 pound per year (Table 1.2). Imported honey has met a large part of total demand, especially in recent years (Figure 1.2), as the share of imports (in terms of quantity) in U.S. honey consumption has increased drastically (Figure 1.1). This fairly rapid increase in imports

---

1Estimated by data from USDA, ERS, Sugar and Sweeteners Outlook, U.S. Per Capita Caloric Sweeteners Estimated Deliveries for Domestic Food and Beverage Use, by Calendar Year. It is puzzling, however, that total quantity consumed of a given year is less than the summation of net imports and domestic production. Plausible
has imposed costs on the U.S. beekeeping industry, leading to various government actions to provide relief.

Changes in U.S. honey trade policies were closely related to the elimination of the honey program in 1996. According to the USDA (Moissett [2010]), 80 percent of insect crop pollination is accomplished by honey bees, and pollination services are provided by beekeepers. The beekeeping industry has long been supported (see Muth et al. [2003]), nominally to ensure an adequate supply of honey bees for the sake of pollination services. The honey program had two major forms of support: Nonrecourse Marketing Assistance Loans (MAL) and Loan Deficiency Payments (LDP)\textsuperscript{2}. Due to huge Treasury costs during the 1980s, the program was eliminated in the 1996 Farm Bill. Although the honey program was reinstated in the 2002, 2007 and 2013 Farm Bills (MAL and LDP), there have been no loan deficiency payments (LDP) made to eligible producers because the CCC-determined market price of honey was higher than the loan rate.

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure1.png}
\caption{U.S. Honey Production and Consumption (millions of pounds), 1980–2013}
\end{figure}

explanations may include (1) data on honey production are collected according to the quantity of raw honey reported by beekeepers, while data on honey consumptions are from the quantity of processed honey delivered; and (2) some consumers purchase honey directly from beekeepers (e.g., at farmers’ markets) and this part of honey consumption is not captured by the Sugar and Sweeteners Outlook.

\textsuperscript{2}Nonrecourse Marketing Assistance Loans provide producers interim financing at harvest time to meet cash flow needs without having to sell their commodities when market prices are typically at harvest-time lows. Loan Deficiency Payments (LDP) is for a producer who is eligible to obtain a MAL but agrees to forgo the MAL in return for a payment on the eligible commodity. The LDP is the difference between the loan rate and the value determined by Commodity Credit Corporation (CCC) when the CCC-determined value is lower than the loan rate.
<table>
<thead>
<tr>
<th>Year</th>
<th>Honey Production (Million Pounds)</th>
<th>Honey Producer Price ($/Pound)</th>
<th>Honey Per Capita Consump. (Pounds)</th>
<th>Average Honey Price ($/Pound)</th>
<th>Average Honey Support Price ($/Pound)</th>
<th>CPI (1982–84=100)</th>
<th>Imports (Million Pounds)</th>
<th>Exports (Million Pounds)</th>
<th>Net Imports (Million Pounds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1950</td>
<td>233.0</td>
<td>0.102</td>
<td>0.423</td>
<td>N.A.</td>
<td>0.153</td>
<td>0.635</td>
<td>0.90</td>
<td>0.373</td>
<td>24.1</td>
</tr>
<tr>
<td>1951</td>
<td>258.1</td>
<td>0.103</td>
<td>0.396</td>
<td>N.A.</td>
<td>0.160</td>
<td>0.615</td>
<td>0.101</td>
<td>0.388</td>
<td>26.0</td>
</tr>
<tr>
<td>1952</td>
<td>272.0</td>
<td>0.114</td>
<td>0.430</td>
<td>N.A.</td>
<td>0.162</td>
<td>0.611</td>
<td>0.114</td>
<td>0.430</td>
<td>26.5</td>
</tr>
<tr>
<td>1953</td>
<td>223.8</td>
<td>0.115</td>
<td>0.431</td>
<td>N.A.</td>
<td>0.165</td>
<td>0.618</td>
<td>0.105</td>
<td>0.393</td>
<td>26.7</td>
</tr>
<tr>
<td>1954</td>
<td>216.4</td>
<td>0.118</td>
<td>0.439</td>
<td>N.A.</td>
<td>0.170</td>
<td>0.632</td>
<td>0.102</td>
<td>0.379</td>
<td>26.9</td>
</tr>
<tr>
<td>1955</td>
<td>255.2</td>
<td>0.129</td>
<td>0.481</td>
<td>N.A.</td>
<td>0.178</td>
<td>0.664</td>
<td>0.099</td>
<td>0.369</td>
<td>26.8</td>
</tr>
<tr>
<td>1956</td>
<td>214.0</td>
<td>0.136</td>
<td>0.500</td>
<td>N.A.</td>
<td>0.190</td>
<td>0.699</td>
<td>0.097</td>
<td>0.357</td>
<td>27.2</td>
</tr>
<tr>
<td>1957</td>
<td>241.2</td>
<td>0.134</td>
<td>0.477</td>
<td>N.A.</td>
<td>0.187</td>
<td>0.665</td>
<td>0.097</td>
<td>0.345</td>
<td>28.1</td>
</tr>
<tr>
<td>1958</td>
<td>260.5</td>
<td>0.120</td>
<td>0.415</td>
<td>N.A.</td>
<td>0.174</td>
<td>0.602</td>
<td>0.096</td>
<td>0.332</td>
<td>28.9</td>
</tr>
<tr>
<td>1959</td>
<td>236.6</td>
<td>0.122</td>
<td>0.419</td>
<td>N.A.</td>
<td>0.170</td>
<td>0.584</td>
<td>0.083</td>
<td>0.285</td>
<td>29.1</td>
</tr>
<tr>
<td>1960</td>
<td>242.8</td>
<td>0.129</td>
<td>0.436</td>
<td>1.20</td>
<td>0.179</td>
<td>0.605</td>
<td>0.086</td>
<td>0.291</td>
<td>29.6</td>
</tr>
<tr>
<td>1961</td>
<td>255.9</td>
<td>0.132</td>
<td>0.441</td>
<td>1.10</td>
<td>0.180</td>
<td>0.602</td>
<td>0.112</td>
<td>0.375</td>
<td>29.9</td>
</tr>
<tr>
<td>1962</td>
<td>249.6</td>
<td>0.128</td>
<td>0.424</td>
<td>1.10</td>
<td>0.174</td>
<td>0.576</td>
<td>0.112</td>
<td>0.371</td>
<td>30.2</td>
</tr>
<tr>
<td>1963</td>
<td>266.8</td>
<td>0.142</td>
<td>0.464</td>
<td>1.10</td>
<td>0.180</td>
<td>0.588</td>
<td>0.112</td>
<td>0.366</td>
<td>30.6</td>
</tr>
<tr>
<td>1964</td>
<td>251.2</td>
<td>0.138</td>
<td>0.445</td>
<td>1.00</td>
<td>0.186</td>
<td>0.600</td>
<td>0.112</td>
<td>0.361</td>
<td>31.0</td>
</tr>
<tr>
<td>1965</td>
<td>241.8</td>
<td>0.132</td>
<td>0.419</td>
<td>1.10</td>
<td>0.178</td>
<td>0.565</td>
<td>0.112</td>
<td>0.356</td>
<td>31.5</td>
</tr>
<tr>
<td>1966</td>
<td>241.6</td>
<td>0.131</td>
<td>0.404</td>
<td>1.00</td>
<td>0.174</td>
<td>0.537</td>
<td>0.114</td>
<td>0.352</td>
<td>32.4</td>
</tr>
<tr>
<td>1967</td>
<td>215.8</td>
<td>0.124</td>
<td>0.371</td>
<td>0.90</td>
<td>0.156</td>
<td>0.467</td>
<td>0.125</td>
<td>0.374</td>
<td>33.4</td>
</tr>
<tr>
<td>1968</td>
<td>191.4</td>
<td>0.129</td>
<td>0.371</td>
<td>0.90</td>
<td>0.169</td>
<td>0.486</td>
<td>0.125</td>
<td>0.359</td>
<td>34.8</td>
</tr>
<tr>
<td>1969</td>
<td>267.5</td>
<td>0.136</td>
<td>0.371</td>
<td>1.00</td>
<td>0.175</td>
<td>0.477</td>
<td>0.130</td>
<td>0.354</td>
<td>36.7</td>
</tr>
<tr>
<td>1970</td>
<td>221.7</td>
<td>0.142</td>
<td>0.366</td>
<td>1.00</td>
<td>0.174</td>
<td>0.448</td>
<td>0.130</td>
<td>0.335</td>
<td>38.8</td>
</tr>
<tr>
<td>1971</td>
<td>197.8</td>
<td>0.180</td>
<td>0.444</td>
<td>0.90</td>
<td>0.218</td>
<td>0.538</td>
<td>0.140</td>
<td>0.346</td>
<td>40.5</td>
</tr>
<tr>
<td>1972</td>
<td>215.6</td>
<td>0.270</td>
<td>0.646</td>
<td>1.00</td>
<td>0.302</td>
<td>0.722</td>
<td>0.140</td>
<td>0.335</td>
<td>41.8</td>
</tr>
<tr>
<td>Year</td>
<td>Production</td>
<td>Consumption</td>
<td>Export</td>
<td>Protective</td>
<td>Price</td>
<td>Net Export</td>
<td>Sugar</td>
<td>Other</td>
<td>Ratio</td>
</tr>
<tr>
<td>------</td>
<td>-------------</td>
<td>-------------</td>
<td>--------</td>
<td>------------</td>
<td>-------</td>
<td>------------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
</tr>
<tr>
<td>1973</td>
<td>239.1</td>
<td>0.421</td>
<td>0.948</td>
<td>0.90</td>
<td>0.444</td>
<td>1.000</td>
<td>0.363</td>
<td>44.4</td>
<td>10.7</td>
</tr>
<tr>
<td>1974</td>
<td>187.9</td>
<td>0.477</td>
<td>0.968</td>
<td>0.70</td>
<td>0.510</td>
<td>1.034</td>
<td>0.206</td>
<td>49.3</td>
<td>26.0</td>
</tr>
<tr>
<td>1975</td>
<td>199.2</td>
<td>0.457</td>
<td>0.849</td>
<td>1.00</td>
<td>0.505</td>
<td>0.939</td>
<td>0.255</td>
<td>53.8</td>
<td>46.4</td>
</tr>
<tr>
<td>1976</td>
<td>198.0</td>
<td>0.450</td>
<td>0.791</td>
<td>0.92</td>
<td>0.499</td>
<td>0.877</td>
<td>0.294</td>
<td>56.9</td>
<td>66.4</td>
</tr>
<tr>
<td>1977</td>
<td>178.1</td>
<td>0.469</td>
<td>0.774</td>
<td>0.91</td>
<td>0.529</td>
<td>0.873</td>
<td>0.327</td>
<td>60.6</td>
<td>63.9</td>
</tr>
<tr>
<td>1978</td>
<td>231.5</td>
<td>0.483</td>
<td>0.741</td>
<td>1.08</td>
<td>0.545</td>
<td>0.836</td>
<td>0.368</td>
<td>65.2</td>
<td>56.0</td>
</tr>
<tr>
<td>1979</td>
<td>238.7</td>
<td>0.531</td>
<td>0.731</td>
<td>1.04</td>
<td>0.590</td>
<td>0.813</td>
<td>0.439</td>
<td>72.6</td>
<td>58.6</td>
</tr>
<tr>
<td>1980</td>
<td>199.8</td>
<td>0.553</td>
<td>0.671</td>
<td>0.82</td>
<td>0.614</td>
<td>0.745</td>
<td>0.503</td>
<td>82.4</td>
<td>49.0</td>
</tr>
<tr>
<td>1981</td>
<td>185.9</td>
<td>0.566</td>
<td>0.623</td>
<td>0.84</td>
<td>0.632</td>
<td>0.695</td>
<td>0.574</td>
<td>90.9</td>
<td>77.3</td>
</tr>
<tr>
<td>1982</td>
<td>230.0</td>
<td>0.568</td>
<td>0.589</td>
<td>0.90</td>
<td>0.568</td>
<td>0.589</td>
<td>0.604</td>
<td>96.5</td>
<td>92.0</td>
</tr>
<tr>
<td>1983</td>
<td>205.0</td>
<td>0.544</td>
<td>0.546</td>
<td>0.99</td>
<td>0.544</td>
<td>0.546</td>
<td>0.622</td>
<td>99.6</td>
<td>109.8</td>
</tr>
<tr>
<td>1984</td>
<td>165.1</td>
<td>0.495</td>
<td>0.476</td>
<td>0.91</td>
<td>0.500</td>
<td>0.481</td>
<td>0.658</td>
<td>103.9</td>
<td>128.7</td>
</tr>
<tr>
<td>1985</td>
<td>150.1</td>
<td>0.475</td>
<td>0.441</td>
<td>0.88</td>
<td>0.475</td>
<td>0.441</td>
<td>0.653</td>
<td>107.6</td>
<td>138.2</td>
</tr>
<tr>
<td>1986</td>
<td>200.4</td>
<td>0.513</td>
<td>0.468</td>
<td>1.01</td>
<td>0.513</td>
<td>0.468</td>
<td>0.640</td>
<td>109.6</td>
<td>120.0</td>
</tr>
<tr>
<td>1987</td>
<td>226.8</td>
<td>0.465</td>
<td>0.409</td>
<td>0.86</td>
<td>0.503</td>
<td>0.443</td>
<td>0.610</td>
<td>113.6</td>
<td>58.3</td>
</tr>
<tr>
<td>1988</td>
<td>214.1</td>
<td>0.459</td>
<td>0.388</td>
<td>0.82</td>
<td>0.500</td>
<td>0.423</td>
<td>0.591</td>
<td>118.3</td>
<td>55.9</td>
</tr>
<tr>
<td>1989</td>
<td>177.0</td>
<td>0.463</td>
<td>0.373</td>
<td>0.77</td>
<td>0.498</td>
<td>0.402</td>
<td>0.564</td>
<td>124.0</td>
<td>77.3</td>
</tr>
<tr>
<td>1990</td>
<td>197.8</td>
<td>0.507</td>
<td>0.388</td>
<td>0.82</td>
<td>0.537</td>
<td>0.411</td>
<td>0.538</td>
<td>130.7</td>
<td>77.0</td>
</tr>
<tr>
<td>1991</td>
<td>219.2</td>
<td>0.538</td>
<td>0.395</td>
<td>0.91</td>
<td>0.556</td>
<td>0.408</td>
<td>0.538</td>
<td>136.2</td>
<td>92.3</td>
</tr>
<tr>
<td>1992</td>
<td>221.7</td>
<td>0.529</td>
<td>0.377</td>
<td>0.74</td>
<td>0.550</td>
<td>0.392</td>
<td>0.538</td>
<td>140.3</td>
<td>114.6</td>
</tr>
<tr>
<td>1993</td>
<td>230.6</td>
<td>0.512</td>
<td>0.354</td>
<td>0.79</td>
<td>0.539</td>
<td>0.373</td>
<td>0.538</td>
<td>144.5</td>
<td>133.6</td>
</tr>
<tr>
<td>1994</td>
<td>218.2</td>
<td>0.502</td>
<td>0.339</td>
<td>0.96</td>
<td>0.528</td>
<td>0.356</td>
<td>0.500</td>
<td>148.2</td>
<td>123.2</td>
</tr>
<tr>
<td>1995</td>
<td>211.1</td>
<td>0.664</td>
<td>0.436</td>
<td>0.90</td>
<td>0.685</td>
<td>0.449</td>
<td>0.500</td>
<td>152.4</td>
<td>88.6</td>
</tr>
<tr>
<td>1996</td>
<td>199.5</td>
<td>0.864</td>
<td>0.551</td>
<td>0.97</td>
<td>0.888</td>
<td>0.566</td>
<td>N.A.</td>
<td>156.9</td>
<td>150.6</td>
</tr>
<tr>
<td>1997</td>
<td>196.5</td>
<td>0.722</td>
<td>0.450</td>
<td>0.95</td>
<td>0.752</td>
<td>0.469</td>
<td>N.A.</td>
<td>160.5</td>
<td>167.4</td>
</tr>
<tr>
<td>1998</td>
<td>220.3</td>
<td>0.629</td>
<td>0.386</td>
<td>0.94</td>
<td>0.635</td>
<td>0.402</td>
<td>N.A.</td>
<td>163.0</td>
<td>132.4</td>
</tr>
<tr>
<td>1999</td>
<td>205.2</td>
<td>0.564</td>
<td>0.339</td>
<td>1.06</td>
<td>0.601</td>
<td>0.361</td>
<td>N.A.</td>
<td>166.6</td>
<td>182.5</td>
</tr>
<tr>
<td>2000</td>
<td>220.4</td>
<td>0.551</td>
<td>0.320</td>
<td>1.11</td>
<td>0.597</td>
<td>0.347</td>
<td>N.A.</td>
<td>172.2</td>
<td>198.5</td>
</tr>
<tr>
<td>2001</td>
<td>185.9</td>
<td>0.666</td>
<td>0.376</td>
<td>0.94</td>
<td>0.704</td>
<td>0.398</td>
<td>N.A.</td>
<td>177.1</td>
<td>144.8</td>
</tr>
<tr>
<td>2002</td>
<td>171.7</td>
<td>1.313</td>
<td>0.730</td>
<td>1.06</td>
<td>1.327</td>
<td>0.738</td>
<td>0.600</td>
<td>179.9</td>
<td>202.6</td>
</tr>
<tr>
<td>2003</td>
<td>181.7</td>
<td>1.347</td>
<td>0.732</td>
<td>1.00</td>
<td>1.387</td>
<td>0.754</td>
<td>0.600</td>
<td>184.0</td>
<td>200.4</td>
</tr>
</tbody>
</table>
Table 1.1 Continued: U.S. Honey Production, Consumption and Trade

<table>
<thead>
<tr>
<th>Year</th>
<th>Production</th>
<th>Consumption</th>
<th>Trade</th>
<th>Production</th>
<th>Consumption</th>
<th>Trade</th>
<th>Production</th>
<th>Consumption</th>
<th>Trade</th>
<th>Production</th>
<th>Consumption</th>
<th>Trade</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004</td>
<td>183.6</td>
<td>0.992</td>
<td>0.525</td>
<td>0.89</td>
<td>1.069</td>
<td>0.566</td>
<td>0.318</td>
<td>188.9</td>
<td>178.6</td>
<td>7.8</td>
<td>170.8</td>
<td></td>
</tr>
<tr>
<td>2005</td>
<td>174.8</td>
<td>0.812</td>
<td>0.416</td>
<td>1.05</td>
<td>0.918</td>
<td>0.470</td>
<td>0.307</td>
<td>195.3</td>
<td>233.0</td>
<td>7.6</td>
<td>225.4</td>
<td></td>
</tr>
<tr>
<td>2006</td>
<td>154.9</td>
<td>0.940</td>
<td>0.466</td>
<td>1.17</td>
<td>1.036</td>
<td>0.514</td>
<td>0.298</td>
<td>201.6</td>
<td>277.6</td>
<td>7.0</td>
<td>270.6</td>
<td></td>
</tr>
<tr>
<td>2007</td>
<td>148.3</td>
<td>0.999</td>
<td>0.482</td>
<td>0.93</td>
<td>1.077</td>
<td>0.519</td>
<td>0.289</td>
<td>207.3</td>
<td>233.0</td>
<td>8.3</td>
<td>224.7</td>
<td></td>
</tr>
<tr>
<td>2008</td>
<td>163.8</td>
<td>1.354</td>
<td>0.629</td>
<td>0.99</td>
<td>1.421</td>
<td>0.660</td>
<td>0.279</td>
<td>215.3</td>
<td>231.5</td>
<td>10.1</td>
<td>221.4</td>
<td></td>
</tr>
<tr>
<td>2009</td>
<td>146.4</td>
<td>1.415</td>
<td>0.660</td>
<td>0.92</td>
<td>1.473</td>
<td>0.687</td>
<td>0.280</td>
<td>214.5</td>
<td>210.5</td>
<td>9.7</td>
<td>200.8</td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td>176.5</td>
<td>1.541</td>
<td>0.707</td>
<td>1.03</td>
<td>1.619</td>
<td>0.742</td>
<td>0.316</td>
<td>218.1</td>
<td>251.2</td>
<td>9.5</td>
<td>241.7</td>
<td></td>
</tr>
<tr>
<td>2011</td>
<td>148.4</td>
<td>1.677</td>
<td>0.746</td>
<td>1.08</td>
<td>1.765</td>
<td>0.785</td>
<td>0.307</td>
<td>224.9</td>
<td>288.3</td>
<td>11.9</td>
<td>276.4</td>
<td></td>
</tr>
<tr>
<td>2012</td>
<td>142.3</td>
<td>1.913</td>
<td>0.833</td>
<td>1.07</td>
<td>1.992</td>
<td>0.868</td>
<td>0.301</td>
<td>229.6</td>
<td>310.9</td>
<td>12.3</td>
<td>298.6</td>
<td></td>
</tr>
<tr>
<td>2013</td>
<td>149.5</td>
<td>2.047</td>
<td>0.879</td>
<td>1.12</td>
<td>2.121</td>
<td>0.910</td>
<td>0.296</td>
<td>233.0</td>
<td>337.0</td>
<td>11.9</td>
<td>325.1</td>
<td></td>
</tr>
</tbody>
</table>
Given the dramatic increase in honey imports during the 1980s, alternative methods of industry support were sought out from the early 1990s in response to the cessation of honey price support (Muth et al. [2003]), and starting in 1995, various trade restrictions have been imposed on honey imported from China and Argentina.

China and Argentina were the largest exporters of honey into the United States during the 1990s (Figure 1.3). On October 24, 1994, an antidumping investigation was initiated by the Department of Commerce on honey from China\(^3\). The International Trade Commission (ITC) suspended the anti-dumping investigation based on an agreement between the US and China in August 1995 (for 5 years). The agreement included a restriction on annual honey shipments to the United States (limited to 44 million pounds “plus or minus a maximum of six percent per year of quota based upon the U.S. honey market growth in each Relevant Period”) and a price floor (a “reference price”), according to which China was required to price its imports at no less than 92 percent of import prices to the United States from all other countries “for the most recent six months of data available at the time the reference price is calculated.”\(^4\)

---

\(^{3}\)An affirmative preliminary injury determination was issued by the International Trade Commission (ITC) on November 25, 1994. On March 20, 1995, imports of honey from the PRC were preliminarily determined to be sold at “less than fair value” in the United States.

\(^{4}\)“Honey From the People’s Republic of China; Suspension of Investigation,” Import Administration, International Trade Administration, Department of Commerce, 60 Federal Register 158 (16 August 1995), pp. 42521 - 42527.
There was no significant decrease in the share of honey imported from China after the 1995 agreement and, at the same time, imports from Argentina increased dramatically (Table 1.3 and Figure 1.3), which led to antidumping duty orders for honey from Argentina and China and a countervailing duty order for honey from Argentina.

The antidumping duty investigations of honey from Argentina and China were initiated by the Department of Commerce on October 26, 2000. The investigation covered the period July 1, 1999 through June 30, 2000 for Argentina, and the period January 1, 2000 through June 30, 2000 for the PRC. The petitioners in these investigations were the American Honey Producers Association and the Sioux Honey Association.\(^5\) In December 2001, the Department of Commerce imposed anti-dumping duties on China (26 to 184 percent) and Argentina (27 to 55 percent)\(^6\). These duties led to substantially reduced imports from China and Argentina over the next several years.

In November 2006, the Department initiated sunset reviews of the anti-dumping duty orders on honey from Argentina and China and found in March 2007 that revocation of the anti-dumping duty orders would likely lead to continuation or recurrence of dumping. The De-

---


\(^6\)A countervailing duty (CVD) at the rate of 5.85 percent was also imposed for honey from Argentina. The ITC determined that “the total estimated countervailable subsidy rate is 4.53 percent \textit{ad valorem}” and “established a cash deposit rate of 5.85 percent \textit{ad valorem} due to a program-wide change.” See “Notice of Countervailing Duty Order: Honey From Argentina,” Import Administration, International Trade Administration, Department of Commerce, 66 Federal Register 237 (10 December 2001), pp. 63673 - 63674.
partment thus ordered the continuation of the antidumping orders on honey from Argentina and the China and the countervailing duty order on honey from Argentina. Following the 2012 ruling, Argentina imports rose modestly and Chinese imports dwindled, essentially to zero.

In December 2012, The Department of Commerce revoked the anti-dumping duty and countervailing duty orders on honey from Argentina because “we have concluded that substantially all domestic producers lack interest in the relief provided by these orders.” The result for China was different. As a result of the determinations by the Department of Commerce and the International Trade Commission the revocation of the anti-dumping duty order on honey from China “would likely lead to a continuation or recurrence of dumping and material injury to an industry in the United States.” The Department published a notice of continuation of the anti-dumping duty order against China.

It was also argued that after the trade restrictions were imposed on China and Argentina, several countries (e.g., Vietnam and India) increased honey exports to the United States partly because of the transshipment of honey from China. In particular, it is suspected that honey from China has been transshipped through third countries to the United States to avoid trade taxes mentioned above. The possible re-routing of honey through other countries may or may not have significant impacts on U.S. consumers and producers. Though transshipment of honey imported to the United States has been investigated and reported by the U.S. authorities, there is also possibility that transshipment can be empirically identified from trade and production data. A high degree of substitutability across different sources is a necessary condition for transshipment.

Due to the history of trade restrictions and the related transshipment issue, honey imports into the United States give rises to a set of broader issues that has not been examined in the literature, and provide a case study of the demand patterns of agricultural products within a background of trade friction. Like many other trade restrictions, the antidumping policies raise interesting economic problems and issues. Because the effects on domestic consumers and producers depend on the substitutability in demand between imports from restricted sources and imports from non-restricted sources, trade policy evaluation also requires reliable estimates of import demand. Therefore, this paper investigates important features of honey import demand, the objective being to provide estimates of U.S. honey import demand elasticities and other key parameters, especially the substitutability of honey across different sources.

7“Continuation of Antidumping Duty Orders on Honey From Argentina and the People’s Republic of China, and Continuation of Countervailing Duty Order on Honey From Argentina,” Import Administration, International Trade Administration, Department of Commerce, 72 Federal Register 148 (2 August 2007), pp. 42384 - 42385.
1.1.2 A Demand System

Demand systems have been used to estimate import demand for a number of goods, particularly agricultural products. For example, Yang and Koo [1994] estimated Japanese meat import demand with a source-differentiated AIDS model. Seale et al. [1992], treating each importing country as an individual consumer, modeled apple import data using the Rotterdam model.

Total U.S. honey imports have increased dramatically during the last twenty years. There were 40,000 metric tons of honey imported to the United States in 1995 and 153,000 in 2013 (USDA Foreign Agricultural Service). However, no research exists on the estimation of import demand for honey. In this study, following the Armington [1969] framework, source differentiation is assumed and honey imported from different sources will be treated as differentiated goods. U.S. honey import demand can thus be estimated using a standard demand model.

1.2 Data

The study uses monthly data (1995-2013) on honey imports into the United States from the USDA Foreign Agricultural Service. Import value and quantities are available by country of origin. Import prices are calculated as average revenues by dividing the value of the commodity by the quantity. The supplying countries and regions considered include Argentina, China, Taiwan, Vietnam, France, Germany, Canada, Mexico, Australia, New Zealand, RoSA (rest of South America), RoA (rest of Asia), RoE (rest of Europe) and RoW (rest of the world). Argentina, China, Vietnam, Canada and Mexico are countries with the largest shares of imports. Taiwan, France, Germany, Australia and New Zealand are considered based on geographical reasons. The RoSA, RoA, RoE and RoW categories are aggregated from other countries whose roles in international honey trade are minor (Table 1.3). There are 228 monthly observations on the 14 import source countries (and aggregates).

Transactions were not recorded for some months, in which case price is not defined. Different reasons may have resulted in unrecorded transaction. Countries with relatively small import

---

8Taiwan is geographically close to China and Vietnam and thus potentially related to the transshipment problem (see Footnote 9). France, Germany, Australia and New Zealand are included as representatives of Europe and Oceania.

9Choke prices (prices at which imports are zero) then become a problem during the estimation process. There are 268 choke prices that need to be estimated in the dataset, as is shown in bottom row of Table 1.3. As noted by Muhammad [2013], the traditional approach to avoiding the problem of choke prices is to aggregate exporting countries, but when comparing the results using the choke price procedure (explained in next section) to the aggregating approach, significant differences are observed for some countries. Another problem of the aggregating approach is that it will eliminate some of the most interesting countries. For example, Vietnam has 29 choke prices, most of which exist in earlier years, and eliminating choke prices of Vietnam by aggregating (e.g., including Vietnam in the RoA category) would not reflect the huge increase in honey imported from Vietnam in the most recent decade and thus not accurately reveal the demand pattern of U.S. honey imports.
shares tend to have zero import quantities by nature. For example, Australia and New Zealand have import value shares normally less than 1%, and they have 67 and 12 zeros for imports, respectively. Some countries with larger import shares (e.g., China and Argentina) have recorded zero imports (33 and 8, respectively) as a result of the imposition of trade restrictions, especially during the time period immediately after the trade restrictions were announced. Seasonality may also contribute to unrecorded transactions, but given that honey is storable, this effect is generally minor and negligible.
Table 1.2: U.S. Honey Consumption and Imports

<table>
<thead>
<tr>
<th>Year</th>
<th>Honey Per Capita Consump. (Pounds)</th>
<th>Honey Total Consump. (Million Pounds)</th>
<th>U.S. Average Honey Price (Real) (1983) ($/Pound)</th>
<th>Honey Imports (Million Pounds)</th>
<th>Average Import Price (Real) (1983) ($/Pound)</th>
<th>Share of Imported Quantity in U.S. Honey Consump.</th>
<th>CPI (82–84 =100)</th>
<th>U.S. Popul. (Million)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1989</td>
<td>0.77</td>
<td>189.8</td>
<td>0.402</td>
<td>77.3</td>
<td>0.294</td>
<td>0.407</td>
<td>124.0</td>
<td>246.8</td>
</tr>
<tr>
<td>1990</td>
<td>0.82</td>
<td>205.9</td>
<td>0.411</td>
<td>77.0</td>
<td>0.302</td>
<td>0.374</td>
<td>130.7</td>
<td>249.6</td>
</tr>
<tr>
<td>1991</td>
<td>0.91</td>
<td>230.9</td>
<td>0.408</td>
<td>92.3</td>
<td>0.317</td>
<td>0.400</td>
<td>136.2</td>
<td>253</td>
</tr>
<tr>
<td>1992</td>
<td>0.74</td>
<td>189.7</td>
<td>0.392</td>
<td>114.6</td>
<td>0.304</td>
<td>0.604</td>
<td>140.3</td>
<td>256.5</td>
</tr>
<tr>
<td>1993</td>
<td>0.79</td>
<td>205.5</td>
<td>0.373</td>
<td>133.6</td>
<td>0.267</td>
<td>0.650</td>
<td>144.5</td>
<td>259.9</td>
</tr>
<tr>
<td>1994</td>
<td>0.96</td>
<td>251.3</td>
<td>0.356</td>
<td>123.2</td>
<td>0.250</td>
<td>0.490</td>
<td>148.2</td>
<td>263.1</td>
</tr>
<tr>
<td>1995</td>
<td>0.90</td>
<td>240.2</td>
<td>0.449</td>
<td>88.6</td>
<td>0.351</td>
<td>0.369</td>
<td>152.4</td>
<td>266.3</td>
</tr>
<tr>
<td>1996</td>
<td>0.97</td>
<td>261.6</td>
<td>0.566</td>
<td>150.6</td>
<td>0.469</td>
<td>0.576</td>
<td>156.9</td>
<td>269.4</td>
</tr>
<tr>
<td>1997</td>
<td>0.95</td>
<td>258.6</td>
<td>0.469</td>
<td>167.4</td>
<td>0.447</td>
<td>0.648</td>
<td>160.5</td>
<td>272.6</td>
</tr>
<tr>
<td>1998</td>
<td>0.94</td>
<td>259.1</td>
<td>0.402</td>
<td>132.4</td>
<td>0.361</td>
<td>0.511</td>
<td>163.0</td>
<td>275.9</td>
</tr>
<tr>
<td>1999</td>
<td>1.06</td>
<td>294.9</td>
<td>0.361</td>
<td>182.5</td>
<td>0.285</td>
<td>0.619</td>
<td>166.6</td>
<td>279</td>
</tr>
<tr>
<td>2000</td>
<td>1.11</td>
<td>313.9</td>
<td>0.347</td>
<td>198.5</td>
<td>0.262</td>
<td>0.632</td>
<td>172.2</td>
<td>282.2</td>
</tr>
<tr>
<td>2001</td>
<td>0.94</td>
<td>268.1</td>
<td>0.398</td>
<td>144.8</td>
<td>0.279</td>
<td>0.540</td>
<td>177.1</td>
<td>285.1</td>
</tr>
<tr>
<td>2002</td>
<td>1.06</td>
<td>306.2</td>
<td>0.738</td>
<td>202.6</td>
<td>0.455</td>
<td>0.662</td>
<td>179.9</td>
<td>287.8</td>
</tr>
<tr>
<td>2003</td>
<td>1.00</td>
<td>291.6</td>
<td>0.754</td>
<td>200.4</td>
<td>0.570</td>
<td>0.687</td>
<td>184.0</td>
<td>290.3</td>
</tr>
<tr>
<td>2004</td>
<td>0.89</td>
<td>260.4</td>
<td>0.566</td>
<td>178.6</td>
<td>0.415</td>
<td>0.686</td>
<td>188.9</td>
<td>293</td>
</tr>
<tr>
<td>2005</td>
<td>1.05</td>
<td>311.2</td>
<td>0.470</td>
<td>233.0</td>
<td>0.276</td>
<td>0.749</td>
<td>195.3</td>
<td>295.8</td>
</tr>
<tr>
<td>2006</td>
<td>1.17</td>
<td>348.9</td>
<td>0.514</td>
<td>277.6</td>
<td>0.309</td>
<td>0.796</td>
<td>201.6</td>
<td>298.8</td>
</tr>
<tr>
<td>2007</td>
<td>0.93</td>
<td>281.6</td>
<td>0.519</td>
<td>233.0</td>
<td>0.337</td>
<td>0.827</td>
<td>207.3</td>
<td>301.7</td>
</tr>
<tr>
<td>2008</td>
<td>0.99</td>
<td>301.5</td>
<td>0.660</td>
<td>231.5</td>
<td>0.444</td>
<td>0.768</td>
<td>215.3</td>
<td>304.5</td>
</tr>
<tr>
<td>2009</td>
<td>0.92</td>
<td>281.4</td>
<td>0.687</td>
<td>210.5</td>
<td>0.488</td>
<td>0.748</td>
<td>214.5</td>
<td>307.2</td>
</tr>
<tr>
<td>2010</td>
<td>1.03</td>
<td>320.2</td>
<td>0.742</td>
<td>251.2</td>
<td>0.535</td>
<td>0.784</td>
<td>218.1</td>
<td>309.8</td>
</tr>
<tr>
<td>2011</td>
<td>1.08</td>
<td>337.7</td>
<td>0.785</td>
<td>288.3</td>
<td>0.597</td>
<td>0.854</td>
<td>224.9</td>
<td>312</td>
</tr>
<tr>
<td>2012</td>
<td>1.07</td>
<td>337.8</td>
<td>0.868</td>
<td>310.9</td>
<td>0.583</td>
<td>0.920</td>
<td>229.6</td>
<td>314.3</td>
</tr>
<tr>
<td>2013</td>
<td>1.12</td>
<td>354.7</td>
<td>0.910</td>
<td>337.0</td>
<td>0.613</td>
<td>0.950</td>
<td>233.0</td>
<td>316.5</td>
</tr>
<tr>
<td>Year</td>
<td>ARG</td>
<td>RoSA</td>
<td>CHN</td>
<td>TWN</td>
<td>VNM</td>
<td>RoA</td>
<td>FRA</td>
<td>GMN</td>
</tr>
<tr>
<td>------</td>
<td>-----</td>
<td>------</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
</tr>
<tr>
<td>1995</td>
<td>0.2512</td>
<td>0.0015</td>
<td>0.3445</td>
<td>0.0005</td>
<td>0.0018</td>
<td>0.0008</td>
<td>0.0011</td>
<td>0.0045</td>
</tr>
<tr>
<td>1996</td>
<td>0.3982</td>
<td>0.0089</td>
<td>0.3397</td>
<td>0.0003</td>
<td>0.0115</td>
<td>0.0067</td>
<td>0.0008</td>
<td>0.0028</td>
</tr>
<tr>
<td>1997</td>
<td>0.5601</td>
<td>0.0073</td>
<td>0.2246</td>
<td>0.0004</td>
<td>0.0146</td>
<td>0.0213</td>
<td>0.0010</td>
<td>0.0023</td>
</tr>
<tr>
<td>1998</td>
<td>0.4351</td>
<td>0.0023</td>
<td>0.3017</td>
<td>0.0010</td>
<td>0.0492</td>
<td>0.0063</td>
<td>0.0019</td>
<td>0.0029</td>
</tr>
<tr>
<td>1999</td>
<td>0.4022</td>
<td>0.0016</td>
<td>0.3467</td>
<td>0.0007</td>
<td>0.0191</td>
<td>0.0010</td>
<td>0.0022</td>
<td>0.0025</td>
</tr>
<tr>
<td>2000</td>
<td>0.4014</td>
<td>0.0020</td>
<td>0.3610</td>
<td>0.0010</td>
<td>0.0227</td>
<td>0.0015</td>
<td>0.0031</td>
<td>0.0021</td>
</tr>
<tr>
<td>2001</td>
<td>0.2182</td>
<td>0.0433</td>
<td>0.3157</td>
<td>0.0010</td>
<td>0.0991</td>
<td>0.0169</td>
<td>0.0025</td>
<td>0.0047</td>
</tr>
<tr>
<td>2002</td>
<td>0.0953</td>
<td>0.1297</td>
<td>0.0767</td>
<td>0.0006</td>
<td>0.1742</td>
<td>0.0561</td>
<td>0.0014</td>
<td>0.0050</td>
</tr>
<tr>
<td>2003</td>
<td>0.0436</td>
<td>0.1804</td>
<td>0.2569</td>
<td>0.0007</td>
<td>0.1173</td>
<td>0.0765</td>
<td>0.0013</td>
<td>0.0047</td>
</tr>
<tr>
<td>2004</td>
<td>0.0395</td>
<td>0.0979</td>
<td>0.3218</td>
<td>0.0055</td>
<td>0.1319</td>
<td>0.0848</td>
<td>0.0017</td>
<td>0.0068</td>
</tr>
<tr>
<td>2005</td>
<td>0.1898</td>
<td>0.0775</td>
<td>0.2654</td>
<td>0.0165</td>
<td>0.1585</td>
<td>0.0881</td>
<td>0.0018</td>
<td>0.0028</td>
</tr>
<tr>
<td>2006</td>
<td>0.2119</td>
<td>0.0940</td>
<td>0.2335</td>
<td>0.0024</td>
<td>0.1567</td>
<td>0.0969</td>
<td>0.0021</td>
<td>0.0020</td>
</tr>
<tr>
<td>2007</td>
<td>0.1813</td>
<td>0.1208</td>
<td>0.1005</td>
<td>0.0058</td>
<td>0.2430</td>
<td>0.0929</td>
<td>0.0037</td>
<td>0.0054</td>
</tr>
<tr>
<td>2008</td>
<td>0.1074</td>
<td>0.1194</td>
<td>0.0506</td>
<td>0.0247</td>
<td>0.2894</td>
<td>0.1483</td>
<td>0.0023</td>
<td>0.0050</td>
</tr>
<tr>
<td>2009</td>
<td>0.1242</td>
<td>0.1660</td>
<td>0.0013</td>
<td>0.0376</td>
<td>0.2845</td>
<td>0.2119</td>
<td>0.0033</td>
<td>0.0052</td>
</tr>
<tr>
<td>2010</td>
<td>0.1544</td>
<td>0.0905</td>
<td>0.0152</td>
<td>0.0094</td>
<td>0.2916</td>
<td>0.2552</td>
<td>0.0026</td>
<td>0.0037</td>
</tr>
<tr>
<td>2011</td>
<td>0.2215</td>
<td>0.1436</td>
<td>0.0229</td>
<td>0.0043</td>
<td>0.3185</td>
<td>0.1764</td>
<td>0.0023</td>
<td>0.0024</td>
</tr>
<tr>
<td>2012</td>
<td>0.2571</td>
<td>0.1426</td>
<td>0.0003</td>
<td>0.0062</td>
<td>0.2429</td>
<td>0.1312</td>
<td>0.0026</td>
<td>0.0032</td>
</tr>
<tr>
<td>2013</td>
<td>0.2477</td>
<td>0.1169</td>
<td>0.0007</td>
<td>0.0071</td>
<td>0.3267</td>
<td>0.1233</td>
<td>0.0023</td>
<td>0.0041</td>
</tr>
</tbody>
</table>

Note: Number of monthly zero observations are in parentheses.
1.3 Model

This study uses the Liner Approximate Almost Ideal Demand System (LA/AIDS), in which sources of honey are differentiated. The demand model is specified as:

\[
\Delta w_{it} = a_i + b_i \left[ \Delta \log x_t - \sum_j w_{jt} \Delta \log p_{jt} \right] + \sum_j c_{ij} \Delta \log p_{jt} + u_{it} \tag{1.1}
\]

where \(w_{it}\) is the expenditure share of country \(i\) in month \(t\), \(x_t\) is total U.S. expenditure on imported honey and \(p_{jt}\) is the import price defined above as average revenue where import quantities are positive. The \(a_i\), \(b_i\) and \(c_{ij}\) parameters are to be estimated.

Following Muhammad [2013], choke prices are estimated in the following way. The estimation starts from a general expression of own price elasticity:

\[
\frac{q_i - \bar{q}_i}{\bar{q}_i} = \eta_{ii} \frac{p_i - \bar{p}_i}{\bar{p}_i} \tag{1.2}
\]

where \(\bar{q}_i\) and \(\bar{p}_i\) are average quantity and price and \(\eta_{ii}\) is the uncompensated own-price elasticity. Choke prices exist when \(q_i = 0\), and therefore,

\[
p_i = \left[ \frac{\eta_{ii} - 1}{\eta_{ii}} \right] \bar{p}_i \tag{1.3}
\]

Equation (1.3) is the basis for the method used to estimate choke prices.

Average prices (over time) are utilized as initial estimates of choke prices when estimating Equation (1.1). With own-price elasticities being calculated by the initial estimation results, choke prices are updated by equation (1.3) and treated as prices in zero-import months, then equation (1.1) is re-estimated with the updated choke prices. This process is repeated until convergence.

Examples of Argentina and Vietnam are presented here as an illustration of this process (Table 1.4). The average prices are 45.98 cents/pound for Argentina and 72.10 cents/pound for Vietnam. Eight of the monthly observations for Argentina are zero; 29 of the observations for Vietnam are zero. After the first estimation round, the own-price elasticities for Argentina and Vietnam are -1.47 and -1.25, resulting in estimated choke prices of 77.19 and 129.97. The estimation process is repeated after ten rounds when own-price elasticities for Argentina and Vietnam converge to –1.42 and –1.15 and the choke prices converge to 80.39 and 153.96, respectively.
Table 1.4: Choke Prices Estimation for Argentina and Vietnam

<table>
<thead>
<tr>
<th>Iteration</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Own-price Elasticity</td>
<td>Own-price Choke Price</td>
<td>Own-price Elasticity</td>
<td>Own-price Choke Price</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>-1.47272</td>
<td>77.19329293</td>
<td>-1.24586</td>
<td>129.9740682</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>-1.44278</td>
<td>79.69568917</td>
<td>-1.17197</td>
<td>147.2646996</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>-1.42479</td>
<td>80.25705501</td>
<td>-1.15903</td>
<td>152.1184159</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>-1.4212</td>
<td>80.3742196</td>
<td>-1.15599</td>
<td>153.4551124</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>-1.42062</td>
<td>80.3947775</td>
<td>-1.15521</td>
<td>153.8203645</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>-1.4206</td>
<td>80.3947418</td>
<td>-1.15502</td>
<td>153.9187848</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>-1.42066</td>
<td>80.39517288</td>
<td>-1.15497</td>
<td>153.9452338</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>-1.42071</td>
<td>80.39392623</td>
<td>-1.15496</td>
<td>153.9521293</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>-1.42073</td>
<td>80.39338418</td>
<td>-1.15495</td>
<td>153.9543843</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>-1.42075</td>
<td>80.39288427</td>
<td>-1.15495</td>
<td>153.9549194</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>-1.42076</td>
<td>80.39262063</td>
<td>-1.15495</td>
<td>153.9550464</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>-1.42076</td>
<td>80.39260487</td>
<td>-1.15495</td>
<td>153.9550766</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1.4 Results

Uncompensated own-price and expenditure elasticities are reported in Table 1.5. Own-price elasticities are all negative as expected. Except for Mexico, all own-price elasticities are statistically significant at the 5% level. Australia and Germany (which have smaller import shares) have the largest own-price elasticities (-1.77 and -1.70, respectively). Honey from Argentina is the most price elastic (-1.42) among countries with larger import shares. Honey from China, Vietnam and Canada are nearly unit elastic (-1.09, -1.15 and -1.21, respectively). Demand for honey from Mexico is the only inelastic case (-0.83).

Except for France and Germany, all expenditure elasticities are positive and half of them are significant. Expenditure on honey from China, Rest of Asia, Vietnam and Argentina are the most elastic (1.70, 1.17, 1.10 and 1.07, respectively). Those results suggest that as honey import expenditure increases, the United States imports relatively more from countries in Asia and Argentina than from other sources. This, to some extent, justifies the trade restrictions imposed on honey from China and Argentina. A relatively smaller expenditure elasticity for Argentina (1.07), compared with China (1.70), seems consistent with the decision to remove anti-dumping duties for Argentina in 2012, because the removal of trade restrictions may potentially induce more honey imported from China than from Argentina.

Cross-price elasticities are reported in Table 1.6. The cross price elasticities are generally close to zero and statistically insignificant. Neither significant complementary nor substitution relationships are observed. For example, cross price elasticity of the demand for honey from Vietnam and the Rest of Asia with respect to the price of honey from China are 0.07 and 0.16.
Table 1.5: Own-price and Expenditure Elasticities

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Argentina</td>
<td>-1.42076*</td>
<td>0.3321</td>
<td>1.066271*</td>
<td>0.1461</td>
</tr>
<tr>
<td>Rest of SA</td>
<td>-1.06535*</td>
<td>0.2956</td>
<td>0.682659*</td>
<td>0.1436</td>
</tr>
<tr>
<td>China</td>
<td>-1.09569*</td>
<td>0.2009</td>
<td>1.695781*</td>
<td>0.2010</td>
</tr>
<tr>
<td>Taiwan</td>
<td>-1.38353*</td>
<td>0.3395</td>
<td>0.484949</td>
<td>0.4864</td>
</tr>
<tr>
<td>Vietnam</td>
<td>-1.15495*</td>
<td>0.2879</td>
<td>1.096434*</td>
<td>0.1529</td>
</tr>
<tr>
<td>Rest of Asia</td>
<td>-1.03918*</td>
<td>0.3871</td>
<td>1.168707*</td>
<td>0.1668</td>
</tr>
<tr>
<td>France</td>
<td>-1.28886*</td>
<td>0.1746</td>
<td>-0.09388</td>
<td>0.4657</td>
</tr>
<tr>
<td>Germany</td>
<td>-1.69822*</td>
<td>0.1758</td>
<td>-0.04462</td>
<td>0.4907</td>
</tr>
<tr>
<td>Rest of Europe</td>
<td>-1.50629*</td>
<td>0.1895</td>
<td>0.236329</td>
<td>0.2176</td>
</tr>
<tr>
<td>Canada</td>
<td>-1.208*</td>
<td>0.4352</td>
<td>0.480677*</td>
<td>0.1538</td>
</tr>
<tr>
<td>Mexico</td>
<td>-0.82938</td>
<td>0.7675</td>
<td>0.69505</td>
<td>0.3329</td>
</tr>
<tr>
<td>Australia</td>
<td>-1.76726*</td>
<td>0.2473</td>
<td>0.137882</td>
<td>0.8998</td>
</tr>
<tr>
<td>New Zealand</td>
<td>-1.25835*</td>
<td>0.1246</td>
<td>0.199944</td>
<td>0.2986</td>
</tr>
<tr>
<td>Rest of the World</td>
<td>-1.11789*</td>
<td>0.4546</td>
<td>0.635097</td>
<td>0.5734</td>
</tr>
</tbody>
</table>

respectively and not significant, which is not entirely consistent with the suspicion that Chinese honey is transshipped to other areas in Asia and then imported into the United States\(^{10}\), though these positive cross-price elasticities do suggest some substitution relationships.

\(^{10}\)Chapter 2 will study in detail the transshipment problem associated with trade restrictions.
Table 1.6: Matrix of Own-price and Cross-price Elasticities

<table>
<thead>
<tr>
<th></th>
<th>ARG</th>
<th>RoSA</th>
<th>CHN</th>
<th>TWN</th>
<th>VNM</th>
<th>RoA</th>
<th>FRA</th>
<th>GMN</th>
<th>RoE</th>
<th>CAN</th>
<th>MEX</th>
<th>AUS</th>
<th>NZL</th>
<th>RoW</th>
</tr>
</thead>
<tbody>
<tr>
<td>ARG</td>
<td>-1.42*</td>
<td>-0.031</td>
<td>-0.007</td>
<td>-0.012</td>
<td>0.121</td>
<td>-0.049</td>
<td>-0.015</td>
<td>-0.023</td>
<td>0.037</td>
<td>0.153</td>
<td>0.181</td>
<td>0.005</td>
<td>0.011</td>
<td>-0.017</td>
</tr>
<tr>
<td>RoSA</td>
<td>0.002</td>
<td>-1.065*</td>
<td>-0.065</td>
<td>0.007</td>
<td>0.044</td>
<td>0.036</td>
<td>0.005</td>
<td>-0.003</td>
<td>0.028</td>
<td>0.309</td>
<td>0.022</td>
<td>-0.01</td>
<td>0.001</td>
<td>0.007</td>
</tr>
<tr>
<td>CHN</td>
<td>-0.157</td>
<td>-0.115</td>
<td>-1.096*</td>
<td>-0.022*</td>
<td>-0.034</td>
<td>0.032</td>
<td>-0.009</td>
<td>-0.009</td>
<td>-0.036</td>
<td>-0.153</td>
<td>-0.055</td>
<td>0.001</td>
<td>-0.01</td>
<td>-0.033</td>
</tr>
<tr>
<td>TWN</td>
<td>-0.279</td>
<td>0.094</td>
<td>-0.339</td>
<td>-1.384*</td>
<td>0.082</td>
<td>0.086</td>
<td>0.174</td>
<td>-0.028</td>
<td>0.089</td>
<td>0.402</td>
<td>0.532</td>
<td>-0.087</td>
<td>0.039</td>
<td>0.133</td>
</tr>
<tr>
<td>VNM</td>
<td>0.177</td>
<td>-0.011</td>
<td>0.067</td>
<td>-0.001</td>
<td>-1.155*</td>
<td>-0.003</td>
<td>-0.011</td>
<td>-0.011</td>
<td>-0.058</td>
<td>-0.075</td>
<td>0.001</td>
<td>0</td>
<td>-0.007</td>
<td></td>
</tr>
<tr>
<td>RoA</td>
<td>-0.164</td>
<td>-0.004</td>
<td>0.162</td>
<td>0.002</td>
<td>-0.017</td>
<td>-1.039*</td>
<td>-0.006</td>
<td>0.001</td>
<td>-0.028</td>
<td>-0.077</td>
<td>0.027</td>
<td>-0.003</td>
<td>-0.01</td>
<td>-0.013</td>
</tr>
<tr>
<td>FRA</td>
<td>-1.241</td>
<td>0.245</td>
<td>-0.394</td>
<td>0.538</td>
<td>-0.552</td>
<td>-0.129</td>
<td>-1.289*</td>
<td>0.102</td>
<td>0.119</td>
<td>2.416</td>
<td>0.413</td>
<td>0.077</td>
<td>0.035</td>
<td>-0.247</td>
</tr>
<tr>
<td>GMN</td>
<td>-1.041</td>
<td>0.008</td>
<td>-0.076</td>
<td>-0.043</td>
<td>-0.216</td>
<td>0.121</td>
<td>0.056</td>
<td>-1.698*</td>
<td>-0.158</td>
<td>2.631*</td>
<td>0.573</td>
<td>-0.067</td>
<td>-0.128</td>
<td>0.083</td>
</tr>
<tr>
<td>RoE</td>
<td>0.616</td>
<td>0.15</td>
<td>-0.048</td>
<td>0.032</td>
<td>0.054</td>
<td>0.033</td>
<td>0.012</td>
<td>-0.033</td>
<td>0.016</td>
<td>-1.506*</td>
<td>0.664</td>
<td>-0.059</td>
<td>-0.016</td>
<td>-0.06</td>
</tr>
<tr>
<td>CAN</td>
<td>0.357</td>
<td>0.175</td>
<td>0.049</td>
<td>0.017</td>
<td>0.04</td>
<td>0.018</td>
<td>0.033</td>
<td>0.065*</td>
<td>-0.282</td>
<td>-1.208*</td>
<td>-0.221</td>
<td>0.034</td>
<td>0.024</td>
<td>0.057</td>
</tr>
<tr>
<td>MEX</td>
<td>1.068</td>
<td>0.042</td>
<td>-0.049</td>
<td>0.085</td>
<td>-0.204</td>
<td>0.091</td>
<td>0.02</td>
<td>0.052</td>
<td>-0.038</td>
<td>-0.869</td>
<td>-0.829</td>
<td>-0.033</td>
<td>-0.02</td>
<td>0.049</td>
</tr>
<tr>
<td>AUS</td>
<td>0.423</td>
<td>-0.093</td>
<td>0.317</td>
<td>-0.102</td>
<td>0.187</td>
<td>0.043</td>
<td>0.03</td>
<td>-0.049</td>
<td>-0.056</td>
<td>1.025</td>
<td>-0.223</td>
<td>-1.767*</td>
<td>-0.036</td>
<td>0.167</td>
</tr>
<tr>
<td>NZL</td>
<td>0.602</td>
<td>0.05</td>
<td>-0.005</td>
<td>0.044</td>
<td>0.137</td>
<td>-0.052</td>
<td>0.012</td>
<td>-0.084</td>
<td>-0.193</td>
<td>0.644</td>
<td>-0.113</td>
<td>-0.033</td>
<td>-1.258*</td>
<td>0.049</td>
</tr>
<tr>
<td>RoW</td>
<td>-0.153</td>
<td>0.039</td>
<td>-0.186</td>
<td>0.058</td>
<td>0.002</td>
<td>0.002</td>
<td>-0.038</td>
<td>0.019</td>
<td>-0.018</td>
<td>0.57</td>
<td>-0.023</td>
<td>0.059</td>
<td>0.017</td>
<td>-1.118*</td>
</tr>
</tbody>
</table>

16
1.5 Conclusions

A source-differentiated specification of the AIDS model is utilized for estimating U.S. import demand for honey. Choke prices are derived and estimated using a general expression of own-price elasticity. The estimation results suggest significantly negative own-price elasticities as the theory predicts. In terms of own-price elasticity (-1.42), Argentina seems to be in the most important position among countries with large import shares\textsuperscript{11}. China has the largest expenditure elasticity and unit own-price elasticity in the market. Those results help better understand the history of trade restrictions on honey.

The limitation of this chapter is the lack of domestic honey consumption in the model. Domestic honey consumption is currently not considered because monthly data are not available. Substitutions in the honey import market do not seem to be evident, which means suspected transshipment of honey across different sources is not well supported by these estimates. Exclusion of domestic honey consumption data from the estimation may explain this phenomenon. In addition, an inverse demand system can be considered, because quantities could tend to be predetermined within the background of trade restrictions. The empirical framework for inverse demand systems with choke prices may be developed in future work.

\textsuperscript{11}Australia does have the largest own price elasticity of -1.77 but has a much smaller import share (usually less than 1%).
Chapter 2

A Model of Transshipment Under Trade Restrictions

2.1 Introduction

2.1.1 Background

United States imports honey from around the world and the quantity imported has increased from 10 million pounds in 1950 to 350 million pounds in 2013. The quantity exported is generally small, even negligible, compared with imports. A growing demand for honey over recent decades has mainly been met by increases in honey imported from foreign sources.

The dramatic increase in honey imports led the domestic beekeeping industry to seek methods of industry support to replace the cessation of honey price support in 1996 (Muth et al. [2003]). China and Argentina were the largest exporters of honey into the United States during the 1990s. Starting in 1995, various trade restrictions have been imposed on honey imported from China and Argentina. Trade restrictions (anti-dumping duties) are justified on the basis that honey from those two countries is “being sold, or is likely to be sold, in the United States at less than fair value (LTFV).” In 1995, an agreement between the US and China (for 5 years) was reached. The agreement included a restriction on annual honey shipments to the United States (limited to 44 million pounds) and a price floor, according to which China was required to price its imports at no less than 92 percent of import prices to the United States from all other countries1.

1“Honey From the People’s Republic of China; Suspension of Investigation,” Import Administration, International Trade Administration, Department of Commerce, 60 Federal Register 158 (16 August 1995), pp. 42521 - 42527.
There was no significant decrease in the share of honey imported from China after the 1995 agreement and at the same time, imports from Argentina increased dramatically (Table 2.1). This led to antidumping duty orders for honey from Argentina and China and a countervailing duty order for honey from Argentina. The antidumping duty investigations of honey from Argentina and China were initiated by the Department of Commerce on October 26, 2000. In December 2001, the Department of Commerce imposed anti-dumping duties on China (26 to 184 percent) and Argentina (27 to 55 percent). In November 2006, the Department initiated sunset reviews of the anti-dumping duty orders on honey from Argentina and China and ordered the continuation of the antidumping orders on honey from Argentina and the PRC and the countervailing duty order on honey from Argentina. In December 2012, The Department of Commerce revoked the anti-dumping duty and countervailing duty orders on honey from Argentina but published a notice of continuation of the anti-dumping duty order for honey from China.

The adulteration of honey and the aggressive utilization of honey processing technology, though not explicitly mentioned in the official documents about anti-dumping duties, have also been a concern of the industry and consumers for decades. The U.S. Food and Drug Administration has issued import alerts for honey containing antibiotics (e.g., Chloramphenicol) that are not approved for use in honey. Honey containing certain antibiotics is deemed “adulterated” within the meaning of federal food and drug safety laws. Recently, the application of resin technology to honey production has also been brought to attention and “calling the product

---

\[2\] See, for example, *Import Alert 36-04*, “Detention Without Physical Examination of Honey and Blended Syrup Due to Unsafe Drug Residues,” 02/23/2015.

\[3\] Resin technology has been used by food industry to remove various contaminants (Cheng et al. [2012]).
that has been treated with the resin technology simply ‘honey’ would not accurately identify
the food generally understood to be honey.” (Phipps [2016])

2.1.2 The Transshipment Issue

After trade restrictions were imposed on China and Argentina in 1995 and after, several coun-
tries (e.g., Vietnam and India) increased honey exports to the United States likely due in part
to the transshipment of honey from restricted sources (Figure 2.1). Specifically, honey from
sources subject to trade restrictions may have been transshipped through third countries to the
United States to avoid the trade taxes and restrictions mentioned above. Related investigations
were carried out during the past decade on the transshipped honey from various sources. In
2008, federal authorities began investigating allegations of organizations circumventing anti-
dumping duties through illegal imports, including transshipment and mislabeling. According
to a recent investigation in April 2016, for example, 60 tons of Chinese honey valued at more
than $200,000 has been seized and the containers’ shipping documents indicated the honey has
originated in Vietnam.

The country of origin is required to be clearly labeled if the honey comes from sources other
than United States. It is obvious that if the country of origin is disguised (by transshipment),
then the tariff can be avoided. Therefore, with respect to honey, the “real” country of origin
is particularly important because of the fact that trade restrictions are imposed only on some
countries.

Though transshipment of honey imported to the United States has been investigated and re-
ported by the U.S. authorities and public media, there also is the possibility that transshipment
could be identified from trade and production data. Intuition suggests that data on domestic
honey production in countries of interest can be utilized to be compared with quantity of honey
exported, and significant inconsistency in production and export is evidence of transshipment.
For example, Vietnam has long been suspected to be the transshipper of honey from China into
the United States. Honey production and trade data from 1995 through 2000 are presented in
Table 2.1. Vietnam is not known for large bee populations and honey production but its honey

6 International attention has been drawn to the transshipment issue as well. A recent letter (April 14 2016)
by Kevin Nixon, chair of Canadian Honey Council, expresses the unwillingness to see Canada becoming “an
alternate point of entry” of transshipped honey.
7 19 U.S. Code § 1304, *Marking of imported articles and containers*: "Except as hereinafter provided, every
article of foreign origin (or its container, as provided in subsection (b) hereof) imported into the United States
shall be marked in a conspicuous place as legibly, indelibly, and permanently as the nature of the article (or
container) will permit in such manner as to indicate to an ultimate purchaser in the United States the English
name of the country of origin of the article.” A draft guidance that outlines the proper labeling of honey products
was also issued in 2014.
produced and exported increased dramatically in recent decades, which potentially could be used as a signal of transshipment of honey from other sources. The sum of China’s and Vietnam’s share (Figure 2.1), therefore, may suggest transshipment of honey from China into the United States through Vietnam.

Isard and Peck [1954] points out from statistical evidence that a trade model without considering distance and transportation may lead to unrealistic conclusions. Early literature on transportation of international trade focuses on linear programming and the optimum use of transportation, i.e., the minimization of transportation cost (see, for example, Koopmans [1949] and Koopmans and Reiter [1951]). Samuelson [1952], following Enke [1951], develops a model of interspatial markets and proves the effects of changes in each market’s conditions. Their models, however, do not allow for the existence of a transshipper, and the scenario of “going-through the port” was ruled out. A good understanding of the trade pattern is important for trade policy evaluation. This chapter, by taking into consideration the transshipment issue, contributes to a growing literature on the impacts of agricultural trade policy analysis within the background of trade frictions. In terms of the welfare effects, Bhagwati and Hansen [1971] and Connely et al. [1995] analyze the impact of illegal trade by evaluating the change in national income measured at world prices and this criterion is a general measure of welfare changes. The effects of honey trade restrictions on domestic consumers and producers can also be reflected by change in national income associated with the transshipment problem (one form of illegal trade).

Due to the history of trade restrictions and the related transshipment problem, honey imports into the United States give rise to a broader set of issues that has not been examined in the literature. The possible re-routing of honey through other countries may or may not have significant impacts on U.S. consumers and producers. Therefore, the main objective of this chapter is to study the effects of the potentially existing transshipment associated with trade restrictions. This current chapter develops a unified framework attempting to capture the evolution of the trade patterns of a three-country world with transshipment. Comparative static effects are calculated and interpreted.

### 2.2 A 3-country Trade Model

The following theory identifies the observable implication for trade flows from imposing a tariff on one source country, and analyzes in the context of there also being imports from a country not directly affected by the tariff. The situation will be on where County 3 imports from Country 1 and Country 2 and imposes a tariff only on imports from Country 1. In the most general

---

8See, for example, Samuelson [1952]: “Why send exports out if you have to expensively ship in imports to replace them? Instead ship directly.” That being said, an exporter is, by nature, a net exporter.
Table 2.1: Vietnam: Honey Production and Trade, Metric tons. Source: FAOSTAT.

<table>
<thead>
<tr>
<th>Year</th>
<th>Production</th>
<th>Imports</th>
<th>Exports</th>
<th>Exports into U.S.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1980</td>
<td>331</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>1981</td>
<td>250</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>1982</td>
<td>280</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>1983</td>
<td>300</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>1984</td>
<td>319</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>1985</td>
<td>614</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>1986</td>
<td>620</td>
<td>0</td>
<td>150</td>
<td></td>
</tr>
<tr>
<td>1987</td>
<td>635</td>
<td>0</td>
<td>110</td>
<td></td>
</tr>
<tr>
<td>1988</td>
<td>645</td>
<td>0</td>
<td>360</td>
<td></td>
</tr>
<tr>
<td>1989</td>
<td>655</td>
<td>0</td>
<td>290</td>
<td></td>
</tr>
<tr>
<td>1990</td>
<td>661</td>
<td>0</td>
<td>650</td>
<td></td>
</tr>
<tr>
<td>1991</td>
<td>794</td>
<td>0</td>
<td>91</td>
<td></td>
</tr>
<tr>
<td>1992</td>
<td>1,000</td>
<td>0</td>
<td>252</td>
<td></td>
</tr>
<tr>
<td>1993</td>
<td>1,500</td>
<td>0</td>
<td>750</td>
<td></td>
</tr>
<tr>
<td>1994</td>
<td>2,000</td>
<td>23</td>
<td>950</td>
<td>20</td>
</tr>
<tr>
<td>1995</td>
<td>3,000</td>
<td>23</td>
<td>1,300</td>
<td>79</td>
</tr>
<tr>
<td>1996</td>
<td>3,500</td>
<td>2</td>
<td>2,441</td>
<td>717</td>
</tr>
<tr>
<td>1997</td>
<td>3,824</td>
<td>14</td>
<td>2,443</td>
<td>909</td>
</tr>
<tr>
<td>1998</td>
<td>4,593</td>
<td>2</td>
<td>5,400</td>
<td>2,940</td>
</tr>
<tr>
<td>1999</td>
<td>6,051</td>
<td>4</td>
<td>3,000</td>
<td>1,525</td>
</tr>
<tr>
<td>2000</td>
<td>5,661</td>
<td>3</td>
<td>3,400</td>
<td>1,902</td>
</tr>
<tr>
<td>2001</td>
<td>7,321</td>
<td>7</td>
<td>7,600</td>
<td>5,693</td>
</tr>
<tr>
<td>2002</td>
<td>11,401</td>
<td>614</td>
<td>15,876</td>
<td>14,356</td>
</tr>
<tr>
<td>2003</td>
<td>12,758</td>
<td>1,222</td>
<td>10,548</td>
<td>7,876</td>
</tr>
<tr>
<td>2004</td>
<td>10,701</td>
<td>167</td>
<td>15,563</td>
<td>9,895</td>
</tr>
<tr>
<td>2005</td>
<td>13,591</td>
<td>27</td>
<td>16,210</td>
<td>13,582</td>
</tr>
<tr>
<td>2006</td>
<td>16,747</td>
<td>81</td>
<td>14,647</td>
<td>13,263</td>
</tr>
<tr>
<td>2007</td>
<td>15,659</td>
<td>1,418</td>
<td>16,730</td>
<td>15,707</td>
</tr>
<tr>
<td>2008</td>
<td>9,960</td>
<td>1,530</td>
<td>11,400</td>
<td>19,378</td>
</tr>
<tr>
<td>2009</td>
<td>11,549</td>
<td>719</td>
<td>12,000</td>
<td>17,430</td>
</tr>
<tr>
<td>2010</td>
<td>11,944</td>
<td>687</td>
<td>12,600</td>
<td>20,934</td>
</tr>
<tr>
<td>2011</td>
<td>11,804</td>
<td>870</td>
<td>12,600</td>
<td>27,630</td>
</tr>
<tr>
<td>2012</td>
<td>12,365</td>
<td>870</td>
<td>13,200</td>
<td>20,700</td>
</tr>
<tr>
<td>2013</td>
<td>12,883</td>
<td>870</td>
<td>34,924</td>
<td>33,586</td>
</tr>
</tbody>
</table>
setting, perhaps surprisingly, the effects of imposing a tariff on imports from a single country are indeterminate. The imposition of the tariff on imports from Country 1 can increase imports from Country 1. The source of this non-intuitive results is explored by analyzing a sequence of theoretical models that impose prior restrictions on trade flows that allow the comparative static results to be signed.

Consider three countries with given supply and demand conditions for one good (e.g., honey). Let $P_i$ be the domestic price of the good in Country $i$, and $Q_{ij}$ be the trade flow from Country $i$ to Country $j$. Suppose that goods can move from Country $i$ to Country $j$ for $T_{ij}(Q_{ij})$ dollars per unit, where $T'(\cdot) > 0$ (increasing transportation cost).

2.2.1 Triangle Trade: Three Countries with Three Trade Flows

![Diagram of Triangle Trade]

Figure 2.2: Triangle Trade

We first consider a scenario where there are three positive trade flows and a trade restriction imposed on one of those flows. Suppose Country 1 exports goods to both Country 2 and Country 3, Country 3 imports goods from Country 1 and Country 2, and Country 2 both imports from Country 1 and exports to Country 3 (Figure 2.2). Thus, excess supply from each country are

---

That being said, we allow for goods going through the ports of Country to be regarded as both imports and (at the same time) exports of Country 2. Therefore, Country 2 is not a net exporter but a transshipper.
related to trade flows as follows:

\[ E_1(P_1) = Q_{13} + Q_{12} \]  \hspace{1cm} (2.1)
\[ E_2(P_2) = Q_{23} - Q_{12} \]  \hspace{1cm} (2.2)
\[ -E_3(P_3) = Q_{13} + Q_{23}. \]  \hspace{1cm} (2.3)

\( E_i(P_i) = S_i(P_i) - D_i(P_i) \). \( E_i(P_i) \) is the excess supply of Country \( i \) if \( S_i(P_i) > D_i(P_i) \), which if negative, implies net imports. Now consider the tariff \( \tau \) imposed on good from Country 1 to Country 3. In equilibrium, if there are positive trade flows \( Q_{12} > 0, Q_{23} > 0, \) and \( Q_{13} > 0 \), as in Figure 2.2, domestic prices in Country 2 and Country 3 can be expressed as domestic prices in exporting countries plus trade costs, including transportation cost \( T_{ij}(Q_{ij}) \) from \( i \) to \( j \), and tariff \( \tau \). Therefore, it must be the case that (Samuelson [1952]):

\[ P_2 = P_1 + T_{12}(Q_{12}) \]  \hspace{1cm} (2.4)
\[ P_3 = P_2 + T_{23}(Q_{23}) \]  \hspace{1cm} (2.5)
\[ P_3 = P_1 + T_{13}(Q_{13}) + \tau, \]  \hspace{1cm} (2.6)

Equations (2.1) through (2.6) characterize the trade pattern of three countries with increasing transportation costs and a tariff imposed on the good from a particular source. The system can be reduced by substitution to imply the following four equations:

\[ E_1(P_1) = Q_{13} + Q_{12} \]  \hspace{1cm} (2.7)
\[ E_2(P_1 + T_{12}(Q_{12})) = Q_{23} - Q_{12} \]  \hspace{1cm} (2.8)
\[ -E_3(P_1 + T_{12}(Q_{12}) + T_{23}(Q_{23})) = Q_{13} + Q_{23} \]  \hspace{1cm} (2.9)
\[ T_{12}(Q_{12}) + T_{23}(Q_{23}) = T_{13}(Q_{13}) + \tau. \]  \hspace{1cm} (2.10)

Let \( \tilde{x} = \ln x \); then log-differentiating yields

\[ \epsilon_1 \tilde{P}_1 = \sigma \tilde{Q}_{13} + (1 - \sigma)\tilde{Q}_{12} \]
\[ \epsilon_2 \left[ \alpha \tilde{P}_1 + (1 - \alpha)\theta_{12}\tilde{Q}_{12} \right] = \gamma \tilde{Q}_{23} + (1 - \gamma)\tilde{Q}_{12} \]
\[ -\epsilon_3 \left[ \beta_1 \tilde{P}_1 + \beta_2 \theta_{12}\tilde{Q}_{12} + (1 - \beta_1 - \beta_2)\theta_{23}\tilde{Q}_{23} \right] = \delta \tilde{Q}_{13} + (1 - \delta)\tilde{Q}_{23} \]
\[ \rho \theta_{12}\tilde{Q}_{12} + (1 - \rho)\theta_{23}\tilde{Q}_{23} = \mu \theta_{13}Q_{13} + (1 - \mu)\tilde{\tau}, \]

where
• $\epsilon_i = \frac{d \ln E_i(P_i)}{d \ln P_i}$ is excess supply elasticity;

• $\alpha = \frac{P_1}{P_1 + T_{12}(Q_{12})}$ is the share of $P_1$ within $P_2$, and $(1 - \alpha) = \frac{T_{12}(Q_{12})}{P_1 + T_{12}(Q_{12})}$ is the share of transportation cost in $P_2$;

• $\beta_1 = \frac{P_1}{P_1 + T_{12}(Q_{12}) + T_{23}(Q_{23}) + \tau}$ is the share of $P_1$ in $P_3$, $\beta_2 = \frac{T_{12}(Q_{12})}{P_1 + T_{12}(Q_{12}) + T_{23}(Q_{23}) + \tau}$ and $(1 - \beta_1 - \beta_2) = \frac{T_{23}(Q_{23})}{P_1 + T_{12}(Q_{12}) + T_{23}(Q_{23}) + \tau}$ are shares of transportation costs in $P_3$;

• $\gamma = \frac{Q_{23}}{Q_{23} - Q_{12}}$ is the ratio of goods transported from Country 2 to Country 3 in excess quantity supplied of Country 2 at $P_2$;

• $\sigma = \frac{Q_{13}}{Q_{13} + Q_{12}}$ and $\delta = \frac{Q_{13}}{Q_{13} + Q_{23}}$ are shares of $Q_{13}$ in the total quantity exported from Country 1 and total quantity imported into Country 3;

• $\rho = \frac{T_{12}(Q_{12})}{T_{12}(Q_{12}) + T_{23}(Q_{23})}$ and $\mu = \frac{T_{13}(Q_{13})}{T_{13}(Q_{13}) + \tau}$ are shares of transportation costs in total trade costs of good shipped into Country 3;

• $\theta_{ij} = \frac{d \ln T_{ij}(Q_{ij})}{Q_{ij}}$ is the reciprocal of the supply elasticity of transportation.

Solving for the comparative static responses of $Q_{12}$ and $Q_{13}$ to changes in $\tau$ gives
\[
\frac{d \ln Q_{12}}{d \ln \tau} = \left[ \gamma \frac{\mu}{(1-\rho)} \frac{\theta_{13}}{\theta_{23}} - \alpha \sigma \frac{\varphi_2}{\epsilon_1} \right] \left[ (1 - \beta_1 - \beta_2) \theta_{23} \epsilon_3 + (1 - \delta) \frac{(1-\mu)}{(1-\rho)} \frac{1}{\theta_{23}} \right] \\
- \gamma \frac{\mu}{(1-\rho)} \frac{1}{\theta_{23}} \left[ \beta_1 \sigma \frac{\varphi_3}{\epsilon_1} + \delta + [\epsilon_3(1 - \beta_1 - \beta_2) \theta_{23} + (1 - \delta)] \frac{\mu}{(1-\rho)} \frac{\theta_{13}}{\theta_{23}} \right] \\
\left[ \gamma \frac{\mu}{(1-\rho)} \frac{\theta_{13}}{\theta_{23}} - \alpha \sigma \frac{\varphi_2}{\epsilon_1} \right] \left[ \epsilon_3(1 - \beta_1 - \beta_2) \theta_{23} + (1 - \delta) \right] \frac{1}{(1-\rho)} \frac{\varphi_{12}}{\theta_{23}} - \epsilon_3 \left[ \beta_1(1 - \sigma) \frac{1}{\epsilon_1} + \beta_2 \theta_{12} \right] \\
- \left[ \epsilon_2 \left( \alpha \frac{(1-\sigma)}{\epsilon_1} + (1 - \alpha) \theta_{12} \right) + \gamma \frac{\rho}{(1-\rho)} \frac{\theta_{12}}{\theta_{23}} - (1 - \gamma) \right] \left[ (1 - \beta_1 - \beta_2) \theta_{23} \epsilon_3 + (1 - \delta) \frac{(1-\mu)}{(1-\rho)} \frac{1}{\theta_{23}} \right] \\
- \gamma \frac{\mu}{(1-\rho)} \frac{1}{\theta_{23}} \left[ \epsilon_3(1 - \beta_1 - \beta_2) \theta_{23} + (1 - \delta) \right] \frac{1}{(1-\rho)} \frac{\varphi_{12}}{\theta_{23}} - \epsilon_3 \left[ \beta_1(1 - \sigma) \frac{1}{\epsilon_1} + \beta_2 \theta_{12} \right] \right] 
\]

(2.11)

\[
\frac{d \ln Q_{13}}{d \ln \tau} = \left[ \gamma \frac{\mu}{(1-\rho)} \frac{\theta_{13}}{\theta_{23}} - \alpha \sigma \frac{\varphi_2}{\epsilon_1} \right] \left[ \epsilon_3(1 - \beta_1 - \beta_2) \theta_{23} + (1 - \delta) \right] \frac{1}{(1-\rho)} \frac{\varphi_{12}}{\theta_{23}} - \epsilon_3 \left[ \beta_1(1 - \sigma) \frac{1}{\epsilon_1} + \beta_2 \theta_{12} \right] \\
- \left[ \epsilon_2 \left( \alpha \frac{(1-\sigma)}{\epsilon_1} + (1 - \alpha) \theta_{12} \right) + \gamma \frac{\rho}{(1-\rho)} \frac{\theta_{12}}{\theta_{23}} - (1 - \gamma) \right] \left[ (1 - \beta_1 - \beta_2) \theta_{23} \epsilon_3 + (1 - \delta) \frac{(1-\mu)}{(1-\rho)} \frac{1}{\theta_{23}} \right] \\
- \gamma \frac{\mu}{(1-\rho)} \frac{1}{\theta_{23}} \left[ \epsilon_3(1 - \beta_1 - \beta_2) \theta_{23} + (1 - \delta) \right] \frac{1}{(1-\rho)} \frac{\varphi_{12}}{\theta_{23}} - \epsilon_3 \left[ \beta_1(1 - \sigma) \frac{1}{\epsilon_1} + \beta_2 \theta_{12} \right] \right] \right] 
\]

(2.12)
and

\[
\frac{\mathrm{d} \ln Q_{23}}{\mathrm{d} \ln \tau} = \frac{1}{(1 - \rho) \theta_{23}} \left[ \mu \theta_{13} \frac{\mathrm{d} \ln Q_{13}}{\mathrm{d} \ln \tau} - \rho \theta_{12} \frac{\mathrm{d} \ln Q_{12}}{\mathrm{d} \ln \tau} + (1 - \mu) \right]
\]  
(2.13)

\[
\frac{\mathrm{d} \ln P_1}{\mathrm{d} \ln \tau} = \frac{\sigma}{\epsilon_1} \frac{\mathrm{d} \ln Q_{13}}{\mathrm{d} \ln \tau} + \frac{(1 - \sigma)}{\epsilon_1} \frac{\mathrm{d} \ln Q_{12}}{\mathrm{d} \ln \tau}
\]  
(2.14)

\[
\frac{\mathrm{d} \ln P_2}{\mathrm{d} \ln \tau} = \alpha \frac{\mathrm{d} \ln P_1}{\mathrm{d} \ln \tau} + (1 - \alpha) \theta_{12} \frac{\mathrm{d} \ln Q_{12}}{\mathrm{d} \ln \tau}
\]  
(2.15)

\[
\frac{\mathrm{d} \ln P_3}{\mathrm{d} \ln \tau} = \beta_1 \frac{\mathrm{d} \ln P_1}{\mathrm{d} \ln \tau} + \beta_2 \theta_{12} \frac{\mathrm{d} \ln Q_{12}}{\mathrm{d} \ln \tau} + (1 - \beta_1 - \beta_2) \theta_{23} \frac{\mathrm{d} \ln Q_{23}}{\mathrm{d} \ln \tau}.
\]  
(2.16)

It turns out that the comparative statics cannot be signed analytically. Intuition suggests that as natural responses to changes in trade policies, at least \( \frac{\mathrm{d} \ln Q_{13}}{\mathrm{d} \ln \tau} \) should be negative and \( \frac{\mathrm{d} \ln Q_{12}}{\mathrm{d} \ln \tau} \) positive; however, they both could be either positive or negative.10 Also notice that as combinations of \( \frac{\mathrm{d} \ln Q_{13}}{\mathrm{d} \ln \tau} \) and \( \frac{\mathrm{d} \ln Q_{12}}{\mathrm{d} \ln \tau} \), \( \frac{\mathrm{d} \ln P_1}{\mathrm{d} \ln \tau} \), \( \frac{\mathrm{d} \ln P_2}{\mathrm{d} \ln \tau} \), and \( \frac{\mathrm{d} \ln P_3}{\mathrm{d} \ln \tau} \) cannot be signed either.

Therefore, in this most complicated case, we end up with indeterminacy; the effects of a change in tariff on domestic prices and trade flows are not clear. In particular, an increase in \( \tau \) does not necessarily raise \( Q_{23} \), so the quantity transshipped through Country 211 does not necessarily increase12. This constitutes an impossibility result. Without further restrictions on this seemingly simple model, aggregate trade flows cannot be used to identify transshipment.

### 2.2.2 Mono-directional Trade: Three countries with two Trade Flows

If tariff \( \tau \) is so large that it becomes a prohibitive tax, i.e., \( Q_{13} = 0 \) (the trade flow between Country 1 and Country 3 is completely blocked, see Figure 2.3), it must be the case that \( T_{13}(Q_{13}) + \tau > T_{12}(Q_{12}) + T_{23}(Q_{23}) \). It is still interesting, however, to consider the effects of the tariff imposed by Country 3 under this circumstance. Suppose now Country 3 imposes a per unit tax \( \tau_2 \) on goods from Country 2. Now the system of equations becomes

\[
E_1(P_1) = Q_{12}
\]  
(2.17)

\[
E_2(P_2) = Q_{23} - Q_{12}
\]  
(2.18)

\[-E_3(P_3) = Q_{23}
\]  
(2.19)

\[
P_2 = P_1 + T_{12}(Q_{12})
\]  
(2.20)

\[
P_3 = P_1 + T_{12}(Q_{12}) + T_{23}(Q_{23}) + \tau_2.
\]  
(2.21)

---

10For example, the following parameters, \( \alpha = .9, \beta_1 = .05, \beta_2 = .9, \sigma = .5, \gamma = 1.5, \delta = .1, \mu = .9, \rho = .2, \epsilon_1 = 1, \epsilon_2 = 1, \epsilon_3 = 1, \theta_{12} = 10, \theta_{23} = 1 \) and \( \theta_{13} = .1 \), result in \( \frac{\mathrm{d} \ln Q_{13}}{\mathrm{d} \ln \tau} = 3.5065 \) and \( \frac{\mathrm{d} \ln Q_{12}}{\mathrm{d} \ln \tau} = -0.1401 \).

11Quantity transshipped by Country 2 equals \( Q_{23} - E_2(P_2) \) if \( E_2(P_2) > 0 \) (transshipping what is more than that it can produce), or \( Q_{23} + E_2(P_2) \) if \( E_2(P_2) < 0 \) (transshipping what is more than that it needs).

12Appendix A considers a special case where \( \epsilon_1 = 0 \), and the conclusions are similar.
The system can be simplified in a similar manner:

\[ E_1(P_1) = Q_{12} \quad (2.22) \]
\[ E_2(P_1 + T_{12}(Q_{12})) = Q_{23} - Q_{12} \quad (2.23) \]
\[ -E_3(P_1 + T_{12}(Q_{12}) + T_{23}(Q_{23}) + \tau_2) = Q_{23}. \quad (2.24) \]

Let \( \tilde{x} = d \ln x \), and log-differentiating yields

\[ \epsilon_1 \tilde{P}_1 = \tilde{Q}_{12} \quad (2.25) \]
\[ \epsilon_2 \left[ \alpha \tilde{P}_1 + (1 - \alpha) \theta_{12} \tilde{Q}_{12} \right] = \gamma \tilde{Q}_{23} + (1 - \gamma) \tilde{Q}_{12} \quad (2.26) \]
\[ -\epsilon_3 \left[ \beta_1 \tilde{P}_1 + \beta_2 \theta_{12} \tilde{Q}_{12} + \beta_3 \theta_{23} \tilde{Q}_{23} + (1 - \beta_1 - \beta_2 - \beta_3) \tilde{\tau} \right] = \tilde{Q}_{23}. \quad (2.27) \]
The definitions of parameters are the same as the previous scenario. Solving for comparative static responses of $Q_{12}$, $Q_{23}$, $P_1$, $P_2$ and $P_3$ to changes in $\tau_2$ gives

\[
\frac{d \ln Q_{12}}{d \ln \tau_2} = -\frac{\epsilon_3}{\epsilon_1} \cdot \frac{\gamma (1 - \beta_1 - \beta_2 - \beta_3)}{\gamma [\epsilon_3 (\beta_1 + \beta_2 \theta_{12} \epsilon_1)] + [\epsilon_2 (\alpha + (1 - \alpha) \theta_{12} \epsilon_1)] - (1 - \gamma) \epsilon_1] (\beta_3 \theta_{23} \epsilon_3 + 1)
\]

\[
\frac{d \ln Q_{23}}{d \ln \tau_2} = \frac{\gamma (1 - \beta_1 - \beta_2 - \beta_3) \epsilon_3}{\gamma [\epsilon_3 (\beta_1 + \beta_2 \theta_{12} \epsilon_1)] + [\epsilon_2 (\alpha + (1 - \alpha) \theta_{12} \epsilon_1)] - (1 - \gamma) \epsilon_1] (\beta_3 \theta_{23} \epsilon_3 + 1)}
\]

\[
\frac{d \ln P_1}{d \ln \tau_2} = \frac{\gamma (1 - \beta_1 - \beta_2 - \beta_3) \epsilon_3}{\gamma [\epsilon_3 (\beta_1 + \beta_2 \theta_{12} \epsilon_1)] + [\epsilon_2 (\alpha + (1 - \alpha) \theta_{12} \epsilon_1)] - (1 - \gamma) \epsilon_1] (\beta_3 \theta_{23} \epsilon_3 + 1)}
\]

\[
\frac{d \ln P_2}{d \ln \tau_2} = \frac{\gamma (1 - \beta_1 - \beta_2 - \beta_3) \epsilon_3}{\gamma [\epsilon_3 (\beta_1 + \beta_2 \theta_{12} \epsilon_1)] + [\epsilon_2 (\alpha + (1 - \alpha) \theta_{12} \epsilon_1)] - (1 - \gamma) \epsilon_1] (\beta_3 \theta_{23} \epsilon_3 + 1)}
\]

\[
\frac{d \ln P_3}{d \ln \tau_2} = (1 - \beta_1 - \beta_2 - \beta_3)
\]

\[
\left[-\frac{\gamma \epsilon_3 (\beta_1 + \beta_2 \theta_{12} \epsilon_1) + \beta_3 \theta_{23} \epsilon_3 [\epsilon_2 (\alpha + (1 - \alpha) \theta_{12} \epsilon_1)] - (1 - \gamma) \epsilon_1]}{\gamma \epsilon_3 (\beta_1 + \beta_2 \theta_{12} \epsilon_1) + (\beta_3 \theta_{23} \epsilon_3 + 1) [\epsilon_2 (\alpha + (1 - \alpha) \theta_{12} \epsilon_1)] - (1 - \gamma) \epsilon_1]} + 1 \right]
\]

In terms of the signs, what matters is the role of Country 2. If Country 2 transports to Country 3 more than what it imports from Country 1, i.e., $Q_{23} > Q_{12}$ and $\gamma > 1$, then $\frac{d \ln Q_{12}}{d \ln \tau_2} < 0$, $\frac{d \ln Q_{23}}{d \ln \tau_2} < 0$, $\frac{d \ln P_3}{d \ln \tau_2} < 0$, $\frac{d \ln P_2}{d \ln \tau_2} < 0$ and $\frac{d \ln P_3}{d \ln \tau_2} > 0$. In this case, an increase in tariff unambiguously increases domestic price in the importing country (Country 3), and pushes down the domestic prices in Country 1 and Country 2 so that extra quantities can be absorbed; at the same time, trade flows ($Q_{12}$ and $Q_{23}$) shrink because of the increase in trade costs.

In the case where Country 2 has a positive excess demand, i.e., $Q_{23} < Q_{12}$ and $\gamma < 0$, the system suffers from indeterminacy again. The comparative static effects cannot be signed in general. $Q_{12}$, for example, could be either positive or negative, depending on the choice of parameters

\[\text{13}\]

\[\text{2.2.3 Bilateral Trade: Two Countries with One Trade Flow}\]

If the increase in tariff $\tau_2$ is large enough to make $P_2 + \tau_2 > P_3$, then the trade flow $Q_{23}$ will be blocked, i.e., $Q_{23} = 0$. Now the system reduces to a two country model (Figure 2.4). If $\tau_2$ is large enough so that $P_2 + T_{23}(Q_{23}) + \tau_2 > P_3$, then $Q_{23} = 0$. Now $Q_{12}$ is the only surviving trade flow. Suppose Country 2 imposes tariff $\tau_1$ on honey from Country 1. The system can be characterized by

\[\text{13}\] For example, the following parameters, $\alpha = .5$, $\beta_1 = .25$, $\beta_2 = .25$, $\beta_3 = .25$, $\gamma = -2$, $\epsilon_1 = 1$, $\epsilon_2 = 10$, $\epsilon_3 = 1$, $\theta_{12} = 10$, $\theta_{23} = 1$ and $\theta_{13} = 1$, result in $\frac{d \ln Q_{12}}{d \ln \tau_2} = 0.0645$. 

29
Figure 2.4: Two Countries with One Trade Flows

\[ E_1(P_1) = Q_{12} \]  
\[ -E_2(P_2) = Q_{12} \]  
\[ P_2 = P_1 + T_{12}(Q_{12}) + \tau_1 \]

Solving for comparative statics gives:

\[ \frac{d \ln Q_{12}}{d \ln \tau_1} = -\frac{1 - \alpha_1 - \alpha_2}{\frac{1}{\epsilon_2} + \frac{\alpha_1}{\tau_1} + \alpha_2 \theta_{12}} < 0 \]  
\[ \frac{d \ln P_1}{d \ln \tau_1} = -\frac{1}{\epsilon_1} \cdot \frac{1 - \alpha_1 - \alpha_2}{\frac{1}{\epsilon_2} + \frac{\alpha_1}{\tau_1} + \alpha_2 \theta_{12}} < 0 \]  
\[ \frac{d \ln P_2}{d \ln \tau_1} = \frac{1}{\epsilon_2} \cdot \frac{1 - \alpha_1 - \alpha_2}{\frac{1}{\epsilon_2} + \frac{\alpha_1}{\tau_1} + \alpha_2 \theta_{12}} > 0 \]

The result of this textbook-style model unambiguously shows that increase in tariff in a two-country world will push up the price in importing country, pushing down the price in exporting country and decrease the trade flow.\(^{14}\)

2.3 Conclusion

A three-country trade model with transshipment is developed in this chapter. It is demonstrated by the results of comparative statics that an increase in trade cost (e.g., tariff) may or may not have significant effects in a three-country world with triangle trade flows. Therefore, it is not obvious under this circumstance that changes in trade policy may encourage or discourage transshipment. In the three-country scenario with mono-directional trade flows, it is clear that

\(^{14}\) A simpler two-country model with constant transportation cost is presented in Appendix A.
under the circumstance of the transshipper having a positive excess supply, an increase in tariff discourages transshipment and impacts prices and trade flows unambiguously; but there is generally no definite conclusion for the other case in which the transshipper has a positive excess demand.

The model developed in this chapter seems to be the simplest framework that allows for the necessary complexity for the problem of interests. Future work may include production (e.g., Thompson [2015]), allow for differentiated goods, and conceptually derive the welfare effects of trade restrictions and the suspected transshipment issue associated with it. Empirical analysis on transportation may also be incorporated (e.g., Engel and Rogers [1996]) in order to better understand the mechanism of transportation costs and transshipment.
Chapter 3

Migratory Beekeeping and Pollination Services in China

3.1 Introduction

Beekeepers supply not only honey but also pollination services and the market for pollination services is important for migratory beekeeping, at least in North America. Cheung [1973] pointed out that well functioning markets for pollination services were observed in the state of Washington and that the blackboard economics stories about farmers and beekeepers not transacting because of “reciprocal externalities” is fictional. In fact, it appears that colonies of honey bees were first rented for pollination in 1910 for apples in the United States (Stricker [1971]). Today, the market for honey bee pollination services in the United States is extensive. Every year U.S. beekeepers transport bees thousands of miles around the country providing pollination services to crop growers who require these services. Rucker et al. [2012] extended and updated Cheung’s analysis by developing a conceptual model of the market for pollination services and analyzing the determinants of pollination fees. The theoretical and empirical results provide insights into understanding the internalization of externalities provided by pollination markets.

Although the United States has a well developed and liquid market for pollination services, this appears not to be the case in other parts of the world. Among these areas is China, which makes Chinese beekeeping an interesting case study in the development of such markets. Beekeepers in China also migrate and thus can also be characterized by the term “migratory beekeeping,” as in the United States. However, migration in China focuses primarily on honey and is not necessarily associated with pollination services. Bee-hive-renting pollination, in par-
ticular, is rare\(^1\) in China and human pollination\(^2\) by hand is still important in some areas.

Human pollination is labor intensive as pollen is transferred from flower to flower by workers on ladders with paint brushes. A natural reason for hand pollination is low labor costs, but labor costs in China have increased dramatically in recent years. Hourly compensation costs in China’s manufacturing sector nearly tripled between 2002 and 2009, calculated on a U.S. dollar basis.\(^3\) Analyzing the trade-off between bee and human pollination should provide a case study of the substitution between factors of production against a backdrop of changing factor prices.

The current paper characterizes the travel patterns of Chinese beekeepers and sheds lights on the general issue of human and bee pollination in order to understand the institutional details of the market for pollination services in China. The study is mainly and necessarily qualitative because data on pollination services have not been systematically collected in China. Information and data utilized in this paper are from previous literature and from a series of interviews with Chinese beekeepers carried out by the author in the summers of 2014 and 2015. Details about data sources are available in the Appendix. The study comes to a qualitative understanding of the transaction costs involved in contracting for pollination services in China, with particular attention paid to the socio-economic factors that promote and discourage migratory beekeeping and pollination services, and comes to a similar understanding of the substitution between human and bee pollination for specific crops, as well as substitution between pollinator-dependent and less-pollinator-dependent crops in farmers’ land allocation decisions.

A Brief History of Apiculture in China

China has a long history of interactions between human and bees\(^4\). Honey hunting and beekeeping have been practiced in China since three thousand years ago (Chen [1993b]). The earliest record of the Chinese character “bee” 蜂 appeared in Classic of Poetry\(^5\) in the 11th century BC (Qiao and Huang [1993]). Techniques and theories about beekeeping have been developed since the Eastern Han Dynasty (25-220 AD). There is an abundant ancient literature documenting

---

1. According to Dr. Ya Tang, Department of Environment, Sichuan University, Chengdu, China
2. Hand pollination exists in areas other than China as well. For example, vanilla planifolia can be pollinated by hand (Brodelius [1994]). The method was introduced in 1841 by a slave named Edmond Albius on Réunion Island (previously Bourbon Island, an insular region of France located in the Indian Ocean) and is still in use today (Vanilla [2011]).
4. Asiatic honey bees, sometimes called Chinese honey bees (Apis cerana cerana Fabricius), have been kept and managed as the only main species before the introduction of foreign bees. Other bee species in China include Northeast Black Bee 东北黑蜂, Xinjiang Black Bee 新疆黑蜂, giant honey bee (Apis dorsata Fabricius), Himalayan honey bee (Apis laboriosa Smith), dwarf honey bee (Apis florea Fabricius) and black dwarf honey bee (Apis andreniformis Smith).
5. Classic of Poetry, Eulogies of Zhou, Xiao Bi, “I will have nothing to do with a wasp, to seek for myself a painful sting.” Translated by Legge [1871] (《詩經 • 周頌 • 小毖》:“莫予齊臻，自求辛螫。”)
the history and achievements of apiculture in ancient China.

Modern beekeeping in China can be said to have started in 1912 when the first five colonies of Italian bees (Apis mellifera linguistica Spin) were introduced by a diplomat GONG Huaixi (龚怀西) from the United States and related management techniques began to be used. Italian bees became the dominant commercial race after several decades. It should be noted that Italian honey bees are the dominant strain of bees managed in the United States. Beekeeping education and research began to emerge, and a number of journals and books on beekeeping were published. Many apiaries, however, suffered a setback in the beekeeping business during the 1930s due to limited availability of nectar sources and bee diseases. The government thus carried out beekeeping promoting polices⁶, which turned out to be fairly effective, in response to the negative changes. But the beekeeping industry experienced another period of decline during the Second World War and Chinese Civil War (late 1930s through late 1940s).

In 1949, there were approximately 500 thousand colonies in all of China, with 100 thousand being Italian bees and 400 thousand Chinese bees (Apis cerana); 8,000 metric tons of honey were produced. Apiculture has expanded considerably since the 1950s. It was estimated that in 1959 there were 2 million colonies in China, nearly quadruple the number in 1949 (Chen [1993b]). But the beekeeping industry experienced fluctuation and stagnation during 1960-70s due to multiple contemporary socio-economic factors. From 1978, after the Post-Mao Economic Reform⁷, apiculture underwent a rapid expansion (Table 3.1).

Data Collection Procedure

The primary data in this study are from the author’s interviews with individual beekeepers and bee and pollination experts. There is little published literature on the experiences of individual migratory beekeepers in China. Therefore, the author talked with thirteen beekeepers from various parts of China at Shijiazhuang in the summers of 2014 and 2015⁸ and the current paper has details about ten of them⁹. Experts visited by the author are from Hebei Academy of Agricultural and Forestry and the Institute of Apicultural Research in the Chinese Academy of Agricultural Sciences. Secondary data sources include published books, journal articles and news.

⁶For example, the government issued Provisional Rules on Examination of Farm Products Pests (《检验农产物病虫害暂行办法》), Rules on Administration of Honey Bee Breeding (《蜂种制造取缔规则》), Rule on Registration of Apiary (《养蜂场登记规则》) and Rules on Examination of Imported Honey Bees (《蜜蜂进口检验规程》). Policies on tax reduction and transportation cost reduction for migratory beekeeping were also noticeable.

⁷Officially called “Reform and Opening Up.”

⁸A complete list of beekeepers and the questions asked are available in Appendix B. Each interview took about thirty to sixty minutes.

⁹Among the remaining three beekeepers, two have similar experiences with some of the ten beekeepers and one is a country doctor who should not be identified as a professional beekeeper.
Table 3.1: Number of Bee Hives and Honey Production in China, Source: Chen [1993b] (1949-1990) and FAOSTAT (1991-2013)

<table>
<thead>
<tr>
<th>Year</th>
<th>Bee Hives</th>
<th>Honey Production (metric tons)</th>
<th>Honey per hive (KG)</th>
<th>Year</th>
<th>Bee Hives</th>
<th>Honey Production (metric tons)</th>
<th>Honey per hive (KG)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1949</td>
<td>500,000</td>
<td>8,000</td>
<td>16.00</td>
<td>1981</td>
<td>6,335,000</td>
<td>110,400</td>
<td>17.43</td>
</tr>
<tr>
<td>1950</td>
<td>N.A.</td>
<td>N.A.</td>
<td>N.A.</td>
<td>1982</td>
<td>6,875,000</td>
<td>136,000</td>
<td>19.78</td>
</tr>
<tr>
<td>1951</td>
<td>N.A.</td>
<td>N.A.</td>
<td>N.A.</td>
<td>1983</td>
<td>6,561,000</td>
<td>143,300</td>
<td>21.84</td>
</tr>
<tr>
<td>1952</td>
<td>N.A.</td>
<td>N.A.</td>
<td>N.A.</td>
<td>1984</td>
<td>6,826,000</td>
<td>148,000</td>
<td>21.68</td>
</tr>
<tr>
<td>1953</td>
<td>N.A.</td>
<td>N.A.</td>
<td>N.A.</td>
<td>1985</td>
<td>6,674,000</td>
<td>155,000</td>
<td>23.22</td>
</tr>
<tr>
<td>1954</td>
<td>N.A.</td>
<td>N.A.</td>
<td>N.A.</td>
<td>1986</td>
<td>6,646,000</td>
<td>172,000</td>
<td>25.88</td>
</tr>
<tr>
<td>1955</td>
<td>N.A.</td>
<td>N.A.</td>
<td>N.A.</td>
<td>1987</td>
<td>7,597,000</td>
<td>204,000</td>
<td>26.85</td>
</tr>
<tr>
<td>1956</td>
<td>1,350,000</td>
<td>8,300</td>
<td>6.15</td>
<td>1988</td>
<td>7,690,000</td>
<td>195,000</td>
<td>25.36</td>
</tr>
<tr>
<td>1957</td>
<td>1,500,000</td>
<td>9,400</td>
<td>6.27</td>
<td>1989</td>
<td>7,355,000</td>
<td>189,000</td>
<td>25.70</td>
</tr>
<tr>
<td>1958</td>
<td>N.A.</td>
<td>12,300</td>
<td>N.A.</td>
<td>1990</td>
<td>7,645,000</td>
<td>193,000</td>
<td>25.25</td>
</tr>
<tr>
<td>1959</td>
<td>N.A.</td>
<td>12,500</td>
<td>N.A.</td>
<td>1991</td>
<td>7,786,087</td>
<td>212,938</td>
<td>27.35</td>
</tr>
<tr>
<td>1960</td>
<td>N.A.</td>
<td>8,900</td>
<td>N.A.</td>
<td>1992</td>
<td>7,700,420</td>
<td>183,175</td>
<td>23.79</td>
</tr>
<tr>
<td>1961</td>
<td>3,302,000</td>
<td>6,300</td>
<td>1.91</td>
<td>1993</td>
<td>7,176,170</td>
<td>180,895</td>
<td>25.21</td>
</tr>
<tr>
<td>1962</td>
<td>3,152,000</td>
<td>7,300</td>
<td>2.32</td>
<td>1994</td>
<td>6,583,250</td>
<td>181,172</td>
<td>27.52</td>
</tr>
<tr>
<td>1963</td>
<td>3,364,000</td>
<td>16,100</td>
<td>4.79</td>
<td>1995</td>
<td>6,431,375</td>
<td>182,090</td>
<td>28.31</td>
</tr>
<tr>
<td>1964</td>
<td>3,400,000</td>
<td>20,500</td>
<td>6.03</td>
<td>1996</td>
<td>6,390,434</td>
<td>188,791</td>
<td>29.54</td>
</tr>
<tr>
<td>1965</td>
<td>3,500,000</td>
<td>30,500</td>
<td>8.71</td>
<td>1997</td>
<td>6,924,345</td>
<td>215,138</td>
<td>31.07</td>
</tr>
<tr>
<td>1967</td>
<td>N.A.</td>
<td>42,500</td>
<td>N.A.</td>
<td>1999</td>
<td>7,202,550</td>
<td>236,283</td>
<td>32.81</td>
</tr>
<tr>
<td>1968</td>
<td>N.A.</td>
<td>40,000</td>
<td>N.A.</td>
<td>2000</td>
<td>7,494,970</td>
<td>251,839</td>
<td>33.60</td>
</tr>
<tr>
<td>1969</td>
<td>N.A.</td>
<td>34,000</td>
<td>N.A.</td>
<td>2001</td>
<td>7,598,410</td>
<td>254,359</td>
<td>33.48</td>
</tr>
<tr>
<td>1970</td>
<td>N.A.</td>
<td>37,000</td>
<td>N.A.</td>
<td>2002</td>
<td>7,699,630</td>
<td>267,830</td>
<td>34.78</td>
</tr>
<tr>
<td>1972</td>
<td>4,000,000</td>
<td>50,200</td>
<td>12.55</td>
<td>2004</td>
<td>8,101,530</td>
<td>297,987</td>
<td>36.78</td>
</tr>
<tr>
<td>1973</td>
<td>4,069,000</td>
<td>49,200</td>
<td>12.09</td>
<td>2005</td>
<td>8,338,930</td>
<td>299,527</td>
<td>35.92</td>
</tr>
<tr>
<td>1974</td>
<td>4,330,000</td>
<td>49,600</td>
<td>11.45</td>
<td>2006</td>
<td>8,480,750</td>
<td>337,578</td>
<td>39.81</td>
</tr>
<tr>
<td>1975</td>
<td>4,120,000</td>
<td>57,900</td>
<td>14.05</td>
<td>2007</td>
<td>8,573,050</td>
<td>357,220</td>
<td>41.67</td>
</tr>
<tr>
<td>1976</td>
<td>3,927,000</td>
<td>52,400</td>
<td>13.34</td>
<td>2008</td>
<td>8,771,200</td>
<td>407,219</td>
<td>46.43</td>
</tr>
<tr>
<td>1977</td>
<td>3,871,000</td>
<td>67,000</td>
<td>17.31</td>
<td>2009</td>
<td>8,827,150</td>
<td>407,367</td>
<td>46.15</td>
</tr>
<tr>
<td>1978</td>
<td>3,891,000</td>
<td>97,100</td>
<td>24.96</td>
<td>2010</td>
<td>8,897,730</td>
<td>409,149</td>
<td>45.98</td>
</tr>
<tr>
<td>1979</td>
<td>5,298,000</td>
<td>109,900</td>
<td>20.74</td>
<td>2011</td>
<td>8,953,870</td>
<td>446,089</td>
<td>49.82</td>
</tr>
<tr>
<td>1980</td>
<td>5,888,000</td>
<td>96,300</td>
<td>16.36</td>
<td>2012</td>
<td>8,987,204</td>
<td>462,203</td>
<td>51.43</td>
</tr>
<tr>
<td>2013</td>
<td>9,020,000</td>
<td>466,300</td>
<td>51.70</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
A number of examples of migratory beekeeping and pollination services in China are presented here. Agricultural activities, especially beekeeping and pollination, are local by nature. Therefore, the paper does not claim that these examples are representative on a national scale, nor are examples of each province representative on a provincial scale. They are, however, illustrative and useful in understanding the practice of migratory beekeeping and pollination services carried out by Chinese beekeepers. Conclusions from these examples should be generalized with caution.

### 3.2 Migratory Beekeeping

Migratory beekeeping\(^{10}\) in China has emerged since the 1920s. In 1922, seven ships of the Huayizhi Beekeeping Company transported beehives along the Yangtze River, and each colony produced 50 kg of honey every year\(^{11}\). Honey bees were transported mainly by trains from the 1950s through the 1980s. During that period, migratory beekeeping was discouraged due to the limited mode of transportation and restrictive policies (Ministry of Agriculture [1963]). From the late 1980s, due to increasing availability of trucks and improvement in road conditions\(^{12}\), migratory beekeeping began to be practiced extensively (Chen [1993a]). Chen [1993a] summarizes four main routes for long distance migratory beekeeping (Figure 3.1 and Figure 3.2). The following examples of migratory beekeeping are from interviews with beekeepers conducted by the author in Shijiazhuang, Hebei.

#### Interviews with Migratory Beekeepers

A thirty-year-old\(^{13}\) beekeeper, Informant **WJS**\(^{14}\), from Xiangfan, Hubei Province, started in the beekeeping business in 2007. Beekeeping is a family tradition for him – his father and both his paternal and maternal grandfathers are beekeepers. When the author was talking with him, his father was in Baoduzhai Mountain (in Shijiazhuang City, Hebei Province). He has more than 40 hives of Italian bees and most of them are 13-honeycomb hives (5 honeycombs on the upper level and 7 or 8 honeycombs on the lower level of each hive). His father has about 50 hives.

---

\(^{10}\)In terms of Chinese beekeeping terminology, long-distance travels are called *da zhuandi* (大转地, literally “big” “to move” “places”) by beekeepers. If they travel a shorter distance, usually within a province, that’s called *xiao zhuandi* (小转地, literally “small” “to move” “places”).

\(^{11}\)This appears to be the earliest record of migratory beekeeping in China.

\(^{12}\)The expressway network of China has experienced huge growth since 1980s. At the end of 2014, there were 112,000 kilometers expressway in China and the mileage was expected to become 123,000 km at the end of 2015 (People.cn [2015]).

\(^{13}\)In China, it is not a taboo to ask a person’s age.

\(^{14}\)Interviewed June 4, 2015.
Figure 3.1: East, Middle and West

Figure 3.2: South
### Table 3.2: WJS’s Travel

<table>
<thead>
<tr>
<th>Time</th>
<th>Location</th>
<th>Nectar Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apr 15-20</td>
<td>Xindu, Chengdu, Sichuan.</td>
<td>rapeseed and loquat flowers.</td>
</tr>
<tr>
<td>Apr 20 – June</td>
<td>Shijiazhuang, Hebei</td>
<td>locust tree</td>
</tr>
<tr>
<td>After June 20</td>
<td>North East of China</td>
<td>Tilia</td>
</tr>
<tr>
<td>After Late Oct.</td>
<td>Dali, Yunnan; Kunming, Yunnan</td>
<td>rapeseed</td>
</tr>
<tr>
<td>Before Spring Festival</td>
<td>Panzhihua, Sichuan</td>
<td>rapeseed</td>
</tr>
<tr>
<td>(Always in late Jan. or Feb)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spring Festival</td>
<td>Back home: Xiangfan, Hubei</td>
<td>Have a rest</td>
</tr>
<tr>
<td>After Spring Festival</td>
<td>Yunnan or Sichuan</td>
<td>rapeseed</td>
</tr>
</tbody>
</table>

Figure 3.3: WJS’s Travel Pattern
Table 3.3: Rapeseed in China: Area Harvested, Hectare. Source: FAOSTAT

<table>
<thead>
<tr>
<th>Year</th>
<th>Area</th>
<th>Year</th>
<th>Area</th>
<th>Year</th>
<th>Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>1961</td>
<td>1,466,000</td>
<td>1981</td>
<td>3,797,000</td>
<td>2001</td>
<td>7,094,770</td>
</tr>
<tr>
<td>1962</td>
<td>1,360,000</td>
<td>1982</td>
<td>4,118,000</td>
<td>2002</td>
<td>7,143,300</td>
</tr>
<tr>
<td>1963</td>
<td>1,442,000</td>
<td>1983</td>
<td>3,665,700</td>
<td>2003</td>
<td>7,221,000</td>
</tr>
<tr>
<td>1964</td>
<td>1,788,000</td>
<td>1984</td>
<td>3,413,000</td>
<td>2004</td>
<td>7,271,600</td>
</tr>
<tr>
<td>1965</td>
<td>1,822,100</td>
<td>1985</td>
<td>4,494,000</td>
<td>2005</td>
<td>7,278,500</td>
</tr>
<tr>
<td>1966</td>
<td>1,746,000</td>
<td>1986</td>
<td>4,916,000</td>
<td>2006</td>
<td>5,984,000</td>
</tr>
<tr>
<td>1967</td>
<td>1,663,000</td>
<td>1987</td>
<td>5,267,400</td>
<td>2007</td>
<td>5,642,200</td>
</tr>
<tr>
<td>1968</td>
<td>1,403,000</td>
<td>1988</td>
<td>4,936,000</td>
<td>2008</td>
<td>6,593,600</td>
</tr>
<tr>
<td>1969</td>
<td>1,426,000</td>
<td>1989</td>
<td>4,992,730</td>
<td>2009</td>
<td>7,278,000</td>
</tr>
<tr>
<td>1970</td>
<td>1,452,000</td>
<td>1990</td>
<td>5,503,467</td>
<td>2010</td>
<td>7,370,000</td>
</tr>
<tr>
<td>1971</td>
<td>1,614,000</td>
<td>1991</td>
<td>6,133,133</td>
<td>2011</td>
<td>7,347,400</td>
</tr>
<tr>
<td>1972</td>
<td>1,965,000</td>
<td>1992</td>
<td>5,975,800</td>
<td>2012</td>
<td>7,431,860</td>
</tr>
<tr>
<td>1973</td>
<td>2,094,000</td>
<td>1993</td>
<td>5,300,000</td>
<td>2013</td>
<td>7,519,420</td>
</tr>
<tr>
<td>1974</td>
<td>2,061,000</td>
<td>1994</td>
<td>5,783,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1975</td>
<td>2,311,000</td>
<td>1995</td>
<td>6,907,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1976</td>
<td>2,344,000</td>
<td>1996</td>
<td>6,733,750</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1977</td>
<td>2,215,000</td>
<td>1997</td>
<td>6,475,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1978</td>
<td>2,597,000</td>
<td>1998</td>
<td>6,527,030</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1979</td>
<td>2,758,000</td>
<td>1999</td>
<td>6,899,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1980</td>
<td>2,841,000</td>
<td>2000</td>
<td>7,494,360</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The travel pattern of WJS is summarized in Table 3.2 and Figure 3.3. In mid April, he collects honey from rapeseed (*Brassica Campestris L.*) flowers in Xindu District, Chengdu City, Sichuan Province. As a nectar plant, rapeseed (Table 3.3) has been most extensively grown across twenty five provinces in China (Chen [1993a]). Sichuan is one of the provinces with the largest area of rapeseed (981100 hectares in 2013). He also collects honey from loquat (*Eriobotrya japonica*) flowers though the quantity was less than rapeseed honey. The main purpose in Sichuan, as he reported, was spring bee reproduction.\textsuperscript{15}

From late April through late June, he stays at Shijiazhuang City, Hebei Province. For WJS, the main nectar source is the locust tree (*Robinia pseudoacacia L.*). He reported that on average he can produce more than 1000 *jin* (1.1 pounds) of locust tree honey each year. Yields of honey in Hebei depend largely on the weather conditions. He then travels to the Northeast of China (Heilongjiang Province in particular, for most years) after June 20th to produce honey from the nectar of linden trees (*Tilia L.*). After spending nearly four months there, he goes to Dali.

\textsuperscript{15} The spring reproduction (春繁) refers to the period of “revival and development of a colony after living through the winter.” (Chen [1993a])
City, Yunnan Province (in the Southwest) in late October\textsuperscript{16} for rapeseed. He always returns to Sichuan Province again, in a different city (Panzhihua) though, before Spring Festival (usually February). He then comes home in Hubei for the Spring Festival and back to Sichuan shortly after that.

Jiangshan’s travel pattern (Southwest-Northest) seems typical for beekeepers from Central China. In Shijiazhuang, Hebei, the author met several beekeepers from Kaifeng City, Henan Province, including YHC, ZSL, WC, LM and LXC. Except for LXC, They travel a similar route as does WJS, though sometimes there are notable variations in locations and nectar sources.

Informant YHC\textsuperscript{17} is forty-nine years old. He has been keeping honey bees for more than twenty years. His family also has a long history of beekeeping because he “isn’t sure about how many generations we were keeping bees.” As far as he knows, his maternal grandfather started beekeeping sometime before 1949. His knowledge of beekeeping, however, comes from self-education and beekeeper’s mutual education instead of his family.

YHC and his wife keep 180 hives of Italian bees and several hives of Chinese bees (\textit{Apis cerana}). Unlike WJS, he departed from Kaifeng, his hometown, around November 20, 2014. The first stop of their trip, during late November, was Eshan County, Yuxi City, Yunnan Province. Around Jan 1 2015, they went to Luoping County, still in Yunnan, and stayed there until early March. Then “it’s a bit of a gamble,” as he said, because they could choose between Hunan, Sichuan and Hubei; and finally they decided to go to Xiaogan City in Hubei Province. During the four months in Yunan and Hubei, the nectar source was mainly rapeseeds.

They returned to Henan on April 3, but in a different city (Xinzheng). Nectar sources there include paulowniaceae (\textit{Paulownia Siebold & Zuccarini, Fl}) and locust tree (\textit{Robinia pseudoacacia L.}). Shortly after that, on April 27, they arrived at Laoshan City in Shandong Province and collected honey from locust trees.

\begin{table}[h]
\centering
\begin{tabular}{|l|c|c|c|}
\hline
Flowers & Quantity (\textit{jin}) & Whole sale Price (\textit{yuan} / \textit{jin}) & Retail Price (\textit{yuan} / \textit{jin}) \\
\hline
rapeseed & More than 1000 & 5 or 6 & 12 \\
loquat flowers & More than 500 & 17 or 18 & 25 \\
locust tree & More than 1000 & 11 & 18 or 20 \\
Tilia & More than 1000 & 17-18 & 25 \\
\hline
\end{tabular}
\caption{Quantities and Prices Reported by WJS}
\end{table}

\textsuperscript{16}In Yunnan Province, there are two types of rapeseed. The local rapeseed in southern Yunnan blooms in November, and the Shengli rapeseed (\textit{磕利油菜}, imported from Japan during Second World War, according to Rape Data Center) blooms between late January and early March.

\textsuperscript{17}Interviewed June 11, 2015.
Figure 3.4: YHC’s Travel Pattern
Table 3.5: YHC: Travel

<table>
<thead>
<tr>
<th>Time</th>
<th>Location</th>
<th>Flowers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Around Nov 20</td>
<td>Departing from Kaifeng, Henan</td>
<td>NA</td>
</tr>
<tr>
<td>Late Nov.</td>
<td>Yuxi and Eshan, Yunnan</td>
<td>Rapeseed</td>
</tr>
<tr>
<td>Around Jan 1</td>
<td>Luoping, Yunnan</td>
<td>Rapeseed</td>
</tr>
<tr>
<td>Early March</td>
<td>Xiaogan, Hubei (in different years, Hunan and Sichuan are possible options)</td>
<td>Rapeseed</td>
</tr>
<tr>
<td>April 3</td>
<td>Xinzeng, Henan</td>
<td>Paulowniaceae (Paulownia Siebold &amp; Zuccarini, Fl.) and locust tree</td>
</tr>
<tr>
<td>April 27</td>
<td>Laoshan, Shandong</td>
<td>locust tree</td>
</tr>
<tr>
<td>May 25</td>
<td>Longquansi, Shijiazhuang, Hebei</td>
<td>heterophyllous negundo (Vitex negundo var. cannabifolia L.) and jujube</td>
</tr>
<tr>
<td>Mid-or late-June</td>
<td>Jiamusi, Heilongjiang</td>
<td>Tilia and chestnut (Castanea mollissima), white melon</td>
</tr>
<tr>
<td>Oct.</td>
<td>Kaifeng, Henan</td>
<td>Home</td>
</tr>
</tbody>
</table>

They had been at Longquan Temple at Shijiazhuang, Hebei (where Hongchao talked with the author) since May 25. The nectar sources included heterophyllous negundo (*Vitex negundo var. cannabifolia L.*) and jujube. In mid- or late-June, they planned to go northeast to Jiamusi City in Heilongjiang Province for tilia tree and chestnut (*Castanea mollissima*). The final stop would be Kaifeng, Henan in October.

Hongchao also mentioned several different routes chosen by his friends in various years. The west route, as he reported, starts from Yunnan, going through Sichuan and Gansu, and arrives at Xinjiang. The middle goes through Yunnan, Sichuan, Shaanxi and Inner Mongolia.

Mr. ZSL has two hundred hives of Italian bees; fifty hives are in Shijiazhuang City and 150 hives in Luquan (a district of Shijiazhuang). He has one hive of Chinese bees. ZSL is relatively unique among the beekeepers visited by the author. He had been a civil servant in local government, but tired of government intrigue and attracted by the higher level of income from beekeeping, he became a beekeeper sixteen years ago. He is now enjoying the “freedom” of beekeeping, as well as his reported annual net income of 300,000 yuan.

---

18 *Ziziphus jujuba*. It is deciduous shrubs or small trees up to 10 meters tall. The mature fruits are called *dazao* or *zao* in Mandarin Chinese. In English, jujube may also be translated as *Chinese date*.

19 Interviewed June 10, 2015.

20 The author thinks that his estimation of net annual income was not reliable, since it is almost impossible.
Table 3.6: ZSL: Travel

<table>
<thead>
<tr>
<th>Time</th>
<th>Location</th>
<th>Flowers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dec 20</td>
<td>Yuxi and Eshan, Yunnan</td>
<td>Rapeseed</td>
</tr>
<tr>
<td>Feb 20</td>
<td>Pixian, Sichuan</td>
<td>Rapeseed</td>
</tr>
<tr>
<td>March 20</td>
<td>Zhaoxian, Hebei</td>
<td>Pear pollen</td>
</tr>
<tr>
<td>Early June</td>
<td>Shijiazhuang</td>
<td>Heterophyllous negundo and locust tree</td>
</tr>
<tr>
<td>Jun 11</td>
<td>Baoding, Hebei</td>
<td>Sunflower</td>
</tr>
<tr>
<td>July 20</td>
<td>Jiamusi, Heilongjiang</td>
<td>Tilia</td>
</tr>
<tr>
<td>Oct.</td>
<td>Kaifeng, Henan</td>
<td>Home</td>
</tr>
</tbody>
</table>

Figure 3.5: ZSL’s Travel Pattern

Figure 3.6: LM’s Travel Pattern
ZSL’s trip (Table 3.6 and Figure 3.5) started at Yuxi City and Eshan City in Yunnan Province around Dec 20 2014\textsuperscript{21}. One month after Chinese New Year’s Day, on February 20, 2015, he entered Sichuan Province, at Pixian County. Rapeseed was the main nectar source in Sichuan and Yunnan. On Mar 20 he arrived at Zhaoxian County (40 km southeast of Shijiazhuang), Hebei Province. Zhaoxian is famous for its snowflake pears, and pear pollen was the main purpose of Songliang’s visit. He collected pear pollen\textsuperscript{22} and sold it for 300-400 yuan/jin. In early June, he went to Shijiazhuang for nectar from Heterophyllous negundo and locust trees. When the author was talking to him (Jun 10), he was preparing for his trip to Baoding City, about 150 km north of Shijiazhuang. He planned to spend twenty to thirty days producing honey from sunflowers, and head northeast to Jiamusi City in Heilongjiang Province (1700 km from Baoding) for honey from tilia trees in mid-July. He would return to Kaifeng, Henan during October or November.

Mr. LM\textsuperscript{23} is fifty years old and has fourteen years of beekeeping experience. He acquired beekeeping knowledge from self-education, “learning by doing,” as he said. He travels along with other beekeepers (most of them are his relatives) from several different apiaries in a group of about twenty. He has fifty hives of Italian bees at Shijiazhuang and one hundred and seventy managed by his brothers in Luquan (a district of Shijiazhuang) at the same time. In recent years, LM has always migrated between Sichuan and Hebei (Figure3.6). For example, on Mar 10 2015, he left Sichuan and arrived at Shijiazhuang, Hebei on Mar 18. He would migrate to Sichuan again in Sep or Oct. Therefore, he roughly has a “half year in Sichuan and half year in Hebei” travel pattern, except that he comes back to Kaifeng, Henan during Spring Festival. Nectar sources are similar to the beekeepers mentioned above – Rapeseeds in Sichuan and locust tree, jujube, sunflower and heterophyllous negundo in Hebei. Of course, some \textit{xiao zhuandi}’s (short-distance migrations) would take place in both Sichuan and Hebei, which he was not able to summarize because they depend on weather conditions and nectar availabilities.

Informant WC’s\textsuperscript{24} migration is generally consistent with the ones mentioned above but slants more to the east (Figure 3.7). WC is twenty five years old and has had experience keeping bees for six years. Along with him are his father, who is also a beekeeper with more than twenty years’ experience, his wife and a toddler. They have eighty hives of Italian bees at Shijiazhuang and more than one hundred hives at Pingshan (a county under the administration for a beekeeper with 200 hives of bees to earn 300,000 yuan per year. One possible explanation could be that he was not clear about the distinction between gross and net income and was actually reporting the gross income.

\textsuperscript{21}Songliang referred to lunisolar calendar frequently when reporting his travelling experience, and those dates in lunisolar calendar are translated into Gregorian calendar in the current paper. See Aslaksen [2010].

\textsuperscript{22}Pollen is a commercial product and food (protein) for bees. It turns into lumps after being collected and processed by honey bees. Pollen containers are installed “at the entrances or bottoms of the hives for collecting bee pollens.” (Chen [1993a])

\textsuperscript{23}Interviewed June 10, 2015.

\textsuperscript{24}Interviewed June 12, 2015.
of the Shijiazhuang City) managed by his father. The family departed from Kaifeng, Henan in mid-October of 2014 and later arrived at a site near Chengdu, Sichuan. They spent nearly half the year there for rapeseed and, sometimes, loquat honey. In late April, they headed east to Suzhou City, Jiangsu Province mainly for rapeseed honey. In mid May, they got to Shijiazhuang, Hebei, where the author met them. Their next destination, with the expected arrival being June 25, would be Tongliao City in Inner Mongolia. In late July or early August, they would migrate to the Changbai Mountains in Jinlin Province in Northeast China. Nectar sources are similar to those reported by beekeepers mentioned above.

Informant LXC\textsuperscript{25} is forty-three years old. LXC is also from Kaifeng, Henan, but he apprenticed himself to a senior beekeeper in Northeast China and started his beekeeping business fifteen years ago. Now he has one hundred and twenty hives of Italian bees, with eleven or twelve combs in each. LXC, however, usually migrates to sites in the east (Figure 3.8). Instead of Yunnan or Sichuan, he chooses Zhejiang, an eastern coastal province of China, for the spring reproduction. He arrives at Zhejiang During September or October and stays there until April of the next year. At the end of April he goes to Jiangsu Province which borders Zhejiang to the north. Rapeseed is the main nectar source in both provinces, while he also collects honey and

\textsuperscript{25}Interviewed June 12, 2015.
pollen from loquat, cleome viscosa and tee tree. In early May he continues to travel northwards to Shandong Province for locust tree honey. Then he migrates to Shijiazhuang, Hebei in early June and to the Northeast in early July.

According to the author’s conversations with beekeepers, it seems that they are somewhat pessimistic about their business, and many of them hold the view that the beekeeping business of the country will sink into atrophy unless more beekeeping promoting policies emerge. A significant aspect of this issue is the aging of the front-line beekeepers. Luo et al. [2014] collect data from the sign-in sheets of beekeepers attending beekeeping training programs and other events in Hubei, Hunan, Guangdong and Taiwan and compares the average ages across select years. Due to limited sample sizes and variation of locations, the representativeness and comparability of the data are potentially questionable. However, the fact that those data were collected from the “key areas of beekeeping” can, to a great extent, reflect the changes in average age of Chinese beekeepers. The average age of beekeepers has been increasing dramatically, from 35.4 in 1987 to 53.9 in 2013 (Table 3.7). And at the same time, beekeeping, as a business, becomes less attractive to the young generation.

Informant YJL\textsuperscript{26} and his family seem to be an epitome of this trend. At Longquan Temple, the author met this 51-year-old beekeeper and his wife from Yichun City, Jiangxi Province, the Southeast of China. He and his wife started their beekeeping business in 1987. His family has beekeeping experience for three generations, and he learned about beekeeping from his father-in-law. He has 110 hives of bees, with 11–14 honeycombs for each hive.

Unlike beekeepers from Hubei and Henan mentioned above, YJL spends more than half

\begin{table}[h]
\centering
\caption{Average Age of Beekeepers. Source: Luo et al. [2014]}
\label{tab:average_age}
\begin{tabular}{|l|l|l|l|}
\hline
Year & Location & Sample Size (Number of Beekeepers) & Average Age \\
\hline
1986-87 & 23 counties in Hubei & 2071 & 35.4 \\
1995-97 & 11 counties in Hubei & N.A. & 36.2 \\
2002-06 & 20 counties in Hubei, Guangdong, Hunan, Taiwan & 856 & 48.7 \\
2011 & 8 counties in Hubei and Hunan & 1226 & 50.2 \\
2012 & 8 counties in Hubei and Guangdong & 665 & 52.4 \\
2013 & 8 counties in Hubei, Hunan and Guangdong & 915 & 53.9 \\
\hline
\end{tabular}
\end{table}

\textsuperscript{26}Interviewed June 11, 2015.
Table 3.8: YJL’s Travel Pattern

<table>
<thead>
<tr>
<th>Time</th>
<th>Location</th>
<th>Flowers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mar 20</td>
<td>Anhui Province</td>
<td>Rapeseed</td>
</tr>
<tr>
<td>Early April</td>
<td>Jiangsu</td>
<td>Rapeseed</td>
</tr>
<tr>
<td>April 20</td>
<td>Shijiazhuang, Hebei</td>
<td>locust tree, heterophyllous negundo (Vitex negundo var. cannabifolia L.) and jujube</td>
</tr>
<tr>
<td>May 4</td>
<td>Fuping, Hebei, for 10 days</td>
<td>jujube</td>
</tr>
<tr>
<td>May 14</td>
<td>Shijiazhuang</td>
<td>locust tree, heterophyllous negundo (Vitex negundo var. cannabifolia L.) and jujube</td>
</tr>
<tr>
<td>Early June</td>
<td>Shanxi</td>
<td>locust tree, heterophyllous negundo (Vitex negundo var. cannabifolia L.) and jujube</td>
</tr>
<tr>
<td>July 20</td>
<td>Inner Mongolia</td>
<td>Rapeseed and sunflower</td>
</tr>
<tr>
<td>Sep</td>
<td>Home</td>
<td>Tea and Donggui, various mountainous flowers</td>
</tr>
<tr>
<td>Oct – Dec 22</td>
<td>Home</td>
<td>Winter</td>
</tr>
<tr>
<td>Dec 22</td>
<td>Home</td>
<td>spring reproduction</td>
</tr>
</tbody>
</table>

the year, from September to early March, at Jiangxi, his hometown (Table 3.8 and Figure 3.9). Winter in Jiangxi is generally warmer, so he does not have to migrate to other sites for wintering; and his children are “old enough to rely on themselves,” so he himself does not expect too much income from beekeeping. His main purpose of beekeeping, as he described, is “the fun of travel.”

YJL’s first stop is Anhui Province around Mar 20, and he travels to Jiangsu Province in early April. Rapeseed is the main nectar source for him in both provinces. He arrives at Shijiazhuang, Hebei on April 20 for nectar from heterophyllous negundo chastetree and jujube. A *xiao zhuandi* takes place in Hebei: He goes to Fuping County, 93 km (58 miles) north-northwest of Shijiazhuang, on May 4 and back to Shijiazhuang ten days later. He travels to Shanxi sometime in June and nectar sources in Shanxi are similar to those in Hebei. He heads north towards Inner Mongolia around July 20 for sunflowers and rapeseed. Finally he comes back home in Yichun in September. Quantities and prices of honey are reported in Table 3.9. YJL has also taken some alternative routes during past years, including Henan Province (around April 10), Yan’an in Shaanxi Province (around May 15) and Shandong Province, which are marked in dotted lines in Figure 3.9.

YJL thought beekeeping was not a good way to make money. He and his family encountered frequent losses during the 1980s, which forced him to switch to other business in other cities in South China during the early 1990s. He had been a bricklayer for several years until his children got married\(^{27}\) in the early 2000s. He returned to beekeeping after that, partly because

\(^{27}\)It is a custom in his hometown (and in many areas of China) that parents play important roles in children’s
Table 3.9: Quantity and price reported by YJL

<table>
<thead>
<tr>
<th>Flowers</th>
<th>Quantity (jin / Hive)</th>
<th>Whole sale Price (yuan / metric ton)</th>
<th>Retail Price (yuan / jin)</th>
</tr>
</thead>
<tbody>
<tr>
<td>rapeseed</td>
<td>50–60</td>
<td>more than 7000</td>
<td>N.A.</td>
</tr>
<tr>
<td>Jujube</td>
<td>15</td>
<td>more than 10000</td>
<td>15</td>
</tr>
<tr>
<td>locust tree</td>
<td>15–16</td>
<td>more than 20000</td>
<td>20</td>
</tr>
</tbody>
</table>
he thought he was too old to be hired as a bricklayer.

YJL also claimed that young people in China would not start a beekeeping business unless there was a family tradition. For his family, however, he was pretty sure that his children would “never keep bees,” since the profit of beekeeping “completely depends on divine will,” and there are so many risks and dangers within and without. To him it seems that a job with regular working hours and fixed payments is more desirable, while beekeeping, albeit a “sweet career,”28 will finally disappear.

LXS29 is more than seventy years old and he is the oldest beekeeper visited by the author. He and his wife are from Wuchang Village30, Zanhuang County, Hebei Province. They have one hundred and seventy hives of Italian bees (in 13-comb hives). In recent years, he only migrates to sites within Hebei due to his age; therefore, his experience provides examples of xiao zhuan di.

Locust tree and heterophyllous negundo are LXS’s main nectar sources. There are three sites for locust trees. In late April, he migrates to Chenzhuang Village, Gaoyi County (about twenty miles) and later goes back to Baishankou31, Zanhuang County (Figure 3.10) because Baishankou has a higher altitude. The last site for locust trees is Xibaipo, Pingshan County (about ninety miles from Zanhuang). In July, he migrates to the mountain area of Zanhuang and produce heterophyllous negundo honey until August, when the xiao zhuan di ends.

3.3 Pollination Services and Transactions

The benefits of bee pollination to crops have been better understood and researched in China during recent decades. The importance of bee pollination has been reflected directly by increases in output. Liu et al. [2011] estimates the economic value of honeybees as pollinators for thirty-six pollinator-dependent crops in China using method developed by Robinson et al. [1989] and their conclusion indicates that honey bee pollination contributed to 304 billion yuan, or 46 billion dollars of average economic value per annum during 2006-200832. However, honey bee colonies participating in paid pollination services only account for less than five percent of colonies (Wang [2011]). For comparison, roughly two-third of all U.S. colonies are transported marriage arrangements. Therefore, YJL and his wife returned home when his children were ready to get married.

28 A Bite of China, Season 2 - Footstep, 10:47.
29 Interviewed May 22, 2014
30 武昌村, not to be confused with Wuchang District (武昌区) in Hubei Province.
31 白山口. It is too small to be shown on the map.
32 The method by Robinson et al. [1989], however, is misleading and overestimates the value of honey bee pollination. Muth and Thurman [1995] points out that this method does not take into consideration the adjustment made by other pollinators with honey bees’ absence and the adjustment made by crop growers in their land allocation decisions, and the calculation also misleads due to an understanding of the distinction between the marginal and average contribution of honey bees.
Figure 3.10: LXS’s *xiao zhuandi* (short-distance migration)
to California for almond pollination each year. Adding the colonies that pollinate other crops but not almonds would increase that fraction. From the perspective of beekeepers in China, pollination services are still not commercially important.

3.3.1 Pollination Services Provided by Migratory Beekeepers

There are transactions between crop growers and beekeepers like what is seen in the United States, and as one of the consequences of increasing labor costs, these transactions have been occurring more extensively in recent years. However, the renting of honey bees for pollination services still do not account for a large part of beekeepers’ income (less than ten percent), nor do such transactions take place frequently.

Insights into the Contracting for Pollination from Beekeeper Interviews

WJS’s experience seems typical. He offers pollination services once or twice per year, and such transactions occur only when crop growers contact him. In spring 2015, for example, immediately after the Spring Festival, he spent twenty days in Shandong Province pollinating strawberries at the price of 300 yuan (46 dollars) per hive. Shandong has the largest area of strawberries grown and harvested in China. In 2012, there were 100.5 thousand hectares (248 thousand acres) of strawberries with a yield of 2.76 million metric tons (6.08 billion pounds) harvested in China, out of which Shandong accounted for 15.9 thousand hectares with 579 thousand metric tons (1.28 billion pounds). In Shandong, Jiangshan received pollination fees of more than 10,000 yuan (or 1,500 dollars). From Xiangfan, Hubei to Shandong, the transportation cost was 5,000 yuan. In March 2014, a lychee grower in Guangxi Province rented his bees at 280 yuan per hive for about one month. Guangdong and Guangxi produce nearly eighty percent of lychees in China. In 2012, for example, Guangdong harvested 1.06 million metric tons (2.33 billion pounds) of lychees, and Guangxi 0.5 million metric tons (1.17 billion pounds). WJS’s father has offered pollination services for tomatoes and some other crops, but the details were not clear. Jiangshan reported that he paid “agent fees” when offering pollination services: the agent who introduces the beekeepers to crop growers charges a fee. In the above mentioned example of strawberry pollination in Shandong, the pollination fee was 300 yuan per hive, which includes 50 yuan of “agent fee.” That makes the contracting between beekeepers and crop growers more costly. Therefore, “information is important,” said WJS.

33回扣, literally “rebate.”
34Sometimes even stealing is cheaper than contracting. China News [2015] reported that on April 8th 2015, at Hekou Township, Shumping County, Hebei Province, beekeeper RAN ( يأتي) found his ten hives of honey bees disappeared. After being investigated by the police, it turns out that the bees were stolen by four watermelon growers from Qingyuan County. Those growers were clearly aware of the importance of pollination, and therefore
The use of pesticides is another important factor discouraging beekeepers from offering pollination services, which reduces the contractual flexibility. Informant LXS reported his experience: He once migrated to a village pollinating cabbage, and the village mayor said that all the growers in the village promised not to use pesticide during the pollination. It turns out that most growers kept their promise but one or two of them did not. LXS encountered losses, and “accepting the bad luck,” he left the village. According to other examples reported by him, it seems that pesticides even induced him to not charge pollination fees. His bees are used to pollinate apple, pear, cherry and plum, and he charges 40-50 yuan per hive; but at times he does not charge any fee, because he can “leave without any constraint.” The logic is that pollination fees made the contracts strictly enforced and he is not able to leave before the end date of pollination; but if he is not paid, he can leave without any obligation to fulfill.

Contracting is made riskier and less desirable by its informality and incompleteness. Beekeepers and crop growers usually make only oral contracts and do not write anything down. YJL summarizes what are always included in a typical contract: entry and exit time, price per hive, how the transportation cost is shared, etc. What makes the contracts more fragile is the fact that the contracts do not specify how beekeepers would be compensated should there be unexpected incidents resulting in losses to beekeepers. Therefore, YHC represents another, somewhat extreme, attitude of beekeepers towards pollination services. YHC currently does not offer any pollination services because he “is afraid of being defrauded,” as he said; his friends' and his own experience turned out to be “very unpleasant.” In Inner Mongolia and Zhangjiakou, Hebei, for example, sunflowers are widely planted and pollination service is demanded. He and his friends have been there once, but they concluded that they should never do it again. Sunflower growers did not allow them to leave before the due date specified in their contract, even when “bees were almost dying.”

Inner Mongolia produces nearly half of the sunflower seeds in China. In 2012, there were 398.6 thousand hectares of sunflowers in Inner Mongolia which produced 1.07 million tons of sunflowers seeds. Therefore, many migratory beekeepers interested in sunflowers will visit the area. YJL’s bees also suffer from high mortality rates after pollinating sunflowers and he decided to steal bees for pollination purposes.

35 An “officially” appropriate contract, according to Technical Specification for Honey Bee Pollination (Proposed) published by Ministry of Agriculture of the People’s Republic of China, should include “way of payment, quantity and quality of colonies for pollination, time entering the site, crop grower’s way of feeding and pesticide management, in order to protect the interests of both sides.”

36 Hongchao’s friends, though, have a relatively good experience offering pollination services for apple and pear in Zhaoxian County and Jinzhou County in Hebei Province (50 yuan per hive). Hebei produces about 1/10 of apples and 1/4 of pears in China. In 2012, Hebei produced 3114632 metric tons of apple and 4450544 metric tons of pears.

37 It is commonly observed that beekeepers encounter losses after pollinating sunflowers (Wang [1999]) and jujube (Geng [2011]) due to a variety of reasons.
partly agrees with YHC on the issue of “being defrauded,” but he seems more confident. In the past several years, he has been to Inner Mongolia for pollination of sunflowers from late July through late August and he charges about one hundred yuan per hive. In 2014, for example, there were one hundred hives rented by the sunflower growers for the pollination of 200 Mu (16.47 acres). The fortune of his bees, as he said, “depends on whether the grower is kind-hearted or not.” It seems that most growers he met were accommodating enough that he could leave if the mortality rate was significantly higher than expected even before the end date; sometimes, if the growers wanted the end date to be strictly enforced, he had to flee without being paid in order to avoid further losses resulting from dead bees. Personal connections, therefore, are important. Beekeepers share not only information about nectar sources, but also the availability and reputation of crop growers. YJL travels in similar routes each year and in most cases offers pollination services to growers he knows. It reduces the risk of unexpected losses and avoids paying extra fees mentioned by WJS. WC also migrates to Inner Mongolia each year for sunflower pollination. He always arrives on July 15 and spends less than 20 days there. Sunflower growers rent his bee hives at more than 20 yuan per hive. The area pollinated is usually 100-200 mu (16-33 acres).

In Jiangxi, YJL’s hometown, he sometimes sells honey bees to greenhouse strawberry growers for pollination purpose from October to February, though Jiangxi produces less than one percent of strawberries in China. It is common for greenhouse growers to buy (but not to rent) bees (honey bees or bumble bees), because most bees will die after pollinating crops grown in greenhouses. YHC reported his friends’ experience on strawberry pollination in Hebei as well: a 4- or 5-comb hive is sold to strawberry growers at 500 yuan per hive, and a 10- or 12-comb hive at 1000 yuan. LXC reported a similar experience: he sold fifty hives of honey bees to strawberry growers at Zhangjiagang City, Jiangsu Province at 300 yuan per hive (3-honeycomb hive). In general, one greenhouse requires one hive of honey bees for pollination during the florescence. LXC has been offering pollination services for more than ten years and the routes are similar across each years. Also in Zhangjiagang, Jiangsu, for example, peach growers rent his bees for three days at the end of March, and he charges 200 yuan per hive. LXC reported that 20-40 hives of bees can pollinate more than ten mu (1.65 acres) of peach.

---

38 Mu is the Chinese unit of area and 1 mu = 666.67 square metre.
39 It is reasonable to ask why beekeepers sell bees to greenhouse growers but not others. One may expect that selling may solve the externality problem due to insecticide or flower related bee diseases (e.g., sun flower and jujube), but the distinction here is that almost all the bees would die after pollinating greenhouse crops, while at least some of the bees remain alive even after pollinating crops that may cause high mortality rates, and beekeepers can harvest honey by not selling bees. Thus, it is not necessarily desirable for beekeepers to sell bees to everyone.
40 In 2012, Jiangsu grew 11.3 thousand hectares (27.9 thousand acres) of strawberries and harvested 321 thousand metric tons (0.71 billion pounds).
It is reasonable to assume that most Chinese beekeepers do not know the theory of “reciprocal externality,” but they may not charge any fee for their pollination services because they receive enough compensation from the honey produced\textsuperscript{41}, and it is reported that beekeepers even give some honey to the crop growers when practicing migratory beekeeping\textsuperscript{42}. In the United States, the classic story about beekeepers not receiving any fees from the pollination services provided by their bees has been proved to be a myth, whereas the same myth seems still to be the reason persuading beekeepers in China not to charge pollination fees because of the reciprocal benefits they receive in the form of nectar and honey.

LM, for example, holds the view that one should not seriously expect to make money from pollination services since the income from it “cannot even compensate the daily living cost.” He is usually quite flexible about pollination fees, and is “happy with anything the crop grower pays, no matter how much it is,” because he is compensated by the honey and pollen harvested. He offers pollination services for apple (March) and pear (April) Orchards in Hebei, and as he said, most of the time he does not charge any fee because of the compensation from pollen.

As a variation of human pollination, the “bee-human” pollination, mainly for apples and pears, also exists as reported by LM and some other beekeepers. Beekeepers manage bees to collect pollen from flowers and sell the pollen to crop growers, who use the collected pollen to complete the pollination process by humans. Human labor is partly replaced by bees.

LM illustrated the substitution between human and bees according to his observations in recent years. Human labor requires more than 100 \textit{yuan} per day, and one hive of honey bees with a similar cost can pollinate dozens of \textit{mu}; that has made bee pollination more attractive for crop growers. During recent years, more and more watermelon growers on Wuqi Road\textsuperscript{43} have contacted LM requesting pollination services from early May to mid May. He charges about 150 \textit{yuan} per hive. It was also reported that there were several hundred \textit{mu} of watermelons in that area and he was not the only one providing pollination services.

\textbf{Transportation Cost}

There is no doubt that transportation costs are vital to migratory beekeepers. Beekeepers consider their transportation costs, and that becomes another important reason that may prevent beekeepers from offering long-distance pollination services. ZSL, for example, does not offer pollination services at all only because of the transportation cost of migration. Another example is YJL: he even stopped keeping bees in the late 1980s, partly because of difficulties in trans-

\textsuperscript{41}It is possible that in equilibrium, pollination fee is zero. See Rucker et al. [2012].
\textsuperscript{42}This, however, should not be treated as a kind of payment; it is, to a great extent, a gift that helps build connections.
\textsuperscript{43}Shijiazhuang City, Hebei Province.
portation. All the beekeepers visited by the author rely completely on rented truck services, and they blame the high transportation costs on the fact that they do not own trucks. It is not obvious to economists, though, that transportation costs are higher for a renter of truck services than an owner of a truck, since one should consider properly the opportunity costs of owned assets in deriving its user cost. But beekeepers usually do not consider things in the same way as economists. The author heard complaints from virtually every beekeeper about “expensive” transportation.

It is hard to estimate what it costs beekeepers to travel and compare it to their revenues since beekeepers usually do not calculate their daily income and expenditure, and therefore it is hard to come to a solid conclusion about how high the transportation costs are. However, the following examples might be helpful in understanding this issue. LXC spends 2200 yuan on transportation from Shandong to Hebei and 2700 or 2800 yuan from Jiangsu to Shandong. His annual total expenditure on transportation is more than 10,000 yuan in each year. Every year his family (five persons in total) earns more than 100,000 yuan (net income), or 20,000-30,000 yuan per person. LM and his team (more than ten persons) spend about 12,000 yuan migrating between Sichuan and Hebei. A xiao zhuandi within Hebei (e.g., Zhaoxian County and Baoding City) usually cost several hundred yuan. He could not estimate the total net income for the entire team; but for his site at Shijiazhuang, he reported an annual net income of 20,000-30,000 yuan.

3.3.2 Hainan Province

In China, pollination service transactions are not widely observed, to the extent that their occurrence becomes “news.” Hainan is the smallest and southernmost province of China (Figure C.1). The main island of this province, Hainan Island, located in the South China Sea, is separated from Guangdong’s Leizhou Peninsula to the north by Qiongzhou Strait. According to the local newspaper, in the city of Danzhou, Hainan, Pengcheng Agricultural Co-operative spent 750,000 yuan (114,000 dollars) and rented 2500 hives of honey bees from Shanyuan Beekeeper’s Co-operative, at the price of 300 yuan per hive in 2014; that was the largest order of pollination service at that time. Pengcheng planned to use these hives at the beginning of 2014 for the pollination of 10,000 mu (1647 acres) of black-skin winter melon. Previously they used to hire human labors for hand pollination, whose cost, however, was at least 200 yuan per

---

44To clarify, that means they do not own trucks, nor do they rent trucks; they, however, purchase transportation services from professional truck drivers.
45Hainan Daily, November 24, 2013.
46The Latin name of winter melon is *Benincasa hispida* (according to Medical Plant Images Database). In English, it might also be translated as White Gourd, China Waxgourd, Chinese Waxgourd, Wax Gourd, Chinese Preserving Melon, Zit-Kawa, Tunka. It is not commonly found in the United States.
mu, so the Pengcheng Agricultural Co-operative anticipated saving more than 1,000,000 yuan (152,000 dollars) in total.

Figure 3.11: Hainan Daily

This is an example of the substitution between human and bee pollination. The declining populations of natural insect pollinators cannot ensure enough pollination for winter melon and many other crops, so human pollinators are playing an important role. In recent years, however, as was mentioned in *Hainan Daily*, labor costs of hand pollination have been increasing dramatically, and the fact that the pollination for winter melon is always needed during the Spring Festival makes it more difficult to hire human labor for pollination. Therefore, as an attempt to resolve the problem of shortage in labor for pollination, an experiment was carried out by Apicultural Association of Hainan Province, Center of Agricultural Technology of Danzhou and Pengcheng Agricultural Co-operative in March 2013. Pengcheng rented 170 hives of bees for the pollination of 560 mu, or 92 acres, of black-skin winter melon; the bees completed their job successfully and saved Pengcheng 70,000 yuan, or 11,000 dollars.

---

47 Spring festival, or Chinese New Year, is an Asian festival celebrated at the turn of the lunisolar Chinese calendar. In the Gregorian calendar, Chinese New Year falls on different dates each year, a date between 21 January and 20 February (Aslaksen [2010]). It is a tradition that families gather together during the Spring Festival to have reunion dinners with their families.
There are more than one million mu, or 165000 acres of various types of melons in Hainan Province which requires human pollination. It is estimated by experts in Chinese Academy of Tropical Agricultural Sciences that the total cost of human pollination is more than two hundred million yuan, or thirty million dollars per year. The emerging bee-hive-renting pollination seems to be a promising way to deal with the shortage of local pollinators and increasing cost of human labor. In addition, as was reported by GAO jinglin, the quantity and quality of bee pollinated fruits were improved, and bee pollination significantly reduced the dependence on spray pollination and the potential negative effects associated with it.

Although beekeepers and crop growers are aware of the fact that pollination by bees is less costly and more efficient, it still seems difficult to generalize the successful experience of Pengcheng due to the problem of free riders. Croplands in Hainan Province (and in many areas of China) can be small enough to mystify bees and lead them astray; according to an experiment by GAO Jinglin, it is possible in extreme cases that 96 percent of bees go out of the targeted piece of cropland and the crop growers who haven’t paid for the pollination services benefit. Thus, crop growers may find it economically inefficient to employ bees as long as there are free riders. It seems necessary for smaller crop growers to cooperate and adopt bee pollination on a larger scale for the sake of the internalization of externalities.

3.3.3 Pollination of Apples in Sichuan Province

Sichuan is a province in southwest China (Figure C.1). According to Partap and Tang [2012] and Blomstedt [2013], in Maoxian county, all the apples were pollinated by laborers in 2000 due to a shortage of natural pollinators. As the price of labor rose from $2/day to over $12/day during the decade since 2000, apples came to be replaced by less pollinator-dependent crops (e.g., self-pollinated fruit crops like plum and loquat) during 2000-2011 and the apples that remain still were being pollinated by humans. Apple used to be the main cash crop in Maoxian, but currently plums are the main fruit tree present there (Table 3.10).

Hand pollination, as a result of the local pollinator deficit, began in the late 1980s and yielded more fruits with higher quality. The re-introduction of bee pollination by local government was unsuccessful and “not a pleasant experience for beekeepers” because of intensive pesticide sprays. In addition, apple trees require cross-pollination and enough pollinizers are necessary to ensure

48 The President of Apicultural Association of Hainan, Associate Research Fellow at Chinese Academy of Tropical Agricultural Sciences and Administrator of Danzhou Branch of National Technological System of Bee Industry.

49 For example (Wuxi Shangbao [2014]), some consumers reported that the flavor of spray pollinated seedless watermelons was not as good as expected.

50 Data about fruit production in Maoxian County are unavailable. The table here presents data of Aba (Ngawa) Tibetan and Qiang Autonomous Prefecture, to which Maoxian belongs.
Table 3.10: Fruit Production in Aba Tibetan and Qiang Autonomous Prefecture and Sichuan Province, Metric Tons. Source: Sichuan Statistical Yearbook.

<table>
<thead>
<tr>
<th>Year</th>
<th>Aba Apple</th>
<th>Citrus</th>
<th>Pears</th>
<th>Other Fruits</th>
<th>Total</th>
<th>Sichuan Apple</th>
<th>Citrus</th>
<th>Pears</th>
<th>Other Fruits</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>28,600</td>
<td>0</td>
<td>9,900</td>
<td>1,400</td>
<td>39,800</td>
<td>202,300</td>
<td>1,327,500</td>
<td>344,500</td>
<td>651,400</td>
<td>2,525,700</td>
</tr>
<tr>
<td>2001</td>
<td>25,200</td>
<td>0</td>
<td>10,100</td>
<td>1,500</td>
<td>36,800</td>
<td>194,000</td>
<td>1,497,700</td>
<td>394,800</td>
<td>642,500</td>
<td>2,729,000</td>
</tr>
<tr>
<td>2002</td>
<td>25,300</td>
<td>0</td>
<td>7,900</td>
<td>1,600</td>
<td>34,900</td>
<td>206,900</td>
<td>1,661,800</td>
<td>469,700</td>
<td>728,500</td>
<td>3,066,900</td>
</tr>
<tr>
<td>2003</td>
<td>34,300</td>
<td>0</td>
<td>7,000</td>
<td>2,000</td>
<td>42,400</td>
<td>225,400</td>
<td>1,861,600</td>
<td>547,700</td>
<td>847,400</td>
<td>3,482,100</td>
</tr>
<tr>
<td>2004</td>
<td>38,000</td>
<td>0</td>
<td>5,500</td>
<td>2,400</td>
<td>46,900</td>
<td>240,500</td>
<td>1,987,800</td>
<td>620,300</td>
<td>1,005,900</td>
<td>3,854,500</td>
</tr>
<tr>
<td>2005</td>
<td>37,700</td>
<td>0</td>
<td>5,500</td>
<td>3,600</td>
<td>46,800</td>
<td>242,900</td>
<td>2,137,400</td>
<td>684,600</td>
<td>1,092,600</td>
<td>4,157,600</td>
</tr>
<tr>
<td>2006</td>
<td>36,100</td>
<td>0</td>
<td>6,900</td>
<td>4,200</td>
<td>47,200</td>
<td>248,000</td>
<td>2,057,800</td>
<td>746,000</td>
<td>1,186,300</td>
<td>4,238,100</td>
</tr>
<tr>
<td>2007</td>
<td>N.A.</td>
<td>N.A.</td>
<td>N.A.</td>
<td>N.A.</td>
<td>N.A.</td>
<td>N.A.</td>
<td>N.A.</td>
<td>N.A.</td>
<td>N.A.</td>
<td>N.A.</td>
</tr>
<tr>
<td>2008</td>
<td>42,100</td>
<td>0</td>
<td>6,000</td>
<td>13,200</td>
<td>61,300</td>
<td>389,000</td>
<td>2,575,700</td>
<td>821,300</td>
<td>1,384,200</td>
<td>5,170,200</td>
</tr>
<tr>
<td>2009</td>
<td>42,600</td>
<td>0</td>
<td>6,400</td>
<td>11,900</td>
<td>63,900</td>
<td>408,900</td>
<td>2,773,500</td>
<td>845,200</td>
<td>1,655,600</td>
<td>5,683,300</td>
</tr>
<tr>
<td>2010</td>
<td>44,100</td>
<td>0</td>
<td>6,300</td>
<td>18,600</td>
<td>69,000</td>
<td>429,300</td>
<td>2,929,400</td>
<td>873,400</td>
<td>1,763,600</td>
<td>5,995,700</td>
</tr>
<tr>
<td>2011</td>
<td>42,200</td>
<td>0</td>
<td>8,100</td>
<td>23,000</td>
<td>73,200</td>
<td>446,800</td>
<td>3,164,000</td>
<td>903,400</td>
<td>1,915,400</td>
<td>6,249,500</td>
</tr>
<tr>
<td>2012</td>
<td>50,066</td>
<td>0</td>
<td>13,929</td>
<td>30,767</td>
<td>94,762</td>
<td>477,415</td>
<td>3,377,502</td>
<td>999,612</td>
<td>2,054,763</td>
<td>6,849,292</td>
</tr>
<tr>
<td>2013</td>
<td>64,778</td>
<td>0</td>
<td>14,394</td>
<td>40,891</td>
<td>120,063</td>
<td>518,661</td>
<td>3,436,160</td>
<td>962,939</td>
<td>2,269,536</td>
<td>7,187,296</td>
</tr>
</tbody>
</table>

the effectiveness of pollination. But similar to the Hainan example, orchards in Maoxian are generally too small to allow for too many trees (pollinators) that do not produce any fruit. That left hand pollination as the only feasible option for apple orchardists.

The huge increase in the price of labor resulted from shocks in both supply and demand (Partap and Tang [2012]). Better jobs in cities attracted local labor and created a scarcity of labor; at the same time, a shift in climate in Maoxian County caused an increase in demand for labor – pollination becomes more labor intensive under cold and cloudy weather conditions during the apple flowering season and thus raises the price of labor.

The case of Sichuan provides another interesting example of economic substitution induced by a change in factor prices. Notable here is that some of the economic substitutions induced by the wage increase are away from one crop toward other crops, but not away from human pollinators to bees, as was the case in the Hainan example. Besides the change in labor costs, output prices were also a key factor in the substitution. The price of Maoxian apples declined substantially compared to other fruits in the present decade.

51 Most types of apples are self-incompatible or self-sterile (DeGrandi-Hoffman et al. [1984]) and requires cross pollination (Blomstedt [2013]), meaning that the plant does not produce fruit if its flowers are pollinated from its own flowers or flowers from plants that are genetically the same. Therefore, some other types of trees, which in most cases do not produce apples, are required as pollinators. Enough pollinators are required for efficient bee pollination.

52 Partap and Tang [2012] reports that the farm gate price of apples declined to between US$ 0.16/kg and 0.19/kg, while other fruits achieved better prices.
3.3.4 Bumble Bee Pollination in Hebei Province

Hebei is a province in North China. Field research and interviews were carried out by the author in Zanhuang County of Shijiazhuang City in the summer of 2014 and Hengshui City in the summer of 2015.

Figure 3.12: Tomatoes. Left: Malformation caused by improper use of spray pollination. Right: Bumble bee pollination.

In summer 2015, the author visited Mr. LIU Dong, an expert on bumble bee pollination, at Biologic Control Technology Research Center, Dryland Farming Institute, Hebei Academy of Agricultural and Forestry Sciences located in Hengshui City, Hebei Province. The Center operated a company (Figure 3.14), Hengshui Tianyi Biologic Control Ltd., since 2000, and the company was separated and became independent in 2014.

The company produces and sells bumble bees (*Bombus terrestris*) for pollination purpose and other bio-control products. The price of bumble bees was 300–350 yuan or 45.74–53.37 dollars per colony during years after 2005 and 400 yuan or 61 dollars per colony since winter 2014. The quantity sold by the company began to increase in 2008–2010 and reached a peak of 400 colonies in 2014.

Bumble bees are mainly used for the pollination of solanaceous vegetables such as tomatoes, eggplants and peppers, but this form of pollination is not widely seen in China. The proportion of solanaceous vegetables pollinated by bumble bees is less than ten percent, according to Mr. LIU. Moreover, melons, strawberries, blueberries, some fruit trees and crops may, albeit rarely, rely on bumble bee pollination.

Bumble bees are generally more expensive than honey bees, but there are biological and socioeconomic reasons that promote the use of bumble bee pollination. Flowers of some crops have special structures that reduce the efficiency of honey bee pollination but do not negatively affect bumble bees, which have larger bodies covered with hair. Bumble bees tend to be more temperature-adaptive than honey bees, useful for the pollination of out-of-season greenhouse...
vegetables and fruits\textsuperscript{53} during the cold winters in North China.

Hives of bumble bees are pre-ordered and they usually take two to three months to produce (Figure 3.13). Pollination takes place in greenhouses and plastic houses, and the effective time of pollination lasts around forty days. One \textit{mu} (0.16 acre) of Tomatoes requires two colonies, and less than one \textit{mu} of cherry tomatoes requires one colony. Experiments have shown that the yields of bumble bee pollinated tomatoes were increased by more than ten percent and eggplants more than thirty percent, with significant improvement in quality compared to human pollination (Figure 3.12). In addition, bumble bee pollination is more time- and labor-saving, compared with human pollination.

Bumble bee pollination has advantages mentioned above and can be a good substitute for human labor. Mr. LIU also mentioned the labor scarcity and increasing labor costs in recent years, but human pollination (in the form of spray pollination) is still widely utilized for solanaceous vegetables, although spray pollination may sometimes cause hormone residues and flower-related diseases, which could have been avoided if bumble bee pollination were adopted\textsuperscript{54}.

The substitution between humans and bees is imperfect. Currently it costs 70–80 \textit{yuan} (11–

\textsuperscript{53}Bumble bees are always used in greenhouses during October through May in order to produce out-of-season greenhouse vegetables. In some areas of North China, heating equipment is not available for some crop growers, and therefore they have to choose bumble bees or blossom hormone spray, instead of honey bees, for pollination purposes. Sometimes temperature is so low that no pollen is available; in such extreme cases, spray pollination (which requires labor) becomes the only available option.

\textsuperscript{54}Bumble bee pollination reduces diseases related to flowers because petals abscise after crops are pollinated and thus there will be less breeding ground for bacteria.
12 dollars) per day to hire human labor to work in a greenhouse, which is much more expensive than before, but the versatility of human labor compensates for the extra cost. Crop growers hire labor for multiple purposes including pollination, while the job of bumble bees is limited to pollination. According to LIU, pollination only accounts for a small proportion of the value of human labor. Therefore, in many cases, the changes in factor prices are not large enough to induce substitution between factors.
Table 3.11: Pollination Fees

<table>
<thead>
<tr>
<th>Provider</th>
<th>Time</th>
<th>Location</th>
<th>Crop</th>
<th>Duration</th>
<th>Pollination Fee (yuan/hive)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>WANG Jiangshan</td>
<td>Late February, 2015</td>
<td>Shandong</td>
<td>Strawberry</td>
<td>300</td>
<td></td>
<td>Transportation cost (from Xiangfan, Hubei to Shandong): 5000 yuan; agent fee: 50 yuan/hive.</td>
</tr>
<tr>
<td>WANG Jiangshan</td>
<td>March, 2014</td>
<td>Guangxi</td>
<td>Lychee</td>
<td>1 month</td>
<td>280</td>
<td></td>
</tr>
<tr>
<td>WANG Chuang</td>
<td>Mid-July, every year</td>
<td>Inner Mongolia</td>
<td>Sunflower</td>
<td>20 days</td>
<td>20</td>
<td>Area pollinated: 100-200 mu</td>
</tr>
<tr>
<td>YANG Hongchao’s Friends</td>
<td>Hebei</td>
<td>Strawberry</td>
<td>500 (4 or 5-comb hive) or 1000 (10 to 12-comb hive)</td>
<td></td>
<td></td>
<td>Bee hives sold, not rented.</td>
</tr>
<tr>
<td>YANG Hongchao’s Friends</td>
<td>Zhaoxian and Jinzhou, Hebei</td>
<td>Apple and Pear</td>
<td>50</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LI Xinshu</td>
<td>Zhangjiagang, Jiangsu</td>
<td>Strawberry</td>
<td>300 (3-comb hive)</td>
<td></td>
<td></td>
<td>Bee hives sold, not rented.</td>
</tr>
<tr>
<td>LI Xinshu</td>
<td>End of March, more than 10 years</td>
<td>Zhangjiagang, Jiangsu</td>
<td>Pear</td>
<td>3 days</td>
<td>200</td>
<td>20-40 hives of bees can pollinate more than 10 mu</td>
</tr>
<tr>
<td>LU Miao</td>
<td>Early May</td>
<td>Shijiazhuang, Hebei</td>
<td>Watermelon</td>
<td>About 10 days</td>
<td>150</td>
<td></td>
</tr>
<tr>
<td>LI Xinshu</td>
<td>March and April</td>
<td>Hebei</td>
<td>Apple, pear, Cherry and plum</td>
<td>15-20 days</td>
<td>0 or 40-50</td>
<td>Transportation cost may be covered by crop growers.</td>
</tr>
<tr>
<td>Shanyuan Cooperative</td>
<td>2014</td>
<td>Danzhou, Hainan</td>
<td>Black-skin winter-melon</td>
<td>300</td>
<td></td>
<td>Area pollinated: 10000 mu; 2500 hives rented.</td>
</tr>
<tr>
<td>Tianyi Ltd.</td>
<td>2005-2014</td>
<td>various locations</td>
<td>various crops</td>
<td>300-350</td>
<td></td>
<td>Bumble bees; bee hives sold, not rented.</td>
</tr>
<tr>
<td>Tianyi Ltd.</td>
<td>2014-now</td>
<td>various locations</td>
<td>various crops</td>
<td>400</td>
<td></td>
<td>Bumble bees; bee hives sold, not rented.</td>
</tr>
</tbody>
</table>
3.4 Conclusions

China is where the magnificent scenes and nuanced details of beekeeping appear in turn. This article provides some insight into the history and general information of migratory beekeeping and pollination services in China. Stationary and migratory beekeeping are both practiced, with the latter emerging and developing extensively in recent decades.

Chinese beekeepers do not have strong incentives to offer pollination services. The primary purpose of beekeepers’ migration is honey, which, together with pollen, beeswax and other bee-related products, provides about ninety percent of beekeepers’ income. Providing pollination service is thus a costly activity with respect to the honey foregone. Beekeepers’ cost-benefit analysis also includes transportation, which can be a rate-limiting step. The fact that most beekeepers do not have their own trucks have reduced their availability and flexibility in offering pollination services.

Several principal-agent problems may also be impeding contracts between beekeepers and crop growers. Beekeepers encounter the problem of the harmful effect of pesticides on honey bees. Contracts for pollination services always contain provisions concerning the use of pesticides, but it is observed that some crop growers do not honor these provisions. The reputation of a grower may thus become a concern in beekeepers’ decision making, which reduces contractual flexibility. Beekeepers are aware of the fact that pollinating some crops may weaken the bee colony (e.g., sunflower and jujube) and they may encounter losses resulting from the death of bees. However, the contracts of pollination services do not specify how to deal with the problem of unexpected high mortality rate of bees, and that may make beekeepers decide not to offer pollination services in order to avoid the uncertainty. Information about crop growers and connections between beekeepers are therefore important, and help make contracting less costly.

The limitation of this paper is the lack of systemic data. Information about beekeepers’ migration and pollination services in the current paper are from a small sample of beekeepers, bee experts and previous literature. Therefore, the conclusions from these data, though useful, might have limitations to some extent by the particular locations of beekeepers interviewed. Future work may include more frequent observations of pollination fees from different crops, as is done by Muth et al. [2003] on pollination fees in Oregon\textsuperscript{55}.

\textsuperscript{55}Michael Burgett of the Department of Entomology at Oregon State University conducts surveys of beekeepers in Oregon, collecting data on pollination over 25 years.
REFERENCES


64


James Legge. The She King, Or, The Book of Poetry. Lane, Crawford, 1871.

Pengfei Liu, Jie Wu, Haiyan Li, and Suwen Lin. Estimation of economics values of honeybee
pollination for chinese agriculture. Chinese Agricultural Sciences, 44(24):5117–5123, 2011. [《中国农业蜜蜂授粉的经济价值评估》，李海燕，吴杰，刘朋飞，《中国农业科学》].


Appendix A

Special Cases in Chapter 2

A.1 Triangle Trade: Special Case with $\epsilon_1 = 0$

If the excess supply of Country 1 is perfectly inelastic, i.e. $\epsilon_1 = 0$, then

$$\frac{d \ln Q_{12}}{d \ln \tau} = \frac{(1 - \mu)H}{JH + KG} \quad (A.1)$$

$$\frac{d \ln Q_{13}}{d \ln \tau} = \frac{(1 - \sigma)(1 - \mu)H}{\sigma(JH + KG)} \quad (A.2)$$

$$\frac{d \ln Q_{23}}{d \ln \tau} = \frac{(1 - \mu)G}{JH + KG} \quad (A.3)$$

where

$$G = \epsilon_3 \left[ \frac{\beta_1}{\alpha} \left[ (1 - \alpha)\theta_{12} - (1 - \gamma) \frac{1}{\epsilon_2} - \beta_2 \theta_{12} \right] + \frac{(1 - \sigma)}{\sigma} \delta \right] \quad (A.4)$$

$$H = \epsilon_3 \left[ \frac{\beta_1}{\alpha} \gamma \frac{1}{\epsilon_2} + (1 - \beta_1 - \beta_2)\theta_{23} \right] + (1 - \delta) \quad (A.5)$$

$$K = [(1 - \rho)\theta_{23}] \quad (A.6)$$

$$J = [\rho \theta_{12} + \mu \frac{(1 - \sigma)}{\sigma} \theta_{13}] \quad (A.7)$$
or

\[
\frac{d \ln Q_{12}}{d \ln \tau} = \frac{(1 - \mu) \left[ \epsilon_3 \left( \frac{\beta_1}{\alpha} \gamma \frac{1}{\epsilon_2} + (1 - \beta_1 - \beta_2) \theta_{12} \right) + (1 - \delta) \right]}{\left[ \rho \theta_{12} + \mu \left( \frac{1 - \sigma}{\sigma} \theta_{13} \right) \right] \left[ \epsilon_3 \left( \frac{\beta_1}{\alpha} \gamma \frac{1}{\epsilon_2} + (1 - \beta_1 - \beta_2) \theta_{12} \right) + (1 - \delta) \right]}
+ \left[ (1 - \rho) \theta_{23} \right] \left[ \epsilon_3 \left( \frac{\beta_1}{\alpha} \left( (1 - \alpha) \theta_{12} - (1 - \gamma) \frac{1}{\epsilon_2} \right) - \beta_2 \theta_{12} \right) + \frac{(1 - \sigma)}{\sigma} \delta \right] \tag{A.8}
\]

\[
\frac{d \ln Q_{13}}{d \ln \tau} = \frac{(1 - \sigma) \left[ \right]}{\left[ \rho \theta_{12} + \mu \left( \frac{1 - \sigma}{\sigma} \theta_{13} \right) \right] \left[ \epsilon_3 \left( \frac{\beta_1}{\alpha} \gamma \frac{1}{\epsilon_2} + (1 - \beta_1 - \beta_2) \theta_{12} \right) + (1 - \delta) \right]}
+ \left[ (1 - \rho) \theta_{23} \right] \left[ \epsilon_3 \left( \frac{\beta_1}{\alpha} \left( (1 - \alpha) \theta_{12} - (1 - \gamma) \frac{1}{\epsilon_2} \right) - \beta_2 \theta_{12} \right) + \frac{(1 - \sigma)}{\sigma} \delta \right] \tag{A.9}
\]

\[
\frac{d \ln Q_{23}}{d \ln \tau} = \frac{(1 - \mu) \left[ \epsilon_3 \left( \frac{\beta_1}{\alpha} \left( (1 - \alpha) \theta_{12} - (1 - \gamma) \frac{1}{\epsilon_2} \right) - \beta_2 \theta_{12} \right) + \frac{(1 - \sigma)}{\sigma} \delta \right]}{\left[ \rho \theta_{12} + \mu \left( \frac{1 - \sigma}{\sigma} \theta_{13} \right) \right] \left[ \epsilon_3 \left( \frac{\beta_1}{\alpha} \gamma \frac{1}{\epsilon_2} + (1 - \beta_1 - \beta_2) \theta_{12} \right) + (1 - \delta) \right]}
+ \left[ (1 - \rho) \theta_{23} \right] \left[ \epsilon_3 \left( \frac{\beta_1}{\alpha} \left( (1 - \alpha) \theta_{12} - (1 - \gamma) \frac{1}{\epsilon_2} \right) - \beta_2 \theta_{12} \right) + \frac{(1 - \sigma)}{\sigma} \delta \right] \tag{A.10}
\]

and

\[
\frac{d \ln P_1}{d \ln \tau} = \frac{(1 - \mu)}{\alpha} \frac{1}{J H + K G} \left[ \frac{\gamma G}{\epsilon_2} + \left( \frac{(1 - \gamma)}{\epsilon_2} - (1 - \alpha) \theta_{12} \right) \right] \tag{A.11}
\]

\[
\frac{d \ln P_2}{d \ln \tau} = \alpha \frac{d \ln P_1}{d \ln \tau} + (1 - \alpha) \theta_{12} \frac{d \ln Q_{12}}{d \ln \tau} \tag{A.12}
\]

\[
\frac{d \ln P_3}{d \ln \tau} = \beta_1 \frac{d \ln P_1}{d \ln \tau} + \beta_2 \theta_{12} \frac{d \ln Q_{12}}{d \ln \tau} + (1 - \beta_1 - \beta_2) \theta_{23} \frac{d \ln Q_{23}}{d \ln \tau} \tag{A.13}
\]
A.2 Bilateral Trade: Two Countries with One Trade Flow and Constant Transportation Cost

The blackboard economics of two-country trade assumes constant transportation cost from Country 1 to Country 2, $T_{12}$. In equilibrium,

\[ ES_1(P_1) = ED_2(P_2) \quad (A.14) \]

\[ P_2 = P_1 + T_{12} \quad (A.15) \]

\[ ES_1(P_1) = Q_{12} \quad (A.16) \]

Log-differentiating (A.14), (A.15) and (A.16) results in

\[ \varepsilon_1 \ln P_1 = \eta_2 \left[ (1 - \alpha_{12}) \ln P_1 + \alpha_{12} \ln T_{12} \right] \quad (A.17) \]

\[ \ln P_2 = (1 - \alpha_{12}) \ln P_1 + \alpha_{12} \ln T_{12} \quad (A.18) \]

\[ \varepsilon_1 \ln P_1 = \ln Q_{12}, \quad (A.19) \]

where $\alpha_{12} = \frac{T_{12}}{P_1 + T_{12}}$. Solving for the comparative static responses of $P_1$, $P_2$ and $Q_{12}$ to changes in $T_{12}$ gives

\[ \frac{d \ln P_1}{d \ln T_{12}} = \frac{\alpha_{12} \eta_2}{\varepsilon_1} < 0 \quad (A.20) \]

\[ \frac{d \ln P_2}{d \ln T_{12}} = \frac{\alpha_{12}}{1 - (1 - \alpha_{12}) \frac{\eta_2}{\varepsilon_1}} > 0 \quad (A.21) \]

\[ \frac{d \ln Q_{12}}{d \ln T_{12}} = \frac{\alpha_{12} \eta_2}{1 - (1 - \alpha_{12}) \frac{\eta_2}{\varepsilon_1}} < 0 \quad (A.22) \]
Appendix B

Interviews with Beekeepers in China

B.1 Preface

This appendix makes available detailed records of the interviews conducted by the author during summer 2014 and summer 2015. It is designed to provide supplementary information about Chinese beekeeping that is not mentioned in Chapter 3. The interviews took a traditional “question and answer” format; the list of questions asked is available in the next section.

The author interviewed thirteen beekeepers, and this appendix provides information of ten of them whose experiences are summerized in Chapter 3. Beekeepers are anonymized and only their initials are provided. The author is denoted by “HY”. Original Chinese characters are provided when necessary. Audio recordings of the interviews are available upon request.

It should be noticed that these records shown here are not the verbatim transcription. For the purpose of better understanding the economics of beekeeping, verbatim transcription is unnecessary. In addition, sentences may be rearranged to better fit the topics covered. For example, if the informant talks about pollination when answering the question “is there anything else that you would like to say,” then his answer will be moved to the appropriate position under the question “do you offer pollination services.”

This Appendix is purely for information purposes only. The author tries his best to accurately transcribe and translate the materials; however, the information provided by beekeepers per se may be inaccurate, incomplete, inconsistent or biased. In addition, the author does not claim that the information from these interviews is representative on a national scale, nor information of each province representative on a provincial scale. The information is illustrative and useful in understanding the practice of migratory beekeeping and pollination services carried out by Chinese beekeepers, but conclusions from these examples should be generalized.
with caution.

B.2 Questions Asked

There are thirteen questions, each of which may be followed by one or two sub-questions.

- Personal info: name, hometown, age, family, etc.
- For how long have you been a beekeeper? How did you start your beekeeping business?
- How many hives do you have? Italian bees or Chinese bees?
- Do you travel? For what purpose (mainly honey or pollination)?
- What kinds of honey do you produce? What are the quantities and prices?
- Do you offer pollination services? How often? What are the price?
- What is your annual income?
- Have you ever competed with other beekeepers for nectar sources?
- Do you read books or journals about beekeeping?
- Are you a member of any beekeeping organizations?
- What are the mortality rates of your bee colonies in recent years? Have you observed any changes in mortality rate during recent years?
- Are you aware of any kinds of beekeeping related regulations or policies?
- Is there anything else that you would like to say?

B.3 Interviews

HY = Haoshi Yang

B.3.1 Informant WJS

Date: 2015-06-04.
Location: Shijiazhuang, Hebei, China.

HY: Personal info: name, hometown, age, family, etc.
WJS: My name is WJS. I’m thirty years old. I’m from Xiangfan (襄樊) City, Hubei (湖北) Province.

HY: For how long have you been a beekeeper? How did you start your beekeeping business?

WJS: I’ve been keeping bees for seven or eight years. We have a family tradition of beekeeping; both my paternal and maternal grandfathers were beekeepers. I think my family has sixty or seventy years’ history of beekeeping. My father is also a beekeeper; he is now in Baoduzhai (抱犊寨) Mountain.

HY: How many hives do you have? Italian bees or Chinese bees?

WJS: I have more than forty hives; and most of them are 13-honeycomb hives (5 honeycombs on the upper level and 7 or 8 honeycombs on the lower level of each hive). My father has about 50 hives. I keep Italian bees, which are less likely to get sick. Chinese bees produce less honey than Italian bees and are more difficult to manage. I do not want a painful sting from Chinese bees.

HY: Do you travel? For what purpose (mainly honey or pollination)?

WJS: Yes (See Table 3.2). The main purpose is honey production. I travel with my father.

HY: What kinds of honey do you produce? What are the quantities and prices?

WJS: (See Table 3.4) Honey price also depends on the density and quality of honey. Prices are determined by the wholesale merchants; there is a certain degree of monopsony.

HY: Do you offer pollination services? How often? What are the price?

WJS: Yes, there are pollination services taking place, but not very often; once or twice per year. Honey production is not the primary purpose when I offer pollination services. The pollination fee is generally 300-400 yuan per hive. I offer pollination services when the crop growers contact me. For example, this year, immediately after the Spring Festival, I went to Shandong Province offering pollination services for strawberry, charging 300 yuan per hive; the pollination lasted 20 days. The gross income was more than 10000 yuan, within which, however, the transportation cost was 5000 yuan. Another example: last year in March, I went to Guangxi Province offering pollination services for lychee, charging 280 yuan per hive, and that lasted about one month. My father has offered pollination services more frequently than me, for example, for tomatoes and some other crops; but I do not know much about the details.

Offering pollination services is profitable, although I think the price is still below my expectation. There are the so-called “agent fees” (回扣). The agent who introduced the beekeepers to crop growers charges a fee. In the above mentioned example of strawberry pollination in Shandong, pollination fee was 300 yuan per hive, which includes 50 yuan of agent fee. Information is important. Pollination services were very rare but are becoming more in recent several years.
Crops were mainly pollinated naturally or by human in the past.

There are contracts and transactions between crop growers and beekeepers. The contracts always specify the prices, duration of time and how to share the water and electricity cost.

**HY:** What is your annual income?

**WJS:** Net income per year: 20000-30000 yuan. Approximately, honey accounts for 65%, royal jelly 15%, propolis 5%, pollen 7-8%, pollination services 1-2%.

**HY:** Have you ever competed with other beekeepers for nectar sources?

**WJS:** In most cases, no. It is on a first-come-first-served basis. When a beekeeper comes to a site where another beekeeper is present, he will leave voluntarily and search for other spots. I always go to places familiar to me.

**HY:** Do you read books or journals about beekeeping?

**WJS:** *Journal of Bee* (《蜜蜂杂志》), *Apiculture of China* (《中国蜂业》) and *Introduction to Beekeeping* (《养蜂指南》). I also follow instructions from my family.

**HY:** Are you a member of any beekeeping organizations?

**WJS:** I know that there are beekeeping associations and cooperatives, but I am not the member of any of them. There is no need to join. Within a beekeeping organization, beekeepers with a good harvest will somehow compensate beekeepers who are at a loss. Because it is hard to contact and administrate migratory beekeepers, the members of beekeeping organizations are always local beekeepers who do not travel a long distance.

**HY:** What are the mortality rates of your bee colonies in recent years? Have you observed any changes in mortality rate during recent years?

**WJS:** The mortality rate is 60-65%, similar across years. Colonies will quickly recover by spring reproduction. No change in mortality rate has been observed in recent years. There are some common health issues, including varroa (蜂螨) and foul-brood (烂子病). The specific number of mortality rate may be inaccurate due to the fact that some bees fall down from the upper level to the lower level of the bee hives. Crawling bees (爬蜂病) can sometimes be observed due to droughts, bees’ visiting jujube flowers or illness. There are several key factors playing important roles in beekeeping: temperature, feeding, nectar sources and queens. I produce queens by my own colonies. Sometimes when nectar sources are not readily available, bees are fed with sugars or inferior honey, like sunflower honey, whose cost is lower.

**HY:** Are you aware of any kinds of beekeeping related regulations or policies?

---

1. *Apiculture of China* is a journal published jointly by Institute of Apicultural Research, Chinese Academy of Agricultural Sciences, and Apicultural Science Association of China (ASAC). It is published under the auspices of the Ministry of Agriculture of the People’s Republic of China. The journal publishes articles dealing with both beekeeping technology and honey bee biology.
WJS: No. There seems to be a subsidy of 200 yuan per hive per year, but I have never got the money, nor do I know how to get it.

HY: Is there anything else that you would like to say?

WJS: Transportation costs are too high, although the highway tolls are waived for beekeepers. It costs me 1500 yuan per 500 km for a 4.2-meter truck, and 1800 yuan per 500 km for a 6.8-meter truck. Half of the gross income pays for the transportation services. Twenty percent of my gross income covers daily living costs, and thirty to forty percent of the gross income is left and becomes net income.

Sometimes urban management officer (城管) may cause troubles when I practice migratory beekeeping in urban areas. In rural areas, the use of land is regulated and administered by the authorities of the village. There is no restrictions for the use of barren land. I do not need to pay any money to the crop growers, but they are gifted with some honey.

There are, and will be fewer and fewer beekeepers. There are so many difficulties, and the income is very low compared to other jobs. If my wife and I were doing other jobs, we would have 3000 yuan per person per month; our monthly living costs are 1000 yuan, so we can expect the annual net income of 50,000 yuan.

I cannot keep bees by myself; there are too many things to do. And it will be dangerous if I practice migratory beekeeping alone. My child is with my father in Baoduzhai Mountain now.

Do not do beekeeping business; it is much better to choose other jobs. Nowadays only older people are doing the business. People with the following characteristics are doing beekeeping business: living in rural area, poor, jobless, or having family tradition of beekeeping. Beekeeping is better than doing farming in rural areas, though. You should not expect to earn much money from beekeeping, though it is a reliable way to make a living. After ten or twenty years no one will keep bees.

Chinese people do not pay enough attention to daily regimen and only consume honey occasionally (2-3 jin per year). If you want to see significant positive effect from honey, you need to consume 2-3 jin per month. Japanese people love honey and royal jelly and import a lot of them. Much of my royal jelly is bought by wholesale merchants at low prices and then exported to Japan.

Compared to imported honey, domestic honey is actually better. I heard people talking about honey imported from Brazil, 50-60 yuan per jin, but the quality is not as good as the domestic honey. Honey sold in the supermarkets is sometimes adulterated.
B.3.2 Informant LM

Date: 2015-06-10.
Location: Shijiazhuang, Hebei, China.

HY: Personal info: name, hometown, age, family, etc.

LM: I am LM, 50 years old, from Kaifeng (开封) of Henan.

HY: For how long have you been a beekeeper? How did you start your beekeeping business?

LM: I have 13-14 years of experience keeping bees. I learned by myself, learning by doing.

HY: How many hives do you have? Italian bees or Chinese bees?

LM: We have 50 hives here, and 170 hives in Shanqiangdadao Street (山前大道) of Luquan (鹿泉). There are 13-14 combs in each hive. They are all Italian bees. The hives in Luquan are taken care of by my relatives. We have 10 or 20 people from my family migrating together, who are from more than ten different apiaries.

HY: Do you travel? For what purpose (mainly honey or pollination)?

LM: We left Sichuan on March 10 and arrived at Shijiazhuang on March 18. In Sichuan we produce rapeseed honey; in Shijiazhuang we produce locust honey, heterophyllous negundo honey, jujube honey, sunflower honey and pear pollen. We stay at Hebei for half year and then go to Sichuan again. We go back to our hometown, Kaifeng, during Spring Festival.

Sometimes we need to pay for the land we use. Sometimes we have to give money to local bullies and loafers.

HY: What kinds of honey do you produce? What are the quantities and prices?

LM: The yield of sunflowers is 20-30 jin per hive; the retail price is 20 yuan per jin and wholesale price is more than 20,000 yuan per metric ton.

In Sichuan, the yield is 50-60 jin per hive, and cannot be more than 100 jin. When it is droughty, the yield is only 20-30 jin per hive, and sometimes even zero. The retail price is 10 yuan per jin and wholesale price is 12,000-13,000 yuan per metric ton.

The yield of locust honey is 50-60 jin per hive, but can be as low as 20-30 jin per hive. The wholesale price is more than 20,000 yuan per metric ton and retail price is 15 yuan per jin.

The yield of heterophyllous negundo honey less than 20 jin per hive this year; the yield has been low during recent two years. One have can produce 50-60 jin in a bumper year. The wholesale price is more than 10,000 yuan per metric ton, and retail price is 14-15 yuan per jin.

HY: Do you offer pollination services? How often? What are the price?

LM: Yes. I offered pollination services for sunflowers in Inner Mongolia at about 100 yuan
per hive. I do not go there in recent years, however. I went to Wuhai (乌海) of Inner Mongolia in the 8th month of Chinese Calendar. The blooming time of sunflowers lasts more than one month. The contract specifies the duration of time - half month or 20 days - and pollination fee. The contract is not in written form. We also harvest honey from sunflowers.

I offer pollination services for watermelons in Wuqi Road (五七路) of Shijiazhuang; the growers contact me first. The blooming time starts from May 1 and lasts for half month. The pollination fee is about 150 yuan per hive, and it does not vary a lot in recent years. There are several hundreds of mu of watermelons and there are also other beekeepers offering such services. Nowadays if you pay one hundred yuan per day, you will not be able to hire human labor for hand pollination; but if you use bees, one hive of bees can pollinate scores of mu.

I also offer pollination services in the orchards for pear, peach and apple. Pear should be pollinated at the end of March, and the pollination lasts for one week at most. Sometimes I do not charge pollination fees because I can harvest pear pollen. Peach should be pollinated in the 3rd month of Chinese Calendar and the pollination lasts for one week. Apple is pollinated at the end of March. I do not expect to receive too much pollination fees. It is “at will” (“随意”); I am happy with whatever the growers pay.

HY: What is your annual income?

LM: Our income sources include honey, pollination services, pollen, propolis and bee wax. Honey accounts for more than half of the income. Offering pollination services is not profitable, and the income from pollination cannot even compensate our expenditure of food.

The transportation is expensive when we migrate. We use 9-meter and 7-meter trucks. The transportation cost from Sichuan to Hebei is more than 6,000 yuan; more than 200 hives and more than 10 people are transported. We have several people here and several in Luquan. When we go to Sichuan from here, the transportation cost is the same. Short-distance migration, from here to Zhaoxian (赵县) or Zhengding (正定), for example, costs several hundreds of yuan.

Our net income of the site here is 20,000-30,000 yuan. The daily compensation in the nearby construction site is 300-400 yuan, FYI.

HY: Have you ever competed with other beekeepers for nectar sources?

LM: No; but I have heard people talking about such competition and conflicts. First come, first served.

HY: Do you read books or journals about beekeeping?

LM: No. I have presbyopia, so it is difficult to read things.

HY: Are you a member of any beekeeping organizations?

LM: Our family is, if I can call it this way, an organization. We have more than ten people
in the family; we are all brothers and cousins.

We are also members of Beekeeping Association of Kaifeng City (开封市养蜂协会). The association, as our representative, helps us with litigation issues. We do not need to pay membership fees; we only need to register. The association only deals with legal issues, not anything else.

**HY:** What are the mortality rates of your bee colonies in recent years? Have you observed any changes in mortality rate during recent years?

**LM:** Varroa (蜂螨) is common and it happens every year; it should be treated after the Spring Festival, from the spring reproduction to autumn reproduction. If there is moth disease (白蛾病) or Foul-brood disease (烂子病), then all the bees will die (“全军覆没”). Crawling bees are not common; when varroa is serious it is more likely to have crawling bees.

The winter mortality rate is more than 70 percent. It does not matter; colonies can be recovered by spring reproduction.

**HY:** Are you aware of any kinds of beekeeping related regulations or policies?

**LM:** If in the future beekeeping is still not well supported by the government, it will disappear. It has been said for several years that there is subsidy for beekeepers, but I have never received any money. I believe the subsidy has been embezzled. It is my hope that I can receive the subsidy. I heard some time ago that beekeepers in Shanxi (山西) received the subsidy of 200 yuan per hive.

Some spots are not allowed for beekeepers to utilize; that is administered by the urban management officers.

**HY:** Is there anything else that you would like to say?

**LM:** My biggest concern is that the price of honey is too low. Our honey is good but the price does not fairly reflect its quality. I hope the honey price can go up.

### B.3.3 Informant ZSL

Date: 2015-06-10.
Location: Shijiazhuang, Hebei, China.

**HY:** Personal info: name, hometown, age, family, etc.

**ZSL:** I am ZSL, 46 years old, from Kaifeng (开封) of Henan (河南).

**HY:** For how long have you been a beekeeper? How did you start your beekeeping business?

**ZSL:** I have been keeping bees for 16 years. Beekeeping is not a family tradition for me. I was working in the government of the township. I started to keep bees in 30, because the income
in government, 500 yuan per month, was pretty low. My wife and I operate the business.

**HY:** How many hives do you have? Italian bees or Chinese bees?

**ZSL:** Here I have 40-50 hives, and in Shangqian (山前大道) of Luquan (鹿泉), I have 150 hives. On average one hive has 14 combs. They are all Italian bees. I have only one hive of Chinese bees. The yield of Chinese bee is low; one hive produces only a dozen of jin per year, though the price is more than 100 yuan per jin. Honey produced by Chinese bees tastes nearly the same as honey produced by Italian bees, but the nutritional value is higher.

**HY:** Do you travel? What kinds of honey do you produce? What are the quantities and prices?

**ZSL:** (Also see Table 3.6) I was in Zhaoxian (赵县) before I arrived at Shijiazhuang, and was in Sichuan before arriving at Zhaoxian. In the 11th month of Chinese calendar, I arrived at Yuxi (玉溪) and Eshan (峨山) of Yunnan for spring reproduction. The nectar source was rapeseed. At the end of the 1st month of Chinese Calendar, I arrived at Pixian (郫县) of Sichuan. The nectar source there is also rapeseed, and I began to produce honey at that time. If the weather is good, I can produce 60-70 jin per hive. Rapeseed honey was all sold in Sichuan. The retail price was 10 yuan per jin, wholesale price was 5-6 yuan per jin.

After staying at Pixian for one month, around the 20th day of the 3rd month of Chinese Calendar, I arrived at Zhaoxian of Hebei. The transportation cost me 5000 yuan. In Zhaoxian, I produce pear pollen, because pear flower does not have nectar. I stayed at Zhaoxian for at most half month and then went to Shijiazhuang. I will go to Baoding (保定) tomorrow. In Shijiazhuang, the nectar sources include locust tree and heterophyllous negund. It is droughty this year, so each hive produces 30-40 jin of locust honey. The retail price is 20 yuan per jin, and wholesale price is 22,000 yuan per metric ton. Prices do not vary a lot. Due to the drought, one hive can, under best circumstance, produce 20 jin of heterophyllous negund honey. The price is the same as locust honey. I plan to stay at Baoding for more than 20 days, producing honey of oil sunflower (油葵). The yield is expected to be 50 jin per hive, and the wholesale price is 15,000 yuan per metric ton.

I will go to Jiamusi (佳木斯) of Heilongjiang before July 20; the transportation cost will be 7000 yuan. I produce tilia honey there. The yield of tilia honey depends on whether it is “on-year or off-year (大小年);” this year is an “off-year (小年).” The yield is 100 jin per hive, and 20-40 jin per hive in an off-year. Kang tilia (紫椴) is better than Zi tilia (紫椴). Tilia honey is generally sold by bulk. The wholesale price last was 18,000 yuan per metric ton, but became 24,000 shortly after that.

**HY:** Do you offer pollination services? How often? What are the price?
ZSL: No. It is not convenient for me to do that. The transportation condition is not good.

HY: What is your annual income?

ZSL: The main source of income in honey. Income also comes from bee wax, pollen and propolis. Pear pollen, for example, can be sold at 300-400 yuan per jin. The net annual income is 300,000 yuan on average, of which honey accounts for 90 percent. It is toilsome, but I enjoy the freedom of beekeeping. There are intrigues against each other (“勾心斗角”) in the government, about which I felt bad.

HY: Have you ever competed with other beekeepers for nectar sources?

ZSL: Generally, no.

HY: Do you read books or journals about beekeeping?

ZSL: No. I know everything now.

HY: Are you a member of any beekeeping organizations?

ZSL: There is no cooperative, but there is beekeeping association. I am not a member. The administrators in the association do not keep bees but are good at charging fees. They also embezzle subsidies from the government. It is the policy that each hive should have a subsidy of 200 yuan.

HY: What are the mortality rates of your bee colonies in recent years? Have you observed any changes in mortality rate during recent years?

ZSL: After wintering, 5 combs in a hive remain alive and 10 combs die, so the winter mortality rate is 60-70 percent. The mortality rate was similar across different years.

The health problems include varroa, big-belly disease (大肚病), moth disease (白蛾病), paralysis disease (麻痹病) and foul-brood (烂子病). They are troublesome.

HY: Are you aware of any kinds of beekeeping related regulations or policies?

ZSL: Highway tolls are waived for migratory beekeepers; there is subsidy of 200 yuan per hive per year. There is no restrictions on beekeeping; the government encourages beekeeping.

HY: Is there anything else that you would like to say?

ZSL: The main difficulty comes from the droughty weather. Nectar is not abundant in dry weathers.

B.3.4 Informant YHC

Date: 2015-06-11.
Location: Shijiazhuang, Hebei, China.
HY: Personal info: name, hometown, age, family, etc.

YHC: My name is YHC. I’m forty-nine years old. I’m from Kaifeng (开封), Henan (河南) Province. I go back home every year.

HY: For how long have you been a beekeeper? How did you start your beekeeping business?

YHC: I have been keeping honey bees for more than twenty years. My family also has a long history of beekeeping. My maternal grandfather started beekeeping sometime before 1949. My knowledge of beekeeping, however, comes from self-education and beekeeper’s mutual education instead of his family.

HY: How many hives do you have? Italian bees or Chinese bees?

YHC: I have 180 hives Italian bees, with 9-14 combs in each hive (11-12 combs per hive on average). I used to keep Chinese bees, but now I do not, because it is not profitable to do so; I keep several hives of Chinese bees every year, though. Chinese bees tend to flee and it is difficult to extend their colonies.

HY: Do you travel? For what purpose (mainly honey or pollination)?

YHC: (Also see Table 3.5) We left home in last November. We went to Yuxi (玉溪) and Eshan (峨山) for Rapeseeds, and arrived at Luoping (罗平) around January 1. There are different kinds of flowers blooming across the entire year in Yunnan (云南). Afterwards we may go to Hunan (湖南), Sichuan (四川) or Hubei (湖北), and this time we did arrived at Hubei (湖北) on March 10, in Xiaogan (孝感), for Rapeseeds. We stay at Hubei until Qingming Festival (清明节), or April 2 or 3, and then we went to Henan (河南), Xinzhe (新郑) for paulowniaceae (泡桐) and locust trees (洋槐) (mainly locust trees). We stayed at Henan for more than twenty days. We arrived at Shandong (山东) on April 26 or 27, in Laoshan (崂山), for locust trees. Half month later we arrived at here, Longquanzhu Temple (龙泉寺), in Shijiazhuang, on May 25, for heterophyllous negundo and jujube.

Our plan this year is to visit Liaoning (辽宁) or Heilongjiang (黑龙江) in July. It depends on the weather. In last three years, we harvested in Liaoning, so this year we are not that confident and we are afraid lest Liaoning will not offer us too much this year. If it does not rain in the following three days, we will go to Jiamusi (佳木斯) in Heilongjiang, for tilia (椴树), chestnut (栗子) and white-melon (白瓜 or 面瓜). Chestnut can be either artificially cultivated, from August 15 to 20, or wild, from September 1. There are also other wild flowers without names.

Tilia amurensis (紫椴) does not produce nectar in nine years out of ten (“十年九不流”). Osmanthus (桂花) honey is “the king of honey,” but it does not produce nectar in nine years out of ten (“十年九不收”).
We also produce pollen. If we do not harvest enough honey, we must rely more on pollen. We go to the south for tea pollen around October.

We plan to go back home in October. The routes we took have been similar during the past years. When going out of Yunan, it’s a bit of gamble, and we have to choose a direction. We have not been to Jiangsu (江苏) for four years. We did visit Zhenjiang (镇江), Taizhou (泰州), and Yangzhou (扬州) of Jiangsu, in early April 2011, from Hubei. We then went to Shandong (山东), Hebei (河北), and across the Shanhai Pass (山海关) we went to the Northeast. We did not visit Hebei last year but went to the Northeast directly, because it was too droughty. Sometimes we visit Qinhuangdao (秦皇岛) of Hebei. The last time we went there was two years ago. We harvested a lot of honey there for three or four years, so we are not confident to go there this year.

Sometimes we migrate to Shaanxi (陕西), and sometimes Henan or Shandong. Xiaogan of Hubei is our “base area” (老根据地); we have many friends there. We also visit Inner Mongolia for buckwheat (荞麦), sunflower and heterophyllous negundo during August and September.

Some of our friends take the west route, starting from Yunnan, going through Sichuan for rapeseed, Gansu (甘肃) for locust tree and Xinjiang (新疆) for cotton.

Yunnan and Guizhou (贵州) are very under-developed. The weather in the south is wet and air pressure is low. Therefore, it is pretty good to live in the North; man should not be insatiable.

**HY:** What kinds of honey do you produce? What are the quantities and prices?

**YHC:** For rapeseed, a hive typically produces 70-80 jin, but 20-30 jin when the weather is bad. Being too rainy is bad in the South and being too droughty is bad in the North. Retail price is more than 20 yuan per jin, wholesale price is 8,000-9,000 yuan per metric ton. Rapeseed honey with higher concentration can be sold at 15,000-18,000 yuan per metric ton.

The highest price of tilia honey is 30,000 yuan per metric ton, locust tree honey also 30,000 yuan per metric ton. In a bumper year, a hive can produce more than 200 jin of tilia honey, or zero in a bad year. Kang tilia (康椴) had a total failure in last year and the year before last. In the year before last, we did not go to the Northeast.

Sometimes the authors of beekeeping books are misleading. Kang tilia and Zi tilia (紫椴) have a blooming time of only half month, but one author says 40 days. The author might have thought that Kang tilia and Zi tilia both have a half month blooming time, so it is reasonable to say that the blooming time of tilia is about 40 days in total. That’s wrong, however. Because Zi tilia blooms first and Kang tilia starts to bloom before the end of Zi tilia’s blooming time.

Price of tilia honey is 15 or 20 yuan per jin. People in the Northeast are down-to-earth and
straightforward (“实在”), and they always buy scores of jin, instead of only several jin.

The yield of locust honey is 30-40 jin per hive; the blooming one week to ten days. In bumper year the yield can be 150-160 jin, but in bad year nothing. The price of locust honey varies, from 20 to 30 yuan per jin, but there is no huge variations. Adulterated honey has been observed.

For jujube honey, the yield is several dozens of jin. During the past twenty years, the yield was always 10, 20 or 30 jin per hive. In Shijiazhuang, we can expect good harvest in four years out of ten; but the specific year of harvest is hard to predict. It is best to be rainy in the night and sunny during the next day. We had harvest in 2008, no harvest in 2009 and 2010, big harvest in 2011, no harvest in 2012, harvest in 2013, total failure in 2014, and no harvest this year. In the past there was the so called “on-year or off-year” (“大小年”), but now it is hard to say; there is no exact way to predict harvest. The climate is abnormal now. The retail price is 15-20 per jin. There is no wholesale, because it is difficult to find pure jujube honey.

The blooming time has been gradually moved forward in recent years, 15-20 days in general, both in the north and south. In some years the blooming time is postponed, thought the general tendency is moving forward. For example, heterophyllous negundo generally blooms in June in Hebei, but it bloomed in late May this year.

HY: Do you offer pollination services? How often? What are the price?

YHC: No, because I’m afraid of being defrauded. My friend once went to Inner Mongolia and Zhangjiakou of Hebei, offering pollination services for sun flowers, which caused serious crawling bees (爬蜂) problems. The crop grower did not allow him to leave even all the bees are crawling away. He will never go there again.

Other friends of mine has experience offering pollination services for apple and pear. In Hebei, they offer pollination services for pears in Zhaoxian (赵县) and Jinzhou (晋州), at 50 yuan per hive. It is profitable. In Inner Mongolia, pollination services were offered for sunflowers and jujube; but they suffered from crawling bees (爬蜂) problems. For pears, beekeepers collect pollen and the pollen is sold to growers, who hire labor to hand-pollinate pears. Pollination services can be offered to apples, but natural pollination is also available. Strawberry must be pollinated by bees; bees are sold, because they will die after pollinating strawberries in greenhouses. The price of bees being sold depends on the condition of the colony: usually 500 yuan per hive for 4-5-comb hives, and 10,000 yuan per hive for 10-12-comb hives.

If crop growers use pesticide, bees will die. But it seems that there is a strong tendency to spray pesticide.

HY: What is your annual income?
YHC: Honey is the main source of income. We produce 2000-3000 jin of propolis annually; that is not too much. Several hundreds of bee wax was produced in 2013. If we have abundant harvest of honey, then everything is fine. Our annual net income is generally scores of thousands of yuan, but we can earn the same money even within one blooming period in a bumper year. Of course, sometimes we are at losses. For example, in 2009, when we were in the Northeast, the yield was so bad that we even have no money for a trip home.

We use 9.6-meter or sometimes 6.8-meter trucks. It is cheaper when we go back home. The annual transportation cost is 40,000-50,000 yuan, which accounts for a quarter of the gross income.

We sometimes need to pay the local people for the use of land. In Yunnan, for example, it cost us 1,700 yuan to rent the site during the blooming time. In Hubei, we do not need to pay, but we do if the crops there are damaged by us. We have friends in Hubei, so we do not pay any money. That is not administered by the government.

HY: Have you ever competed with other beekeepers for nectar sources?

YHC: In general, no. Conflicts may be caused by local residents and beekeepers; migratory beekeepers, however, always adhere to the law and rules. Last year, a blackguard in Henan Province blackmailed beekeepers for honey. Beekeepers couldn’t get rid of him even after offering him honey and cigarettes. One day, a beekeeper’s wife was blackmailed by this blackguard, and the enraged beekeeper killed him.

HY: Do you read books or journals about beekeeping?

YHC: I do not read books or journals now, because I know everything. Books were given to other people as gifts. We beekeepers also communicate with each other.

HY: Are you a member of any beekeeping organizations?

YHC: I know there are beekeeping associations, and I know there is one in Kaifeng; also beekeeping cooperatives. But I am not a member of any of them; it is useless.

The associations divert the subsidies from the central government. I have heard that beekeepers in Shaanxi and Beijing are subsidized at 200 yuan per hive, and beekeepers in some other areas are subsidized at 50 yuan per hive. However, I have not received any money. The associations collect data on the number of beehives. I heard somewhere that beekeepers with more than 130 hives were eligible for the subsidy, but now I do not know.

HY: What are the mortality rates of your bee colonies in recent years? Have you observed any changes in mortality rate during recent years?

YHC: The most important thing is the prophylaxis of varroa (蜂螨); that must be done during the entire year. Moth disease (白蛾病) is commonly seen in the south, but is not a big
deal. The most harmful disease is still varroa. Paralysis disease (麻痹病) is rare. Foul-brood (烂子病) is rare, but the colonies will be in big trouble if it does happen. The main reason for Crawling bees is bad weather. Bees are also threatened by pesticide. Sometimes the local government notifies us before pesticide is sprayed. Toxication caused by pesticide is not serious this year.

There will be no loss in colonies if the wintering is in Yunnan. The mortality rate is thirty percent if we are at home. There is no change in mortality rate. Queens are both produced by our own colonies and bought from other sources.

HY: Are you aware of any kinds of beekeeping related regulations or policies?

YHC: There is no restriction imposed by the government. I do not know of any policy; the only thing I know is that the highway tolls are waived for migratory beekeepers.

HY: Is there anything else that you would like to say?

YHC: Here are some difficulties I would like to mention. Honey price is too low, but the cost of production too high. And the price of sugar is also high. During spring reproduction and wintering, bees need to be fed with sugar. Here is an example: the price of tilia tree honey is more than 30,000 yuan per metric ton or more than 10 yuan per jin, while the price of sugar is several yuan.

Beekeepers are becoming fewer and fewer. The old beekeepers are retiring but the young are not willing to start the beekeeping business. The total cost is 100,000 or 200,000 yuan per year, and the net income, although in bumper years, is (only) more than 100,000 yuan. And bumper years are pretty rare.

In Hubei, the local government is supportive and asks us whether we are bullied by anyone. The government of the city can protect us. In recent years, there are much fewer blackguards than before.

If one keeps only dozens of hives of bees, he is a professional businessman instead of a professional beekeeper; his primary purpose is selling honey, and the beehives are used only as advertisement. A regular beekeeper keeps at least one hundred of hives and practices migratory beekeeping. This is true in every industry: if there are more than one hundred people, they must be different (“人上一百，形形色色”). Honey price is ruined exactly by these businessman-beekeepers.

Honey goes through many intermediates: wholesale merchants, bee product factory, distributors, supermarkets and finally consumers.

---

\(^2\)Here the character “色” (sé) was pronounced shǎi by the informant, and that was a perfect example of “literary and colloquial readings of Chinese characters” (文白歧读). Such phenomena widely exist in Mandarin but always escape the notice of native speakers.
Many people think that crystallized honey is of low quality; that is wrong. If there are one hundred kinds of honey, ninety-nine of them crystallize. For honey, in fact, crystallization is a signal of high quality.

**B.3.5 Informant YJL**

Date: 2015-06-11.
Location: Shijiazhuang, Hebei, China.

**HY**: Personal info: name, hometown, age, family, etc.

**YJL**: I am YJL, 51 years old. I'm from Yichun (宜春), Jiangxi (江西).

**HY**: For how long have you been a beekeeper? How did you start your beekeeping business?

**YJL**: I started to keep bees in 1987. I stopped beekeeping several years after that, and resumed four or five years ago. Our family has a history of beekeeping for three generations, I learned beekeeping from my father-in-law.

The transportation condition is much better now. Bee hives were transported by train in the past, but by trucks now. It was droughty last year, and the yield was low.

**HY**: How many hives do you have? Italian bees or Chinese bees?

**YJL**: I have 110 hives, 11-14 combs per hive with double queens.

**HY**: Do you travel? For what purpose (mainly honey or pollination)?

**YJL**: (Also see Table 3.8) The first stop is Anhui (安徽), March 20, for rapeseed honey and spring reproduction. This year we stayed there for less than twenty days, but in the past we sometimes stayed there for more than one month. In early April we went to Jiangsu, and late April Shijiazhuang in Hebei. The nectar source in Jiangsu was also rapeseed.

On May 4, we went to Fuping (阜平) of Hebei for jujube, and back to Shijiazhuang on May 14. Probably we will visit Shanxi (山西) later. We are now producing honey from jujube and heterophyllous negundo. Around July 20, we will visit Inner Mongolia for sunflowers and rapeseed. The yield last year was bad in Shanxi; bees fought with each other there.

In September we go back home, in Jiangxi. Nectar sources include wild flowers in the mountain, tea flowers and Sarcococca ruscifolia (冬桂). The harvest depends on the divine will.

In October, wintering begins. We start the spring reproduction after winter solstice (冬至); bees hibernate for about one month. The nectar source is rapeseed as well. We stay at home for more than half year. Rapeseed in the South blooms earlier than the North. Bees are sometimes fed with sugar during wintering.

I can recall that more than twenty years ago, we went to Henan around April 10 for locust
trees, to Yan’an (延安) of Shaanxi in mid-May, and sometimes to Shandong. It depends; we may follow suggestions of beekeepers from our hometown.

HY: What kinds of honey do you produce? What are the quantities and prices?

YJL: It has been droughty since last year, and the yield has been low. We produce 15-16 jin of locust honey per hive, but the yield can be as low as 5-6 jin. When nectar source is not abundant, we extract honey in a timely manner in order that different kinds of honey do not get mixed. The retail price is 20 yuan per jin, and the wholesale price is 20,000 yuan per metric ton. Prices vary across years, depending on the level of harvest. We produce more than 10 jin of jujube honey per hive. The retail price is 15 yuan per jin and wholesale price 10,000 yuan per metric ton. We produce 50-60 jin of rapeseed honey per hive, and the wholesale price is more than 7,000 yuan per metric ton. It depends on gods. Sometimes we experience losses.

HY: Do you offer pollination services? How often? What are the price?

YJL: In recent years, we visit Inner Mongolia at the end of July, offering pollination services for sunflowers. The pollination fee was around 100 yuan per hive. It is likely to have crawling bees there. The contract specifies the dates of entry and exit and the pollination fee. Some crop growers pay for the transportation costs. It all depends on the crop grower: if he is kindhearted, then he will let us go when there are too many crawling bees; otherwise he forces us to stay even if all the bees are dying. Sometimes we leave without being paid, because of the crawling bees. Generally, 200 mu of sunflowers demand 100 hives of bees.

We have a wide acquaintance, so the route we take is similar each year. In Jiangxi, we offer pollination services for strawberry, from October to March, after the Spring Festival. We sell the bees at 200 yuan per hive, because they will die after pollinating strawberries.

In sum, it depends on gods.

HY: Have you ever competed with other beekeepers for nectar sources?

YJL: No. We are all poor migratory beekeepers, so we help each other. We generally do not pay land owners, but offer them some honey as gifts. Sometimes we need to pay when we are using cultivated fields. We had experience being blackmail in the past; the bad guys plundered us of our honey.

HY: Do you read books or journals about beekeeping?

YJL: No. I am not well educated, so I do not read books. We beekeepers learn from each other, for example, what medicine to use for a certain disease.

HY: Are you a member of any beekeeping organizations?

YJL: No. We do not have local beekeeping associations or cooperatives. It is hard to set up such organizations because the registration process is so time consuming. Therefore, we all
keep bees as individual beekeepers. It should be better, however, to have such organizations when negotiating prices, because the wholesale merchants have lots of reasons to lower the price when buying honey. They may say, for example, our honey is thin and impure.

**HY:** What are the mortality rates of your bee colonies in recent years? Have you observed any changes in mortality rate during recent years?

**YJL:** After wintering, we have 2 combs left in a hive with more than 10 combs, so the mortality rate is 80-90 percent. The colonies recover very quickly after the spring reproduction. However, it is rainy in the south, which is not good for reproduction. It is cold during winter in the north, so bees do not move, which saves their energy. It is hot in the south, so bees are always flying, so they get old and die very quickly.

The main health problem is varroa; nothing else. Crawling bees may be caused by jujube flowers, by hot weather, or by high humidity.

**HY:** Is there anything else that you would like to say?

**YJL:** The transportation cost from Jiangxi to Hebei is 8,000-9,000 yuan, and will be higher when we go back. The annual transportation cost is more than 20,000 yuan. The treatment for bee diseases is also costly. Daily living cost is hard to estimate.

We experienced losses every year in the 1980s, when honey price was 1 yuan per jin. Afterwards we were in some southern cities doing other jobs, until my children got married. We needed to talk with the parents of their girlfriend and boyfriend, so we went back home. They got married and now have their own jobs, so I do not have any extra burdens and I am not expecting to earn too much money from beekeeping. My son will never be a beekeeper. I was a bricklayer, but now I am more than 50 years old and no one hires me, so I began to keep bees again. In the past we had heavy burdens, but not too much now. We migrate as travelers. If we do not earn enough money, our son will support us.

Nowadays beekeepers are all from families with traditions of beekeeping, otherwise no one keeps bees, because it is toilsome and dangerous to be a professional beekeeper. It is much easier to do other jobs, and the income is stable (‘旱涝保收’).

Beekeeping will disappear in the future, unless it is subsidized. I have heard that there are beekeeping cooperatives in some areas, and the cooperative reports the information of beekeepers to the related authorities and gets the beekeepers subsidized. Individual beekeepers not participating the cooperatives are not subsidized.

My father-in-law is more than 70 years old. He is at home and still keeping 20-30 hives of bees.

There is no much difficulty for us now; everything depends on gods.
When we are transporting bee hives, it is not allowed for us to sit beside the beehives on the truck, but that is impossible. We need to take care of the hives when transporting. It is generally not a big deal, but sometimes the officer of related authorities stops us for the sake of blackmail. If the truck stops for too much time, bees will flee. Some people are doing evil, though I believe most people are kindhearted.

B.3.6 Informant LXC

Date: 2015-06-12.
Location: Shijiazhuang, Hebei, China.

HY: Personal info: name, hometown, age, family, etc.

LXC: I am LXC, 43 years old, from Kaifeng (开封), Henan. There are five people in my family, including a child. We migrate together.

HY: For how long have you been a beekeeper? How did you start your beekeeping business?

LXC: 15 years. I learned knowledge on beekeeping from an old beekeeper in the Northeast.

HY: How many hives do you have? Italian bees or Chinese bees?

LXC: I have 120 hives of Italian bees. Each hive has 11-12 combs.

HY: Do you travel? For what purpose (mainly honey or pollination)?

LXC: This year in April, I was in Zhejiang (浙江), and I arrived at Jiangsu (江苏) at the end of April. I produce rapeseed honey in those two provinces. On May 1, I arrived at Shandong (山东) for locust and stayed there for one month. I went to Hebei in June, producing honey from heterophyllous negundo and jujube. I stay at Hebei for about one month. I will go to Northeast for tilia honey on July 1 and stay there until the end of October. I may leave the Northeast for Zhejiang during September to October and stay at Zhejiang until April. It is warm there, which is good for the reproduction of bees. Nectar sources include rapeseed, loquat, Cleome viscosa (黄花草 or 菖子); there are also different kinds of pollen there, like tea flower pollen and rapeseed pollen. Producing tea flower pollen does not cause the crawling bee problem.

HY: What kinds of honey do you produce? What are the quantities and prices?

LXC: The yield of rapeseed honey was not good this year; one hive produced 40-50 jin. In a bumper year one hive may produce more than 100 jin. But it was too rainy this year. I did not have enough rapeseed honey to sell. The retail price is 20-30 yuan per jin; there is no wholesale. It is the regular customers who purchase my honey.

For locust honey, one hive produces 40-50 jin. The price is 20-30 per jin. Again, there is no wholesale because I do not have enough honey to sell.
In a bumper year one hive produces 70-80 jin of jujube honey. But I had a total failure of harvest last year; there was a huge loss.

In general I do not pay the landowners but gift them some honey. Sometimes I do need to pay; and the price goes up every year. Now the price is 500 yuan.

HY: Do you offer pollination services? How often? What are the price?

LXC: Yes. In Jiangsu, I offer pollination services for peach at 200 yuan per hive. That takes place in Zhangjiagang (张家港) in late march and lasts for three days. The area pollinated is more than 10 mu, which requires 20-40 hives of bees.

Also in Zhangjiagang, I sell bee hives to greenhouse strawberry growers at 100 yuan per comb. I sell them because bees all die after pollinating strawberries in greenhouses. There are three combs in one hive and I sell 40-50 hives; there is one hive for each greenhouse. The area of the greenhouse is uncertain. We do not have a formal contract; we just make oral contracts. The price per hive is 300 yuan, and there is 900 yuan deposit, so I receive 1200 yuan first.

I have been offering pollination services for more than 10 years; the route I took is similar across years.

HY: What is your annual income?

LXC: Our net income is more than 10,000 yuan. We do not go home during the entire year. On average each person in the family earns 20,000-30,000 per year. Honey accounts for more than half of the income, and pollination less than 10 percent. Other income sources include royal jelly, pollen, propolis and bee wax.

The transportation cost is 2,200 yuan from Shandong to Hebei, and 2,700-2,800 yuan from Jiangsu to Shandong. The total transportation cost is more than 10,000 yuan per year. My friends have been to Yunnan, and the transportation cost is even higher.

HY: Have you ever competed with other beekeepers for nectar sources?

LXC: No. We beekeepers take care of each other.

HY: Do you read books or journals about beekeeping?

LXC: I used to read books but now I do not; because I know everything. I have an apprentice in Wuji (无极).

HY: Are you a member of any beekeeping organizations?

LXC: I am not a member of any association; it is not useful. Nor do I join any cooperative; there is no benefit. If I Join these organizations, I will have to sell my products to them, and the prices are very low. Cooperatives, in particular, demand very low prices.

HY: What are the mortality rates of your bee colonies in recent years? Have you observed
any changes in mortality rate during recent years?

LXC: Varroa (蜂螨) is pretty common. There is no moth disease (白蛾病) or paralysis disease (麻痹病). Sunflowers are likely to cause crawling bees. Jujube flowers also causes crawling bees because of its biological alkali (生物碱) and the use of pesticide.

After wintering 2-3 combs remain alive and the rest die; the winter mortality rate is 80 percent. There is no change in mortality rate.

HY: Are you aware of any kinds of beekeeping related regulations or policies?

LXC: It is said that there is subsidy, but I have never received. I believe it is embezzled by the organizations mentioned above.

In terms of other policies and restrictions, the most important thing, I suppose, is that we should not sell adulterated honey. Guanshengguan (冠生园) of Shanghai was reported to have sold adulterated honey. Adulterated honey is also produced in Zanhuang (赞皇) of Hebei; I know that is still the case now. There is no use to report this illegal activity because of local protectionism.

HY: Is there anything else that you would like to say?

LXC: I do not think there is any difficulty. Highway tolls are waived, which is good. Beekeeping is good for your health; being stung by bees is good for the body.

B.3.7 Informant WC

Date: 2015-06-12.
Location: Shijiazhuang, Hebei, China.

HY: Personal info: name, hometown, age, family, etc.

WC: I am WC, 25 years old, from Kaifeng of Henan. I migrate with my family, within which there are four people.

HY: For how long have you been a beekeeper? How did you start your beekeeping business?

WC: I have only several years of beekeeping experience, but my father has more than 20 years. I have been keeping bees with my father for 6 years.

HY: How many hives do you have? Italian bees or Chinese bees?

WC: Here I have 80 hives, and in Pingshan (平山) have more than 100 hives. Each hive has 9-10 combs on average. They are all Italian bees; there is no Chinese bee. We had two hives of Chinese bees, but now we do not, because the yield is too low.

HY: Do you travel? For what purpose (mainly honey or pollination)?
WC: We left Kaifeng for Sichuan in mid-October last year. The nectar source was rapeseed, and loquat before the Spring Festival. We stayed at Sichuan, near Chengdu, until late April. Around April 20, we went to Suzhou (苏州) of Jiangsu. We stayed at Jiangsu for about 20 days.

We arrived at Hebei in mid-May. I am here taking care of these 80 hives and my father the other 100 hives in Pingshan (平山). Nectar sources in Hebei include locust, heterophyllous negundo and jujube.

Now it is Jun 12. We plan to go to Tongliao (通辽) of Inner Mongolia in late June for sunflowers. We will stay there for about one month until late July. We will visit the Northeast in August, producing tilia honey in Changbaishan Mountain (长白山) of Jilin. We will go back to Chengdu of Sichuan before September 10. If the temperature is low, we will go to Panzhihua (攀枝花). We will stay at Sichuan until late April, and will not go back home. But if we have time, we will go back home during Spring Festival.

Every year the route is similar. We visited Shanxi (山西) during 2012-2013, when we went out of Sichuan but did not visit Jiangsu; instead, we went to Shanxi for rapeseed, and arrived at Hebei in June.

HY: What kinds of honey do you produce? What are the quantities and prices?

WC: Depending on the weather, the yield of rapeseed varies from 20-30 jin to 70 jin per hive. The retail price is 15 yuan per jin, and wholesale price is a little more than 10,000 yuan (“一万多点儿”) per metric ton. Price is related to the harvest; if the harvest is not good then the price goes up.

The blooming time of locust tree is short. On average one hive produces 30-40 jin. The retail price is 20 yuan per jin, and wholesale price is more than 20,000 yuan per metric ton.

The blooming time of jujube overlaps with heterophyllous negundo’s. The yield of jujube honey is about 50 jin per hive. The wholesale price is less than 20,000 yuan (“一万多点儿”) per metric ton. The price of jujube honey is the same as locust. Crawling bees (爬蜂) are more likely to be observed after bees visit jujube flowers, because the flower contains jujube-flower-alkali (“枣花碱”), which causes toxification of bees. In addition, crop growers tend to spray pesticide on jujube. If it is not droughty, the yield of heterophyllous negundo can be more than 60 jin per hive. The retail price is about 20 yuan per jin, and the wholesale price is about 15,000 yuan per metric ton.

The yield of sunflower honey is about 30 jin per hive. The retail price is 15-18 yuan per jin, and the wholesale price is a little more than 10,000 yuan (“一万多点儿”) per metric ton.

We pay the land owners several hundreds of yuan during one blooming period.

HY: Do you offer pollination services? How often? What are the price?
WC: Yes. We offer pollination services in mid-July in Inner Mongolia for sunflowers.Blooming time of sunflowers is more than twenty days and the pollination lasts more than ten days. The pollination fee is more than 20 yuan per hive. We make only oral contracts. We offer pollination service for 100-200 mu of sunflowers using about 80 hives of bees. The specific number of areas and hives cannot be predicted because we offer the service for different growers every year.

HY: What is your annual income?

WC: The annual net income is more than 100,000 yuan. We can earn more than that if the weather is good. If the weather is droughty, however, then no honey will be harvested. Honey accounts for 70-80 percent of the income, and pollination about 10 percent. Other income sources include pollen, propolis, and bee wax.

HY: Have you ever competed with other beekeepers for nectar sources?

WC: Generally, no. We have heard of conflicts between beekeepers when nectar sources are limited. If we are aware of the limited availability of nectar sources in a certain area, we simply do not go there.

HY: Do you read books or journals about beekeeping?

WC: I read Bee Journal (《蜜蜂杂志》), and sometimes Apiculture of China (《中国蜂业》). We do not subscribe, though, because it is impossible to receive mails during migration.

HY: Are you a member of any beekeeping organizations?

WC: No. I do not know if there is an association in Kaifeng. The beekeeping associations seem to be something new, and many areas do not have their local beekeeping associations. I do not think there is any beekeeping cooperative either.

HY: What are the mortality rates of your bee colonies in recent years? Have you observed any changes in mortality rate during recent years?

WC: Our bees are healthy in general. There is varroa. Crawling bees may be caused by jujube flowers. There is no moth disease (白蛾病), because the breed we are using this year is very good and anti-disease. There might be some paralysis disease (麻痹病) when the weather is wet in the south.

After wintering two combs remain alive and eight die in a hive, so the winter mortality rate is 80 percent. Spring reproduction follows the wintering. The winter mortality rate does not vary much across years. It is cold in the winter, so the queen does not give birth to new bees. In winter we look for piecemeal nectar sources for bees, and rapeseed is the nectar source for wintering. If there is no enough honey during wintering, we feed the bees with sugar.

HY: Are you aware of any kinds of beekeeping related regulations or policies? Is there
WC: The most difficult thing for migratory beekeeping is transportation. During our migration, we need to load and unload the hives, and that makes us exhausted. Nowadays it is better, though, because there is the so called “green highway,” the tolls of which are waived for migratory beekeepers. The transportation from Sichuan to Hebei costs several thousands of yuan (“大几千块钱”). We use 9.6-meter trucks. The total annual transportation cost is 50,000-60,000 yuan.

Another problem is that there is not a good platform for transactions of honey. Wholesale merchants tend to offer very low prices.

B.3.8 Informant LSJ

Date: 2015-05-27.
Location: Pingshan, Shijiazhuang, Hebei, China.

HY: Personal info: name, hometown, age, family, etc.

LSJ: I am LSJ, 45 years old, from Shiziping (狮子坪) of Pingshan (平山), Shijiazhuang, Hebei.

HY: For how long have you been a beekeeper? How did you start your beekeeping business?

LSJ: 23 years. I have nothing to do after I graduated from Beiye Middle School (北冶中学) in 1992, so I started to keep bees. I started with only one hive of bee. I also work in the Department of Electric Management (电管所).

HY: How many hives do you have? Italian bees or Chinese bees?

LSJ: I have 140-150 hives. Italian bees.

HY: Do you travel? For what purpose (mainly honey or pollination)?

LSJ: Yes. I practice short-distance migratory beekeeping (小转地). Every year around May 1 I go to to Tuling Village (土岭村) 10 km from here for locust honey. Later I also produce jujube and heterohyllous negundo honey there. The blooming time of jujube and heterohyllous negundo are May 20 to June 10 and June 10 to July 20, respectively. In August, I go back home in Shiziping (狮子坪) and begin autumn reproduction and wintering.

I do not need to pay the land owners or crop growers.

HY: What kinds of honey do you produce? What are the quantities and prices?

LSJ: The yield of all kinds of honey, in total, is 100-150 jin per hive. I am not able to say specifically the yield of each kink of honey. The wholesale price of locust honey is about 20,000 yuan per metric ton, varying from 15,000-16,000 to 30,000 yuan per metric ton. 2007 was a
bumper year. The wholesale price of jujube honey is 10,000-12,000 yuan per metric ton. The wholesale price of heterophyllous negundo honey is about 10,000 yuan per metric ton. In the spring, a small amount of honey of different kinds of flowers in the mountain is produced. The retail price is 15-20 yuan per jin, or 30-40 yuan per kg.

I have been keeping bees for 23 years, but I experienced losses in only one year, when the weather was extremely droughty.

HY: Do you offer pollination services? How often? What are the price?

LSJ: No; but I know other people doing that. They offer pollination services for different kinds of greenhouse vegetables, strawberry and Prunus armeniaca (杏), charging 300-500 yuan of pollination fee per hive. Each greenhouse requires one or two hives of bees. I do not offer pollination services because we do not have greenhouses nearby. In Zhengding (正定) and Baoding (保定) there are greenhouses, but not here.

Some people buy my bees for pollination services. I sold 45 hives this year at 400 yuan per hive. One should not use colonies that are too strong for pollination services, because strong colonies tend to be hotheaded and all bees may flee.

HY: What is your annual income?

The net income is 50,000-60,000 yuan per year. When the total revenue is high, the cost is also high; for example, if the total revenue is 100,000 yuan, then the net income is about 50,000-60,000 yuan. The main income source is honey; bee wax accounts for less than 10 percent.

LSJ: 50,000-60,000 yuan per year. Honey is the main source of income.

HY: Have you ever competed with other beekeepers for nectar sources?

LSJ: There are competition; but it is not a big deal. I can build good interpersonal relationships so there is no trouble. There is no governmental restrictions on that.

HY: Do you read books or journals about beekeeping?

LSJ: Yes. I began to subscribe and read journals two or three years after I started beekeeping. I read Journal of Bee (蜜蜂杂志) and Apiculture of China (中国蜂业), and now only Apiculture of China.

HY: Are you a member of any beekeeping organizations?

LSJ: Yes. We have beekeeping associations in every county. I am in the Tianguishan beekeeping Cooperative (天桂山蜜蜂合作社). During winter when beekeepers are not busy, beekeeping experts are organized to offer training to us.

HY: What are the mortality rates of your bee colonies in recent years? Have you observed any changes in mortality rate during recent years?
LSJ: Varroa is the most serious natural enemy; all the bees will die if the management is not effective. Crawling bees are caused by malnutrition; jujube flowers are also likely to cause crawling bees, because the flowers contains biological alkali (“生物碱”).

The winter mortality rate is hard to predict. Under good circumstances the mortality rate is one fifth, and bad circumstances one half or even one hundred percent. The mortality rate did not change a lot in recent years. The feeds are most important for wintering.

HY: Are you aware of any kinds of beekeeping related regulations or policies?

LSJ: I know beekeepers in Beijing are subsidized; each hive is subsidized by some money. We do not have it here. The government encourages beekeeping; but we are too far from the central government (“山高皇帝远”).

Antibiotics are not allowed; it is prohibited by the government, because honey with antibiotics cannot be exported. It is not allowed to use medicine for the treatment of varroa when producing honey, because the medicine would pollute the bee products.

HY: Is there anything else that you would like to say?

LSJ: The most serious problem is the disorderly market, where there is too much adulterated honey. For example, there was adulterated honey in Zhejiang (浙江) being investigated several years ago.

The wholesale price is too low, and sometimes honey is even cheaper than sugar. Especially in 2011 or 2012, the wholesale price of honey was 8,000 yuan per metric ton, but the sugar price was higher than 8,000 yuan per metric ton. In that year I did not produce honey in autumn because I would need to feed the bees with sugar if I had produced honey, which is economically undesirable. Good honey is not sold at good price.

The wholesale merchants do not make the distinction between high quality and low quality, so they offer very low prices. The export prices are, however, very high. There are both local and non-local wholesale merchants, but the non-local ones cannot buy our honey. Once a merchant from another area visited us and tried to purchase honey, but finally he was attacked by the local merchants, who have the monopsony power. I heard that in Zhejiang, all the honey is bought by the beekeeping associations at a good price, and the associations have a larger price negotiating power when selling honey to the merchants.

I sell honey relying on my good reputation. Visitors in the tourist areas buy my honey. I am located near the 207-Highway, where there is a lot of traffic; many visitors and drivers purchase honey from me.
B.3.9 Informant QHS

Date: 2015-05-27.
Location: Pingshan, Shijiazhuang, Hebei, China.

HY: Personal info: name, hometown, age, family, etc.

QHS: I am QHS, 58 years old, from Taoke Village (桃科村) of Pingshan (平山), Shijiazhuang, Hebei.

HY: For how long have you been a beekeeper? How did you start your beekeeping business?

QHS: I started beekeeping when I was 19. I learnt from book and journals.

HY: How many hives do you have? Italian bees or Chinese bees?

QHS: I have 200 hives of Italian bees and 2 hives of Chinese bees. There are 12-13 combs in each hive.

HY: Do you travel? For what purpose (mainly honey or pollination)?

QHS: On January 1, we arrived to Jingzhou (荆州) of Hubei, in Huangjiakou Township (黄家口镇), Xiangkou Village (相口村). That was the third time we visited Jingzhou. There we produce rapeseed honey. We went back home on April 20. We rent the 6.8-meter truck; the transportation cost from Hebei to Jingzhou was 4500 yuan, but only 2500 yuan when we came back, because there were more trucks available when we came back. Then our migration ends; next migration will start next year on January 1 again.

We went to Licun Village (李村) of Huailu (获鹿) in 2010, more than 100 li (50 km) from here. We spent half month there for autumn reproduction. We also produce heterophyllous negundo honey and some pollen there. We went there on July 25 and came back on August 25.

We went to Eshi Village (恶石村) in 2007, from June 15 to September 25. We produced heterophyllous negundo honey. It was very droughty in that year, so we had to migrate to Eshi to produce honey.

We also visited Shimen Reservoir (石门水库) three times. We produce locust, heterophyllous negundo and jujube honey there.

HY: What kinds of honey do you produce? What are the quantities and prices?

QHS: We harvested 2.5 metric tons of locust this year. The wholesale price is 17,000 per metric ton, and retail price is 10, 15 or 20 yuan per jin, depending on the personal relationships.

---

3Here “获” should be pronounced huái instead of huò.
4Some interesting linguistic facts here. The informant used nián (“年”, year) when referring to a particular year, like the year of 2007; but when counting the years, one of the informant’s relatives said bā zǎi (“八載”, eight years). The use of zǎi (“載”) here is archaic, and very rare in modern spoken Chinese, either the standardized Mandarin or Pingshan Dialect.
Now the production of jujube honey just began, and we have produced 1200 jin until now. The whole sale price is 10,000 yuan per metric ton, and we have already been prepaid. The price of locust honey last year was 21,000 yuan per metric ton, jujube honey 10,700 yuan (“一万零七”) per metric ton, and heterophyllous negundo 10,000 yuan per metric ton. Last year the yield of locust honey was 1.5 metric ton, jujube 3 metric ton, and heterophyllous negundo 6 metric ton. Last year was a bumper year for heterophyllous negundo.

We do not pay the land owners or crop growers. We rent a room, however, for which we need to pay 200 yuan for four months.

**HY**: Do you offer pollination services? How often? What are the price?

**QHS**: No. The rapeseed was indeed pollinated by us, though we did not charge any fee. People in Hubei are nice and friendly; they gave us vegetables and fish as gifts.

I do not offer pollination services because the colonies will be weakened after pollination. I have enough income now; I am pretty satisfied with the annual income of 30,000-50,000 yuan now and not expecting more.

**HY**: What is your annual income?

**QHS**: It is difficult to estimate the net income. The total cost is high, including hives, honey extracting machine, the honey barrel, tents, medicine and sugar. Honey is the main source of income. I sold 100 jin of bee wax at 19 yuan per jin and earned more than 1,000 yuan this year. The yield of propolis last year was 23 jin, and I sold it at 90 yuan per jin. The propolis contained impurities.

**HY**: Have you ever competed with other beekeepers for nectar sources?

**QHS**: No. We have friends in Hubei, and we have a very good personal relationship. I have heard there were such conflicts, however.

**HY**: Do you read books or journals about beekeeping?

**QHS**: Yes. I read books and Journal of bees (《蜜蜂杂志》). I used to read Apiculture of China (《中国蜂业》), but now I do not.

**HY**: Are you a member of any beekeeping organizations?

**QHS**: Yes. I am the member of Tianguishan Beekeeping Association (天桂山养蜂协会). They offer lectures with the Animal Husbandry Bureau (畜牧局). The association was spontaneously organized by individual beekeepers. We have more than 100 households in the association, and each pay 50 yuan for the membership.

**HY**: What are the mortality rates of your bee colonies in recent years? Have you observed any changes in mortality rate during recent years?
QHS: The bees are very healthy now, because we have protection regularly. When finishing producing heterophyllous negundo honey, we treat the bees three times, which is considered one course of treatment. We start the spring reproduction on January 1, when we treat the varroa disease. Afterwards we treat the varroa three times again.

The moth disease can be treated by Moth Cleaned (“白蛾清”). There is no other health issues.

We go to the south for wintering, where the temperature is around 0 C. The mortality rate is one fifth. There was no change in recent years. In the past when we did not perform long-distance migration (大转地), the mortality rate was 50 percent, which was pretty high.

HY: Are you aware of any kinds of beekeeping related regulations or policies?

QHS: The Animal Husbandry Bureau organizes symposia, and we were taught that we should not use antibiotics. We are producing organic (“绿色”) honey, which is not allowed to be polluted.

B.3.10 Informant LXS

Date: 2014-05-22.
Location: Zanhuang, Shijiazhuang, Hebei, China.

HY: Personal info: name, hometown, age, family, etc.

LXS: I am LXS, more than 70 years old, from Wuchang village (武昌村) of Zanhuang, Hebei.

HY: How many hives do you have?

LXS: I have 170 hives. Each hive has 13 combs, and each comb has 2000 bees.

HY: Do you travel? For what purpose (mainly honey or pollination)? What kinds of honey do you produce? What are the quantities and prices?

LXS: The yield of honey varies from scores of jin to about a hundred jin per year. The price of locust honey is 17,000 yuan per metric ton, and 8.5 yuan per jin. The price of heterophyllous negundo is about 5 yuan per jin.

Some may be afraid lest the jujube honey is polluted by pesticide. In fact, it does not matter. Just think of the fact that bees are not killed by the pesticide, so human will not be harmed by pesticide. However, during the blooming time of jujube, pesticide should not be sprayed, because the pesticide may hurt the flowers.

I mainly practice short-distance migratory beekeeping (小转地). This year, I went to Gaoyi (高邑) and Chenzhuang (陈庄) on April 27 or 28 and produced locust honey during the following
days. Afterwards I would go to Baishankou (白山口) to harvest the second round of locust, because the altitude there is higher and the weather is colder. The third round of locust would be harvested in the Xibaipo tourist area (西柏坡旅游区) if Pingshan (平山), where the prices are good because there are lots of visitors. The raw locust honey (生蜜) must become mature before selling, and the signal of maturity is a high density. The honey will not be storable if not mature. I am not willing to sell immature locust honey even if the buyer offers a high price, because I am afraid lest my honey is treated as adulterated honey.

I then go back to Zanhuang, producing heterophyllous negundo honey in the mountain, during Xiaoshu (小暑) and Dashu (大暑). The short-distance migration ends in August.

Long-distance migration (大转地) also takes place, and we would go to Inner Mongolia for sunflowers. We do not drive trucks but rent truck services.

**HY:** Do you offer pollination services? How often? What are the price?

**LXS:** Yes. I generally do not charge pollination fees, however. Sometimes crop growers invite me to pollinate the crops. During March and April I offer pollination services for apple and cherry. The crop growers take care of the transportation, and they must promise that no pesticide will be used. In Gaoyi (高邑), I offered pollination services for plums for half month to twenty days, and charged 40-50 yuan per hive. I offered pollination services free of charge for corns (棒子). I offered pollination services in Zhaoxian (赵县) for pear.

Pollination has significant positive effects for agriculture.

Pollination is not profitable. I do not charge fees when offering such services, because I can leave whenever I want and I am not restricted by anything. If I am paid, then I will be subject to the constraints, and will not be able to leave when I want. For example, the Party Branch Secretary (支部书记) promised that no pesticide would be used, but it turned out that there were still people sprayed pesticide. I was there pollinating cabbage; most people followed the Secretary’s instruction but still there are one or two households did not. My bees were poisoned, but it is difficult for us to be compensated for the loss. Ill luck.

I offered pollination services in Baoding (保定) for cherry; they agreed to cover the transportation cost, so I did not charge any fee.

**HY:** What is your annual income?

**LXS:** One cannot make lots of money by keeping bees.

**HY:** What are the mortality rates of your bee colonies in recent years? Have you observed any changes in mortality rate during recent years?

**LXS:** It is very normal that bees die after wintering. I change queens every year, though queens of good quality can be used for two years, and very good quality 3 years. The life
expectancy of queens is five years.

There is varroa (蜂螨) disease.

**HY**: Is there anything else that you would like to say?

**LXS**: Honey has become cheaper and cheaper. When I started beekeeping, one unit of honey equals one unit of sesame oil (香油), later one unit of honey equals one unit of white oil (白油), and then one unit of honey equals one unit of pork. Now it is even cheaper than pork.
Appendix C

The Map of China
Figure C.1: Political Map of China. Source: National Bureau of Surveying and Mapping