

## ABSTRACT

CHVOSTA, JAN. The Economic Effects of Federal Peanut Policy: the 1996 Fair Act, the 2002 Farm Security Act, and the Federal Crop Insurance Program. (Under the direction of Walter N. Thurman.)

Government programs that restrict production and increase prices to particular groups of producers have a long history in the United States. The purpose of this research is to analyze the implications of such a program for peanuts in three independent essays.

The first essay focuses on the development of a model of the effects of cross-county transfers on peanut quota after the 1996 farm bill. Using a spatial linear regression model, the hypothesis that the lifting of transfer restrictions tends to equilibrate lease rates across counties is tested. The results indicate that, after the 1996 bill, peanut quota moved out of counties that under produce their quota to overproducing counties, indirectly indicating a tendency for lease rates to equalize.

The second essay studies the most recent changes to the peanut program, enacted by the U.S. Congress in 2002, and reviews important events that led to these changes. Several models are developed that analyze the costs and benefits of the revised program in domestic and foreign markets. It is concluded that farmers in most peanut producing states will incur losses due to the peanut program changes, with the exception of Texas and Florida. The impact of the transformation on the world price of edible peanuts is analyzed and shown to be theoretically ambiguous-- the world price could either increase or decrease depending on demand and supply elasticities. The essay explores numerically the influence of the relevant elasticities.

The third essay reviews the U.S. federal crop insurance program and investigates

its interaction with the peanut program. A model of a risk neutral profit maximizing farmer is developed and comparative static results are derived. The results show that in equilibrium peanut quota lease rates do not represent the full difference between the support price and world price and are affected by the cost of crop insurance.

**THE ECONOMIC EFFECTS OF FEDERAL PEANUT POLICY:  
THE 1996 FAIR ACT, THE 2002 FARM SECURITY ACT,  
AND THE FEDERAL CROP INSURANCE PROGRAM**

by

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**Approved by:**

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**Chair of Advisory Committee**

## **BIOGRAPHY**

Jan Chvosta was born in Prague, Czech Republic. He received his undergraduate and graduate degree in Computer Engineering from the Agricultural University in Prague, Czech Republic. After the changes in Central and Eastern Europe in 1989, Jan became involved in the international exchange program organized by Ohio State University and came to the United States to gain experience as an exchange student. After 18 months in the exchange program, Jan decided to pursue his education further and received a M.S. degree in Applied Economics at Montana State University in Bozeman, MT. Upon graduating, Jan spent an additional year at the Department of Economics at the University as a research assistant.

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## 1. INTRODUCTION

This dissertation consists of three independent essays. The first essay focuses on the development of a model of the effects of cross-county transfers of peanut quota after the 1996 FAIR-act. The act loosened restrictions on such transfers. The empirical predictions from the model are tested on two pre- and post-FAIR data sets, containing data on production, effective quota and lease rates. The data are further tested for spatial dependencies and several spatial models are developed.

The second essay focuses on the most recent changes after the 1996 FAIR-act. Among recent forces for change in the peanut program are international trade agreements signed by the United States, most importantly NAFTA and the GATT/WTO. Under these treaties, imports of domestic edible peanuts rose substantially. Free-trade pressures and others led in 1996 to the FAIR act, which lowered the support price, and to reductions in the aggregate level of quota. Both changes reduced the cost of the program. However, peanut program opponents have pushed for further changes. In July 1998, during floor debate on an agriculture appropriations measure, the U.S. House rejected an amendment that would further lower the quota support price to \$550. In 1999 and 2000, the differences between growers and manufacturers became deeper and the House of Representatives and U.S. Senate began work on a new farm bill that contemplated the elimination of the current peanut program. This bill was signed on May 13, 2002 by president Bush and its impact on the peanut industry will be analyzed along with the U.S. House and Senate bill's proposals. Its implications for the domestic price of peanuts, the location of production, and the economic effects on producers, consumers,

and current owners of peanut quota are discussed.

The third essay summarizes the history of the Federal Crop Insurance Program and investigate the relationship between the Peanut program and Federal Crop Insurance program. Interactions are analyzed between the two programs, both of which have income-reducing features. Borges and Thurman's (1994) model is updated to include changes in the Peanut Program after FAIR and altered to include insurance choice variable and comparative statics results are derived.

## **ESSAY I**

### **2. THE 1996 FAIR ACT**

The U.S. peanut program has restricted peanut production and increased the price received by farmers since 1949. Unlike the programs for grains, cotton, and rice, the 1996 Federal Agriculture Improvement and Reform (FAIR) Act left the peanut program largely intact. As before FAIR (and since 1977) the right to grow peanuts for the domestic edible market is embodied in marketing quota, which can be leased and sold. Also as before FAIR, the right to grow peanuts to be exported or crushed into oil and meal is unrestricted. What did change post-FAIR was the set of restrictions on the lease and transfer of quota.

Due to these changes, quota has moved as much as the regulatory caps allow in some parts of the country. For example, between 1995 and 2000 in Texas, cross-county

quota movement represented 53% of 1995 quota<sup>1</sup>. Other areas have seen less, but still substantial, movement: in Oklahoma 36% of 1995 quota had migrated by 2000. The traditional peanut-growing areas of the Southeast have seen less cross-county movement: in Georgia 8% and Alabama 14% of quota moved across county lines, in Florida 8%, and in North Carolina and Virginia 7%.

Changes in peanut production levels were also substantial. Georgia, the largest peanut producing state, produced more than 1.3 billion pounds in 2000 and its production declined by 16% over the 1994-2000 period. Production in number two Texas was under 700 million pounds in 2000, representing a remarkable 40% increase from pre-FAIR levels. (Even more remarkable were the levels of production in Texas in the late 1990's, which reached 900 million pounds before dropping sharply in 2000.) Further, production growth in Texas is unique among the states. Total national production declined by 8% over the 1994-2000 period. Among other peanut-producing states, only Florida (which grew by 16%) saw positive, but smaller, growth. Notably, Texas' neighbor state of Oklahoma produced 31% fewer peanuts in the later period than in the earlier period.

The objective of this essay is to examine these changes, develop a model of the effects of cross-county quota transfer and to test empirical predictions from it with a county-level panel of pre- and post-FAIR data. The usefulness of the model lies in its contribution toward assessing the effects of changes in U.S. peanut policy.

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<sup>1</sup> On its face, the 53% figure for Texas appears to violate a transfer provision of the FAIR Act. There are, however, unlimited transfers allowed between adjacent counties, which likely explains the seemingly excess movement.

## **2.1 Review of the Peanut Program**

The peanut program was established in 1934.<sup>2</sup> It originated from the Agricultural Adjustment Act of 1933, which was designed to increase and stabilize prices and income for farmers. When peanuts were designated a basic commodity in 1934, they came under provisions of the Act. Contracts were made with producers to reduce their acreage in return for a payment. Regional growers' associations were formed in 1937, which purchased specified quantities of peanuts at the USDA support prices. The peanuts were diverted to the crush market and away from the market for edible peanuts. These voluntary efforts to sustain high prices for peanut growers were not successful due to quick expansion of the industry. Many farmers recognized the opportunity for profit and started to produce peanuts which lowered the price of peanuts.

A mandatory program was established in 1941. Individual acreage allotments were set, in the aggregate, at 1.9 million acres and penalties were applied to farmers who produced on additional acres. However, during World War II, compliance with the program was not enforced and plantings quickly expanded to 3.4 million acres. The Agricultural Act of 1949 established support prices for peanuts and other commodities between 75 and 90 percent of then-current levels. From 1949 to 1978 all peanuts from approved allotments were guaranteed the support price and the program ran into similar difficulties as in its beginnings. New peanut varieties and farming techniques were introduced and per-acre yields started to grow, increasing dramatically the cost of the

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<sup>2</sup>The following discussion is based on Rucker, Thurman and Borges (1996), Borges (1994) and various documents provided on Farm Service Agency (FSA) web page.



program.

Beginning in 1978, producers received the support price only on quota peanuts, where quota was set annually in poundage terms to meet expected edible market demand. Between 1978 and 1982, farmers were required to own both poundage quota and acreage allotments. In 1982 acreage allotments were completely abandoned. This was an important program change because the support price was still paid only on quota peanuts, but there was no limit on total domestic production. Before 1977, all peanuts were either sold directly to the edible market or placed under loan with Commodity Credit Corporation (CCC). In both cases, growers received at least the edible support price.

Under the new 1977 program, growers that grew more than their quota had two options. First, they could make a contract with a handler for export or sale in the crush market. Second, they could place their peanuts under loan with the area grower association. In both cases the grower would receive a price well below the support price.

Since 1977, the aggregate quota has been set on a yearly basis to meet edible market demand. Historically, there have been many changes in the farm distribution of quota. Prior to 1978, all peanuts produced on acreage allotments received the support price. From 1978 to 1981, poundage quota was determined by multiplying the farm's historical base production by the ratio of the state's quota allotment to the state's historical base production. For the period 1986 -1990 increases in quota were distributed equally among all farms that either had quota in the previous year or had produced peanuts in at least two out of three previous years. After 1991, increases in quota were distributed proportionally among all quota holders in the state according to their total

production rather than equally among all producers. In the event that producers failed to meet their quota, they were allowed to carry the unproduced quantity, so called carryovers, into the next growing season. Total national carry-overs could not exceed 10 percent of the national quota. If the 10 percent limit was met, producers whose individual undermarketings exceeded this limit had to wait until the next growing season to transfer their carryovers. In order to carry over under-marketings, the producer had to show an intent to produce his quota. The Secretary of Agriculture had the right to reduce the quota to a producer if in the last three growing seasons the quota was not met at least twice. Weather and natural disasters were allowable exceptions to this rule. In these cases, farmers did not need to produce their quota but only needed to show that they planted enough to meet their quota based on their historical yields. In the event that a grower's quota was reduced, the lost quota was then redistributed among all producers in the state.

From 1978 to 1996, quota could be leased or sold only within county limits. There were two exceptions to this rule. The first involved a producer who was farming in two contiguous counties. Under this special condition, he could transfer the quota located on the farm in one county to the part of the farm that was located in another county. Second, states with very small allotments of quota were allowed to trade the quota within the state without restrictions.

After the approval of NAFTA and GATT in the fall of 1993 the peanut program

came under considerable pressure.<sup>3</sup> Many members of Congress started to call for substantial changes in the program or its complete elimination. This led to the 1996 farm bill peanut program revision.<sup>4</sup> The price support program for peanuts was extended through 2002, with the quota support price set at \$610 per ton. The national poundage quota floor (then 1,350,000 tons) and the undermarketing provisions of the current law were eliminated. Producers that marketed quota peanuts through marketing associations for two consecutive years and received a written offer from a handler to purchase quota peanuts at a price at least equal to the quota support price were ineligible for quota price support for the next marketing year. The national poundage quota was to be based on domestic edible and related uses, excluding seed. For the next six years, farms would receive a temporary seed quota each year through 2002, equal in amount to the pounds of peanuts they used for planting. Certain entities, such as municipalities and non-producers who lived outside the State, were prohibited from holding poundage quota beginning in 1997. Disaster transfer provisions were limited to 70 percent of the quota support rate on a quantity not exceeding 25 percent of the farm's effective quota.

The most important change from the perspective of this essay concerned the transferability of peanut quota across county lines. Spring transfers by sale or lease for farms in a county to any owner or operator outside the county but within the same state

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<sup>3</sup>The peanut program was accused of placing barriers to trade and unfairly protecting of peanut farmers from international competition. For a detailed discussion of this topic see Essay II.

<sup>4</sup>A graph showing a time series of effective quota and total production from 1994 to 1998 is shown in figure 1. It can be seen that the 1996 peanut program revision significantly reduced the effective quota.

were permitted, but could not in the aggregate exceed the percentage in the following table 1.

The percentages were applied to the quota in the county on January 1, 1996 less out of county transfers by sale, beginning with the 1996 crop.<sup>5</sup> All owner and operator sales and leases to contiguous counties were excluded from the limitation. If the application for transfers out of county exceeded the limitation, the applicants allowed to transfer quota were chosen at random.

The national poundage quota is announced by the Secretary of Agriculture on or before December 15 each year and apportioned to peanut producing states in fixed proportions as listed in table 2.

State Farm Service Agencies in cooperation with county offices are responsible for dividing the quota among counties and farms. Basic quota is a farm's share of the poundage quota allocated to its state. Effective quota is the basic quota adjusted for temporary transfers of quota to or from the farm by lease, temporary seed quota and pounds reduced under the Conservation Reserve Program (CRP).<sup>6</sup>

## **2.2 Literature Review**

Rucker and Thurman (1990) analyzed the economic effects of supply controls under the U.S. peanut program. They developed a model of the post-1985 peanut

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<sup>5</sup>See peanut poundage quota FSA handbook for detail on transfer limitations.

<sup>6</sup>A temporary seed quota is a temporary allocation of quota pounds for the current crop year equal to the pounds of seed peanuts planted on a farm.

program, focusing on its main elements and showed that the restrictions on imports eliminate gains from trade and that the poundage quota and the support price maintain an artificially high price in the domestic market for edible peanuts. They further showed how the buyback provision prevents the price of edibles from rising above the quota support price and also leads to placement of high quality edible peanuts in the crush market. Their estimates of transfers and dead weight losses from the peanut program in the domestic edible and crush markets suggest that in the domestic edible market where demand is inelastic, the transfers are large relative to the dead weight losses. They concluded that in the late 1980's the annual costs of the program were small per consumer (\$1.23 per U.S. citizen), but the net benefits per producer were large (approximately \$11,000).

Borges and Thurman (1994) examined the supply response of North Carolina peanut growers to yield uncertainty. It is commonly argued in the industry that peanut producers plant additional for “insurance” reasons because the opportunity cost of failing to meet their quota is very high. However, Borges and Thurman argued that uncertainty about yields cannot explain why some peanut producing counties produced as much as 50 percent above their effective quota. They concluded that farmers grow additional for “profitability” reasons.

Rucker, Thurman and Borges (1996) analyzed the effects of the GATT on trade in peanut butter between Canada and the United States, on the U.S. peanut market, and on the welfare of U.S. peanut producers. They argued that a GATT side agreement, which was to halt growth in U.S. imports of Canadian peanut butter, would increase the demand

for U.S. grown peanuts and decrease any treasury costs associated with the U.S. peanut program. They concluded that the primary effect of the GATT on U.S. markets would be to increase raw peanut imports, which would reduce the demand for U.S. grown peanuts. The net effect of such increased imports on growers would depend on how US policy makers responded. If there were no responses in aggregate quota or support price, the increased imports would mainly increase the cost to the U.S. Treasury. If there were policy responses to the GATT agreement, they forecasted the annual loss in peanut producer surplus would be less than one cent per pound of quota peanuts produced.

Most recently, Pease, Lehman and Orden (2001) discussed the history of the peanut program and examined the impact of changes under the Farm Security Act of 2002 then proposed by the U.S. Senate and House of Representatives on Virginia producers. They examined the impact of the proposal on a representative farm in Southhampton County that planted peanuts, cotton, soybeans, and wheat. They showed that under current peanut policy and recent peanut prices and yields, farm-related income exceeds the variable costs of production and land and quota rents but does not fully cover the farmer's fixed cost. They further showed that under the new proposed program, market sales revenue decline if the farmer continues with his current cropping decisions but direct payments from the government increase. They concluded that the farmer could do better under the proposed program by shifting production to cotton.

### 2.3 Model Specifications

Quota rentals have large impacts on income streams to quota owners and costs to peanut growers. The movement of quota and associated changes in lease rates imply important welfare effects to these groups.

Currently we have five years of experience with peanut quota markets post-FAIR and data collected demonstrate some very significant quota and production movements. Under the current version of the program, peanut growers are allowed to grow “additional” production beyond the amount of their poundage quota for sale in the export market or for placement with growers' association pools. The price that growers receive for additional is less than the quota support price and represents the foreign demand price for U.S. edible peanuts.<sup>7</sup> As analyzed by Rucker and Thurman (1990), the equilibrium determination of production in a county is shown in figure 2.  $P_w$  represents the world price paid for additional,  $P_s$  represents the support price,  $q$  is the peanut quota allotment, and  $Q$  is the total production in the county.  $MC$  represents the county's marginal cost of production. Since  $Q - q > 0$ , the picture above represents a county that finds the production of additional profitable and its peanut quota lease rate is the full difference between the support price  $P_s$  and the world price  $P_w$ .

Another county, with higher marginal cost of production is depicted in figure 3. We can see that  $Q - q < 0$  and therefore this county does not produce its quota and there is no production of additional. The competitive peanut quota lease rate in this county will

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<sup>7</sup>Rucker and Thurman (1990) discussed reasons why the price of additional sold for export and the expected price for additional placed in association pools will tend to be equal.

be zero.

The price difference between quota peanuts and additional implies that quota ownership has value and, with binding restrictions on production for the domestic edible market and with no restrictions on the transfer of quota, positive lease and sale values for peanut quota will be observed. Any aggregate level of output will be produced at minimum cost. When markets for quota are restricted and poundage quota ownership cannot be freely transferred, however, output may be produced at a cost in excess of the minimum.

First, analyze how demand for quota interacts with the peanut program and the marginal cost of producing peanuts. The relationships among quota support price  $P_s$ , world price  $P_w$ , marginal costs of production, and the rental demand for quota are illustrated in figure 4 in the appendix. If the depicted county is not endowed with any quota, there will be  $q_0$  additional produced at the world price,  $P_w$ .

For levels of quota less than  $q_0$ , a competitive market for quota within the county will dictate a demand price for quota of  $P_s - P_w$ , the price difference to which an incremental unit of quota entitles growers. If the county's quota allocation is less than  $q_0$ , all the quota will be used and the difference between  $q_0$  and the quota amount will be the quantity of additional produced.

For quota levels greater than  $q_0$ , the price of quota is determined by the difference between the marginal cost of production,  $MC$ , and support price,  $P_s$ . There will be no additional produced if the quota is set between  $q_0$  and  $q_1$ . For quota levels beyond  $q_1$ , the marginal cost of production is greater than the support price and the rental rate for



quota is zero.

Because lease rates depend on marginal cost of production, which differs across counties, lease rates also differ. Counties where the cost of production is high are expected to have zero lease rates, while lease rates in counties with low cost of production are expected to represent the whole difference between the world and support price for peanuts. The lease rates will tend to equalize, however, when transfers across counties are allowed.

#### **2.4 Quota Transfer Post-FAIR: Empirical Analysis**

Substantial amounts of quota have migrated across county lines since the 1996 Act. Table 3 reports a measure of quota movement for each of the seven major peanut producing states. The USDA-TPD reports county-level data on effective quota, which includes the quota owned in a county and the quota that is leased in from other counties. Thus, post-1996, it includes all quota that has been transferred via lease or sale. The economic model from the previous section suggests that quota will move to equalize lease rates across counties. Low lease rate counties should include those that fail to meet or just meet their quota. High lease rate counties should include those that regularly produce additional. If it were known in advance that a county would fail to meet its quota, then its lease rate would be expected to equal zero. If it were known in advance that additional would be produced, the lease rate should equal the full difference between the support price and the world export price. If it were known in advance that the county would exactly hit its quota but no more, the lease rate would fall between

these values.

These arguments suggest an elementary prediction that the lifting of transfer restrictions should result in a movement of quota out of counties that under produce their quota. A cross-sectional regression of changes in county quota on additional production, then, should have a positive slope. The prediction of the model is asymmetric. It is additional producing counties to which transferred quota will flow, but there is no necessary connection between the extent to which an additional-producing county overproduces its quota and the extent of its quota inflow. All additional-producing counties are equally likely candidates for absorbing quota. Therefore, if one regresses changes in quota (from before to after the lifting of transfer restrictions) on a measure of the tendency to produce additional, one should find a positive slope larger than one for under producing counties and no slope for additional producing counties.

These empirical predictions can be tested in regressions with the following specification for quota changes in under-producing and additional-producing counties:

$$(1) \quad \bar{Q}_i^{2000} - \bar{Q}_i^{1995} = \alpha + \phi D_i + \beta (q_i^{1995} - \bar{Q}_i^{1995}) + \delta D_i (q_i^{1995} - \bar{Q}_i^{1995}) + \varepsilon_i,$$

where  $\bar{Q}_i^{2000}$  denotes the level of adjusted effective quota in county  $i$  in year 2000 and  $\bar{Q}_i^{1995}$  denotes the actual basic quota in 1995,  $q_i^t$  denotes the expected level of production in county  $i$  in year  $t$ , and  $D_i$  is county dummy variable which equal to one when a county over-produces its quota and  $\alpha$  and  $\alpha + \phi D_i$  represent the intercept for under-producing

and over-producing counties.<sup>8</sup> The regressions are run separately for each state.

The dependent variable is the change in quota between 1995 (the last year pre-FAIR) and 2000.<sup>9</sup> This spans the lifting of transfer restrictions and allows five years for quota movement. The independent variable is expected additional production in 1995: expected total peanut production less basic quota in that year.<sup>10</sup>

## **2.5 Data**

Peanut production is mainly concentrated in the South in seven major peanut producing states: Alabama, Florida, Georgia, North Carolina, Oklahoma, Texas and Virginia. Within these states, peanut production is concentrated in a small fraction of counties, the distribution of production based on historical distributions of quota.

The county data on effective and basic quota were received from the USDA PA-99R reports. These reports summarize the county quota levels on a yearly basis and the county Farm Service Agency (FSA) offices are required to file them with the USDA-FSA office in Washington, D.C. Production data were obtained from the USDA PA-82R

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<sup>8</sup>The level of effective quota in 2000 was adjusted due to the 1996 farm bill aggregate national quota reduction. For more detail on the adjustment see section 2.5 Data.

<sup>9</sup>A modified model where the dependent variable is the change in effective quota between 1995 (the last year pre-FAIR) and 1998 was also used and will be discussed in the next section.

<sup>10</sup>See data description in the next section for calculations of expected additional and expected production.

reports and the National Agricultural Statistics Service (NASS).<sup>11</sup> USDA reports contain production data for all individual peanut producing counties, while NASS data aggregate smaller counties.<sup>12</sup> To measure a county's tendency to produce additional in 1995, two approaches were employed. One uses historical production data to measure average county production. The other forms expected production as the product of 1995 planted acreage and a measure of historical average yield. Average production and average additional production are calculated as follows<sup>13</sup>:

$$(2) \quad \textit{Average\_Production} = \frac{\textit{Production\_93} + \textit{Production\_95}}{2},$$

$$(3) \quad \textit{Average\_Additional\_Production} = (\textit{Average\_Production} - \textit{Basic\_Quota\_95}),$$

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<sup>11</sup>Production records were received from the USDA Tobacco and Peanut Division (TPD) from 1995 to 2000. Because the analysis also required earlier production records and records on planted acreage that were not available from TPD, the second data set obtained from NASS was assembled. This data set contains observations on production, acres planted and acres harvested from 1993 to 2000. The results obtained for overlapping years showed high levels of similarity for both data sets.

<sup>12</sup>The National Agricultural Statistics Service (NASS) does not publish peanut production data in counties with small production. NASS abides by its pledge not to divulge information on any individual's operation when the agricultural statistics are published. When there are fewer than three producers whose data contribute to the estimate, or when any one producer represents more than 60 percent of an estimate, the data are grouped together and reported as Combined Counties in the Agricultural Statistics District. Even though the combined districts are always located in a small geographic region, they cannot be considered as single markets before the 1996 FAIR act due to restrictions on transfers.

<sup>13</sup>Initially, the average production was intended to be calculated as an average of 1993, 1994 and 1995 production. However, 1994 data were not available.

where *Production\_93*, and *Production\_95* represent the county's actual peanut production (lbs) and *Effective\_Quota* is the 1995 effective quota (lbs).

*Expected\_Additionals\_Production* was specified as follows:

$$(4) \quad \textit{Expected\_Production} = (\textit{Average\_Yield} * \textit{Acres\_Planted}),$$

$$(5) \quad \textit{Expected\_Additional\_Production} = (\textit{Expected\_Production} - \textit{Effective\_Quota95}),$$

where *Acres\_Planted* represents the actual acreage planted in a county. *Average\_Yield* was calculated as:

$$(6) \quad \textit{Average\_Yield} = \left( \sum_{t=1994}^{1994+n-1} \textit{County\_Yield}_t \right) / n,$$

where *n* represents the number of years for which observations on the county's yield are available. Typical values for *n* are between four and seven.

In order to account for changes in aggregate quota, the change in quota between 1995 and 2000 was adjusted according to the following formula:

$$(7) \quad \textit{Adjusted\_Change\_in\_Quota} = c * \textit{Effective\_Quota\_2000} - \textit{Basic\_Quota\_1995},$$

where  $c$  is equal to 1.14 for the change between 1995 and 2000; and  $c$  is equal to 1.15 for the change between 1995 and 1998.<sup>14</sup>

## 2.6 Empirical Results

The regression results in tables 4 and 5 are consistent with the predictions of the model. In all states, the coefficient on additional production for under producing counties is greater than one. There are no regression coefficients reported for underproducing counties in Alabama, Florida, North Carolina and Virginia due to the lack of observations when expected additional production was measured as 1993 and 1995 average production; and no regression coefficients are reported for under-producing counties in Alabama, Florida, Georgia, North Carolina and Virginia when expected production is measured as the average yield between 1994 and 2000 multiplied by 1995 acreage.

All of the coefficients for underproducing counties are statistically different from zero at a 0.05 level of significance in table 4. The  $R^2$  statistics for several of the states are quite high.

Just as the coefficients for under-quota counties are consistent with the

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<sup>14</sup>The adjustment of effective quota is necessary to correct for changes in national aggregate quota applied by the 1996 FAIR act. The act also eliminated under-marketings and declared that unused quota cannot be transferred from one planting season to the other. Due to the ineligibility to transfer under-marketings after 1995, the 1995 basic quota has to be used, which does not include under-marketings instead of the 1995 effective quota. If the effective quota is adjusted and 1995 basic quota is used, the average change in quota across counties between 1995 and 2000 equals zero which makes the results presented in the next section easier to interpret.

predictions of the model so too are the coefficients for over-quota counties. The model predicts coefficients for overproducing counties to be less than one and the table 4 and 5 results bear this out. In all cases except for Oklahoma in table 5, the slope of the regression for over-quota counties is less than one. All coefficients except for Alabama in table 4 are statistically different from zero at a 0.05 level of significance and most reported coefficients are also statistically significant from one at 0.05 level of significance. The data are plotted along with the estimated regression lines in figure 5 and 6 and counties with unusually high or low values are marked on the plot.

The county-level panel data allow the imposition and testing of various homogeneity restrictions.<sup>15</sup> In particular, the equality of regression slopes across states was tested, both for under-quota counties and over-quota counties. All such tests were rejected at conventional levels. More general versions of the table 4 and 5 regressions were also estimated. The hypothesis that over-quota counties should have a different relation between quota movement and over-quota production than should under-quota counties requires the identification of those counties that are over-quota.<sup>16</sup> These counties were identified as those that produced more than their quota in 1995. One could

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<sup>15</sup>These tests were done on an alternative data set where production information for all counties was available. The measure of expected production was 1995 production received from USDA.

<sup>16</sup> In fact, an attempt to distinguish between two types of counties is, perhaps, overly simplistic. In reality, farmers might better be thought of as planting so as to maximize expected profits or expected utility. Farmers then produce quantities greater than their quota with some probability greater than zero and less than one in attempt to meet their quota. See Borges and Thurman (1994), Babcock (1990) and Babcock and Foster (1992) for discussions of these models.

also identify over-quota counties as those that produced more than  $(100+x)\%$  of their quota in 1995 and estimate a switching regression model, varying  $x$  between, say, -40 and +50. By calculating the likelihood value for each value of  $x$  over a grid, the cutoff  $x$  could be estimated by maximum likelihood. Remarkably, the maximum likelihood estimate of  $x$  is 0 and is fairly precisely estimated. Clearly, the slope of the relationship changes, and changes near a level of production approximately equal in percentage terms to a county's quota.

A modified model was also estimated where the dependent variable is the change in quota between 1995 (the last year pre-FAIR) and 1998. The independent variable is expected additional production in 1995. The model was used to examine the intermediate period under the 1996 farm bill when approximately one half of quota was allowed to move across county lines. It also allowed for examination of outliers from the model reported in table 4 and graphed in figure 5.

Results of this model are reported in table 6 and are remarkably similar to those reported in table 4. Outliers from the model along with the regression lines are depicted in figure 6 and showed that estimates for counties that greatly overproduced or underproduced their quota stayed approximately the same under both models.

## **2.7 Spatial Dependencies**

The model presented in the previous section and allocation maps of peanut production in the U.S. depicted in figure 7 suggest that there might be spatial dependencies among peanut producing counties. If spatial dependencies do exist, the



standard OLS model provides us with biased and inconsistent or inefficient estimates and a development of a model that addresses these issues will be required.

### 2.7.1 Overview of Spatial Econometric Models

Assume that the simple spatial autoregressive model is defined as follows:

$$(8) \quad y = \rho W y + \varepsilon,$$

where  $y$  is an observed variable over the space domain  $D$ .  $W$  represents an  $n \times n$  matrix of known spatial weights and  $\rho$  is the spatial autoregressive parameter. The error term  $\varepsilon \sim N(0, \sigma^2 I)$ . If we use the Ordinary Least Squares (OLS),  $\hat{\rho}$  can be expressed as follow:

$$(9) \quad \hat{\rho} = [(W y)' (W y)]^{-1} (W y)' y = \rho + [(W y)' (W y)]^{-1} (W y)' \varepsilon,$$

however, the obtained estimate is not unbiased because

$$(10) \quad E(\hat{\rho}) = \rho + E\left[[(W y)' (W y)]^{-1} (W y)' \varepsilon\right].$$

The expectation operator in equation (10) cannot be passed through the expression  $[(W y)' (W y)]^{-1} (W y)'$  as in the case of standard OLS because matrix  $W y$  is not fixed in repeated samples when spatial correlation is present. This reason also rules out consistency of OLS estimate because the probability limit of  $(W y)' \varepsilon$  is not zero:

$$(11) \quad plim N^{-1} (W y)' \varepsilon = plim N^{-1} \varepsilon' W (I - \rho W)^{-1} \varepsilon.$$

Expression (11) only equals to zero in the trivial case when  $\rho$  is equal to zero.<sup>17</sup>

If the spatial autocorrelation is present in residuals, properties of OLS estimators are more in line with the time series results. Parameter estimates will remain unbiased, but inefficient, due to the non-diagonal structure of the disturbance variance matrix.

Estimation methods for models using lattice data and taking spatial dependence into account were first developed by Whittle (1954), Ord (1975) and Hepple (1976). The form of models that is the most commonly used is known as Simultaneous Autoregression (SAR) and Moving Average (MA).

### 2.7.1.1 Simultaneous Autoregressive Model

Suppose that a scalar  $Y_i$  is defined as follows:

$$(12) \quad Y_i = \sum_{j \neq i} g_{ij} Y_j + e_i, \quad i = 1, \dots, n$$

which could also be written in matrix notation as:

$$(13) \quad Y = GY + \varepsilon,$$

and

$$(14) \quad E(\varepsilon_i) = 0, \text{Var}(\varepsilon_i) = \sigma^2.$$

If we denote  $\rho W' G$ , then

$$(15) \quad Y = \rho WY + \varepsilon,$$

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<sup>17</sup>For more details on bias and inconsistency of OLS estimates when spatial dependencies are present see Anselin (1988 a,b).

which can be also represented as:

$$(16) \quad Y = (I - \rho W)^{-1} \varepsilon \quad \text{or} \quad (I - \rho W)Y = \varepsilon.$$

where

$$(17) \quad E(\varepsilon) = 0, \quad \text{var}(\varepsilon) = \begin{bmatrix} \sigma^2 & \dots & 0 \\ \vdots & \ddots & \vdots \\ 0 & & \sigma^2 \end{bmatrix} = \Sigma,$$

$$(18) \quad \text{var}(Y) = (I - \rho W)^{-1} E(\varepsilon \varepsilon') [(I - \rho W)']^{-1} = [(I - \rho W)' \Sigma^{-1} (I - \rho W)]^{-1}$$

### 2.7.1.2 Moving Average Model

The following section presents a Moving average model (MA) as developed by Cliff and Ord (1981).

Suppose that  $Y_i$  is defined as follows:

$$(19) \quad Y_i = e_i + \sum_{j \neq i} g_{ij} e_j, \quad i = 1, \dots, n$$

where

$$(20) \quad E(e_i) = 0, \quad E(e_i^2) = \sigma^2, \quad \text{and} \quad E(e_i e_j) = 0, \quad \text{if } i \neq j.$$

The model in equation (19) can be rewritten in matrix notation as follows:

$$(21) \quad Y = (I + \rho W)\varepsilon,$$

where

$$(22) \quad \text{var}(\varepsilon) = \Sigma, \text{ and } \text{var}(Y) = (I + \rho W)\Sigma(I + \rho W)'$$

Adding  $X\beta$  to the Simultaneous Autoregressive Model (SAR) and Moving Average Model (MA) we get a Spatial Autoregressive model with Substantive Dependence and Spatial Autoregressive Model with Spatial Error Dependence. These two models will be estimated using Maximum Likelihood (ML) in the empirical section of this essay.

### 2.7.1.3 Spatial Autoregressive Model with Substantive Dependence

This model was developed by Anselin (1993) and it can be expressed as follow:

$$(23) \quad y = \rho Wy + X\beta + \varepsilon,$$

where  $X$  is a vector of explanatory variables that are assumed to be uncorrelated with the error term  $\varepsilon$ . The log-likelihood function for the Spatial Autoregressive model with Substantive Dependence is:

$$(24) \quad L(\beta, \rho, \sigma^2) = -\frac{n}{2} \ln(2\pi) - \frac{n}{2} \ln \sigma^2 + \ln |(I - \rho W)| \\ - \left( \frac{1}{2} \sigma^2 \right) ((I - \rho W)y - X\beta)' ((I - \rho W)y - X\beta)$$

### 2.7.1.4 Spatial Autoregressive Model with Spatial Error Dependence

This model also was developed by Anselin (1993). In this model, the explanatory variables contain only exogenous variables but the error term follows a spatial autoregressive process.

$$(25) \quad y = X\beta + \varepsilon, \quad \varepsilon = \lambda W\varepsilon + \xi \text{ and } \varepsilon = (I - \lambda W)^{-1} \xi$$

where  $\xi$  represent a white noise error term. Rewriting the model in (25) we get

$$(26) \quad Y = X\beta + (I - \lambda W)^{-1}\xi,$$

and

$$(27) \quad x = (I - \lambda W)(Y - X\beta).$$

The log-likelihood function for Spatial Autoregressive Model with Spatial Error dependence is:

$$(28) \quad L(\beta, \lambda, \sigma^2) = -\frac{n}{2} \ln(2\pi) - \frac{n}{2} \ln \sigma^2 + \ln |(I - \lambda W)| \\ - \left( \frac{1}{2} \sigma^2 \right) (y - X\beta)' (I - \lambda W)' (I - \lambda W) (y - X\beta).$$

#### 2.7.1.5 Spatial Autoregressive Model with Substantive Dependence and Spatial Error Dependence (SARMAX)

A General version of this spatial model includes both the spatial lagged term and the spatially correlated error term:

$$(29) \quad Y = \rho W_1 Y + X\beta + e,$$

where

$$(30) \quad e = \lambda W_2 e + \xi,$$

$$(31) \quad e = (I_n - \lambda W_2)^{-1} \xi$$

and the error term is distributed as:

$$(32) \quad \xi \sim N(0, \sigma^2 I_n).$$

Rewriting equation (29) we get (33):

$$(33) \quad Y = \rho YW_1 + X\beta + (I - \lambda W_2)^{-1} \xi.$$

The log-likelihood function for the SARMAX model as shown in (31) is:

$$(34) \quad L(\beta, \rho, \lambda, \sigma^2) = -\frac{n}{2} \ln(2\pi) - \frac{n}{2} \ln \sigma^2 + \ln(|A|) + \ln(|B|) - \left( \frac{1}{2} \sigma^2 \right) (e' B' B e),$$

where

$$(35) \quad \begin{aligned} e &= (AY - X\beta), \\ A &= (I_n - \rho W_1), \\ B &= (I_n - \lambda W_2). \end{aligned}$$

This model is usually used if there is evidence that spatial dependence exists in the error structure from a spatial autoregressive model with substantive dependence. The tests for spatial correlations will be discussed in the next section.

### 2.7.2 Tests for Spatial Dependence

Spatial dependence can be identified by using several diagnostics tests which could be divided into two categories: tests to detect substantive dependence and those to

detect error dependence. Both types of these tests are based on residuals from an ordinary least squares (OLS) model where spatial dependence is not considered.

Considering these two types of diagnostics procedures, tests of spatial error dependence lately have received more attention. The best known of these tests is Moran's  $I$  which is applied to OLS residuals as suggested by Cliff and Ord (1973):

$$(36) \quad I = \frac{e'We}{e'e},$$

where  $e$  represents a vector of OLS residuals and  $W$  is a row standardized spatial weights matrix.<sup>18</sup> Moran's  $I$  test is formally equivalent to a Durbin-Watson test of serial correlation in time series and, similarly, its distribution depends on explanatory variables used in the model. In addition, it also depends on the standardized weighting matrix  $W$ .

Moran's  $I$  Index based on the OLS residuals follows an asymptotic standard normal distribution after adjusting the  $I$ -statistic by subtracting the mean and dividing by the standard deviation of the statistics. For a standardized weighting matrix  $W$ , the adjustment takes the following form as shown by Anselin (1988 a):

$$(37) \quad E(I) = \frac{tr(MW)}{n - k},$$

where projection matrix  $M$  is defined as  $M = I - X(X'X)^{-1}X'$  and  $tr$  represents the trace operator. Variance of the Index is defined:

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<sup>18</sup>See equation (41) for an example of row standardization. Some other tests of spatial correlation in the residuals of OLS regression used are likelihood ratio test, Wald test, Geary and Lagrange multiplier test.

$$(38) \quad V(I) = \frac{tr(MWMW') + tr(MW)^2 + (tr(MW))^2}{(n-k)(n-k+2)} - E(I)^2,$$

and the calculated z-value is equal to:

$$(39) \quad Z(I) = \frac{I - E(I)}{\sqrt{V(I)}}.$$

Anselin and Ray (1991, a, b) conducted a large Monte Carlo study to assess the reliability of Moran's  $I$  test. They concluded that it does not provide a good indication of the form of spatial dependence. This essay employs an alternative approach suggested by LeSage (1998).

First, an Ordinary Least Squares (OLS) model is estimated and Moran's  $I$  test is calculated from the residuals. If Moran's  $I$  is significant, it can be said that a spatial correlation of some form was identified. Second, a spatial autoregressive model with substantive dependence (SAR) is estimated. Residuals obtained from the SAR model are then tested with a Lagrange Multiplier test to determine if the spatial correlation has been eliminated by the application of SAR model. This test is conditional on setting  $\rho$  in equations (29)-(31) equal to a non-zero value, rather than relying on OLS residuals. The focus of the test is to determine if the parameter  $\lambda$  is equal to zero and the statistics is based on Anselin (1988 a) as follows:

$$(40) \quad \frac{e'We}{\sigma^2} (T_{22} - (T_{21})^2 \text{var}(r))^{-1} \sim \chi^2(I),$$



where  $T_{21} = \text{tr}(W_2 \cdot (W_1 A' \otimes W_2 W_1 A'))$ ,  $T_{22} = \text{tr}(W_2 \cdot (W_2 \otimes W_2 W_2))$ ,  $A = I_n \otimes \rho W_1$  and  $W_1$  and  $W_2$  represent the spatial weight matrices and  $\text{var}(\rho)$  is the maximum likelihood estimate of the variance of autoregressive parameter in the model. Element by element matrix multiplication is denoted by  $\cdot$ . If the obtained LM test is significant at the 10 % level then a Spatial Autoregressive Model with Substantive Dependence and Spatial Error Dependence (SARMAX) is estimated.

### 2.7.3 Application of Spatial Models

This sub-section describes the application of spatial methods to the county-level peanut data. First, several standardized weighting matrices were created according to the following principle. County centroids were identified in the program ArcView and all counties segmented by centroid distance less than 30, 40, 50, 60 and 100 miles were considered neighbors. For each state a separate matrix was created for underproducing and over-producing counties. A matrix of immediate (bordering) neighbors was also created using centroid distance of 30 miles for Alabama, Florida, Georgia, North Carolina and Virginia. Because of their larger size, in Oklahoma and Texas, counties were considered to be immediate neighbors if their centroid distances were less than 40 miles.<sup>19</sup> The weight matrices obtained were standardized by forcing all rows to sum to one. For example, if we had a sample with five counties where neighboring pairs of counties were 1 and 2, 1 and 3, 1 and 4, 2 and 3, and 4 and 5, the non-standardized

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<sup>19</sup>See figure 8 for detailed graphs of immediately neighboring counties.

weighting matrix,  $W$ , and standardized counterpart,  $W_s$ , be as follows:<sup>20</sup>

$$(41) \quad W = \begin{bmatrix} 0 & 1 & 1 & 0 & 1 \\ 1 & 0 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 \\ 1 & 0 & 0 & 1 & 0 \end{bmatrix}, \quad W_s = \begin{bmatrix} 0 & 0.33 & 0.33 & 0 & 0.33 \\ 0.5 & 0 & 0.5 & 0 & 0 \\ 0.5 & 0.5 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 \\ 0.5 & 0 & 0 & 0.5 & 0 \end{bmatrix}.$$

OLS residuals from the model presented in table 4 were obtained next and Moran's  $I$  test was performed on these residuals with a weighting matrix of neighboring counties. The results of these tests are presented in table 7 and show spatial correlation for over producing counties in North Carolina, Georgia and Texas. Sensitivity analyses were performed for these three states with different weighting matrices to check for stability of coefficients and standard errors. Coefficients tend to increase slightly when a weighting matrix with larger centroid distance was used, while standard errors stayed approximately the same. Based on these results it was concluded that the results are not sensitive to the use of weighting matrix and only the weighting matrix of immediate neighbors was used in all further analysis.

All coefficients from the spatial autoregressive model with substantive dependence (SAR) except for the Alabama coefficient are statistically different from zero at the 0.05 level of significance and have expected magnitude and signs. Most of the

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<sup>20</sup>All neighboring counties are identified by 1 and all non-neighboring counties are identified by 0 in the weighting matrix  $W$  in equation (41). According to this specification all counties are given equal weights. An alternative approach was used where counties were weighted by 1998 county production. However, obtained results were not substantially different from those presented in table 7.

coefficients are also statistically different from one at the 0.05 level of significance.<sup>21</sup>

None of the autoregressive coefficients  $\rho$  reported in table 7 for underproducing counties was significantly different from zero at the 0.10 level of significance. Oklahoma and Texas coefficients for overproducing counties were statistically different from zero at the 0.10 level.

Lagrange Multiplier (LM) tests of SAR residuals indicated possible correlation in errors for Georgia and North Carolina. A model with Substantive Dependence and Spatial Error Dependence (SARMAX) was constructed for these two states and its results are reported in table 8. Both spatial correlation coefficients,  $\rho$  and  $\lambda$ , are statistically different from zero at the 0.10 level for Georgia; only the spatial correlation coefficient  $\lambda$  is statistically different from zero at the 0.10 level for North Carolina.

Overall, results are not substantially different from the OLS results reported in tables (4)-(6). The model is not sensitive to the specification of weighting matrix and the acknowledgment of spatial dependence did not change the magnitude of estimates nor improve their efficiency.

## **2.8 Examination of Lease Rates**

In the previous section of this chapter, quota values were examined indirectly. The underlying assumption of the model was that the removal of transfer restrictions on quota will tend to equalize lease rates across counties, with quota moving from counties with high costs of production to counties where production costs are lower. High cost

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<sup>21</sup>See table 7 in the appendix for complete results.

production counties were assumed to be those under producing their quota and counties with low costs were those counties that produced additional. If these assumptions are correct, the movement of quota will be captured through the model in equation (1). The coefficient for under producing counties is expected to be greater than one while the coefficient for over-producing counties is expected to be less than one.

The current section examines quota values using a more direct approach requiring the collection of primary data on county-level lease rates. No such data are collected by U.S. government agencies and no alternative source is available. As will be seen, I conclude that despite the appeal of examining lease rates directly the survey are not very informative about variation over time in quota lease rates.

Several attempts were made by different investigators at North Carolina State University to acquire lease rate data in the past.<sup>22</sup> Their efforts span from 1978 to 1993 and the county level lease rate data they collected represented a good value for initial analysis of this essay. I have attempted to update their database and collected lease rate data along with peanut quota sales prices and peanut contract prices from 1993 to 2000. The method used to collect lease rate information was to survey Farm Service Agency (FSA) county agents and county extension agents.<sup>23</sup> Each agent was contacted by email and a written letter. If he or she did not reply, another email and a letter was sent. If agents did not reply after four attempts to contact them, they were either contacted by phone or we obtained the assistance of state extension directors, who contacted them for

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<sup>22</sup>See Fabre and Rucker (1989) for more details.

<sup>23</sup>A copy of the survey is enclosed in the appendix table 15.

us.

The overall response to the survey was relatively good. FSA directors and county agents in some states proved to be very helpful and response rates for their states are quite high. On the other hand, obtaining the information in other states was difficult and required numerous follow up emails, letters and phone calls. Ultimate response rates to the survey in terms of 1998 production are presented in table 9.

All surveys were subjectively checked for outliers several times. Some FSA and county agents were serving in their counties for a limited time when we contacted them with the survey and either were not able to reply to the survey at all or provided us with unrealistic information. Unrealistic responses were excluded from the data file.<sup>24</sup> Minimum and maximum values, means, and standard deviations by state and year for lease rates are presented in table 10.

Assuming that the models presented in figures 2-4 are correct, peanut quota lease rates should tend to equalize when the restrictions on transfers are removed. This prediction could be verified directly by comparing the lease rates. Figure 9 represents box plots for all seven peanut producing states where the lower boundary of the box represents the 25<sup>th</sup> percentile and the upper boundary represent the 75<sup>th</sup> percentile.<sup>25</sup> If the lease rates tended to equalize over time, we would expect the upper and lower boundary of the box to come closer together after the 1996 FAIR act. This trend can be seen from

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<sup>24</sup>For example, a response was considered unrealistic if the lease rate significantly exceeded the support price or if the agent was rather inconsistent in his/her response.

<sup>25</sup>There are just four years of data available at this time for Georgia.

the box plots for Florida, Georgia and North Carolina, but in other states the trend is uncertain.

Another, more formal, approach to the problem is to test pooled variances before and after the FAIR act according to the following model:

$$(42) \quad Lease Rate_{it} = \alpha^{Pre} d_{it}^{pre} + \alpha^{Post} (1 - d_{it}^{pre}) + \sum_{k=1994}^{1995} \beta_k^{Pre} d_{it}^k + \sum_{k=1996}^{1999} \beta_k^{Post} d_{it}^k + \varepsilon_{it},$$

where  $d_{it}^{pre}$  is a pre-FAIR dummy variable for county  $i$  in year  $t$  and  $d_{it}^k$  is equal to one if  $t=k$  and is equal to zero otherwise. If we wish to test the claim that the variation in the lease rates is lower after the FAIR than it was before, we can use the pooled variance before and after the FAIR from the model above as a pre- and post-variance measures and perform an F-test:

$$(43) \quad F = \frac{\hat{\sigma}_{Pre}^2}{\hat{\sigma}_{Post}^2},$$

where  $\hat{\sigma}_{Pre}^2$  is the estimate of pre-FAIR variance and  $\hat{\sigma}_{Post}^2$  represent the estimate of post-FAIR variance, both calculated from OLS residuals from equation (28). Results of this test are presented in table 11. Even though several states have lower variance after the FAIR than before, the only states for which the hypothesis  $H_0: \sigma_{post}^2 \geq \sigma_{pre}^2$  was rejected and  $H_A: \sigma_{post}^2 < \sigma_{pre}^2$  was accepted at a five percent level were Florida and Georgia.

To allow for systematic county effects, county dummy variables were added to the model expressed in equation (42) according to the following specification:

$$(44) \quad Lease\ Rate_{it} = \left( \sum_{k=1}^n a_k^{Pre} d_{it}^k \right) d_{it}^{Pre} + \left( \sum_{k=1}^n a_k^{Post} (1 - d_{it}^{Pre}) \right) d_{it}^{Post} \\ + \sum_{k=1994}^{1995} b_k^{Pre} d_{it}^k + \sum_{k=1996}^{1999} b_k^{Post} d_{it}^k + e_{it},$$

where  $d_{it}^k$  is equal to one if  $i=k$  and is equal to zero otherwise; and  $d_{it}^{Pre}$  is equal to one if  $t \in \{Pre-FAIR\ years\}$  and is equal to zero otherwise. The test of cross-sectional variance of the county effects comparing pre- and post-FAIR periods was performed according to the model in (29) and its results are presented in table 12. However, addressing county effects did not present any improvement in terms of significance. The two states for which the hypothesis  $H_0: \sigma_{post}^2 = \sigma_{pre}^2$  was rejected and  $H_A: \sigma_{post}^2 < \sigma_{pre}^2$  was accepted at the five percent level were once again only Florida and Georgia.

One of the potential explanations of unreliability of any analysis that includes lease rates is the inaccuracy in survey answers provided by county agents. It is possible that agents in small counties did not have enough relevant information to provide accurate estimates and in reality sent us estimates that were more accurate for larger surrounding counties.

In order to address the problem, the third of the counties with the smallest peanut production in 1998 were eliminated from the sample and the investigation presented in the previous section was repeated. Box plots and F-tests from these analyses are reported

in figure 9 and tables 13 and 14 and they are consistent with the full sample results above. The null hypotheses that pre- and post-FAIR variances are equal was rejected for Florida and Georgia in table 13; and for Florida, Georgia and North Carolina in table 14.

## **2.9 Summary of Results and Conclusion**

Loosening of restrictions on the transfer of peanut quota across county lines under the 1996 FAIR act caused significant changes in the peanut industry. The objective of this essay was to analyze these changes and to develop a model of the effects of cross-county quota transfers on peanut quota lease rates. Two different methods were employed analyzing the change indirectly and directly. The underlying assumption of both approaches was that the removal of transfer restrictions on quota would tend to equalize lease rates across counties, with quota moving from counties with high costs of production to counties where production costs are lower. High cost production counties were assumed to be those under-producing their quota and counties with low costs were those counties that produced additional.

Under the indirect approach, the movement of quota was captured through a series of models attempting to explain the process by regressing the difference in quota between 1995 and 2000 crop years, and 1995 and 1998 crop years, on 1995 production of additional. The coefficient on additional production for under-producing counties was expected to be greater than one signaling intentions to move unused quota out of county. It is additional producing counties to which transferred quota will flow, but there is no necessary connection between the extent to which an additional-producing



county overproduces its quota and the extent of its quota inflow. All additional-producing counties are equally likely candidates for absorbing quota. Therefore, the coefficient on additional production for over-producing counties is expected to be in the neighborhood of zero. The results of these models are presented in tables 4-8 and are consistent with theoretical predictions. The coefficients for under-producing counties are in general greater than one while the coefficients for over-producing counties are less than one.<sup>26</sup> The nature of peanut production suggests that spatial dependencies among peanut producing counties could exist. Therefore, a Spatial Autoregressive model with Substantive Dependence and a Spatial Autoregressive Model with Spatial Error Dependence were constructed and the presence of spatial correlation tested. Even though spatial correlation was detected for over-producing counties in Georgia, North Carolina and Texas, the corrected results in tables 7 and 8 are not substantially different from OLS results reported in tables 4-6. The model is not sensitive to the specification of weighting matrix and the acknowledgment of spatial dependence did not change the magnitude of estimates nor improve their estimated efficiency.

The direct approach to the analyses of lease rates required a survey of Farm Service Agency and University Extension county agents. The survey provided lease rates, which were later analyzed using box plots and F-tests of pre-FAIR and post-FAIR lease rate variance<sup>27</sup>. The results of the direct approach did not consistently show that

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<sup>26</sup>The only state where the coefficient for under-producing counties is smaller than the coefficient for over-producing counties is Oklahoma.

<sup>27</sup>See table 9-15 and figures 9-10 for complete results.

lease rates would equalized after FAIR and therefore did not confirm the expectations from the theoretical model. The failure to comply with the theoretical model is likely due to inaccuracy in lease rates provided by county agents. Many of the time series were implausibly constant over several or all years. Even though there may be interesting cross-sectional variation among counties, the tests that rely on time series variation do not provide results compliant with the theory.

## ESSAY II

### 3. THE 2002 FARM SECURITY ACT

The objective of this essay is to assess the most recent transformation of the peanut program enacted by the U.S. Congress and to review important events that led to these changes and evaluate their impact on the peanut industry. Several models will be developed which analyze proposals' costs and benefits in the domestic and foreign markets. The emphasis will be placed on the relationship between the peanut program and the world price for edible peanuts.

#### 3.1 Introduction

During its almost seventy years of existence, the peanut program has gone through many changes and modifications. During its early history the program was designed to increase and stabilize prices and income for farmers based on acreage allotments. All peanuts produced on acreage allotments were guaranteed the support price. By the end of the 1960s, the federal treasury costs of the peanut program were increasing and the first talks about changes in the program appeared. The United States was criticized at the time by the international community for placing barriers to trade and artificial protecting of domestic peanut farmers.<sup>28</sup> In 1968, the U.S. Government Accounting Office (GAO) released a report addressing the increasing cost of the program and predicted that the cost of the program to the government would be \$250 million over

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<sup>28</sup>See Borges (1994) and Skully (1999 a, b) for discussions of costs of the program and criticism of the program from the international community.

the next five years. While there was no action taken based on the report, the program was further criticized in the early seventies. The GAO released a second report in 1973 emphasizing that the actual cost of the program exceeded their projections once again over the 1968-1973 period. Transformation of the program became inevitable due to its mounting costs, and change came with the passage of the Food and Agricultural Act of 1977. Acreage allotments were suspended and a national poundage quota was implemented for the first time in the 1978 crop year<sup>29</sup>.

The new peanut policy reduced the program costs during the 1980s. The Treasury costs were low and there were no significant changes made in the 1990 farm bill. Treasury costs of the program started to increase again, however, due to decreasing domestic demand in the 1990s.<sup>30</sup> The peanut program was exposed to further pressure by new trade talks that could further jeopardize the existence of the program and its import restrictions.

### **3.2 The 1996 Farm Bill (FAIR Act) Peanut Program Revision**

The 1996 omnibus farm bill extended the peanut program for the next seven years. The main goal of the bill was to guarantee stable income to peanut producers and to ensure ample supply for the domestic market. Once again, this was supposed to be

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<sup>29</sup>See Borges (1994), Borges and Thurman (1994), Rucker and Thurman (1990) and Sanford and Evans (1995) for detail discussions of the peanut program history.

<sup>30</sup>The 1990 farm bill guaranteed a floor of 1.35 million tons of peanut quota. If the demand was lower than the floor, the government had to purchase all excess demand at the support price and dispose of it on the crush market.

guaranteed through a two-level price support system and a ban on imports. However, during the 1995/1996 farm bill debate, the issue of mounting costs was raised and participants suggested in the debate making such changes that the program would operate at no-net cost to the government. Program proponents argued that the program significantly supported rural communities and that its structure should be maintained. On the other hand, peanut shellers and manufacturers recommended a significant reduction in quota support prices and even elimination of the program. Each group argued that the change it suggested was vital to the survival of peanut industry in the long run and was needed to reverse declining consumer demand for peanut products. Other manufacturers and their partners favored extension of the pre-FAIR program and argued that government should not dictate prices and manage supply.

House and Senate debates over the bill were intense.<sup>31</sup> The key issues included the cost of the program, an oversupply of quota peanuts, the ban on imports, and the high domestic price compared to the world price. House floor action in 1996 passed a House Agriculture Committee proposal to modify the existing program by a vote of 212 - 209. The final law that was agreed on by the House and Senate resulted in several important changes. The support price for peanuts was lowered for the first time in history. The support price was reduced by 10 percent to \$610 and the peanut program was extended through the 2002 crop season only.<sup>32</sup> Several factors that had increased the cost of program were eliminated. The new farm bill did not allow for the price support to

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<sup>31</sup>See Congressional Research Service Report IB95118 - Peanuts: Policy Issues.

<sup>32</sup>For changes in the peanut support price see table 16.

increase at the same rate as the cost of production, which had been increasing up to five percent per year. Under the new program, the quota could be set to reflect the domestic demand for edible peanuts. This was in contrast with the 1990 farm bill, which guaranteed a floor of 1.35 million tons of quota peanuts to be bought at the support price. Undermarketings, which allowed transfers of unused quota to the next planting season were eliminated. Leases and sales of peanut quota across county lines were allowed but quota still could not be transferred across state lines.

Peanut program opponents have pushed for further changes to the program since 1996. In July 1998 during floor debate on agriculture appropriations measure the house rejected (181-244) an amendment that would further lower the quota loan rate to \$550. In 1999 and 2000, the divide between growers and manufacturers grew even deeper.

### **3.3 A History of The Farm Security Act of 2002 - The U.S. House and Senate Proposals<sup>33</sup>**

The House Agricultural Committee began preparation of a new farm bill in Spring 2000 by holding farm policy field hearings. House Agriculture Committee members convened hearings to listen to producers in communities in 10 regions of the country during March, April and May of 2000. Further hearings were held in Washington, D.C. in February, March, April and May to provide detailed policy proposals. The committee's bipartisan bill was introduced by Representative Larry Combest (R-Texas), Chair of the House Agricultural Committee. The House

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<sup>33</sup>Discussion of the history of The Farm Security Act of 2002 is based on various government sources provided on the U.S. House and Senate web pages.

Agricultural Committee completed the bill with a vote on July 27, 2001. The House version of the farm bill was approved on Friday, October 5, 2001 by a vote of 291 to 120 in the House of Representatives.

The House version of the farm bill was introduced in the U.S. Senate on November 9, 2001 by Senator Tom Harkin. It was given the number S. 1628 and referred to the Committee on Agriculture, Nutrition and Forestry. The committee held five follow up sessions and on November 15, 2001 ordered that the bill be reported to the Senate floor. The bill was given number S. 1731. On December 11, 2001 substitute amendment S. 2471 was offered to accompany S. 1731 by Senator Daschle for Senator Harkin. On February 13, 2002, the House Farm Bill H.R. 2646 was reported to the Senate floor. The Senate deleted all its language and replaced it with the amended language of S. 1731. The amended vote was passed on a vote 58 to 40.

Next, the Senate and House Agricultural Conferee Committee was created to discuss differences between the two versions of the bill. The Senate Agriculture Committee Conferees were Senators Harkin, Leahy, Conrad, Daschle, Lugar, Helms and Cochran. The House Agriculture Committee Conferees were Representatives Combest, Boehner, Goodlatte, Pombo, Everett, Lucas, Chambliss, Moran, Stenholm, Condit, Peterson, Dooley, Clayton, and Holden. One piece of legislature was agreed on by the committee members which was signed on May 13, 2002 by president Bush and enacted as the new farm bill.

### **3.4 The Farm Security Act of 2002**

Both the House and Senate versions make historic reforms to the program such that the program will closely resemble those for other crops. The reform consist of fixed decoupled payments, counter cyclical payments, and a marketing loan. Both proposals terminate the poundage quota for peanuts and compensate quota holders for the loss of their asset. In the following section, all parts of the program will be reviewed. First, the House version of the bill will be discussed. Then important differences proposed by the U.S. Senate will be reviewed and the final version of the bill will be discussed.

#### **3.4.1 Fixed decoupled Payments and Counter Cyclical Payments**

Fixed decoupled payments and counter cyclical payments are based on eligible payment yield and eligible peanut acres for peanut farms, which are determined according to the following rules. First, payment yield for peanuts on the farm is determined as the average yield for the 1998 through 2001 crop years, excluding any crop year in which acreage planted to peanuts was zero. Second, average peanut acres for the farm planted to peanuts are calculated for the 1998 through 2001 crop years. Payment acres for peanuts on a farm are equal to 85 % of the peanut acres for the farm. Fixed decoupled payments are to be made to all eligible producers for each of the 2002 through 2011 crop years at a payment rate of \$36 per ton. The amount of the fixed decoupled payment is equal to the product of the payment rate, payment acres, and payment yield. Fixed decoupled payments must be paid no later than September 30 of the fiscal year. A producer may receive up to 50 % of the fixed decoupled payment in



advance anytime after December 1 of a fiscal year.

Counter-cyclical payments are paid whenever the effective price for peanuts is less than the target price. The effective price is equal to the sum of (1) the higher of the national average market price during the 12-month marketing year for peanuts and the national average loan rate for peanuts, and (2) the payment rate for fixed decoupled payments for peanuts. Notice that the price a farmer actually receives for his peanuts is not the relevant price in determining the counter-cyclical payment. Thus, a grower could receive an unusually high price for his peanuts and still receive a counter-cyclical payment if the national market average price were low. The target price for peanuts is set at \$480 per ton. The payment rate for counter-cyclical payments is equal to the difference between the target price and the effective price for the commodity (defined above). The payment amount for the counter-cyclical payments is the product of the payment rate, the payment acres and the payment yield. Partial payment of the counter-cyclical payment can be provided in advance six months into the marketing year for the crop.

### **3.4.2 Marketing Assistance Loans and Loan Deficiency Payments**

Under the new bill nonrecourse marketing assistance loans will be available for all peanut production on a farm for each of the 2002 through 2011 crops of peanuts. The loan rate for a marketing assistance loan for peanuts is set at \$350 a ton. The Secretary of Agriculture will permit producers to repay a marketing assistance loan at a rate that is the lesser of the loan rate for the commodity, plus interest, or a rate that the Secretary

determines will minimize forfeitures, accumulation of stock, storage cost, and allow peanuts to be marketed freely and competitively.

The Secretary of Agriculture may make loan deficiency payments available to producers, who, although eligible to obtain a marketing assistance loan for peanuts, agree to forego obtaining the loan in return for payment. A loan deficiency payment is calculated by multiplying the loan payment rate, quantity of the peanuts produced by the eligible producer, excluding any quantity for which producer obtained a marketing loan. Loan deficiency payments (LDPs) are based on actual production which gives incentives to peanut farmers to increase their production. In contrast to LDPs, decoupled payments are based on historical yields.

### **3.4.3 The Termination of the Marketing Quota Program for Peanuts and Compensation to Peanut Quota Holders For Loss of Quota Asset Value**

The Secretary of Agriculture will make payments to eligible quota holders to compensate them for the lost value of the quota caused by the elimination of the marketing quota program for peanuts during fiscal years 2002 through 2006. The payments will be provided in five equal installments not later than September 30 of each fiscal year. The amount of the payment for a fiscal year to a peanut quota holder is calculated as a multiple of \$0.10 per pound and the actual farm poundage quota of the quota holder for the 2001 marketing year excluding seed and experimental peanuts.

The following illustrates the case of a peanut producer who farms on 50 acres with a yield of 1 ton per acre and currently owns 50 tons of peanut quota. The farmer's payment yield is one and his payment acreage is 50. Under the current program his

income from the farm operation would be the support price, \$610, multiplied by acres farmed, 50, and his income would be \$30,500. Under the new farm bill, this producer could take a loan on all 50 tons of his production and his farm income including the compensation for loss of marketing quota could be calculated as follows. Income from a marketing loan is equal to the multiple of the loan rate, \$350, multiplied by acres farmed, 50, and by yield per acre, 1 ton.

$$(1) \quad \begin{array}{l} \textit{Marketing Loan Income} = \textit{Loan Rate} * \textit{Acres Farmed} * \textit{Average Yield} \\ (\$17,500) \qquad \qquad (\$350) \qquad \qquad (50) \qquad \qquad (1) \end{array}$$

If the average market price is below the target price, counter-cyclical payments for this farmer will be equal to the multiple of the target price, \$480, minus marketing loan rate, \$350, multiplied by acres farmed and yield per acre, 1 ton.

$$(2) \quad \begin{array}{l} \textit{Counter - cyclical Payment} = \\ (\$5,525) \\ (\textit{Target Price} - \textit{Loan Rate}) * \textit{Acres Farmed} * \textit{Farm Yield} * 0.85 \\ (\$480) \qquad \qquad (\$350) \qquad \qquad (50) \qquad \qquad (1) \end{array}$$

Income from the compensation due to the loss of marketing quota is the marketing quota, 50 tons, multiplied by the compensation rate, \$200 per ton,

$$(3) \quad \begin{array}{l} \textit{Quota Buyout Payment} = \textit{Marketing Quota} * \textit{Quota Compensation Rate}, \\ (\$10,000) \qquad \qquad (50) \qquad \qquad (\$200) \end{array}$$

Income for this producer under the modified program between 2002 and 2006 is the sum of (1), (2) and (3), \$33,025, which is by \$2525 more than under the current peanut program with marketing quotas. The example above was set for a farmer who owned his quota and production land. The situation would be different for someone who leased peanut quota prior to 2002. He would not receive any quota buyout payments but he would be eligible for counter-cyclical and fixed decoupled payments. He would not encounter any quota lease rate payments since peanut quota was eliminated.

The peanut section of the Senate version and the House version of the farm bill are similar in many aspects. However, the Senate proposal spans the next five years while the House proposal spans the next ten.<sup>34</sup> Comparing the first five years of the bill, the senate version would provide \$7 billion more in spending. The Senate proposal increases the target price for peanuts to \$520 per ton from the \$480 proposed by the House. The marketing loan for peanuts is increased to \$400 per ton compared to the \$350 per ton proposed by the House. The Senate also increased the payment for lost marketing quota in a last minute bill amendment from 10 cents per pound to 11 cents per pound. Calculations of counter-cyclical payments, marketing loan income and decoupled payments are similar under both bills.

Most recently, the final version of a new farm bill was signed by President Bush on May 13, 2002. It provides a quota buyout of 11 cents a pound per year over 5 years. The target price for edible peanuts was set at \$495/ton and allows for the payment of

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<sup>34</sup>Peanut quota buy out is affecting 2002 through 2006 crop seasons in both versions.

storage costs for peanuts under loan. The loan rate for a marketing assistance loan for peanuts was set at \$355/ton. Fixed decoupled payments will be made to all eligible producers for each of the 2002 through 2011 crop years at a payment rate of \$36 per ton. The most disputed issue in the new farm bill regarding peanuts was the compensation to peanut quota holders for the loss of quota asset value. The “buy out” program is estimated to cost the government \$1.3 billion. The data on the quota ownership collected by the Environmental Working Group ([www.ewg.org](http://www.ewg.org)) show that the top ten percent of quota owners own sixty percent of marketing quota. It is argued by some that this buy out is a wasteful subsidy to the biggest farmers, who do not need to be subsidized. Many quota holders are not even peanut farmers. The biggest quota holder in the nation is the John Hancock Mutual Life Insurance Company of Boston. Under the current proposal, this insurance company could receive a buy out payment of \$2.1 million from the government.

One view is that farmers should not be offered any quota compensation because they are allowed to continue farming under the new subsidy system. In fact, farmers in some regions are likely to be able to make their operations more profitable than under the current marketing quota program. Others feel that the peanut marketing quota was created by the government and distributed to a wide peanut farming population. They argue that many quota holders are small landowners in the poorest countries who rely on the ownership of marketing quota as a source of income. They further argue that it would be wrong to perceive quota holders as large corporations only and, as a result, to not buy out quota from small peanut farmers who deserve compensation for their loss. Some

might even argue that non-small farmers deserve compensation.

### 3.4.4 Impacts of the Expected Changes on the Peanut Industry

The impact of the expected changes to the peanut program and peanut producing states will be discussed in the next section. Consider two peanut producing states. One, depicted in figure 11.a, produces small amounts of additional relative to its marketing quota; the other produces large amounts of additional depicted in figure 11.b. Assuming that the proposed target price will be greater than the current world price,  $P_w$ , but lower than the current support price,  $P_s$ , the incurred loss to the quota holders due to the marketing quota elimination will be rectangle  $P_sABP_w$  depicted in both figure 11.a and 11.b. Since the target price,  $P_T$ , which will be paid to producers on 85 percent of the multiple of their average yield and average acres planted between 1998 and 2001 is greater than the world price,  $P_w$ , land owners will gain rectangle  $P_TCDP_w$  also depicted in both figure 11.a and 11.b.<sup>35</sup> Depending on production of additional between 1998 and 2001, the change in the policy will impact peanut producing states differently. The largest loss will be seen in states that under produced their quota or produced small amounts of additional. Peanut states with large production of additional will be affected less severely and in some cases rectangle  $P_TCDP_w$  could be larger than rectangle  $P_sABP_w$  signaling a gain due to the elimination of marketing quota and setting up a new subsidy program. The total gain or loss to peanut quota owners and landowners can be

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<sup>35</sup>Note that part of the area  $P_sABP_w$  lost by quota owner is gained by land owner therefore redistributing the wealth from one group to the other.

calculated as a sum of rectangles  $P_T CDP_w$ ,  $P_s ABP_w$  and the compensation to quota holders for lost asset. Payments from government to quota holders will be awarded in five instalments and therefore its present value can be calculated as follows:

$$(4) \quad \textit{Payment Present Value} = \textit{Quota Held} * \textit{Payment Rate} * \sum_{i=0}^4 \left( \frac{1}{1+r} \right)^i,$$

where  $r$  represents the nominal interest rate. If the quota holder decided to invest the payment earning the nominal interest rate on his investment, his yearly sustainable interest income would be:

$$(5) \quad \textit{Interest Income} = r * \textit{Payment Present Value},$$

and the total yearly gain or loss to a quota-owning peanut farmer due to the peanut program's elimination can be written as:

$$(6) \quad \textit{Yearly Income} = \textit{Quota Owner Loss} + \textit{Landowner Gain} + \textit{Interest Income}.$$

The next section presents empirical analyses of this scenario under the Senate and House proposals and the final version of the farm bill which set the target price,  $P_T$ , for edible peanuts at \$480, \$520 and \$495. The world price of peanuts is assumed to be fixed at \$350 or \$355 and nominal interest rate  $r$  is equal to 0.05. Table 17 presents the impact of the House and Senate proposed farm bill on peanut producing states. Under the House bill, the loss to the U.S. quota holders due to quota elimination is estimated at \$332 million per year. The loss per peanut producing state varies between \$15 million in Florida and \$135 million in Georgia per year. The U.S. quota holders yearly

compensation from return on investment would be \$58 million ranging from \$3 million in Florida to \$24 million in Georgia. Since all peanut producing states are growing additional that were either sold to the export market or placed in the CCC pool under the current peanut program, landowners in all peanut producing states will have some benefit from the increase of additional peanuts sales price.<sup>36</sup> The total gain to U.S. landowners is estimated at \$220 million and ranges between 10 million in Oklahoma and 78 million in Georgia per year.

The average loss per U.S. farm is estimated at \$1,695 per year. Interestingly, farmers in Florida and Texas will benefit from the change at an estimated rate of \$898 per year per farm and \$5,935 per year per farm. All other peanut producing states will suffer losses ranging from \$1,965 in North Carolina to \$5,909 in Oklahoma per year.

The proposed Senate bill is more generous with payments and compensations and losses due to the marketing quota elimination are smaller. Further, target price and quota buyout benefits are greater. The U.S. marketing quota holders will lose \$332 million and the loss ranges between \$15 million in Florida and \$135 million in Georgia. The gain to landowners due to the increased peanut additional sales price is estimated at \$288 million for the U.S. and ranges between \$13 million in Oklahoma and \$103 million in Georgia. The quota buyout would provide the U.S. quota holders with \$64 million per year. The loss or gain from the elimination of marketing quota and increased additional

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<sup>36</sup>Under the current program, producers either contracted their additional production for export or placed it with CCC pools. As argued by Thurman and Rucker (1991) the price that producers receive under these two scenarios is equal to the world price.



peanuts sales price combined would range from a loss of \$3,316 per farm per year in Oklahoma to a loss of \$616 in Georgia per farm.per year. Florida and Texas would gain \$2,934 and \$11,053 per farm per year. Interestingly, the U.S. farmers would gain \$621 per farm per year under the proposed U.S. Senate fam bill.

The gains and losses under the new farm bill enacted by President Bush on May 13, 2002 are presented in table 18. The U.S. peanut quota holders will lose \$332 million and the loss ranges between \$15 million in Florida and \$135 million in Georgia. These estimates are the same as under the U.S. House and Senate Proposals. Target price under the new bill is set \$495 per ton which is approximately in the middle of rates proposed by the U.S. House and Senate. The gain to the U.S. landowners due to the additional sales price set at \$495 is estimated at \$246 million and ranges between \$11 million in Oklahoma and \$88 million in Georgia. The quota buyout at 11 cents/pound would provide the U.S. quota holders with \$64 million which is the same as under the U.S. Senate proposal. The combined loss or gain from the elimination of marketing quota and increased additional peanuts sales price would range from a loss of \$4,759 per farm per year in Oklahoma to a loss of \$1,448 in Georgia per farm.per year. Florida and Texas would gain \$1,733 and \$7,987 per farm per year. The U.S. farmers would lose \$712 per farm per year under the new bill.

### **3.5 Effects of the Peanut Program on Domestic and Foreign Markets**

Thurman and Rucker (1991) discuss the effects of the peanut program on the domestic and foreign edible markets. They model the program under several

assumptions. Peanuts are used in two separate markets, edible and crush. Foreign producers grow both edible and crush grade peanuts and their prices are exogenous to domestic markets. Imports for edible peanuts are prohibited; exports of U.S. edible peanuts are not restricted. No restrictions on imports and exports of crush peanuts exist.

The aggregate effects of the peanut program under their model assuming no errors in estimating demand are shown in figure 12.a. Policy makers set aggregate marketing quota for the year at  $Q_q$  units, which is exactly the amount demanded at the support price,  $P_s$ . The total domestic supply at world price,  $P_w$ , is at  $Q_s$  and there will be  $Q_s - Q_q$  units exported. Quantity  $Q_c$  crush grade peanuts will be demanded by the crush market at price  $P_c$ . Because all peanuts produced domestically are of edible grade this quantity will be imported to the U.S. from abroad.

Figure 11.b shows a more typical situation when marketing quota underestimates the domestic demand. There,  $Q_q$  units of marketing quota are set by policy makers. However, at the support price  $P_s$ , there will be  $Q_D$  units of edible peanuts demanded in the domestic market. Quantity  $Q_B = Q_D - Q_q$  will be bought back from CCC pools to the edible domestic market. Quantity,  $Q_E = Q_s - Q_D$ , will be exported from the U.S. In the domestic edible market, buyback simply serves to fix the supply at quantity demanded at the support price. Their effects on the crush and export market are more complicated. Additional in general can be contracted for sale into the export market or they can be placed with CCC growers association pools. Participants in the pool receive profits from the pool in proportion to their contribution. The price for received pool peanuts is calculated according to the following formula,

$$(7) \quad P = \frac{Q^B}{Q^B + Q^C} P^S + \frac{Q^C}{Q^B + Q^C} P^C,$$

where  $P$  represent the average price from the pool;  $Q^B$  is the quantity of peanuts bought back to the edible market and  $Q^C$  is the quantity of peanuts crushed.  $P^S$  and  $P^C$  represent the support price and crush price.

Figure 13 shows the average pool price received, the quantity of buybacks, and the quantity of peanuts crushed. The average pool price received is decreasing with the quantity of peanuts placed in the pool. There will be  $Q_B$  peanuts bought back to the edible market. It is further argued by Thurman and Rucker (1991) that at the margin the equilibrium CCC pool price received is equal to the marginal cost of production and the world price for edible peanuts,  $P^W$ , and therefore peanut producers are indifferent between selling their peanuts on the world market or placing them in the pool<sup>37</sup>. For any given quantity of additional sold on the domestic edible and crush market, the  $P^*$  curve shows the price that domestic producers receive for peanuts placed in CCC pools. Therefore,  $P^*$  can be viewed can be viewed as a domestic demand curve from the pools for edible peanuts.

The following section advances the Rucker and Thurman model and analyzes the effects of peanut program modifications on the world price. First the effect of the program will be analyzed assuming no errors by policy makers and assuming away the CCC pools. These complexities will be introduced afterwards.

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<sup>37</sup>Peanuts producers will place peanuts in the pool until the expectation of pool price received is equal to the world price,  $E(P)=E(P^W)$ .

Figure 14 depicts equilibrium in the domestic, export and foreign markets. Policy makers made no mistake in estimating quantity demanded on the domestic market: quantity demanded,  $Q^D$ , is equal to the marketing quota,  $Q_q$ , at the support price,  $P_S$ . If the world price is below  $P_q$  there will not be any export of edible peanuts observed and the entire quantity produced will be supplied to the domestic market where it will be purchased at the support price,  $P_S$ . When the world price exceeds  $P_q$ , U.S. producers will contract for export. The supply of peanuts for export under the peanut program,  $S_x^{w/P.P.}$  is depicted in figure 14.b.

As shown in figure 14.b, without the peanut program, edible peanuts will be imported to the U.S. when the equilibrium price is below  $P^A$  and exported to the foreign markets when the price is above. Figure 14.c shows the equilibrium in the world market. Demand and supply of the rest of the world for edible peanuts is graphed as  $D^{ROW}$  and  $S^{ROW}$ . Under the peanut program the aggregate supply curve,  $S_{w/P.P.}^{ROW\&US}$ , is the horizontal sum of  $S^{ROW}$  and  $S_x^{w/P.P.}$  and there will be  $Q_w^{w/P.P.}$  of edible peanuts demanded at world price,  $P_w^{w/P.P.}$ . When the current version of the peanut program is eliminated, a new supply curve,  $S_{w/out P.P.}^{ROW\&US}$ , which includes U.S. exports and imports is created by rotating the world supply curve,  $S^{ROW}$ , around point where no U.S. export and imports occur. This can also be viewed as a rotation of  $S_{w/P.P.}^{ROW\&US}$  about the point where price equals  $P_S$ . This is an upward shift of supply in the relevant range and when the program is removed the world price will necessarily increase from  $P_{w/P.P.}^{ROW\&US}$  to  $P_{w/out P.P.}^{ROW\&US}$ .

### 3.5.1 Empirical Specifications of the Model with no Policy Errors

The price effects of eliminating the peanut program are estimated here under the assumption that the marketing quota equals quantity demanded at the support price and ignoring the grower association pools. Both assumptions are relaxed in the following section. Equilibrium conditions as depicted in figure 14 without the peanut program (8) and with the peanut program (9) are as follows:

$$(8) \quad S^{US}(P^1) - D^{US}(P^1) = D^{EXP}(P^1) = D^{ROW}(P^1) - S^{ROW}(P^1),$$

$$(9) \quad S^{US}(P^0) - D^{US}(P^{SUP}) = D^{EXP}(P^0) = D^{ROW}(P^0) - S^{ROW}(P^0),$$

subtracting equation (8) from (9) we get:

$$(10) \quad S^{US}(P^1) - S^{US}(P^0) - [D^{US}(P^1) - D^{US}(P^{SUP})] = D^{EXP}(P^1) - D^{EXP}(P^0),$$

Parametrizing the change in terms of demand, export and supply elasticities yields,

$$(11) \quad \varepsilon_S^{US} \frac{P^1 - P^0}{P^0} Q_S^0 - \eta_D^{US} \frac{P^S - P^1}{P^S} Q_q = -\eta_D^{EXP} \frac{P^1 - P^0}{P^0} Q_0^{EXP},$$

where

$$(12) \quad \eta_D^{US} = -\frac{d \ln D^{US}}{d \ln P} > 0, \quad \eta_D^{EXP} = -\frac{d \ln D^{EXP}}{d \ln P} > 0, \text{ and } \varepsilon_S^{US} = \frac{d \ln S^{US}}{d \ln P} > 0.$$

Solving expression (11) for  $\frac{P^1}{P^0}$  we get the following equation,

$$(13) \quad \frac{P^1}{P^0} = \frac{\varepsilon_S^{US} Q_S^0 + \eta_D^{EXP} Q_0^{EXP} + \eta_D^{US} Q_q}{\varepsilon_S^{US} Q_S^0 + \eta_D^{EXP} Q_0^{EXP} + \eta_D^{US} Q_q \frac{P^0}{P^S}},$$

and the percentage change in the world price is equal to

$$(14) \quad \% \Delta P = \frac{P^1}{P^0} - 1 = \frac{\eta_D^{US} Q_q \left( 1 - \frac{P_0}{P^S} \right)}{\varepsilon_S^{US} Q_S^0 + \eta_D^{EXP} Q_{EXP}^0 + \eta_D^{US} Q_q \frac{P^0}{P^S}}.$$

Finally, noting that  $Q_q \% Q_{EXP}^0 = Q_S^0$  and defining  $\alpha = \frac{Q_q}{Q_S^0}$ , the share of current U.S.

production represented by quota we obtain

$$(15) \quad \% \Delta P = \frac{\alpha \left( 1 - \frac{P^0}{P^S} \right)}{\frac{\varepsilon_S^{US}}{\eta_D^{US}} + \alpha \frac{P^0}{P^S} + (1 - \alpha) \frac{\eta_D^{EXP}}{\eta_D^{US}}},$$

where the percentage change in the world price depends on the known  $\alpha$  and  $\frac{P^0}{P^S}$ , and

three unknown parameters:  $\varepsilon_S^{US}$ ,  $\eta_D^{US}$ ,  $\eta_D^{EXP}$ . Interestingly, only relative elasticities,  $\frac{\varepsilon_S^{US}}{\eta_D^{US}}$

and  $\frac{\eta_D^{EXP}}{\eta_D^{US}}$ , matter in the percentage change formula.

Figure 15 shows the level curves of percentage change in price as a function of  $\varepsilon_S^{US}$  and  $\eta_D^{EXP}$  for a given domestic demand elasticity and price change. Price change

isoquants show all the possible combination of  $\varepsilon_S^{US}$  and  $\eta_D^{EXP}$ ; and are decreasing in export

demand elasticity,  $\eta_D^{EXP}$ . Note that for plausible values of  $\varepsilon_S^{US}$  and  $\eta_D^{EXP}$ , the percentage change in price is near 10 %.

### 3.5.2 Empirical Specifications of the Model with Policy Errors and the Existence of Grower Association Pools

Figure 16 allows for the underestimation of domestic demand at the support price and for the existence of grower association pools. Rucker and Thurman (1990) argue that policy makers display a consistent bias in the setting of quota levels so as to ensure that government purchases and expenses are zero. As discussed by them, the demand curve under this scenario becomes nonlinear as depicted in figure 16.a. The slope of the demand curve  $D_{w/P.P.}^{US}$  becomes less steep as the underestimation of domestic demand at support price by policy makers is more severe. For prices above  $P^2$ ,  $Q^q$  is equal to the marketing quota set by policy makers. Since the domestic demand at the support price is underestimated, there are  $Q^b$  units of edible peanuts bought back to the market. Quantity  $Q^c$  placed with grower association pools will be crushed and quantity  $Q^l$  will be exported. If the price was initially below  $P^2$ , the quantity of peanuts demanded is greater than the quantity supplied and the price would be bid up to  $P^2$ . No exports of edible peanuts occur for prices below  $P^2$  as can be seen in figure 16.b. For prices above  $P^2$ , the U.S. exports are equal to the difference between  $S^{US}$  and  $D_{w/P.P.}^{US}$ .

Once again, figure 16.c analyzes the equilibrium in the world market. The supply curve,  $S_{w/P.P.}^{ROW\&US}$ , is the horizontal summation of  $S_{w/P.P.}^X$  and  $S^{ROW}$  and the supply curve

without the peanut program,  $S_{w/outP.P.}^{ROW\&US}$ , is created by rotating the world supply curve around point where no U.S. imports or exports occur. Figure 16.c shows that the elimination of the peanut program will increase the price of edible peanuts, however, this result does not hold in general. The world price could either increase or decrease.

The world price of edible peanuts after program elimination could go down if two conditions hold. First, the intersection of supply and demand curves  $S^{US}$  and  $D^{US}$  without the peanut program would have to occur below the intersection of  $S^{US}$  and  $D_{w/P.P.}^{US}$ . In order to examine the reasonableness of this alternative,  $D_{w/P.P.}^{US}$  was simulated based on equation (7) and the 1999 crop year marketing quota and buybacks to the edible market.<sup>38</sup> The result of this simulation is presented in figure 17. The obtained demand curve is initially extremely steep making it very difficult for the intersection of  $S^{US}$  and  $D^{US}$  to happen below the intersection of  $S^{US}$  and  $D_{w/P.P.}^{US}$ . As depicted in figure 18, however, it could still happen for demand elasticities in the neighborhood of zero. Second, grower association pool purchases need to be considered in order to be able to correctly predict changes in the equilibrium world price without the peanut program. On the one hand, the current peanut program increases the supply of U.S. peanuts for export by maintaining the support price and marketing quota provisions. However, on the other hand, the supply of peanuts for export is decreased by the program because peanut producers are

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<sup>38</sup>Buybacks to the edible market were estimated at about 10 % of effective quota in 1999 crop season.



given incentives to place their peanuts into growers association pools and therefore, the domestic crush market.<sup>39</sup> The net effect of these two forces is not clear and could either increase or decrease the quantity of peanuts exported.

### 3.5.3 An Empirical Specification of the Model with Policy Errors and Grower Association Pools

Under the model assumptions presented in this section policy makers are allowed to underestimate the domestic demand and quantity supplied is set equal to quantity demanded at the support price through buybacks from grower association pools. Equilibrium conditions as depicted in figures 16 and 18 without the peanut program (16) and with the peanut program (17) are as follow.

Without the program, the equilibrium condition is:

$$(16) \quad S^{US}(P^1) - D^{US}(P^1) = D^{EXP}(P^1) = D^{ROW}(P^1) - S^{ROW}(P^1).$$

With the program, the equilibrium condition is:

$$(17) \quad S^{US}(P^0) - (D^{US}(P^{SUP}) + Q^C(P^0)) = D^{EXP}(P^0) = D^{ROW}(P^0) - S^{ROW}(P^0),$$

Subtracting (14) from (13) yields

$$(18) \quad S^{US}(P^1) - S^{US}(P^0) - D^{US}(P^1) + D^{US}(P^S) + Q^C(P^0) = D^{EXP}(P^1) - D^{EXP}(P^0).$$

The inverse demand for pool peanuts can be expressed as

$$(19) \quad P = \frac{Q^B}{Q^B + Q^C} P^S + \frac{Q^C}{Q^B + Q^C} P^C,$$

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<sup>39</sup>Depending on buybacks to the edible market, some peanuts in the pool are crushed for oil and meal.

where  $Q^B$  is the quantity of peanuts from the pool bought back to the edible market at the support price  $P^S$  and  $Q^C$  is the quantity of peanuts from the pool used in the crush market.

The quantity of crushed peanuts,  $Q^c$ , can be expressed as

$$(20) \quad Q^C = \frac{P^P - P^0}{P^0 - P^C} Q.$$

substituting (20) into (18) yields,

$$(21) \quad S^{US}(P^I) - S^{US}(P^0) - D^{US}(P^I) + D^{US}(P^S) + \frac{P^S - P^0}{P^0 - P^C} Q^B \\ = D^{EXP}(P^I) - D^{EXP}(P^0),$$

and substituting (7) into (21) yields,

$$(22) \quad \epsilon_S^{US} \frac{P^I - P^0}{P^0} Q_S^0 - \eta_D^{US} \frac{P^S - P^I}{P^S} Q_q + \frac{P^S - P^0}{P^0 - P^C} Q^B = -\eta_D^{EXP} \frac{P^I - P^0}{P^0} Q_0^{EXP},$$

$$(23) \quad P^S \epsilon_S^{US} (P^I - P^0)(P^0 - P^C) Q_S^0 - \eta_D^{US} P^0 (P^0 - P^C)(P^S - P^I) Q_q \\ + (P^S - P^0) P^0 P^S Q^B = -\eta_D^{EXP} (P^I - P^0)(P^0 - P^C) P^S Q_0^{EXP},$$

$$(24) \quad P^I = \frac{P^0 P^S [(P^0 - P^C)(h_D^{US} Q_q + e_S^{US} Q_S^0 + h_D^{EXP} Q_0^{EXP}) - (P^S - P^0) Q^B]}{(P^0 - P^C)[P^S (e_S^{US} Q_S^0 + h_D^{EXP} Q_0^{EXP}) + P^0 h_D^{US} Q_q]},$$

$$\begin{aligned}
\% \Delta P &= \frac{P^1}{P^0} - 1 \\
(25) \quad &= \frac{P^S \left[ (P^0 - P^C)(\eta_D^{US} Q_q + \varepsilon_S^{US} Q_S^0 + \eta_D^{EXP} Q_0^{EXP}) - (P^S - P^0) Q^B \right]}{(P^0 - P^C) [P^S (\varepsilon_S^{US} Q_S^0 + \eta_D^{EXP} Q_0^{EXP}) + P^0 \eta_D^{US} Q_q]} - 1 \\
&= \frac{P^S \left[ (P^0 - P^C)(\eta_D^{US} Q_q - (P^S - P^0) Q^B) \right] - (P^0 - P^C) P^0 \eta_D^{US} Q_q}{(P^0 - P^C) [P^S (\varepsilon_S^{US} Q_S^0 + \eta_D^{EXP} Q_0^{EXP}) + P^0 \eta_D^{US} Q_q]}
\end{aligned}$$

The last expression for  $\% \Delta P$ , equation (25), can be calculated for given observed values of domestic demand elasticity and for hypothetical unobserved values of export and supply elasticities. Figures 19 and 20 show the level curves of  $\% \Delta P$  as a function of  $\varepsilon_S^{US}$  and  $\eta_D^{EXP}$  for a given domestic demand elasticity. The domestic demand elasticity,  $\eta_D^{US}$ , was set to 0.2 in figure 19 and 0.4 in figure 20 to assess the effects of changes in  $\eta_D^{US}$ . Price change isoquants show all possible combinations of  $\varepsilon_S^{US}$  and  $\eta_D^{EXP}$  and are decreasing in export demand elasticity,  $\eta_D^{EXP}$ . Notice, that the price change in figure 19 is negative for all plausible values of  $\varepsilon_S^{US}$  and  $\eta_D^{EXP}$ , while it is positive in figure 20. This conclusion enforces the result from figures 16 and 18 indicating that the world price could either decrease or increase depending on the elasticity of domestic demand.

### 3.6 Overview of U.S. Tariff-Rate Quotas for Peanuts<sup>40</sup>

The U.S. tariff-rate quota was designed to protect the peanut program, which increased producer prices by restricting the production of peanuts that could be used for human consumption in the United States. If the peanut program was not protected and peanut imports were freely allowed, the domestic support price would have been undermined and the program would not have been effective.

The U.S. tariff-rate quotas for peanuts originated from the Agricultural Adjustment Act of 1933, Section 22. This section allowed the president to impose fees or quantitative restrictions on imports of products that could interfere with any domestic price support programs. The legislature was further amended in 1948, 1950 and 1951. It specified that imposed restrictions on imports could not be abridged by any treaty or international agreement. Quantitative restriction on peanuts were initiated on July 1, 1953 and the import tariff quota was set at 1,709,000 pounds per marketing year.<sup>41</sup> Due to insufficient domestic supply this quota was relaxed three times in 1954, 1980 and 1990 over the next 45 years.

Over the years, U.S. tariff-rate quotas were criticized by many countries and organizations. The first challenge came in 1955 by the General Agreement on Tarriffs and Trade (GATT). However, the same year an indefinite waiver was granted to the United States from its GATT obligations and the U.S. peanut farmers were fully protected

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<sup>40</sup>The following discussion is based on Borges (1994), Skully (1999 a, b), WTO-Trading into the Future (1999) and various documents found at the WTO web page.

<sup>41</sup>The marketing year starts on August 1 and ends on July 31. The tariff quota was set for shelled peanuts. Approximately 25 % of the weight is ocunted for the shell.

from imports for next thirty years. In the late eighties, talk of the liberalization of trade, removing barriers to trade and fair international competition started to appear and threatened the positions of U.S. peanut farmers. Such talks led later to multinational trade negotiations, which resulted in several important agreements to be analyzed in the next section.

### **3.6.1 The Mechanics of U.S. Tariff-Rate Quotas for Peanuts**

Even though the peanut program protects the price of raw, in shell peanuts for human consumption, it was necessary to restrict imports not only on this controlled commodity but also on all its derivatives and substitutes. Currently, there are tariffs for raw in-shell peanuts, shelled, blanched, “other” peanuts and peanut butter.

The tariff-rate quota program consists of two tariffs. The lower, in-quota tariff is applied to the first  $Q$  units of imports and the higher tariff applied to all units above  $Q$ . Figure 21 shows how the tariff system operates as described by Skully (1999 a). Domestic demand for imported peanuts is represented by  $D_c$ . If we assume that the world supply of peanuts is completely elastic, there would be  $Q_w$  units of peanuts imported to the U.S. at the world price  $P_w$ . In fact,  $Q$  pounds of peanuts are allowed to be imported at the lower tariff,  $t$ , and any quantity imported above  $Q$  up to the quantity demanded,  $Q_D$ , is charged the higher tariff of  $T$ . Due to this two tier tariff scheme, a new supply curve is depicted as a horizontal line  $P_w+t$  up to  $Q$  and then continuing elastic at  $P_w+T$ . In-quota tariff revenue and over-quota tariff revenue, which is collected by U.S. customs is presented by two rectangles ABED and BCIH. Figure 21 also demonstrates the value of

the rights to import to the United States at the lower tariff rate. Rectangle DEHG shows the profit to those producers who are able to import to the U.S. at  $P_w+t$  and sell on the domestic market at  $P_w+T$ .

### 3.6.2 The United States-Canada Free Trade Agreement (CFTA)<sup>42</sup>

The CFTA agreement was implemented on January 1, 1989. Its objectives were to eliminate barriers to trade in goods and services between the United States and Canada, establish conditions for fair competition, liberalize conditions for investment, and establish procedures to administer the agreement and to resolve possible future disputes.

The implementation period to reduce tariffs and fees between the two countries for most agricultural goods was set at 10 years.<sup>43</sup> The tariffs on peanut butter and blanched and process peanuts was set at 2.7 cents per pound in 1989 and was continuously lowered at 0.3 cents/year until it was completely eliminated in 1998. The tariff on candied nuts was set at 5.4 percent ad valorem and was lowered at 0.6 percent/year. The tariff on mixed nuts was set at 25.2 percent ad valorem and was lowered at a rate of 2.8 percent per year.<sup>44</sup> The path of lowering tariffs between 1989 and 1998 for peanut butter, candied,

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<sup>42</sup>The following discussion on CFTA and NAFTA is based on Borges (1994), Schmitz and al. (1996).

<sup>43</sup>The first tariff reduction occurred in 1989 and all tariffs were completely eliminated in 1998.

<sup>44</sup>These tariffs only apply to peanut products that were processed and manufactured in Canada by the Rule of Origin. This rule was implemented to make sure that Canada did not bring peanut products into the United States that were produced by other countries that follow a higher tariff schedule.

and mixed nuts is depicted in figure 22.

As can be seen from the previous discussion, the CFTA only covered peanut products that originated in Canada. The peanut industry was still protected against imports of raw, blanched and other peanuts and therefore the effect of the CFTA was expected to be minor. This expectation proved to be true with respect to mixed and candied nuts. However, there were significant increases in imports of peanut butter and paste. As can be seen from table 19, Canadian imports of peanut butter and paste were non-existent before 1989 and started to pick up significantly until they reached a peak in 1996 and started to decrease again. The increase in Canadian imports correspond exactly to the CFTA tariff schedule but it is rather unlikely that such a large increase in imports could only be caused by 3 cents change in import tariffs.<sup>45</sup> The increase in total world imports is easier to explain and is mainly due to increased imports from Argentina, which became a larger producer in mid eighties.

### **3.6.3 The North American Free Trade Agreement (NAFTA)**

The North American Free Trade Agreement (NAFTA) was implemented on January 1, 1994, its long term objective being full economic integration of North

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<sup>45</sup>Borges (1994) explained the increase in Canadian imports into the United States by Canadian firms developing large processing facilities for exports of edible peanuts from China. These Chinese peanuts were preprocessed in Canada and imported into the United States as peanut butter.

America.<sup>46</sup> According to this agreement, Canada and Mexico were granted easier access to the American market than non-NAFTA members. The conditions of NAFTA for Canada were discuss in the previous section.

Under NAFTA, Mexico was released from the duties that were implemented based on Section 22 of the Agricultural Adjustment Act of 1933. Mexico was initially endowed with a duty-free TRQ of 3,377 metric tons (MT). The quota is currently increasing at a rate of 3 percent per year until it reaches 4,957 MT in 2007. Starting in 2008, peanuts originating in Mexico will be allowed to be imported freely to the United States.

The over-quota tariffs are reduced in two phases. They are reduced 15% a year during the first six years. Then starting in 2000, the rates are further reduced until they reach zero in 2008. Over-quota tariffs for peanut butter and paste from Mexico were set at 2.66 cents/pound in 1994 and are being eliminated over a period of nine years. Starting in 2004 peanut butter and paste will be imported to the Unites States from Mexico freely.

Table 20 shows total imports of peanuts and peanut paste and butter from Mexico into the United States. Imports from Mexico were almost nonexistent prior to 1994. However, they started to increase significantly with TRQ increases and over-quota tariff reduction. Since 1994, Mexico has always imported more peanuts than its TRQ endowment.<sup>47</sup> Imports of peanut butter and paste increased significantly in the last three

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<sup>46</sup>The agricultural provisions of the U.S.-Canada Free Trade Agreement, in effect since 1989, were incorporated into the NAFTA.

<sup>47</sup>In order to approximate total quantity imported shelled peanuts must be converted to in-shell basis by multiplying by 1.25.



years.

### **3.6.4 The General Agreement on Tariff and Trade (GATT) and the World Trade Organization (WTO)<sup>48</sup>**

The GATT was established on a provisional basis in 1948 in an effort to liberalize trade after the Second World War. Its 23 founding countries drafted a chapter for an International Trade Organization (ITO) to provide world trade rules and commodity agreements. GATT's first negotiations resulted in 45,000 tariff concessions affecting one-fifth of world trade.

Over its almost fifty years of existence, GATT countries went through many multilateral trade negotiations (trade rounds). The first rounds were fully devoted to reductions in tariffs. The Kennedy Round (1964-1967) added negotiations on anti-dumping measures. The Tokyo Round (1973-1979) continued GATT's effort to reduce tariffs but rules also were created relating to technical barriers to trade, custom valuation, international dairy trade, and import licensing procedures. The most important of all rounds was the Uruguay Round, which started in 1986. The following items were on its agenda: tariffs, non-tariff barriers, natural resource products, textile and clothing, agriculture, tropical products, GATT articles, Tokyo Round codes, anti-dumping rules, subsidies, intellectual properties, investment measures, dispute settlements. It took until December 15, 1993 for all issues to be discussed to all members' satisfaction. The final version of the agreement was signed by ministers of all 123 participating countries on

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<sup>48</sup>For details see WTO-Trading into the Future (1999), Borges (1994), Skully (1999 a, b) and [www.wto.org](http://www.wto.org).

April 15, 1994. One of the biggest accomplishment of the Uruguay Round was creation of World Trade Organization (WTO) which currently regulates international trade.

### **3.6.5 Tariff Rata Quotas for Peanuts under the GATT and WTO**

Under the new WTO agreement, the in-quota volume for peanuts was set at 30,500 metric tons. The in-quota volume increased each year until April 1, 2000 when it reached 52,906 metric tons. Under the GATT agreement, over-quota tariffs for in-shell and shelled peanuts were set at 192.7 percent and 155 percent. Under the new WTO agreement, these rates were reduced at a rate of 15 percent between 1995 and 2000 when they reached 163.8 and 131.8 percent. In-quota volume and over-quota tariffs are summarized in table 21.

The TRQ for peanuts is divided among countries based on historic allocation where specific countries are granted a fixed share of the total in-quota volume on a first-come first-served basis; access to the in-quota volume is granted to countries that import first. Total in-quota volume is divided among several countries based on bilateral agreements. Argentina is guaranteed 78 percent of the minimum access in-quota volume. Israel and nations of the Caribbean Basin and Andean Pact Trade Areas are also guaranteed duty free in-quota access.<sup>49</sup> Peanuts from all other WTO member and non-member countries each face a set of separate tariffs. All tariffs charged under the peanut TRQ are shown in table 22.

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<sup>49</sup>Peanut imports from Mexico are excluded from WTO TRQs and follow its own import schedules under NAFTA.

Total imports and exports of shelled and in-shell peanuts including Mexico are shown in table 23. The significant increase in imports can be seen after new TRQs were set in place under the WTO agreement in 1994. Since 1995, the imports of shelled and in-shell peanuts combined into the United States always exceeded the TRQ. This finding is rather surprising because the in-quota tariff is thought to be set sufficiently high to prevent any larger imports into the United States.

Peanut butter and paste TRQs under WTO regulations reached 20,000 metric tons in 2000.<sup>50</sup> They are divided between Canada and Argentina, countries with Generalized System of Preference (GSP) status, and all other countries as shown in table 24.

### **3.6.6 New Round of International Trade Talks<sup>51</sup>**

The 4<sup>th</sup> Ministerial Conference of the World Trade Organization (WTO) was held in Doha, Qatar in November 2001. All 142 members agreed to launch a new agenda for trade negotiation. According to the USDA secretary, Ann Veneman, this historic agreement will provide a tremendous boost for trade negotiations to further open markets and reduce trade barriers that impede competitiveness of American farmers. The United States delegation proposed a new agricultural trade reform with the following objectives:

1. Eliminate export subsidies.
2. Reduce trade-distorting domestic support.

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<sup>50</sup>The volume includes Canada's TRQ. Mexico's TRQ is not included under WTO and it is regulated under NAFTA.

<sup>51</sup>Based on information provided on the United States Department of Agriculture web page ([www.fas.usda.gov/itp/wto](http://www.fas.usda.gov/itp/wto)).

3. Substantially reduce or eliminate tariffs.
4. Further discipline state-trading enterprises that control imports and exports.
5. Give special consideration to the needs of least developed and developing countries.
6. Recommit to the concept of the availability of food for all.
7. Engage in sectoral initiatives for specific commodities to go beyond those generally applicable in the areas of market access, export competition, and domestic support.

President Bush is supportive of new Qatar talks and he recommended the decision to launch a new round of new trade negotiations. He stated that the Qatar action advances the United States' agenda to liberalize world trade and he also praised the decision to accept the People's Republic of China and Taiwan to WTO.

It is obvious from the preliminary Qatar discussions that further reduction in tariffs and elimination of domestic support programs is being planned. If such plans come through, it is likely that the peanut industry will be affected at large and U.S. farmers will have to face tougher international competition for their domestic market.

### **3.7 Summary and Conclusion**

The main objective of this essay was to analyze the most recent changes in the peanut industry and evaluate the impact of elimination of the peanut program on quota holders and landowners. It was concluded that losses to quota owners due to peanut quota elimination outweighs the gains to landowners in most states and nationwide. The only two states benefitting from the new legislature are Florida and Texas. Losses are smaller under the U.S. Senate farm bill proposal due to its greater payment generosity. The final

version of the farm bill as proposed by the U.S. House and Senate Conferees Committee was signed by President Bush on May 13, 2002. It provides a quota buyout of 11 cents a pound per year over 5 years. The target price for edible peanuts was set at \$495/ton and allows for the payment of storage costs for peanuts under loan. The loan rate for a marketing assistance loan for peanuts was set at \$355/ton. Fixed decoupled payments will be made to all eligible producers for each of the 2002 through 2011 crop years at a payment rate of \$36 per ton. Gains and losses to quota owners and landowners under the final version of the bill are smaller than under the U.S. House proposal and larger than under the U.S. Senate proposal.

Further, the impact of the elimination of the peanut program on the world price of edible peanuts was investigated. Initially, a simple model of domestic, export and world markets was constructed which did not allow for policy errors and grower association pools. The results from this model indicated that the world price would undoubtedly increase if the peanut program was removed. The restrictions of this model were later relaxed and policy errors and grower association pools were allowed. Under this model, it was concluded that the world price could either increase or decrease depending on the elasticity of domestic demand.

All calculations in this section were carried out under the assumption that the value of the loan rate does not exceed the world price of edible peanuts. However, as indicated by our extension agent survey, recent contract prices for Runner type of peanuts might actually be lower in some counties and, further, this assumption might not always hold. If the loan rate is above the world price, the domestic production of edible peanuts will

increase until the marginal cost is equal to the loan rate. The increase in the production is likely to be exported which will put additional downward pressure on the world price. World peanut producers will suffer a loss due to the decrease in world price. In the domestic market, the gain to producers from increase of the effective price will be more than offset by the increase in the treasury cost of the program that will be covered by taxpayers.

Next, the United States tariff-rate quota for peanuts was reviewed. It was concluded that peanut imports to the United states in last six years significantly exceeded its TRQ. This finding is rather surprising. It was thought that the over-quota tariff was set sufficiently high that imports above the in-quota tariff were virtually impossible. Currently, new round of trade talks is expected to start. It was indicated by preliminary discussions that further liberalization of trade and elimination of tariffs will be on its agenda. The WTO trade rounds are usually quite lengthy, but any future agreement from these rounds is expected to further liberalized the international trade and eliminate protectionism of the U.S. peanut producers.

## ESSAY III

### 4. FEDERAL CROP INSURANCE AND PEANUT PROGRAM

Agricultural production is subject to many different adverse shocks, such as adverse weather conditions, fire, insects, plant disease, wildlife, earthquakes and failure of the water supply. Buying a crop insurance policy is one of the options for managing the production risk. In contrast to other government programs, including the peanut program, the main purpose of the federal crop insurance is not to provide producers with income transfers and stable income. It is aimed at protecting producers against downside risk. The main objective of this essay is to review the U.S. federal crop insurance program and to investigate its interaction with the peanut program and its influence on the peanut industry.

#### 4.1 Review of the Federal Crop Insurance Program<sup>52</sup>

Legislative efforts to protect farmers against yield risk date as far back as 1938 when the Crop Insurance Act was established, providing protection against multiple risks. It was briefly discontinued between 1943 and 1945 but maintained many of its original features for fifty years until 1994. Under this program producers had the opportunity to insure their crops at guaranteed yield levels from 50 to 75 percent of their average yields. The insurance was marketed mainly through private insurance companies. In some cases it could be purchased directly from the Agricultural Stabilization and Conservation

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<sup>52</sup>The following discussion is based on Goodwin and Smith (1995) and various RMA sources describing the Federal Crop Insurance program and policies.

Service (ASCS) at the USDA. The private insurance companies were reimbursed for a share of their operating expenses and actuarial losses. Historically, participation in the crop insurance program was very low. To encourage participation, since 1980 the government has provided a premium subsidy that averages about 25 percent of total premiums.

According to Goodwin and Smith (1995) the history of the U.S. federal crop insurance between 1938 and 1994 can be divided in four periods: 1938-1943, 1945-1973, 1973-1980 and 1980-1994. Discussion of a fifth period, 1994-current, was added by the author and is based on various materials from obtained from the Risk Management Agency.

#### **4.1.1 1938-1943, Beginnings of the Federal Crop Insurance Program**

In the first years of the program, farm premiums failed to cover losses in each year. FCIC paid out \$1.65 for every dollar of premiums it received. There were several reasons for the actuarial problems that the program encountered in its beginnings. First, the program was administered by local committees of the Agricultural Adjustment Administration at the farm level which meant that the committee was assessing premiums and losses for their neighbors leading to a potential for moral hazard problems. Second, farms did not provide reliable data that their average yields could be accurately assessed. Lack of adequate data resulted in rates for individual farms being established on the basis of county data which has much lower variability. Third, due to many administrative delays farmers were asked to sign contracts long after they planted their crops. As a result



the farmers that expected a good crop based on their field observations did not sign the contract and only farmers expecting very low yields entered the insurance pool. This is an instance of adverse selection. A cotton contract was introduced in 1942 but it also was unsuccessful and suffered big losses. Due to the losses, Congress canceled the entire program in 1943.

#### **4.1.2 1945-1973, Expansion of the Federal Crop Insurance Program**

The program was reestablished in the 1945 crop year for wheat, cotton and flax. For the first time Congress authorized experimental insurance programs aimed at expanded participation, decreased losses and reducing adverse selection and moral hazard problems. Despite these efforts, the average loss ratio over the two year period 1945-1946 was \$1.95. There seemed to be two main reasons for these losses. First, larger subsidies were paid than in previous years. The main reason for the large subsidies was the shift in 1946 to the exclusive use of county data to determine yield variability and premium rates. Second, crop insurance was offered in areas in which crop production was a marginal activity. Congress responded to these problems in 1947 by passing amendments that restricted the availability of crop insurance geographically. This practice was in effect till 1980. As a result, the average loss ratio between 1947 and 1955 was substantially lower at \$1.16. Regardless of their effort, adverse selection remained a problem. In 1955 FCIC identified 14 counties in Colorado, New Mexico and Texas that were no longer eligible

for crop insurance.<sup>53</sup> During the 1956-1973 period, FCIC continued its efforts to reduce the losses. These efforts were somewhat successful until 1967. Unfortunately, participation in the program remained low. Thus, beginning in 1965, FCIC extended the availability of crop insurance at reduced premium rates.<sup>54</sup> Farmers' participation quickly increased, as did indemnities, and the program suffered losses in the 1967-1969 period. In 1970, some high loss insurance programs were canceled and as a result the loss ratio fell to 0.6 during the period of 1971-1974.

#### **4.1.3 1973-1980, A Mandatory Disaster Program**

During the 1973-1980 period, a mandatory disaster payments program operated along with the crop insurance program. The disaster program was authorized under the provisions of the 1974 farm bill and was renewed under the 1977 farm bill. The crop insurance program changed very little during this period and the loss ratio remained high at 1.32. Year-to-year changes in the loss ratio largely were due to changes in growing conditions.

The federal crop insurance program was modified once again in 1980 but this time, the reasons for modification were not the high losses of the the crop insurance program, but the costs of mandatory disaster relief introduced in 1973. During the 1974-1980

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<sup>53</sup>FCIC estimated that if these counties were not included in the program during the period 1949-1954, premiums would exceeded losses in all, instead of just two, of these six years.

<sup>54</sup>The rates fell from the average of 6.9 percent of total liabilities between 1956 and 1963 to an average of 5.8 percent between 1964 and 1969.

period, disaster payments under this program reached \$3.39 billion.<sup>55</sup>

#### **4.1.4 1980-1994, Crop Insurance Act**

The intent of the 1980 Federal Crop Insurance Act was to expand the program to ensure that most farmers in all geographic areas of the country would be able to purchase crop insurance against losses for all crops.<sup>56</sup> Farms were able to choose three levels of insurance coverage relative to their average yield and the government would subsidize 30 percent of the premium to the farmer for up to 65 percent coverage. All annual restrictions on expansion of the program were removed.<sup>57</sup> The purpose of the 1980 Crop Insurance Act was to develop a program under which the current disaster relief program would be replaced by a universal crop insurance program. Changes were also introduced to the crop insurance marketing system.<sup>58</sup> Since 1981, private reinsurance companies were permitted to sell crop insurance contracts for all crops in all counties for which insurance contracts have been approved.

Adverse selection issues were also recognized and addressed under the 1980 act.

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<sup>55</sup>Mandatory disaster program was subject to criticism because it encouraged production in high-risk areas, insured against moral hazard actions and it encouraged adverse selection.

<sup>56</sup>The act established a target goal of 50 percent participation in the program. Participation is expressed as a ratio of acres insured to acres planted.

<sup>57</sup>These changes have been made to increase participation in the program. Participation rates have increased from 10 percent in 1980 to 32 percent in 1992 but still fell short of the intended 50 percent.

<sup>58</sup>Before 1981, private companies could sell crop insurance contract and be reinsured for their losses by the federal government. However, the maximum number of counties at which the federal crop insurance could be sold was limited.

A new rate setting procedure was established based on an individual farm's actual production history. Under this rate setting procedure, farmers who could provide ten years of yield history would be charged premiums based on that yield history. Information on the yield variability of the individual farm was still ignored.<sup>59</sup>

Although more farmers took part in the program after passage of the 1980 Act, it did not achieve the level of participation that Congress had hoped for. Therefore, after a major drought in 1988, *ad hoc* disaster assistance was authorized to provide relief to needy farmers. Another *ad hoc* disaster bill was passed in 1989. A third one enacted in 1992 gave farmers the option of claiming disaster losses on a farm-by-farm basis for any year between 1990 and 1992. An extremely wet and cool growing season in 1993 caused more losses, and Congress passed yet another *ad hoc* disaster bill. However, dissatisfaction with the annual *ad hoc* disaster bills that were competing with the crop insurance program led to enactment of the Federal Crop Insurance Reform Act of 1994.

#### **4.1.5 1994-Present, 1994 Crop Insurance Act and Policies Offered**

The 1994 Act made participation in the crop insurance program mandatory.<sup>60</sup> Catastrophic coverage (CAT) compensated farmers for losses exceeding 50 percent of their average yield paid at 60 percent of the price established for the crop for that year. The premium for CAT coverage was subsidized.

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<sup>59</sup>Two farms within the same region with identical average yields would be charged the same premium regardless the variability in their yields and expected losses.

<sup>60</sup>Non-participating farmers were not eligible for certain types of loans and support programs.

In 1996, Congress abandoned the general mandatory participation requirement. However, farmers who accepted government benefits were still required to purchase CAT or otherwise waive their eligibility for any disaster benefits that might be made available for the crop year. These provisions are still in effect. The Risk Management Agency (RMA) was created in 1996 to administer FCIC programs and other non-insurance-related risk management and education programs that help support U.S. agriculture.

Participation in the crop insurance program increased significantly following enactment of the 1994 Act. For example, in 1998, more than 180 million acres of farmland were insured under the program. This is more than three times the acreage insured in 1988, and more than twice the acreage insured in 1993. According to estimates by the USDA National Agricultural Statistics Service (NASS), in 1998, about two-thirds of the country's total planted acreage of field crops (except for hay) was insured under the program. The liability (or value of the insurance in force) in 1998 was \$28 billion, the largest amount since the inception of the program. The total premium, which includes subsidy, and the premium paid by insured persons was nearly \$950 million. Currently the Risk Management Agency provides policies for more than 100 crops. Federal crop insurance policies typically consist of the Common Crop Insurance Policy, the specific crop provisions, and the policy endorsements and special provisions.

#### **4.2 Current Types of Policies**

Currently farmers may select from various types of policies. Standard Multiple Peril Crop Insurance (MPCI) policies are offered for most insured crops; other plans may not be

available for some insured crops in some areas. In addition, some of the policies listed below are not available nationwide; they are being tested in pilot programs and are only available in selected states and counties. I list them here for reference to other crops and discuss the specific programs relevant to peanuts afterward.

#### **4.2.1 Yield-based Insurance Coverage**

**Multiple Peril Crop Insurance (MPCI)**--These policies protect producers against losses due to natural causes such as drought, excessive moisture, hail, wind, frost, insects, and disease. A farmer chooses a percentage of his/her average yield that he/she wants to insure. This percentage is usually between 50 to 75 percent. The farmer also selects the percent of the predicted price he or she wants to insure; between 55 and 100 percent of the crop price established annually by RMA. If the harvest falls below the insured yield, the farmer is paid an indemnity based on the difference.<sup>61</sup>

**Group Risk Plan (GRP)** - These policies use a county index as the basis for determining a loss. When the county yield for the insured crop, as determined by the National Agricultural Statistics Service (NASS), falls below the trigger level chosen by the group of farmers, an indemnity is paid. An individual farmer's loss is not taken into consideration for these calculations. Yield levels are available for up to 90 percent of the expected county yield. GRP protection is simpler to administer than farm level policies and also costs less. However, individual farm losses may not be covered if the county

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<sup>61</sup>For an example of indemnity calculation for peanuts see section 3.4.

yield variation is large. This type of insurance is most often selected by farmers whose yield variation is small.

**Dollar Plan** - The dollar plan provides protection against declining value due to damage that causes a yield shortfall. The amount of insurance is based on the cost of growing a crop in a specific area. A loss occurs when the annual value of the crop is less than the amount of insurance. The maximum dollar amount of insurance is stated on the actuarial document. The insured may select a percent of the maximum dollar amount equal to CAT (catastrophic level of coverage), limited, or additional coverage levels.

#### **4.2.2 Revenue Insurance Plans**

**Group Revenue Insurance Policy (GRIP)**--GRIP makes indemnity payments only when the average county revenue for the insured crop falls below the revenue chosen by the farmer. Risk and benefits of this plan are similar to Group Risk Plan (GRP).

**Adjusted Gross Revenue (AGR)**--insures the revenue of the entire farm rather than an individual crop by guaranteeing a percentage of average gross farm revenue. The plan uses information from a producer's tax forms to calculate the policy revenue guarantee.

**Crop Revenue Coverage (CRC)**--provides revenue protection based on price and yield expectations by paying for losses below the guarantee at the higher of an early-season price or the harvest price.

**Income Protection (IP)**--protects producers against reductions in gross income when either a crop's price or yield declines from early-season expectations.

**Revenue Assurance (RA)**--provides dollar-denominated coverage by the producer selecting a dollar amount of target revenue from a range defined by 65-75 percent of expected revenue.

#### **4.2.3 Policy Endorsements**

**Catastrophic Coverage (CAT)**--pays 55 percent of the established price of the commodity on crop losses in excess of 50 percent. The premium on CAT coverage is paid by the Federal Government; however, producers must pay a \$100 administrative fee for each crop insured in each county. Limited-resource farmers may have this fee waived. CAT coverage is not available on all types of policies.

#### **4.3 Peanut Crop Provision**

Peanut producers can choose from insurance plans mentioned in the previous section. However, the calculation of their indemnities is rather complicated due to the peanut program. The FCIC has to use two different prices in their calculations — an average support price per pound and average non-quota peanut price. The price elections that producers choose for the quota and non-quota peanuts must have the same percentage



relationship to the maximum price election offered.<sup>62</sup> The maximum pounds that may be insured at the quota price election are the lesser of the effective marketing quota or the insured acreage multiplied by the production guarantee.<sup>63</sup> If the insured acres multiplied by the production guarantee exceeds the effective poundage marketing quota, the difference will be insured at the non-quota peanut price election. The annual premium is determined by following equations:

$$(1) \quad \text{Insured Pounds (Value)} = \text{Insured Quota} * \text{Price Election (Quota)} \\ + \text{Insured non - quota} * \text{Price Election (Nonquota)},$$

$$(2) \quad \text{Premium} = \text{Insured Pounds(Value)} * \text{Premium Rate}.$$

In the event of damage or loss, RMA may require representative samples of the unharvested crop which must be at least 10 feet wide and extend the entire length of each field in the unit. In the event of damage or loss covered by the policy, the settlement of the claim will require following calculations:

- (a) Multiply the insured acreage for the unit by the production guarantee per acre;
- (b) Subtracting the insured effective poundage marketing quota from the result to

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<sup>62</sup>For example, if the farmer chooses 100 percent of the maximum quota peanut price election, he must also choose 100 percent of the maximum non-quota election.

<sup>63</sup>Production guarantee is the number of pounds determined by multiplying the yield per acre contained in the actuarial documents or the approved yield multiplied by the coverage level percentage farmer elects.

- determine the amount of insured non-quota peanuts;
- (c) multiply the insured effective poundage marketing quota and the result of calculation (b) by the representative election type, if applicable, for quota and non-quota peanuts;
  - (d) Total the results of section (c);
  - (e) Multiply the production to count for quota and non-quota peanuts, for each type, if applicable, by the respective price election;
  - (f) Total the results of section (e)<sup>64</sup>;
  - (g) Subtract the results of section (f) from section (d);
  - (h) Multiply the result from (g) by farmer's share in production.

For example, suppose that a farmer has 100 percent share in 25 acres of Valencia peanuts in the unit, with a 2,000 pounds per acre guarantee; effective poundage marketing quota of 40,000 pounds, and a price election of \$0.305 per pound for quota peanuts and \$0.15 per pound for non-quota peanuts. He harvested 43,000 pounds in which 40,000 pounds are quota peanuts and 3,000 pounds are accounted for as non-quota peanuts. His indemnity payment will be calculated as follows:

- (a) Multiply the insured acreage for the unit by the production guarantee per acre  
25 acres \* 2,000 lbs=50,000 lbs guarantee
- (b) Subtracting the insured effective poundage marketing quota from the result to determine the amount of insured non-quota peanuts

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<sup>64</sup>This amount will be the same if there is only one type.

50,000 lbs guarantee - 40,000 lbs of effective marketing quota = 10,000 lbs of non-quota guarantee

- (c) multiply the insured effective poundage marketing quota and the amount of insured non-quota peanuts by the representative election type for quota and non-quota peanuts

40,000 lbs \* \$0.305 price election for quota = \$12,200 value guarantee

10,000 lbs \* \$0.15 price election for non-quota = \$1,500 value guarantee

- (d) Total guarantees for quota and non-quota peanuts

Total value of guarantee = \$12,200 + \$1,500 = \$13,700

- (e) Multiply the production to count for quota and non-quota peanuts, for each type, by the respective price election

Value of quota production = 40,000 lbs of quota production \* \$0.305 = \$12,200

Value of non-quota production = 3,000 lbs of non-quota production \* \$0.15 = \$450

- (f) Total values of quota and non-quota production

Total value of production = \$12,200 + \$450 = \$12,650

- (g) Subtract the total value of production from total value of guarantee to calculate the farmer's loss

Loss = \$13,700 total value guarantee - \$12,650 total value of production = \$1,050

- (h) Calculate the indemnity payment by multiplying the loss by the farmer's share in production

Indemnity payment = \$1050 x 100 percent = \$1050.

#### 4.4 Literature Review

Over the years many economists have developed models of optimal crop insurance. Such models typically use the von Neumann-Morgenstern utility function under uncertainty.

Goodwin and Smith (1995) considered a simple case of a risk averse-agent that faces two uncertain states:

$$(3) \quad w_1 = W,$$

$$(4) \quad w_2 = W - L,$$

where  $W$  refers to wealth and  $L$  refers to loss. Equation (3) represents a state in which the agent does not suffer a loss and equation (4) represents a state when the loss is suffered.

They further consider an insurance contract that will collect a premium of  $\alpha$  and will pay an agent  $L$  when a loss occurs. Assuming that the farmer is risk neutral, contract costs are zero, and the insurance market is competitive, the insurance contract must satisfy following zero profit constraint,

$$(5) \quad \alpha = \pi L,$$

where  $\alpha$  is the total amount paid by the farmer for the insurance contract and  $\pi$  represents the probability of loss occurrence. They further define  $q$  to be the price per unit of compensation in the event of loss (per unit premium) and  $z$  to be the units of insurance purchased.<sup>65</sup>

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<sup>65</sup>The zero profit condition implies that  $q = \pi$ .

Under these assumptions, the consumer will choose a level of insurance  $z$  that maximizes:

$$\begin{aligned} & \max [(1 - \pi)U(w_1) + \pi U(w_2)] \\ (6) \quad \text{subject to: } & w_1 = W - qz, \\ & w_2 = W - L + z + qz \end{aligned}$$

The first order conditions imply:

$$(7) \quad (1 - \pi)qU'(W - qz) = \pi(1 - q)U'(W - L + z - qz).$$

Assuming that the premium is actuarially fair, equation (7) can be simplified as follows:

$$(8) \quad U'(W - qz) = U'(W - L + z - qz),$$

and solving the equation (8), the optimal level of insurance is  $z=L$ . Thus in a competitive environment with actuarially fair premiums, a risk averse agent will completely insure.

Next, Goodwin and Smith (1995) analyze the optimal insurance levels under adverse selection and moral hazard conditions. Under adverse selection, they conclude that high-risk agents will purchase more insurance raising the gross premium rate  $q$ . Low risk

agents will compose a smaller proportion of the insurance pool.<sup>66</sup> Under moral hazard conditions, the problem is extended by allowing the moral hazard to become endogenous with respect to some effort towards self-protection on the part of agents. Problems arise if the insurer is not able to monitor agents' efforts and adjust premiums accordingly. If an agent's degree of self-protection cannot be observed by the insurer and individual premium rates do not reflect self-protection, agents will choose zero self-protection.

Borges and Thurman (1994) analyzed the optimal acreage supply under yield uncertainty but without insurance. They assumed that a grower owns a quantity of quota in the amount of  $q$  pounds, plants  $A$  acres and harvests according to yield  $y$ . Yield is random with a continuous probability density function  $f(y)$ . The grower receives the support price,  $P_q$ , on all production up to  $q$  pounds and receives the additional price,  $P_a$ , for all production in excess of  $q$ . If the grower's production is less than his quota, the unused quota, with some restrictions can be used next year.<sup>67</sup> Future uses of carried-over quota are represented by a per-pound value of  $\tilde{P}_q$ .

Under these assumptions the decision of a risk-neutral maximizer of expected profit can be described as follows:

$$(9) E(\Pi) = \int_0^{\frac{q}{A}} [P_q Ay + \tilde{P}_q (q - Ay)] f(y) dy + \int_{\frac{q}{A}}^{\infty} [P_a (Ay - q) + P_q q] f(y) dy - C(A),$$

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<sup>66</sup>Low-risk agents may be even priced completely out of the market.

<sup>67</sup>Borges and Thurman's model was developed before the 1996 FAIR act that eliminated the carryover provision.

where  $C(A)$  is the cost of planting and harvesting on  $A$  acres. The first order condition for maximizing  $E(\Pi)$  with respect to a choice variable  $A$  is

$$(10) \quad (P_q - \tilde{P}_q) \int_0^{\frac{q}{A}} yf(y)dy + P_a \int_{\frac{q}{A}}^{\infty} yf(y)dy = C'(A),$$

where the left-hand side of equation (10) represents expected value marginal product from a change in  $A$ .<sup>68</sup> The first order condition equates expected value marginal product with the marginal cost of acreage. Further, they totally differentiate the first order condition in equation (10) to find the comparative statics of acreage choice:

$$(11) \quad \left[ \int_0^{\frac{q}{A}} yf(y)dy \right] (dp_q - d\tilde{P}_q) + \left[ \int_{\frac{q}{A}}^{\infty} yf(y)dy \right] dP_a \\ = \left[ MC' + (P_q - \tilde{P}_q - P_a) \frac{q}{A} \frac{\partial f}{\partial A} \right] dA,$$

where

$$(12) \quad \phi = \int_{\frac{q}{A}}^{\infty} f(y)dy.$$

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<sup>68</sup>It is a decreasing function of  $A$  if  $P_q$  &  $\tilde{P}_q > P_a$  and an increasing function otherwise.

Quantity  $\phi$  is the probability that the production exceeds quota.

A pound of unused quota will either have value  $P_q$  &  $P_a$  if production exceeds quota in the next period, or will be carried over again if production is less than quota. Based on this statement the current value of carry-over can be derived as the expected present value of its future uses:

$$(13) \quad \tilde{P}_q = \frac{\phi}{1+\phi}(P_q - P_a).$$

Partially differentiating equation (13), equation (14) is obtained as follows:

$$(14) \quad d\tilde{P}_q = \frac{\phi}{r+\phi}(dP_q - dP_a).$$

Substituting equation (14) into equation (11) yields:

$$(15) \quad \frac{\partial A}{\partial P_q} = \frac{\frac{r}{r+\phi} \int_0^{\frac{q}{A}} yf(y)dy}{MC' + (P_q - \tilde{P}_q - P_a) \frac{q}{A} \frac{\partial \phi}{\partial A}}$$

and

$$(16) \quad \frac{\partial A}{\partial P_a} = \frac{\frac{\phi}{r+\phi} \int_0^{\frac{q}{A}} yf(y)dy + \int_{\frac{q}{A}}^{\infty} yf(y)dy}{MC' + (P_q - \tilde{P}_q - P_a) \frac{q}{A} \frac{\partial \phi}{\partial A}}.$$

Both acreage supply responses are positive according to the second-order conditions for



expected profit maximization.

#### 4.5 Model Specifications

In the present work, the model of Borges and Thurman (1994) is modified by including a choice variable  $\alpha$ , which represents the percentage of average yield insured. Since the 1996 FAIR act eliminated the carryover provision, the part that included price for carried over quota represented by  $\tilde{P}_q$  could be dropped from the model. Carried over quota, since 1996, has had zero value thus increasing the incentive to plant so as to insure that all quota is produced. The goal of the analysis is to understand how exogenous changes in program parameters and market price affect the insurance and quota rental decisions.

##### 4.5.1 Model with only Quota Peanuts Insured

Under these new assumptions, the decision of a risk-neutral maximizer of expected profit depends on whether he wants to insure quota peanuts only or quota peanuts and some additional. Figure 24 shows a distribution of yields where  $\bar{y}$  represents the average yield.

If  $\frac{q}{A} > \alpha\bar{y}$ , farmer is insuring quota peanuts only. If  $\frac{q}{A} < \alpha\bar{y}$ , both quota and additional

peanuts are being insured. Figure 24 shows a distribution function for a producer insuring quota peanuts only. Notice that for such a producer, a yield less than  $\frac{q}{A}$  results in an

under-production of quota. A yield less than  $\frac{q}{A}$ , but greater than  $\alpha\bar{y}$ , results in an under-

production of quota but indemnity payment. A yield less than  $\alpha\bar{y}$  results in an under-production of quota,  $(\alpha\bar{y} - y)A$  of which is covered by the crop insurance election.

Assuming that the farmer can rent quota and is a price taker, model in figure 24 can thus be written in the following form:

$$(17) \quad \max E(\Pi) = \int_{\frac{q}{A}}^{\alpha\bar{y}} P_q A y f(y) dy + \int_{\frac{q}{A}}^{\infty} (P_a (A y - q) + P_q q) f(y) dy + \int_0^{\alpha\bar{y}} f(y) dy a \bar{y} A P_q - C(A) - Prem(\alpha, P_q, A, q) - r q$$

, where  $Prem(\alpha, P_q, A, q)$  represents the insurance premium and  $r$  represents the peanut quota rental rate. It is assumed that the prices at which production is insured are the full support price,  $P_q$ , and a known-in-advance additional price,  $P_a$ . Taking derivatives with respect to level of insurance,  $\alpha$ , acreage,  $A$ , and poundage quota rented,  $q$ , we get the following three first order conditions (FOCs):

$$(18) \quad \frac{\partial E(\Pi)}{\partial \alpha} = f(\alpha\bar{y}) \bar{y} \alpha \bar{y} A P_q + \int_0^{\alpha\bar{y}} f(y) dy \bar{y} A P_q - P_q A \alpha \bar{y}^2 f(\alpha\bar{y}) - \frac{\partial Prem(\alpha, P_q, A, q)}{\partial \alpha} = P_q A \bar{y} P(y < \alpha\bar{y}) - \frac{\partial Prem(\alpha, P_q, A, q)}{\partial \alpha} = 0,$$

$$(19) \quad \frac{\partial E(P)}{\partial A} = \alpha \bar{y} P_q \int_0^{\alpha \bar{y}} f(y) dy + P_q \int_{\alpha \bar{y}}^{\frac{q}{A}} y f(y) dy + P_a \int_{\frac{q}{A}}^{\infty} y f(y) dy - C'(A)$$

$$- \frac{\partial Prem(\alpha, P_q, A, q)}{\partial A} = 0,$$

$$(20) \quad \frac{\partial E(\Pi)}{\partial q} = \int_{\frac{q}{A}}^{\infty} (P_q - P_a) f(y) dy - \frac{\partial Prem(\alpha, P_q, A, q)}{\partial q} - r = 0.$$

Totally differentiating the FOCs in equations (18)- (20) yields:

$$(21) \quad \left( f(\alpha \bar{y}) \bar{y}^2 A P_q - \frac{\partial^2 Prem(\alpha, P_q, A, q)}{\partial^2 \alpha} \right) d\alpha + \left( \int_0^{\alpha \bar{y}} f(y) dy \bar{y} P_q - \frac{\partial Prem(\alpha, P_q, A, q)}{\partial \alpha \partial A} \right) dA$$

$$- \left( \frac{\partial^2 Prem(\alpha, P_q, A, q)}{\partial \alpha \partial q} \right) dq + \left( \int_0^{\alpha \bar{y}} f(y) dy \bar{y} A - \frac{\partial^2 Prem(\alpha, P_q, A, q)}{\partial \alpha \partial P_q} \right) dP_q = 0,$$

and

$$\begin{aligned}
& \left( \bar{y} P_q \int_0^{\bar{\alpha}} f(y) dy - \frac{\partial \text{Prem}(\alpha, P_q, A, q)}{\partial A \partial \alpha} \right) d\alpha \\
& + \left( - (P_q - P_a) \frac{q}{A} f\left(\frac{q}{A}\right) \frac{q}{A^2} - \frac{\partial^2 C(A)}{\partial A^2} - \frac{\partial^2 \text{Prem}(\alpha, P_q, A, q)}{\partial A^2} \right) dA \\
& + \left( (P_q - P_a) \frac{q}{A} f\left(\frac{q}{A}\right) \frac{1}{A} - \frac{\partial \text{Prem}(\alpha, P_q, A, q)}{\partial A \partial q} \right) dq \\
(22) \quad & + \left( \alpha \bar{y} \int_0^{\bar{\alpha}} f(y) dy + \int_{\frac{q}{A}}^{\frac{q}{A}} y f(y) dy - \frac{\partial \text{Prem}(\alpha, P_q, A, q)}{\partial A \partial P_q} \right) dP_q \\
& + \left( \int_{\frac{q}{A}}^{\infty} y f(y) dy \right) dP_a = 0.
\end{aligned}$$

$$\begin{aligned}
& - \left( \frac{\partial \text{Prem}(\alpha, A, P_q, q)}{\partial q \partial \alpha} \right) + \left( (P_q - P_a) f\left(\frac{q}{A}\right) \frac{q}{A^2} - \frac{\partial \text{Prem}(\alpha, A, P_q, q)}{\partial q \partial A} \right) dA \\
(23) \quad & + \left( - (P_q - P_a) f\left(\frac{q}{A}\right) \frac{1}{A} \right) dq + \left( \int_{\frac{q}{A}}^{\infty} f(y) dy - \frac{\partial \text{Prem}(\alpha, A, P_q, q)}{\partial q \partial P_q} \right) dP_q \\
& - \left( \int_{\frac{q}{A}}^{\infty} f(y) dy \right) dP_a - dr = 0,
\end{aligned}$$

The comparative statics equations (21), (22) and (23) can be rewritten in the following linear form:

$$\begin{aligned}
(24) \quad & b_{11}d\alpha + b_{12}dA + b_{13}dq = c_{11}dP_q + c_{12}dP_a + c_{13}dr \\
& b_{21}d\alpha + b_{22}dA + b_{23}dq = c_{21}dP_q + c_{22}dP_a + c_{23}dr, \\
& b_{31}d\alpha + b_{32}dA + b_{33}dq = c_{31}dP_q + c_{32}dP_a + c_{33}dr
\end{aligned}$$

where

$$(25) \quad b_{11} = P_q A \bar{y}^2 f(\alpha \bar{y}) - \frac{\partial^2 Prem(\alpha, P_q, A, q)}{\partial^2 \alpha},$$

$$(26) \quad b_{12} = P_q \bar{y} \int_0^{\alpha \bar{y}} f(y) dy - \frac{\partial Prem(\alpha, P_q, A, q)}{\partial \alpha \partial A},$$

$$(27) \quad b_{13} = - \frac{\partial Prem(\alpha, P_q, A, q)}{\partial \alpha \partial q},$$

$$(28) \quad c_{11} = -A \bar{y} \int_0^{\alpha \bar{y}} f(y) dy + \frac{\partial^2 Prem(\alpha, P_q, A, q)}{\partial \alpha \partial P_q},$$

$$(29) \quad c_{12} = c_{13} = 0,$$

$$(30) \quad b_{21} = P_q \bar{y} \int_0^{\alpha \bar{y}} f(y) dy - \frac{\partial Prem(\alpha, P_q, A, q)}{\partial A \partial \alpha},$$

$$(31) \quad b_{22} = -(P_q - P_a) \frac{q^2}{A^3} f\left(\frac{q}{A}\right) - \frac{\partial^2 C(A)}{\partial A^2} - \frac{\partial^2 Prem(\alpha, P_q, A, q)}{\partial A^2},$$

$$(32) \quad b_{23} = (P_q - P_a) \frac{q}{A^2} f\left(\frac{q}{A}\right) - \frac{\partial Prem(\alpha, P_q, A, q)}{\partial A \partial q},$$

$$(33) \quad c_{21} = \frac{\partial Prem(\alpha, P_q, A, q)}{\partial P_q} - \alpha \bar{y} \int_0^{\alpha \bar{y}} f(y) dy - \int_{\frac{q}{A}}^{\frac{q}{\alpha \bar{y}}} y f(y) dy,$$

$$(34) \quad c_{22} = - \int_{\frac{q}{A}}^{\infty} y f(y) dy,$$

$$(35) \quad c_{23} = 0.$$

$$(36) \quad b_{31} = - \frac{\partial Prem(\alpha, P_q, A, q)}{\partial q \partial \alpha},$$

$$(37) \quad b_{32} = (P_q - P_a) f\left(\frac{q}{A}\right) \frac{q}{A^2} - \frac{\partial Prem(a, A, P_q, q)}{\partial q \partial A},$$

$$(38) \quad b_{33} = -(P_q - P_a) f\left(\frac{q}{A}\right) \frac{1}{A},$$

$$(39) \quad c_{31} = \frac{\partial Prem(\alpha, A, P_q, q)}{\partial q \partial P_q} - \int_{\frac{q}{A}}^{\infty} f(y) dy,$$

$$(40) \quad c_{32} = \int_{\frac{q}{A}}^{\infty} f(y) dy,$$

$$(41) \quad c_{33} = I.$$

Recognizing the zero coefficients, the system can be written in matrix form as:

$$(42) \quad \begin{bmatrix} b_{11} & b_{12} & b_{13} \\ b_{21} & b_{22} & b_{23} \\ b_{31} & b_{32} & b_{33} \end{bmatrix} \begin{bmatrix} d\alpha \\ dA \\ dq \end{bmatrix} = \begin{bmatrix} c_{11} & 0 & 0 \\ c_{21} & c_{22} & 0 \\ c_{31} & c_{32} & c_{33} \end{bmatrix} \begin{bmatrix} dP_q \\ dP_a \\ dr \end{bmatrix}.$$

Solving the system of equations in (42) is rather complicated and leads largely to indeterminate comparative statics results. This is not surprising because the specification

to date is very general with respect to the premium charged for crop insurance. Crop insurance payments can be expressed as follows:

$$(43) \quad \text{Payment} = \begin{cases} 0 & \text{if } y > \alpha\bar{y} \\ AP_q(\alpha\bar{y} - y) & \text{if } y < \alpha\bar{y} \end{cases},$$

and

$$(44) \quad E(\text{Payment}) = \int_0^{\alpha\bar{y}} AP_q(\alpha\bar{y} - y)f(y)dy.$$

One simplification that leads to determinate comparative statics results is to assume that crop insurance premiums are set at actuarially fair rates. If the premium that farmers pay is set in such a way then

$$(45) \quad \text{Prem}^{AF} = AP_q \left\{ \alpha\bar{y}P(y < \alpha\bar{y}) - \int_0^{\alpha\bar{y}} yf(y)dy \right\}.$$

Taking derivatives of equation (45) yields the following equations called for in the general comparative statics system:



$$(46) \quad \frac{\partial Prem(\alpha, P_q, A)}{\partial \alpha} = AP_q(\alpha\bar{y} - \alpha\bar{y})f(\alpha\bar{y})\bar{y} + AP_q\bar{y} \int_0^{\alpha\bar{y}} f(y)dy =$$

$$AP_q\bar{y} \int_0^{\alpha\bar{y}} f(y)dy,$$

$$(47) \quad \frac{\partial^2 Prem(\alpha, P_q, A)}{\partial \alpha \partial A} = P_q\bar{y} \int_0^{\alpha\bar{y}} f(y)dy > 0,$$

$$(48) \quad \frac{\partial Prem(\alpha, P_q, A)}{\partial \alpha \partial q} = 0,$$

$$(49) \quad \frac{\partial^2 Prem(\alpha, P_q, A)}{\partial \alpha \partial P_q} = A\bar{y} \int_0^{\alpha\bar{y}} f(y)dy > 0,$$

$$(50) \quad \frac{\partial^2 Prem(\alpha, P_q, A)}{\partial \alpha^2} = AP_q\bar{y}^2 f(\alpha\bar{y}) > 0,$$

$$(51) \quad \frac{\partial Prem(\alpha, P_q, A)}{\partial A} = P_q\alpha\bar{y} \int_0^{\alpha\bar{y}} f(y)dy - \int_0^{\alpha\bar{y}} yf(y),$$

$$(52) \quad \frac{\partial Prem(\alpha, P_q, A)}{\partial A \partial q} = 0,$$

$$(53) \quad \frac{\partial \text{Prem}(\alpha, P_q, A)}{\partial A \partial P_q} = \alpha \bar{y} \int_0^{\alpha \bar{y}} f(y) dy - \int_0^{\alpha \bar{y}} y f(y) dy,$$

$$(54) \quad \frac{\partial^2 \text{Prem}(\alpha, P_q, A)}{\partial A^2} = 0,$$

$$(55) \quad \frac{\partial \text{Prem}(\alpha, P_q, A)}{\partial q} = 0,$$

$$(56) \quad \begin{aligned} \frac{\partial^2 \text{Prem}(\alpha, P_q, A)}{\partial q \partial \alpha} &= \frac{\partial^2 \text{Prem}(\alpha, P_q, A)}{\partial q \partial A} = \frac{\partial^2 \text{Prem}(\alpha, P_q, A)}{\partial q \partial P_q} \\ &= \frac{\partial^2 \text{Prem}(\alpha, P_q, A)}{\partial q^2} = 0, \end{aligned}$$

Substituting these derivatives into the comparative statics expressions in (25)-(41), the following equations are obtained:

$$(57) \quad b_{11} = P_q A \bar{y}^2 f(\alpha \bar{y}) - \frac{\partial^2 \text{Prem}(\alpha, P_q, A)}{\partial^2 \alpha} = 0,$$

$$(58) \quad b_{12} = P_q \bar{y} \int_0^{\alpha \bar{y}} f(y) dy - \frac{\partial \text{Prem}(\alpha, A, P_q, q)}{\partial \alpha \partial A} = 0,$$

$$(59) \quad c_{11} = A \bar{y} \int_0^{\alpha \bar{y}} f(y) dy - \frac{\partial^2 \text{Prem}(\alpha, P_q, A)}{\partial \alpha \partial P_q} = 0,$$

$$(60) \quad b_{13} = c_{12} = c_{13} = 0.$$

$$(61) \quad b_{21} = P_q \bar{y} \int_0^{\alpha \bar{y}} f(y) dy - \frac{\partial \text{Prem}(\alpha, P_q, A)}{\partial A \partial \alpha} = 0.$$

Bear in mind that the coefficients above are zero only if premiums are set to be actuarially fair. Further,

$$(62) \quad \begin{aligned} b_{22} &= -(P_q - P_a) \frac{q^2}{A^3} f\left(\frac{q}{A}\right) - \frac{\partial^2 C(A)}{\partial^2 A} - \frac{\partial^2 \text{Prem}(\alpha, P_q, A)}{\partial^2 A} \\ &= -(P_q - P_a) \frac{q^2}{A^3} f\left(\frac{q}{A}\right) - \frac{\partial^2 C(A)}{\partial^2 A} \end{aligned}$$

is indeterminate in sign,

$$(63) \quad b_{23} = -(P_q - P_a) \frac{q}{A^2} f\left(\frac{q}{A}\right) < 0,$$

$$(64) \quad c_{21} = \frac{\partial \text{Prem}(\alpha, P_q)}{\partial P_q} - \alpha \bar{y} \int_0^{\alpha \bar{y}} f(y) dy - \int_{\alpha \bar{y}}^{\frac{q}{A}} y f(y) dy =$$

$$- \int_0^{\alpha \bar{y}} y f(y) dy - \int_{\alpha \bar{y}}^{\frac{q}{A}} y f(y) dy = - \int_0^{\frac{q}{A}} y f(y) dy < 0,$$

$$(65) \quad c_{22} = - \int_{\frac{q}{A}}^{\infty} y f(y) dy < 0 \text{ and } c_{23} = 0,$$

$$(66) \quad c_{23} = 0.$$

$$(67) \quad b_{32} = (P_q - P_a) f\left(\frac{q}{A}\right) \frac{q}{A^2} > 0,$$

$$(68) \quad b_{33} = -(P_q - P_a) f\left(\frac{q}{A}\right) \frac{1}{A} < 0,$$

$$(69) \quad c_{31} = - \int_{\frac{q}{A}}^{\infty} f(y) dy < 0,$$

$$(70) \quad c_{32} = \int_{\frac{q}{A}}^{\infty} f(y)dy > 0,$$

$$(71) \quad c_{33} = 1,$$

$$(72) \quad b_{31} = 0.$$

From the second order conditions (SOCs) for profit maximization,

$$(73) \quad - (P_q - P_a) \frac{q^2}{A^3} f\left(\frac{q}{A}\right) - \frac{\partial^2 C(A)}{\partial A^2} < 0,$$

Since some additional coefficients are equal to zero when assumptions of actuarially fair premium and risk neutrality is made, equation (42) can be rewritten as<sup>69</sup>:

$$(74) \quad \begin{aligned} b_{22}dA + b_{23}dq &= c_{21}dP_q + c_{22}dP_a \\ b_{32}dA + b_{33}dq &= c_{31}dP_q + c_{32}dP_a + c_{33}dr, \end{aligned}$$

which can be rewritten in matrix notation as:

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<sup>69</sup>Due to the risk neutrality and actuarially fair premium assumptions all coefficients in equation (21) are equal to zero and the equation drops out from the system.

$$(75) \quad \begin{bmatrix} b_{22} & b_{23} \\ b_{32} & b_{33} \end{bmatrix} \begin{bmatrix} dA \\ dq \end{bmatrix} = \begin{bmatrix} c_{21} & c_{22} & 0 \\ c_{31} & c_{32} & c_{33} \end{bmatrix} \begin{bmatrix} dP_q \\ dP_a \\ dr \end{bmatrix},$$

$$(76) \quad \begin{bmatrix} dA \\ dq \end{bmatrix} = \begin{bmatrix} b_{22} & b_{23} \\ b_{32} & b_{33} \end{bmatrix}^{-1} \begin{bmatrix} c_{21} & c_{22} & 0 \\ c_{31} & c_{32} & c_{33} \end{bmatrix} \begin{bmatrix} dP_q \\ dP_a \\ dr \end{bmatrix},$$

$$(77) \quad \begin{bmatrix} dA \\ dq \end{bmatrix} = \frac{1}{b_{22}b_{33} - b_{23}b_{32}} \begin{bmatrix} b_{33} - b_{23} \\ -b_{32} & b_{22} \end{bmatrix} \begin{bmatrix} c_{21} & c_{22} & 0 \\ c_{31} & c_{32} & c_{33} \end{bmatrix} \begin{bmatrix} dP_q \\ dP_a \\ dr \end{bmatrix},$$

$$(78) \quad \begin{bmatrix} dA \\ dq \end{bmatrix} = \frac{1}{b_{22}b_{33} - b_{23}b_{32}} \begin{bmatrix} b_{33}c_{21} - b_{23}c_{31} & b_{33}c_{22} - b_{23}c_{32} & -b_{23}c_{33} \\ -b_{32}c_{21} + b_{22}c_{31} & -b_{32}c_{22} + b_{22}c_{32} & b_{22}c_{33} \end{bmatrix} \begin{bmatrix} dP_q \\ dP_a \\ dr \end{bmatrix},$$

$$\begin{aligned}
\frac{dA}{dP_q} &= \frac{b_{33}c_{21} - b_{23}c_{31}}{b_{22}b_{33} - b_{23}b_{32}} \\
&= \frac{\left[ -(P_q - P_a)f\left(\frac{q}{A}\right)\frac{1}{A} \right] \left[ -\int_0^{\frac{q}{A}} yf(y)dy \right] - \left[ (P_q - P_a)f\left(\frac{q}{A}\right)\frac{q}{A^2} \right] \left[ -\int_{\frac{q}{A}}^{\infty} f(y)dy \right]}{\left[ -\frac{\partial^2 C}{\partial A^2} - (P_q - P_a)\left(\frac{q^2}{A^3}\right)f\left(\frac{q}{A}\right) \right] \left[ (P_q - P_a)f\left(\frac{q}{A}\right)\frac{1}{A} \right] - \left[ (P_q - P_a)f\left(\frac{q}{A}\right)\frac{q}{A^2} \right]^2} \\
(79) \quad &= \frac{\left[ \int_0^{\frac{q}{A}} yf(y)dy \right] + \left[ \frac{q}{A} \left( \int_{\frac{q}{A}}^{\infty} f(y)dy \right) \right]}{\frac{\partial^2 C}{\partial A^2}} > 0
\end{aligned}$$

$$\begin{aligned}
\frac{dA}{dP_a} &= \frac{b_{33}c_{22} - b_{23}c_{32}}{b_{22}b_{33} - b_{23}b_{32}} \\
&= \frac{\left[ -(P_q - P_a)f\left(\frac{q}{A}\right)\frac{1}{A} \right] \left[ -\int_{\frac{q}{A}}^{\infty} yf(y)dy \right] - \left[ (P_q - P_a)f\left(\frac{q}{A}\right)\frac{q}{A^2} \right] \left[ \int_{\frac{q}{A}}^{\infty} f(y)dy \right]}{\left[ -\frac{\partial^2 C}{\partial A^2} - (P_q - P_a)\left(\frac{q^2}{A^3}\right)f\left(\frac{q}{A}\right) \right] \left[ -(P_q - P_a)f\left(\frac{q}{A}\right)\frac{1}{A} \right] - \left[ (P_q - P_a)f\left(\frac{q}{A}\right)\frac{q}{A^2} \right]^2} \\
(80) \quad &= \frac{\int_{\frac{q}{A}}^{\infty} yf(y)dy - \frac{q}{A} \int_{\frac{q}{A}}^{\infty} f(y)dy}{\frac{\partial^2 C}{\partial A^2}} = \frac{E\left(y|y > \frac{q}{A}\right)P\left(y > \frac{q}{A}\right) - \frac{q}{A}P\left(y > \frac{q}{A}\right)}{\frac{\partial^2 C}{\partial A^2}} \\
&= \frac{P\left(y > \frac{q}{A}\right) \left[ E\left(y|y > \frac{q}{A}\right) - \frac{q}{A} \right]}{\frac{\partial^2 C}{\partial A^2}} > 0
\end{aligned}$$

$$\begin{aligned}
\frac{dA}{dr} &= \frac{-b_{23}c_{33}}{b_{22}b_{33} - b_{23}b_{32}} \\
&= \frac{-\left[(P_q - P_a)f\left(\frac{q}{A}\right)\frac{q}{A^2}\right]}{\left[-\frac{\partial^2 C}{\partial A^2} - (P_q - P_a)\left(\frac{q^2}{A^3}\right)f\left(\frac{q}{A}\right)\right]\left[-(P_q - P_a)f\left(\frac{q}{A}\right)\frac{1}{A}\right] - \left[(P_q - P_a)f\left(\frac{q}{A}\right)\frac{q}{A^2}\right]^2} \\
(81) \quad &= \frac{-\frac{q}{A}}{\frac{\partial^2 C}{\partial A^2}} < 0
\end{aligned}$$

$$\begin{aligned}
\frac{dq}{dP_q} &= \frac{-b_{32}c_{21} + b_{22}c_{31}}{b_{22}b_{33} - b_{23}b_{32}} \\
&= \frac{-\left[(P_q - P_a)f\left(\frac{q}{A}\right)\left(\frac{q}{A^2}\right)\right]\left[-\int_0^{\frac{q}{A}} yf(y)dy\right] + \left[-\frac{\partial^2 C}{\partial A^2} - (P_q - P_a)\left(\frac{q^2}{A^3}\right)f\left(\frac{q}{A}\right)\right]\left[-\int_{\frac{q}{A}}^{\infty} f(y)dy\right]}{\left[-\frac{\partial^2 C}{\partial A^2} - (P_q - P_a)\left(\frac{q^2}{A^3}\right)f\left(\frac{q}{A}\right)\right]\left[-(P_q - P_a)f\left(\frac{q}{A}\right)\frac{1}{A}\right] - \left[(P_q - P_a)f\left(\frac{q}{A}\right)\frac{q}{A^2}\right]^2} \\
(82) \quad &= \frac{-\left[(P_q - P_a)f\left(\frac{q}{A}\right)\left(\frac{q}{A^2}\right)\right]\left[-\int_0^{\frac{q}{A}} yf(y)dy\right] + \left[-\frac{\partial^2 C}{\partial A^2} - (P_q - P_a)\left(\frac{q^2}{A^3}\right)f\left(\frac{q}{A}\right)\right]\left[-\int_{\frac{q}{A}}^{\infty} f(y)dy\right]}{(P_q - P_a)f\left(\frac{q}{A}\right)\frac{1}{A}\frac{\partial^2 C}{\partial A^2}} > 0,
\end{aligned}$$



$$\begin{aligned}
\frac{dq}{dP_a} &= \frac{-b_{32}c_{22} + b_{22}c_{32}}{b_{22}b_{33} - b_{23}b_{32}} \\
&= \frac{-\left[(P_q - P_a)f\left(\frac{q}{A}\right)\left(\frac{q}{A^2}\right)\right]\left[-\int_{\frac{q}{A}}^{\infty} yf(y)dy\right] + \left[-\frac{\partial^2 C}{\partial A^2} - (P_q - P_a)\left(\frac{q^2}{A^3}\right)f\left(\frac{q}{A}\right)\right]\left[\int_{\frac{q}{A}}^{\infty} f(y)dy\right]}{\left[-\frac{\partial^2 C}{\partial A^2} - (P_q - P_a)\left(\frac{q^2}{A^3}\right)f\left(\frac{q}{A}\right)\right]\left[-(P_q - P_a)f\left(\frac{q}{A}\right)\frac{1}{A}\right] - \left[(P_q - P_a)f\left(\frac{q}{A}\right)\frac{q}{A^2}\right]^2} \\
(83) \quad &= \frac{-\left[(P_q - P_a)f\left(\frac{q}{A}\right)\left(\frac{q}{A^2}\right)\right]\left[-\int_{\frac{q}{A}}^{\infty} yf(y)dy\right] + \left[-\frac{\partial^2 C}{\partial A^2} - (P_q - P_a)\left(\frac{q^2}{A^3}\right)f\left(\frac{q}{A}\right)\right]\left[\int_{\frac{q}{A}}^{\infty} f(y)dy\right]}{(P_q - P_a)f\left(\frac{q}{A}\right)\frac{1}{A}\frac{\partial^2 C}{\partial A^2}}
\end{aligned}$$

$$\begin{aligned}
\frac{dq}{dr} &= \frac{b_{22}c_{33}}{b_{22}b_{33} - b_{23}b_{32}} \\
&= \frac{\left[-\frac{\partial^2 C}{\partial A^2} - (P_q - P_a)\left(\frac{q^2}{A^3}\right)f\left(\frac{q}{A}\right)\right]}{\left[-\frac{\partial^2 C}{\partial A^2} - (P_q - P_a)\left(\frac{q^2}{A^3}\right)f\left(\frac{q}{A}\right)\right]\left[-(P_q - P_a)f\left(\frac{q}{A}\right)\frac{1}{A}\right] - \left[(P_q - P_a)f\left(\frac{q}{A}\right)\frac{q}{A^2}\right]^2} \\
(84) \quad &= \frac{\left[-\frac{\partial^2 C}{\partial A^2} - (P_q - P_a)\left(\frac{q^2}{A^3}\right)f\left(\frac{q}{A}\right)\right]}{(P_q - P_a)f\left(\frac{q}{A}\right)\frac{1}{A}\frac{\partial^2 C}{\partial A^2}} < 0,
\end{aligned}$$

and

$$(85) \quad \frac{\partial \alpha}{\partial P_q} = \frac{\partial \alpha}{\partial P_a} = \frac{\partial \alpha}{\partial q} = 0.$$

#### 4.5.2 Model with Both Quota and Additional Peanuts Insured

Next, turn to the situation when the farmer insures more than his production quota. If the farmer's decision is to insure both quota peanuts and additional, the model can be written as follows:

$$\begin{aligned}
 (86) \quad \text{Max } E(\Pi) &= \left[ \int_0^{\alpha\bar{y}} f(y)dy \right] \left[ P_q q + (\alpha\bar{y}A - q)P_a \right] \\
 &+ \int_{\alpha\bar{y}}^{\infty} \left[ P_q q + P_a(Ay - q) \right] f(y)dy - C(A) - \text{Prem}(\alpha, P_q, P_a, A, q) - rq
 \end{aligned}$$

First order conditions are:

$$\begin{aligned}
 (87) \quad \frac{dE(\pi)}{d\alpha} &= f(\alpha\bar{y})\bar{y} \left[ P_q q + (\alpha\bar{y}A - q)P_a \right] + \int_0^{\alpha\bar{y}} f(y)dy \bar{y} A P_a - \\
 &- f(\alpha\bar{y})\bar{y} \left[ P_q q + (\alpha\bar{y}A - q)P_a \right] - \frac{\partial \text{Prem}(\alpha, P_q, P_a, A, q)}{\partial \alpha} = \\
 &\int_0^{\alpha\bar{y}} f(y)dy \bar{y} A P_a - \frac{\partial \text{Prem}(\alpha, P_q, P_a, A, q)}{\partial \alpha} = 0
 \end{aligned}$$

$$(88) \quad \frac{\partial E(\pi)}{\partial A} = \alpha\bar{y}P_a \int_0^{\alpha\bar{y}} f(y)dy + P_a \int_{\alpha\bar{y}}^{\infty} yf(y)dy - C'(A) - \frac{\partial \text{Prem}(\alpha, P_q, P_a, A, q)}{\partial A} = 0$$

$$\begin{aligned}
\frac{\partial E(\pi)}{\partial q} &= \left[ \int_0^{\alpha\bar{y}} f(y)dy \right] (P_q - P_a) + \left[ \int_{\alpha\bar{y}}^{\infty} f(y)dy \right] (P_q - P_a) - \frac{\partial \text{Prem}(\alpha, P_q, P_a, A, q)}{\partial q} - r \\
(89) \quad &\left[ \int_0^{\infty} f(y)dy \right] (P_q - P_a) - \frac{\partial \text{Prem}(\alpha, P_q, P_a, A, q)}{\partial q} - r = \\
&P_q - P_a - \frac{\partial \text{Prem}(\alpha, P_q, P_a, A, q)}{\partial q} - r = 0
\end{aligned}$$

Totally differentiating the FOCs yields:

$$\begin{aligned}
&\left( f(\alpha\bar{y})\bar{y}^2 AP_a - \frac{\partial^2 \text{Prem}(\alpha, P_q, P_a, A, q)}{\partial^2 \alpha} \right) d\alpha + \left( P_a \bar{y} \int_0^{\alpha\bar{y}} f(y)dy - \frac{\partial \text{Prem}(\alpha, P_q, P_a, A, q)}{\partial \alpha \partial A} \right) dA \\
(90) \quad &- \left( \frac{\partial^2 \text{Prem}(\alpha, P_q, P_a, A, q)}{\partial \alpha \partial q} \right) dq - \left( \frac{\partial^2 \text{Prem}(\alpha, P_q, P_a, A, q)}{\partial \alpha \partial P_q} \right) dP_q + \\
&\left( A \bar{y} \int_0^{\alpha\bar{y}} f(y)dy - \frac{\partial^2 \text{Prem}(\alpha, P_q, P_a, A, q)}{\partial \alpha \partial P_a} \right) dP_a = 0
\end{aligned}$$

$$\begin{aligned}
&\left( \bar{y} P_a \int_0^{\alpha\bar{y}} f(y)dy - \frac{\partial \text{Prem}(\alpha, P_q, P_a, A, q)}{\partial A \partial \alpha} \right) d\alpha - \left( \frac{\partial^2 C(A)}{\partial^2 A} + \frac{\partial^2 \text{Prem}(\alpha, P_q, P_a, A, q)}{\partial^2 A} \right) dA \\
(91) \quad &- \left( \frac{\partial \text{Prem}(\alpha, P_q, P_a, A, q)}{\partial A \partial q} \right) dq - \left( \frac{\partial^2 \text{Prem}(\alpha, P_q, P_a, A, q)}{\partial A \partial P_q} \right) dP_q \\
&+ \left( \alpha \bar{y} \int_0^{\alpha\bar{y}} f(y)dy + \int_{\alpha\bar{y}}^{\infty} y f(y)dy - \frac{\partial \text{Prem}(\alpha, P_q, P_a, A, q)}{\partial A \partial P_a} \right) dP_a = 0
\end{aligned}$$

$$\begin{aligned}
(92) \quad & - \left( \frac{\partial^2 Prem(\alpha, P_q, P_a, A, q)}{\partial q \partial \alpha} \right) d\alpha - \left( \frac{\partial^2 Prem(\alpha, P_q, P_a, A, q)}{\partial q \partial A} \right) dA - \\
& \left( \frac{\partial^2 Prem(\alpha, P_q, P_a, A, q)}{\partial^2 q} \right) dq + \left( 1 - \frac{\partial^2 Prem(\alpha, P_q, P_a, A, q)}{\partial q \partial P_q} \right) dP_q \\
& - \left( 1 + \frac{\partial^2 Prem(\alpha, P_q, P_a, A, q)}{\partial q \partial P_a} \right) dP_a - dr = 0
\end{aligned}$$

Rewriting the comparative statics equations (90) - (92) in the form below,

$$\begin{aligned}
(93) \quad & b_{11}d\alpha + b_{12}dA + b_{13}dq = c_{11}dP_q + c_{12}dP_a + c_{13}dr \\
& b_{21}d\alpha + b_{22}dA + b_{23}dq = c_{21}dP_q + c_{22}dP_a + c_{23}dr, \\
& b_{31}d\alpha + b_{32}dA + b_{33}dq = c_{31}dP_q + c_{32}dP_a + c_{33}dr
\end{aligned}$$

following expressions for coefficients are obtained :

$$(94) \quad b_{11} = P_a A \bar{y}^2 f(\alpha \bar{y}) - \frac{\partial^2 Prem(\alpha, P_q, P_a, A, q)}{\partial^2 \alpha},$$

$$(95) \quad b_{12} = P_a \bar{y} \int_0^{\alpha \bar{y}} f(y) dy - \frac{\partial Prem(\alpha, P_q, P_a, A, q)}{\partial \alpha \partial A},$$

$$(96) \quad b_{13} = -\frac{\partial^2 \text{Prem}(\alpha, P_q, P_a, A, q)}{\partial \alpha \partial q},$$

$$(97) \quad c_{11} = \frac{\partial^2 \text{Prem}(\alpha, P_q, P_a, A, q)}{\partial \alpha \partial P_q},$$

$$(98) \quad c_{12} = \left( A \bar{y} \int_0^{\alpha \bar{y}} f(y) dy - \frac{\partial^2 \text{Prem}(\alpha, P_q, P_a, A, q)}{\partial \alpha \partial P_a} \right),$$

$$(99) \quad c_{13} = 0$$

$$(100) \quad b_{21} = P_a \bar{y} \int_0^{\alpha \bar{y}} f(y) dy - \frac{\partial \text{Prem}(\alpha, P_q, P_a, A, q)}{\partial A \partial \alpha},$$

$$(101) \quad b_{22} = -\frac{\partial^2 C(A)}{\partial A^2} - \frac{\partial^2 \text{Prem}(\alpha, P_q, P_a, A, q)}{\partial A^2},$$

$$(102) \quad b_{23} = -\frac{\partial \text{Prem}(\alpha, P_q, P_a, A, q)}{\partial A \partial q},$$

$$(103) \quad c_{21} = \frac{\partial \text{Prem}(\alpha, P_q, P_a, A, q)}{\partial A \partial P_q},$$

$$(104) \quad c_{22} = \frac{\partial \text{Prem}(\alpha, P_q, P_a, A, q)}{\partial A \partial P_a} - \alpha \bar{y} \int_0^{\alpha \bar{y}} f(y) dy - \int_{\alpha \bar{y}}^{\infty} y f(y) dy,$$

$$(105) \quad c_{23} = 0.$$

$$(106) \quad b_{31} = - \frac{\partial^2 \text{Prem}(\alpha, P_q, P_a, A, q)}{\partial q \partial \alpha},$$

$$(107) \quad b_{32} = - \frac{\partial^2 \text{Prem}(\alpha, P_q, P_a, A, q)}{\partial q \partial A},$$

$$(108) \quad b_{33} = - \frac{\partial^2 \text{Prem}(\alpha, P_q, P_a, A, q)}{\partial q^2},$$

$$(109) \quad c_{31} = \frac{\partial^2 \text{Prem}(\alpha, P_q, P_a, A, q)}{\partial q \partial \alpha} - 1,$$

$$(110) \quad c_{32} = 1 + \frac{\partial^2 \text{Prem}(\alpha, P_q, P_a, A, q)}{\partial q \partial P_a},$$

$$(111) \quad c_{33} = 1,$$

$$(112) \quad \begin{bmatrix} b_{11} & b_{12} & b_{13} \\ b_{21} & b_{22} & b_{23} \\ b_{31} & b_{32} & b_{33} \end{bmatrix} \begin{bmatrix} d\alpha \\ dA \\ dq \end{bmatrix} = \begin{bmatrix} c_{11} & c_{12} & 0 \\ c_{21} & c_{22} & 0 \\ c_{31} & c_{32} & c_{33} \end{bmatrix} \begin{bmatrix} dP_q \\ dP_a \\ dr \end{bmatrix},$$

As in the model where only quota is insured, determinate comparative static results require more specificity as to the structure of premiums charged. Using similar simplifications as in the first model comparative statics can be obtained as follow:

$$(113) \quad \text{Payment} = \begin{cases} 0 & \text{if } y > \alpha\bar{y} \\ AP_a(\alpha\bar{y} - y) & \text{if } \frac{q}{A} < y \leq \alpha\bar{y} \\ P_q(q - Ay) + P_a(A\alpha\bar{y} - q) & \text{if } 0 \leq y \leq \frac{q}{A} \end{cases},$$

and

$$(114) \quad E(\text{Payment}) = \int_{\frac{q}{A}}^{\alpha\bar{y}} AP_a(\alpha\bar{y} - y)f(y)dy + \int_0^{\frac{q}{A}} (P_q(q - Ay) + P_a(A\alpha\bar{y} - q))f(y)dy.$$

Once again, the comparative statics expression become determinate if we assume that crop

insurance premiums are set at actuarially fair rates:

$$(115) \quad Prem^{AF} = \int_{\frac{q}{A}}^{\alpha\bar{y}} AP_a(\alpha\bar{y} - y)f(y)dy + \int_0^{\frac{q}{A}} \left( P_q(q - Ay) + P_a(A\alpha\bar{y} - q) \right) f(y)dy.$$

Taking derivatives and cross derivatives of equation (115) we obtain the following expressions:

$$(116) \quad \frac{\partial Prem(\alpha, P_q, P_a, A, q)}{\partial \alpha} = \int_{\frac{q}{A}}^{\alpha\bar{y}} AP_a \bar{y} f(y) dy + AP_a \bar{y} \int_0^{\frac{q}{A}} f(y) dy$$

$$= AP_a \bar{y} \int_0^{\alpha\bar{y}} f(y) dy > 0,$$

$$(117) \quad \frac{\partial^2 Prem(\alpha, P_q, P_a, A, q)}{\partial \alpha \partial P_a} = A\bar{y} \int_0^{\alpha\bar{y}} f(y) dy > 0,$$

$$(118) \quad \frac{\partial^2 Prem(\alpha, P_q, P_a, A, q)}{\partial \alpha \partial P_q} = \frac{\partial^2 Prem(\alpha, P_q, P_a, A, q)}{\partial \alpha \partial q} = 0,$$

$$(119) \quad \frac{\partial^2 Prem(\alpha, P_q, P_a, A, q)}{\partial \alpha \partial A} = P_a \bar{y} \int_0^{\alpha\bar{y}} f(y) dy > 0,$$



$$(120) \quad \frac{\partial^2 Prem(\alpha, P_q, P_a, A, q)}{\partial \alpha^2} = AP_a \bar{y}^2 f(\alpha \bar{y}) > 0,$$

$$(121) \quad \frac{\partial Prem(\alpha, P_q, P_a, A, q)}{\partial A} = P_a \int_{\frac{q}{A}}^{\alpha \bar{y}} (\alpha \bar{y} - y) f(y) dy + \int_0^{\frac{q}{A}} (P_a \alpha \bar{y} - P_q y) f(y) dy,$$

$$(122) \quad \frac{\partial^2 Prem(\alpha, P_q, P_a, A, q)}{\partial A \partial \alpha} = P_a \bar{y} \int_0^{\alpha \bar{y}} f(y) dy > 0,$$

$$(123) \quad \frac{\partial Prem(\alpha, P_q, P_a, A, q)}{\partial A \partial P_q} = - \int_0^{\frac{q}{A}} y f(y) dy < 0,$$

$$(124) \quad \frac{\partial^2 Prem(\alpha, P_q, P_a, A, q)}{\partial A \partial P_a} = \alpha \bar{y} \int_0^{\alpha \bar{y}} f(y) dy - \int_{\frac{q}{A}}^{\alpha \bar{y}} y f(y) dy,$$

$$(125) \quad \frac{\partial^2 Prem(\alpha, P_q, P_a, A, q)}{\partial A \partial q} = -(P_q - P_a) f\left(\frac{q}{A}\right) \frac{q}{A^2} < 0,$$

$$(126) \quad \frac{\partial^2 Prem(\alpha, P_q, P_a, A, q)}{\partial A^2} = (P_q - P_a) \frac{q^2}{A^3} f\left(\frac{q}{A}\right) > 0,$$

$$(127) \quad \frac{\partial Prem(\alpha, P_q, P_a, A, q)}{\partial q} = (P_q - P_a) \int_0^{\frac{q}{A}} f(y) dy > 0,$$

$$(128) \quad \frac{\partial^2 Prem(\alpha, P_q, P_a, A, q)}{\partial q \partial \alpha} = 0,$$

$$(129) \quad \frac{\partial^2 Prem(\alpha, P_q, P_a, A, q)}{\partial q \partial A} = -(P_q - P_a) f\left(\frac{q}{A}\right) \frac{q}{A^2} < 0,$$

$$(130) \quad \frac{\partial^2 Prem(\alpha, P_q, P_a, A, q)}{\partial q \partial P_q} = \int_0^{\frac{q}{A}} f(y) dy > 0,$$

$$131) \quad \frac{\partial^2 Prem(\alpha, P_q, P_a, A, q)}{\partial q \partial P_a} = - \int_0^{\frac{q}{A}} f(y) dy < 0,$$

$$(132) \quad \frac{\partial^2 Prem(\alpha, P_q, P_a, A, q)}{\partial q^2} = (P_q - P_a) f\left(\frac{q}{A}\right) \frac{1}{A}.$$

Substituting these derivatives into equations (94)-(111), the following expressions are obtained, which can be in most cases signed:

$$(133) \quad b_{11} = P_a A \bar{y}^2 f(\alpha \bar{y}) - \frac{\partial^2 \text{Prem}(\alpha, P_q, P_a, A, q)}{\partial^2 \alpha} = 0,$$

$$(134) \quad b_{12} = P_a \bar{y} \int_0^{\alpha \bar{y}} f(y) dy - \frac{\partial \text{Prem}(\alpha, P_q, P_a, A, q)}{\partial \alpha \partial A} = 0,$$

$$(135) \quad c_{12} = A \frac{\partial^2 \text{Prem}(a, P_q, P_a, A, q)}{\partial a \partial P_a} - A \bar{y} \int_0^{\alpha \bar{y}} f(y) dy = 0,$$

$$(136) \quad b_{13} = c_{11} = c_{13} = 0,$$

$$(137) \quad b_{21} = P_a \bar{y} \int_0^{\alpha \bar{y}} f(y) dy - \frac{\partial \text{Prem}(a, P_q, P_a, A, q)}{\partial A \partial a} = 0,$$

The coefficients above are only zero if premiums are set to be actuarially fair.

$$(138) \quad \begin{aligned} b_{22} &= -\frac{\partial^2 C(A)}{\partial A^2} - \frac{\partial^2 \text{Prem}(a, P_q, P_a, A, q)}{\partial A^2} = \\ &= -\frac{\partial^2 C(A)}{\partial A^2} - (P_q - P_a) \left( \frac{q^2}{A^3} \right) f\left( \frac{q}{A} \right) < 0, \end{aligned}$$

$$(139) \quad b_{23} = -\frac{\partial \text{Prem}(a, P_q, P_a, A, q)}{\partial A \partial q} = (P_q - P_a) f\left(\frac{q}{A}\right) \frac{q}{A^2} > 0,$$

$$(140) \quad c_{21} = \frac{\partial \text{Prem}(a, P_q, P_a, A, q)}{\partial A \partial P_q} = -\int_0^{\frac{q}{A}} y f(y) dy < 0,$$

$$(141) \quad \begin{aligned} c_{22} &= \frac{\partial \text{Prem}(a, P_q, P_a, A, q)}{\partial A \partial P_a} - a\bar{y} \int_0^{a\bar{y}} f(y) dy - \int_{a\bar{y}}^{\infty} y f(y) dy = \\ & a\bar{y} \int_0^{a\bar{y}} f(y) dy - \int_{\frac{q}{A}}^{a\bar{y}} y f(y) dy - a\bar{y} \int_0^{a\bar{y}} f(y) dy - \int_{a\bar{y}}^{\infty} y f(y) dy = \\ & - \int_{\frac{q}{A}}^{a\bar{y}} y f(y) dy < 0, \end{aligned}$$

$$(142) \quad c_{23} = 0.$$

$$(143) \quad b_{32} = -\frac{\partial^2 \text{Prem}(a, P_q, P_a, A, q)}{\partial q \partial A} = (P_q - P_a) f\left(\frac{q}{A}\right) \left(\frac{q}{A^2}\right) > 0,$$

$$(144) \quad b_{33} = -\frac{\partial^2 Prem(a, P_q, P_a, A, q)}{\partial q^2} = -(P_q - P_a) f\left(\frac{q}{A}\right) \frac{1}{A} < 0,$$

$$(145) \quad c_{31} = \frac{\partial^2 Prem(a, P_q, P_a, A, q)}{\partial q \partial a} - 1 = \int_0^{\frac{q}{A}} f(y) dy - 1 = -\int_{\frac{q}{A}}^{\infty} f(y) dy < 0,$$

$$(146) \quad c_{32} = 1 + \frac{\partial^2 Prem(a, P_q, P_a, A, q)}{\partial q \partial P_a} = -\int_0^{\frac{q}{A}} f(y) dy + 1 = \int_{\frac{q}{A}}^{\infty} f(y) dy > 0,$$

$$(147) \quad c_{33} = 1,$$

$$(148) \quad b_{31} = 0.$$

Substituting in the zero coefficients, equation (24) can once again be rewritten as:

$$(149) \quad \begin{aligned} b_{22}dA + b_{23}dq &= c_{21}dP_q + c_{22}dP_a \\ b_{32}dA + b_{33}dq &= c_{31}dP_q + c_{32}dP_a + c_{33}dr, \end{aligned}$$

which can be rewritten in matrix notation as:

$$(150) \quad \begin{bmatrix} b_{22} & b_{23} \\ b_{32} & b_{33} \end{bmatrix} \begin{bmatrix} dA \\ dq \end{bmatrix} = \begin{bmatrix} c_{21} & c_{22} & 0 \\ c_{31} & c_{32} & c_{33} \end{bmatrix} \begin{bmatrix} dP_q \\ dP_a \\ dr \end{bmatrix}.$$

Again,  $\alpha$  is indeterminate.

$$(151) \quad \begin{bmatrix} dA \\ dq \end{bmatrix} = \begin{bmatrix} b_{22} & b_{23} \\ b_{32} & b_{33} \end{bmatrix}^{-1} \begin{bmatrix} c_{21} & c_{22} & 0 \\ c_{31} & c_{32} & c_{33} \end{bmatrix} \begin{bmatrix} dP_q \\ dP_a \\ dr \end{bmatrix},$$

$$(152) \quad \begin{bmatrix} dA \\ dq \end{bmatrix} = \frac{1}{b_{22}b_{33} - b_{23}b_{32}} \begin{bmatrix} b_{33} - b_{23} \\ -b_{32} & b_{22} \end{bmatrix} \begin{bmatrix} c_{21} & c_{22} & 0 \\ c_{31} & c_{32} & c_{33} \end{bmatrix} \begin{bmatrix} dP_q \\ dP_a \\ dr \end{bmatrix},$$

$$(153) \quad \begin{bmatrix} dA \\ dq \end{bmatrix} = \frac{1}{b_{22}b_{33} - b_{23}b_{32}} \begin{bmatrix} b_{33}c_{21} - b_{23}c_{31} & b_{33}c_{22} - b_{23}c_{32} & -b_{23}c_{33} \\ -b_{32}c_{21} + b_{22}c_{31} & -b_{32}c_{22} + b_{22}c_{32} & b_{22}c_{33} \end{bmatrix} \begin{bmatrix} dP_q \\ dP_a \\ dr \end{bmatrix},$$

$$(154) \quad \begin{aligned} \frac{dA}{dP_q} &= \frac{b_{33}c_{21} - b_{23}c_{31}}{b_{22}b_{33} - b_{23}b_{32}} \\ &= \frac{\left[ -(P_q - P_a)f\left(\frac{q}{A}\right)\frac{1}{A} \right] \left[ -\int_0^{\frac{q}{A}} yf(y)dy \right] - \left[ (P_q - P_a)f\left(\frac{q}{A}\right)\frac{q}{A^2} \right] \left[ \int_0^{\frac{q}{A}} f(y)dy - 1 \right]}{\left[ -\frac{\partial^2 C}{\partial A^2} - (P_q - P_a)\left(\frac{q^2}{A^3}\right)f\left(\frac{q}{A}\right) \right] \left[ -(P_q - P_a)f\left(\frac{q}{A}\right)\frac{1}{A} \right] - \left[ (P_q - P_a)f\left(\frac{q}{A}\right)\frac{q}{A^2} \right]^2} \\ &= \frac{\left[ \int_0^{\frac{q}{A}} yf(y)dy \right] - \left[ \frac{q}{A} \left( -\int_{\frac{q}{A}}^{\infty} f(y)dy \right) \right]}{\frac{\partial^2 C}{\partial A^2}} > 0 \end{aligned}$$

$$\frac{dA}{dP_a} = \frac{b_{33}c_{22} - b_{23}c_{32}}{b_{22}b_{33} - b_{23}b_{32}}$$

$$\frac{\left[ - (P_q - P_a) f\left(\frac{q}{A}\right) \frac{1}{A} \right] \left[ - \int_{\frac{q}{A}}^{\infty} y f(y) dy \right] - \left[ (P_q - P_a) f\left(\frac{q}{A}\right) \frac{q}{A^2} \right] \left[ \int_{\frac{q}{A}}^{\infty} f(y) dy \right]}{\left[ - \frac{\partial^2 C}{\partial A^2} - (P_q - P_a) \left(\frac{q^2}{A^3}\right) f\left(\frac{q}{A}\right) \right] \left[ - (P_q - P_a) f\left(\frac{q}{A}\right) \frac{1}{A} \right] - \left[ (P_q - P_a) f\left(\frac{q}{A}\right) \frac{q}{A^2} \right]^2}$$

(155)

$$= \frac{\int_{\frac{q}{A}}^{\infty} y f(y) dy - \frac{q}{A} \int_{\frac{q}{A}}^{\infty} f(y) dy}{\frac{\partial^2 C}{\partial A^2}} = \frac{E\left(y|y > \frac{q}{A}\right) P\left(y > \frac{q}{A}\right) - \frac{q}{A} P\left(y > \frac{q}{A}\right)}{\frac{\partial^2 C}{\partial A^2}}$$

$$= \frac{P\left(y > \frac{q}{A}\right) \left[ E\left(y|y > \frac{q}{A}\right) - \frac{q}{A} \right]}{\frac{\partial^2 C}{\partial A^2}} > 0$$

$$\frac{dA}{dr} = \frac{-b_{23}c_{33}}{b_{22}b_{33} - b_{23}b_{32}}$$

$$\frac{- \left[ (P_q - P_a) f\left(\frac{q}{A}\right) \frac{q}{A^2} \right]}{\left[ - \frac{\partial^2 C}{\partial A^2} - (P_q - P_a) \left(\frac{q^2}{A^3}\right) f\left(\frac{q}{A}\right) \right] \left[ - (P_q - P_a) f\left(\frac{q}{A}\right) \frac{1}{A} \right] - \left[ (P_q - P_a) f\left(\frac{q}{A}\right) \frac{q}{A^2} \right]^2}$$

$$(156) \quad = \frac{- \frac{q}{A}}{\frac{\partial^2 C}{\partial A^2}} < 0$$

$$\begin{aligned}
\frac{dq}{dP_q} &= \frac{-b_{32}c_{21} + b_{22}c_{31}}{b_{22}b_{33} - b_{23}b_{32}} \\
&= \frac{-\left[(P_q - P_a)f\left(\frac{q}{A}\right)\left(\frac{q}{A^2}\right)\right]\left[-\int_0^{\frac{q}{A}} yf(y)dy\right] + \left[-\frac{\partial^2 C}{\partial A^2} - (P_q - P_a)\left(\frac{q^2}{A^3}\right)f\left(\frac{q}{A}\right)\right]\left[-\int_{\frac{q}{A}}^{\infty} f(y)dy\right]}{\left[-\frac{\partial^2 C}{\partial A^2} - (P_q - P_a)\left(\frac{q^2}{A^3}\right)f\left(\frac{q}{A}\right)\right]\left[-(P_q - P_a)f\left(\frac{q}{A}\right)\frac{1}{A}\right] - \left[(P_q - P_a)f\left(\frac{q}{A}\right)\frac{q}{A^2}\right]^2} \\
(157) \quad &= \frac{-\left[(P_q - P_a)f\left(\frac{q}{A}\right)\left(\frac{q}{A^2}\right)\right]\left[-\int_0^{\frac{q}{A}} yf(y)dy\right] + \left[-\frac{\partial^2 C}{\partial A^2} - (P_q - P_a)\left(\frac{q^2}{A^3}\right)f\left(\frac{q}{A}\right)\right]\left[-\int_{\frac{q}{A}}^{\infty} f(y)dy\right]}{(P_q - P_a)f\left(\frac{q}{A}\right)\frac{1}{A}\frac{\partial^2 C}{\partial A^2}} > 0
\end{aligned}$$

$$\begin{aligned}
\frac{dq}{dP_a} &= \frac{-b_{32}c_{22} + b_{22}c_{32}}{b_{22}b_{33} - b_{23}b_{32}} \\
&= \frac{-\left[(P_q - P_a)f\left(\frac{q}{A}\right)\left(\frac{q}{A^2}\right)\right]\left[-\int_{\frac{q}{A}}^{\infty} yf(y)dy\right] + \left[-\frac{\partial^2 C}{\partial A^2} - (P_q - P_a)\left(\frac{q^2}{A^3}\right)f\left(\frac{q}{A}\right)\right]\left[\int_{\frac{q}{A}}^{\infty} f(y)dy\right]}{\left[-\frac{\partial^2 C}{\partial A^2} - (P_q - P_a)\left(\frac{q^2}{A^3}\right)f\left(\frac{q}{A}\right)\right]\left[-(P_q - P_a)f\left(\frac{q}{A}\right)\frac{1}{A}\right] - \left[(P_q - P_a)f\left(\frac{q}{A}\right)\frac{q}{A^2}\right]^2} \\
(158) \quad &= \frac{-\left[(P_q - P_a)f\left(\frac{q}{A}\right)\left(\frac{q}{A^2}\right)\right]\left[-\int_{\frac{q}{A}}^{\infty} yf(y)dy\right] + \left[-\frac{\partial^2 C}{\partial A^2} - (P_q - P_a)\left(\frac{q^2}{A^3}\right)f\left(\frac{q}{A}\right)\right]\left[\int_{\frac{q}{A}}^{\infty} f(y)dy\right]}{(P_q - P_a)f\left(\frac{q}{A}\right)\frac{1}{A}\frac{\partial^2 C}{\partial A^2}}
\end{aligned}$$



$$\begin{aligned}
\frac{dq}{dr} &= \frac{b_{22}c_{33}}{b_{22}b_{33} - b_{23}b_{32}} \\
&= \frac{\left[ -\frac{\partial^2 C}{\partial A^2} - (P_q - P_a) \left( \frac{q^2}{A^3} \right) f \left( \frac{q}{A} \right) \right]}{\left[ -\frac{\partial^2 C}{\partial A^2} - (P_q - P_a) \left( \frac{q^2}{A^3} \right) f \left( \frac{q}{A} \right) \right] \left[ - (P_q - P_a) f \left( \frac{q}{A} \right) \frac{1}{A} \right] - \left[ (P_q - P_a) f \left( \frac{q}{A} \right) \frac{q}{A^2} \right]^2} \\
(159) \quad &= \frac{\left[ -\frac{\partial^2 C}{\partial A^2} - (P_q - P_a) \left( \frac{q^2}{A^3} \right) f \left( \frac{q}{A} \right) \right]}{(P_q - P_a) f \left( \frac{q}{A} \right) \frac{1}{A} \frac{\partial^2 C}{\partial A^2}} < 0,
\end{aligned}$$

and

$$(160) \quad \frac{\partial \alpha}{\partial P_q} = \frac{\partial \alpha}{\partial P_a} = \frac{\partial \alpha}{\partial q} = 0.$$

#### 4.6 Summary an Conclusion

Interestingly, the both models provided the same comparative statics results. This is due to the introduction of actuarially fair premium and the assumption of risk-neutrality which in fact reduced the two models into one. This result would not be obtained if this simplification was not made.

The outcome of the comparative statics analysis is consistent with expectations based on the theoretical model and it provided several interesting results. The results indicated the peanut acreage would increase if the support and additional prices increased and that it would decrease if the peanut quota lease rates increased. Farmers would like to acquire more peanut quota if the peanut support price increased and less quota when the

peanut quota lease rates increased. The derivative of peanut quota with respect to additional price is indeterminate in sign. The support price and additional price and lease rates do not effect the share of production,  $\alpha$ , insured indicating that a risk neutral farmer is indifferent between purchasing a crop insurance and the share of production insured. This result only holds if the crop insurance premium is actuarially fair.

It was noticed by both industry observers and peanut program researchers that the lease rates for additional producing counties do not reflect the full difference between the support price and additional price. One possible explanation could be hidden in the cost of crop insurance. Manipulating equation (89) we obtain equation (160):

$$(160) \quad r = P_q - P_a - \frac{\partial Prem(\alpha, P_q, P_a, A, q)}{\partial q},$$

which indicates that county lease rates are adjusted by crop insurance cost.

If the model does not allow for crop insurance, it is written in the following form

$$(161) \quad \max E(\Pi) = P_q A \int_0^{\frac{q}{A}} y f(y) dy + \int_{\frac{q}{A}}^{\infty} [P_q q + P_a (Ay - q)] f(y) dy - C(A) - rq.$$

Taking derivative of equation (161) with respect to production quota,  $q$ , we obtain:

$$(162) \quad r = \left( P_q - P_a \right) \int_{\frac{q}{A}}^{\infty} f(y) dy = \left( P_q - P_a \right) Pr \left( y > \frac{q}{A} \right),$$

which indicates that the lease rates are reduced by the probability of meeting the production quota. If the county produces additional with certainty, the lease rate should be the full difference between the support price and the additional price. However, as noted by Rucker and Thurman (1990) county lease rates for additional producing counties that represents the full difference between the support and additional price are rarely seen. One of the possible reasons, why we see lower lease rates could be explain by the cost of crop insurance as seen in equation (160).

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## **APPENDIX**

*Table 1: Limitation on out of county transfers: percentage of county quota allowed to move*

Crop Year	Percentage
1996	15
1997	25
1998	30
1999	35
2000 and subsequent crops	40

*Table 2: Proportion of National Quota by State*

State	Proportion of National Quota
Alabama	0.134
Florida	0.043
Georgia	0.413
North Carolina	0.111
Oklahoma	0.067
Texas	0.132
Virginia	0.079
Sum	0.979

Note:

Arizona, Arkansas, California, Louisiana, Mississippi, Missouri, New Mexico, South Carolina and Tennessee combined are endowed with 2.1 percent of national quota.



*Table 3: Peanut Production by State: Before and After FAIR*

State	2000 Production (millions of pounds)	Change in Production*	Percent of State Quota Moving Across County Lines**
Georgia	1,339	-16%	9%
Texas	675	40%	53%
North Carolina	357	-21%	7%
Alabama	273	-22%	14%
Virginia	214	-13%	7%
Florida	205	16%	8%
Oklahoma	131	-31%	36%
U.S. Total	3,288	-8%	

Note:

\* Pre-FAIR production is the average of production in years 1994 and 1995. Post-FAIR production is the average of production in years 1999 and 2000.

\*\* Quota movement is measured as the net change in effective quota in quota-increasing counties between 1995 and 2000.

Table 4. Explaining Cross-County Quota Movement with Additional Production:  
Linear Regressions by State, Version 1

Dependent Variable: Change in Quota, 1995-2000 Independent Variable: Expected  
Additional Production, Measured as Average Production (93 and 95)

State	Expected Additional Production						Num- ber of coun- ties	Number of counties produ- cing addition- als
	Counties Under Quota			Counties Over Quota				
	Coeffi- -cient	Standard Error	Adj R <sup>2</sup>	Coeffi- -cient	Standard Error	Adj R <sup>2</sup>		
Alabama				0.28 †	0.20	0.06	18	17
Florida				0.09*†	0.04	0.19	21	20
Georgia	1.55*†	0.05	0.99	0.25*†	0.05	0.26	76	70
North Carolina				0.18*†	0.02	0.76	27	26
Oklahoma	1.03*	0.34	0.43	1.48*	0.36	0.36	41	29
Texas	2.37*†	0.52	0.37	0.84*†	0.07	0.72	93	58
Virginia				0.31*†	0.04	0.80	13	13

Key:

\* denotes rejection of  $H_0: \beta=0$  against  $H_A: \beta>0$  at a significance level less than .05.

† denotes rejection of  $H_0: \beta=1$  against  $H_A: \beta>1$  at a significance level less than .05.

Table 5. Explaining Cross-County Quota Movement with Additional Production: Linear Regressions by State, Version 2

Dependent Variable: Change in Quota, 1995-2000 Independent Variable: Expected Additional Production, Measured as Average Yield (94-00) times 95 acreage, less 95 Quota

State	Expected Additional Production						Number of counties	Number of counties producing additional
	Counties Under Quota			Counties Over Quota				
	Coefficient	Standard Error	Adj R <sup>2</sup>	Coefficient	Standard Error	Adj R <sup>2</sup>		
Alabama				0.53	0.33	0.08	17	17
Florida				0.08*†	0.03	0.25	20	20
Georgia				0.30*†	0.06	0.29	65	64
North Carolina				0.21*†	0.02	0.78	28	28
Oklahoma	1.78	1.06	0.23	1.32*	0.44	0.26	31	24
Texas	6.63*†	1.03	0.69	0.94*	0.11	0.71	53	34
Virginia				0.36*†	0.04	0.91	9	9

Key:

\* denotes rejection of  $H_0: \beta=0$  against  $H_A: \beta>0$  at a significance level less than .01.

† denotes rejection of  $H_0: \beta=1$  against  $H_A: \beta>1$  at a significance level less than .01.

Table 6. Explaining Cross-County Quota Movement with Additional Production: Linear Regressions by State, Version 3

Dependent Variable: Change in Quota, 1995-1998 Independent Variable: Expected Additional Production, Measured as Average Production (93 and 95)

State	Expected Additional Production						Number of counties	Number of counties producing additional
	Counties Under Quota			Counties Over Quota				
	Coefficient	Standard Error	Adj R <sup>2</sup>	Coefficient	Standard Error	Adj R <sup>2</sup>		
Alabama				0.42*†	0.13	0.38	19	17
Florida				0.12*†	0.02	0.63	21	20
Georgia	1.25*†	0.07	0.98	0.24*†	0.03	0.39	77	71
North Carolina				0.22*†	0.01	0.96	26	24
Oklahoma	0.75	0.40	0.20	1.66*†	0.18	0.74	41	30
Texas	2.44*†	0.63	0.30	0.86*	0.09	0.60	92	58
Virginia				0.29*†	0.04	0.78	13	13

Key:

\* denotes rejection of  $H_0: \beta=0$  against  $H_A: \beta>0$  at a significance level less than .05.

† denotes rejection of  $H_0: \beta=1$  against  $H_A: \beta>1$  at a significance level less than .05.

Table 7. Explaining Cross-County Quota Movement with Additional Production: Linear Regressions by State - Spatial Model

Dependent Variable: Change in Quota, 1995-2000 Independent Variable: Expected Additional Production, Measured as Average Production (93 and 95)

State	Expected Additional Production										Number of counties	Number of counties producing additional
	Counties Under Quota					Counties Over Quota						
	Coefficient	Standard Error	Rho	Moran I Index	LM Test	Coefficient	Standard Error	Rho	Moran I Index	LM Test		
Alabama <sup>a</sup>						0.27 <sup>†</sup>	0.19	0.11	0.05	0.39	18	17
Florida <sup>a</sup>						0.09* <sup>†</sup>	0.03	0	-0.23	0.77	21	20
Georgia <sup>a</sup>	1.54* <sup>†</sup>	0.04	-0.03	0.04	0.19	0.22* <sup>†</sup>	0.04	0.51	0.42 <sup>#</sup>	6.46 <sup>^</sup>	76	70
North Carolina <sup>a</sup>						0.20* <sup>†</sup>	0.02	-0.19	-0.37 <sup>#</sup>	3.52 <sup>^</sup>	27	26
Oklahoma <sup>b</sup>	1.07*	0.32	0.10	-0.04	0.17	1.39*	0.33	0.31 <sup>l</sup>	0.11	0.63	41	29
Texas <sup>b</sup>	2.32* <sup>†</sup>	0.50	0.08	0.03	0.18	0.79* <sup>†</sup>	0.06	0.20 <sup>l</sup>	0.35 <sup>#</sup>	1.98	93	58
Virginia <sup>a</sup>						0.31* <sup>†</sup>	0.04	0.16	-0.06	1.03	13	13

Key:

<sup>a</sup> Centroid distance between two county is less than 30 miles.

<sup>b</sup> Centroid distance between two county is less than 40 miles.

<sup>l</sup> Denotes rejection of  $H_0: \text{Rho}=0$  against  $H_A: \text{Rho}.0$  at a significance level less than .10.

<sup>#</sup> Denotes rejection of  $H_0: \text{No spatial autocorrelation exists}$  at a significance level less than 0.10.

\* Denotes rejection of  $H_0: \beta=0$  against  $H_A: \beta>0$  at a significance level less than .05.

<sup>†</sup> Denotes rejection of  $H_0: \beta=1$  against  $H_A: \beta>1$  at a significance level less than .05.

<sup>v</sup> Denotes rejection of  $H_0: \text{No spatial autocorrelation exists in the SAR residuals}$  at a significance level less than 0.10.

Table 8. Explaining Cross-County Quota Movement with Additional Production: Linear Regressions by State - Spatial Autoregressive Model with Substantive Dependence and Spatial Error Dependence (SARMAX)

Dependent Variable: Change in Quota, 1995-2000 Independent Variable: Expected Additional Production, Measured as Avg Production (93 and 95)

State	Expected Additional Production - Counties Over Quota					
	Coefficient	Standard Error	Rho	Lambda	Number of counties	Number of Counties Producing Additional
Georgia	0.28*†	0.04	0.02 <sup>L</sup>	0.63	76	70
North Carolina	0.17*†	0.02	0.16	-0.84	27	26

Key:

- <sup>L</sup> Denotes rejection of  $H_0: \text{Rho}=0$  against  $H_A: \text{Rho} > 0$  at a significance level less than .10.
- Denotes rejection of  $H_0: \text{Lambda}=0$  against  $H_A: \text{Lambda} > 0$  at a significance level less than .10.
- \* Denotes rejection of  $H_0: \beta=0$  against  $H_A: \beta > 0$  at a significance level less than .05.
- † Denotes rejection of  $H_0: \beta=1$  against  $H_A: \beta > 1$  at a significance level less than .05.

Table 9: Response Rate to the Survey in Terms of 1998 Production

State	Year							
	1993	1994	1995	1996	1997	1998	1999	2000
Alabama	59.82	59.82	59.82	59.82	59.82	59.82	59.82	59.82
Florida	83.48	85.52	85.52	85.52	85.52	85.52	85.52	85.52
Georgia	95.88		97.78		95.3		99.30	
North Carolina	96.46	96.46	96.46	96.46	96.46	96.46	96.46	96.46
Oklahoma	85.073	85.073	85.073	87.92	87.92	87.92	87.92	88.46
Texas	63.59	63.59	63.59	81.07	81.07	82.59	84.51	84.51
Virginia	95.88	95.88	95.88	95.88	95.88	97.86	97.86	97.86

Key:

For example, the year 2000 responses from Oklahoma came from counties represented 88.46% of 1998 Oklahoma production.

Table 10: Lease Rates (Number of Observations, Mean, Standard Deviation, Minimum, Maximum)

----- state\_name=AL -----

Variable	Year	Obs	Mean	Std Dev	Minimum	Maximum
Lease Rate	1993	9	7.2222222	1.3718398	5.0000000	9.0000000
Lease Rate	1994	9	7.2222222	1.3718398	5.0000000	9.0000000
Lease Rate	1995	9	7.4444444	1.4883809	5.0000000	9.0000000
Lease Rate	1996	9	7.8333333	1.7853571	5.0000000	10.0000000
Lease Rate	1997	9	8.1666667	1.9525624	5.0000000	10.0000000
Lease Rate	1998	10	8.5500000	2.0473560	5.0000000	10.5000000
Lease Rate	1999	10	9.3500000	1.1559027	8.0000000	11.0000000
Lease Rate	2000	10	9.7000000	1.0327956	7.5000000	11.0000000

----- state\_name=FL -----

Variable	Year	Obs	Mean	Std Dev	Minimum	Maximum
Lease Rate	1993	13	9.5000000	2.5413251	6.0000000	12.5000000
Lease Rate	1994	14	9.6428571	2.5752414	6.0000000	12.5000000
Lease Rate	1995	14	9.8214286	2.3255036	6.0000000	12.5000000
Lease Rate	1996	14	10.2142857	2.0821059	6.0000000	12.5000000
Lease Rate	1997	14	10.6071429	1.6776652	7.0000000	12.5000000
Lease Rate	1998	14	10.8928571	1.9726843	7.0000000	12.5000000
Lease Rate	1999	14	11.1785714	1.7165164	7.0000000	12.5000000
Lease Rate	2000	14	11.2857143	1.7288756	7.0000000	12.5000000

----- state\_name=GA -----

Variable	Year	Obs	Mean	Std Dev	Minimum	Maximum
Lease Rate	1993	58	9.0775862	1.7516952	5.0000000	12.0000000
Lease Rate	1995	59	9.3220339	1.6102118	5.0000000	12.5000000
Lease Rate	1997	58	9.3318966	1.4474629	5.0000000	12.0000000
Lease Rate	1999	62	9.9193548	1.2905506	6.0000000	15.0000000

----- state\_name=NC -----

Variable	Year	Obs	Mean	Std Dev	Minimum	Maximum
Lease Rate	1993	17	5.9705882	1.5857824	4.0000000	10.0000000
Lease Rate	1994	17	6.0882353	1.6224528	4.0000000	10.0000000
Lease Rate	1995	17	6.3235294	1.3800043	4.0000000	10.0000000
Lease Rate	1996	17	6.3823529	1.3866485	4.0000000	10.0000000
Lease Rate	1997	17	6.4411765	1.4348601	4.0000000	10.0000000
Lease Rate	1998	17	6.6176471	1.3408185	4.0000000	10.0000000
Lease Rate	1999	17	6.6764706	1.3800043	4.0000000	10.0000000
Lease Rate	2000	17	6.6764706	1.3800043	4.0000000	10.0000000

Table 10 - Continued: Lease Rates (Number of Observations, Mean, Standard Deviation, Minimum, Maximum)

----- state\_name=OK -----

Variable	Year	Obs	Mean	Std Dev	Minimum	Maximum
Lease Rate	1993	20	5.8250000	2.0855076	2.0000000	10.0000000
Lease Rate	1994	20	6.3500000	3.0783625	2.0000000	15.0000000
Lease Rate	1995	20	6.4000000	2.9226880	2.0000000	14.0000000
Lease Rate	1996	21	7.9047619	2.4011406	3.0000000	12.0000000
Lease Rate	1997	21	8.5238095	2.7725268	3.0000000	15.0000000
Lease Rate	1998	21	9.8095238	3.2767216	3.0000000	15.0000000
Lease Rate	1999	21	10.5000000	3.7047267	3.5000000	17.0000000
Lease Rate	2000	22	10.1136364	3.3733261	3.5000000	15.0000000

----- state\_name=TX -----

Variable	Year	Obs	Mean	Std Dev	Minimum	Maximum
Lease Rate	1993	27	7.6481481	3.1949925	2.0000000	15.0000000
Lease Rate	1994	27	7.6851852	3.2289202	2.0000000	15.0000000
Lease Rate	1995	27	7.5925926	3.1866218	2.0000000	15.0000000
Lease Rate	1996	31	9.5483871	3.1314396	2.0000000	15.0000000
Lease Rate	1997	32	10.1250000	3.0480030	2.0000000	15.0000000
Lease Rate	1998	33	10.6818182	2.9838581	2.0000000	15.0000000
Lease Rate	1999	35	10.8571429	2.9792701	3.0000000	15.0000000
Lease Rate	2000	35	10.9142857	2.9317875	4.0000000	15.0000000

----- state\_name=VA -----

Variable	Year	Obs	Mean	Std Dev	Minimum	Maximum
Lease Rate	1993	7	5.7142857	0.3933979	5.0000000	6.0000000
Lease Rate	1994	7	5.5714286	0.5345225	5.0000000	6.0000000
Lease Rate	1995	7	5.5714286	0.5345225	5.0000000	6.0000000
Lease Rate	1996	7	5.8571429	0.6267832	5.0000000	7.0000000
Lease Rate	1997	7	5.7142857	0.9063270	4.0000000	7.0000000
Lease Rate	1998	8	5.8125000	1.0329396	4.5000000	8.0000000
Lease Rate	1999	8	5.7500000	1.0690450	4.5000000	8.0000000
Lease Rate	2000	8	5.5625000	1.2374369	4.0000000	8.0000000



Table 11: Test of Pooled Variance, Model 1

State	Variance Pre-FAIR	Number of Observations	Variance Post-FAIR	Number of Observations	F-Test
Alabama	1.8397	27	2.4544	48	0.750
Florida	5.8501	41	3.1984	70	1.829*
Georgia	2.8042	117	1.8573	120	1.510*
North Carolina	2.2564	51	1.8262	85	1.236
Oklahoma	7.2027	60	9.4974	106	0.758
Texas	9.7088	84	8.6553	171	1.122
Virginia	0.2178	21	0.9046	38	0.241

Key:

\* denotes rejection of  $H_0: \text{Var}(\alpha_i^{\text{Post-FAIR}}) = \text{Var}(\alpha_i^{\text{Pre-FAIR}})$  at a significance level less than .05.

Table 12: Test of Pooled Variance, Model 2

State	Variance Pre-FAIR	Number of Observations	Variance Post-FAIR	Number of Observations	F-Test
Alabama	1.8111	27	2.2238	48	0.815
Florida	5.7618	41	2.9178	70	1.975*
Georgia	2.4405	117	1.3932	120	1.752*
North Carolina	2.1137	51	1.7617	85	1.200
Oklahoma	6.5695	60	8.7998	106	0.747
Texas	9.4766	84	7.7550	171	1.222
Virginia	0.2107	21	0.8482	38	0.248

Key:

\* denotes rejection of  $H_0: \text{Var}(\alpha_i^{\text{Post-FAIR}}) = \text{Var}(\alpha_i^{\text{Pre-FAIR}})$  at a significance level less than .05.

Table 13: Test of Pooled Variance without Small Peanut Counties, Model 1

State	Variance Pre-FAIR	Number of Observations	Variance Post-FAIR	Number of Observations	F-Test
Alabama	0.3536	21	0.9327	35	0.379
Florida	4.8517	29	2.3847	50	2.034*
Georgia	2.3548	80	0.8648	82	2.722*
North Carolina	2.7955	33	1.7373	55	1.609*
Oklahoma	8.2348	39	7.2598	71	1.134
Texas	7.2547	51	5.8291	111	1.244
Virginia	0.2214	15	1.1625	25	0.190

Key:

\* denotes rejection of  $H_0: \text{Var}(\alpha_i^{\text{Post-FAIR}}) = \text{Var}(\alpha_i^{\text{Pre-FAIR}})$  at a significance level less than .05.

Table 14: Test of Pooled Variance without Small Peanut Counties, Model 2

State	Variance Pre-FAIR	Number of Observations	Variance Post-FAIR	Number of Observations	F-Test
Alabama	0.3250	21	0.8668	35	0.375
Florida	4.7559	29	2.4753	50	1.921*
Georgia	2.0196	80	0.6087	82	3.318*
North Carolina	2.5909	33	1.7050	55	1.519
Oklahoma	7.4537	39	6.6664	71	1.118
Texas	7.1882	51	5.6814	111	1.265
Virginia	0.2166	15	1.0950	25	0.198

Key:

\* denotes rejection of  $H_0: \text{Var}(\alpha_i^{\text{Post-FAIR}}) = \text{Var}(\alpha_i^{\text{Pre-FAIR}})$  at a significance level less than .05.

*Table 15: Peanut Quota Survey*

Please provide us with your estimates of average lease rates and prices for each year, rather than with ranges of these values for each year.

My best estimates (cents/pound) of past average peanut quota lease rates in your county are:

1993:

1994:

1995:

1996:

1997:

1998:

1999:

2000:

My best estimates (cents/pound) of past average peanut quota sales prices in Atascosa county are:

1993:

1994:

1995:

1996:

1997:

1998:

1999:

2000:

My best estimates (cents/pound) of average contract prices for additional, non-quota, peanuts in your county are:

1993:

1994:

1995:

1996:

1997:

1998:

1999:

2000:

Please return the survey to [jchvost@unity.ncsu.edu](mailto:jchvost@unity.ncsu.edu) or by the U.S. mail to:

Walter N. Thurman

Department of Agricultural and Resource Economics

North Carolina State University

P.O. Box 8109

Raleigh, NC 27695

Table 16: Quota and Additional Support Price

Year	Quota Support Price (cents per pound)	National Average Additional Support Price (cents per pound)
1978	21	12.5
1979	21	15.0
1980	22.75	12.5
1981	22.75	12.5
1982	27.5	10.0
1983	27.5	9.25
1984	27.5	9.25
1985	27.95	7.40
1986	30.37	7.49
1987	30.37	7.49
1988	30.76	7.49
1989	30.79	7.49
1990	31.57	7.49
1991	32.14	7.49
1992	33.37	6.55
1993	33.37	6.55
1994	33.92	6.60
1995	33.92	6.60
1996	30.50	6.60
1997	30.50	6.60
1998	30.50	8.75
1999	30.50	8.75
2000	30.50	6.60
2001	30.50	6.60

Table 17: Average Effective Quota, Average Total Production, Gains and Losses under House and Senate Proposals

State	Average Effective Quota <sup>1</sup>  thousand lbs	Average Total production <sup>1</sup>  thousand lbs	House Proposal <sup>2</sup>				Senate Proposal			
			Quota Elimination Loss  thousand \$	Counter-Cyclical and Direct Payment Gain  thousand \$	Quota Buyout Gain  thousand \$	Loss or Gain per Farm  Dollars	Quota Elimination Loss  thousand \$	Counter-Cyclical and Direct Payment Gain  thousand \$	Quota Buyout Gain  thousand \$	Loss or Gain per Farm  Dollars
Alabama	343,260	387,411	-44,624	21,404	7,802	-2,976	-44,624	27,990	8,583	-1,554
Florida	113,015	256,270	-14,692	14,159	2,569	898	-14,692	18,516	2,826	2,934
Georgia	1,041,198	1,420,244	-135,356	78,469	23,666	-3,049	-135,356	102,613	26,033	-616
North Carolina	279,618	346,989	-36,350	19,171	6,356	-1,965	-36,350	25,070	6,991	-779
Oklahoma	168,351	182,867	-21,886	10,103	3,827	-5,909	-21,886	13,212	4,209	-3,316
Texas	356,404	1,102,383	-46,332	60,907	8,101	5,935	-46,332	79,647	8,911	11,053
Virginia	197,823	219,458	-25,717	12,125	4,497	-3,302	-25,717	15,856	4,946	-1,784
U.S.	2,555,308	3,986,626	-332,190	220,261	58,082	-1,695	-332,190	288,034	63,890	621

Key:

<sup>1</sup> Average effective Quota and Average Total Production are average of 1998 through 2000 production years

<sup>2</sup> The Target Prices under House and Senate Proposals are \$480 and \$520 per ton

<sup>3</sup> The payment rates for quota buyout are 0.10 cents/lb and 0.11 cents/lb under House and Senate proposals.

Table 18: Average Effective Quota, Average Total Production, Gains and Losses under the Final Version of the Farm Bill

State	Average Effective Quota <sup>1</sup>  thousand lbs	Average Total production <sup>1</sup>  thousand lbs	Final Version of the Farm Bill <sup>2</sup>			
			Quota Elimination Loss  thousand \$	Counter-Cyclical and Direct Payment Gain  thousand \$	Quota Buyout Gain  thousand \$	Loss or Gain per Farm  Dollars
Alabama	343,260	387,411	-44,624	23,874	8,583	-2,349
Florida	113,015	256,270	-14,692	15,793	2,826	1,733
Georgia	1,041,198	1,420,244	-135,356	87,523	26,033	-2,001
North Carolina	279,618	346,989	-36,350	21,383	6,991	-1,448
Oklahoma	168,351	182,867	-21,886	11,269	4,209	-4,759
Texas	356,404	1,102,383	-46,332	67,934	8,911	7,987
Virginia	197,823	219,458	-25,717	13,524	4,946	-2,631
U.S.	2,555,308	3,986,626	-332,190	245,676	63,890	-712

Key:

<sup>1</sup> Average effective Quota and Average Total Production are average of 1998 through 2000 production years

<sup>2</sup> The Target Price under the final version of farm bill is \$495 per ton

<sup>3</sup> The payment rates for quota buyout is 0.11 cents/lb under the final version of the farm bill

Table 19: Canadian and World Imports of Peanut Butter and Paste into the United States

Year	Peanut Butter and Paste (Metric Tons)		
	Canada	World	Percentage of World Production
1987	0	0	0
1988	0	0	0
1989	1451.1	2538.5	57.16
1990	2046.7	3609.4	56.70
1991	4281.7	7802.1	54.88
1992	8148.2	12035.5	67.70
1993	14527.3	18129.5	80.13
1994	16383.2	19640.6	83.41
1995	13058.2	14771.4	88.40
1996	15149.7	19989.5	75.79
1997	14554.9	19314.5	75.36
1998	14265.2	18826.8	75.77
1999	13786.9	16936.5	81.40
2000	13891.0	18645.7	74.50
2001	14287.2	21177.6	67.46

Table 20: Imports of Peanuts, Peanut Butter and Paste from Mexico into the United States

Year	Tariff-Rate Quota	In-Shell	Shelled	Prepared or Preserved	Peanut Butter and Paste
1994		2468.2	60	0	3
1995	3377	1213.9	3351.7	228.0	0
1996	3478	2584.4	1946.0	132.0	0
1997	3583	3176.4	1093.5	126.0	0
1998	3690	2663.4	2259.2	72.5	437.2
1999	3801	2413.3	1524.1	202.9	589.2
2000	3915	2422.8	3084.9	265.3	2413.0
2001	4032	3452.7	3115.0	362.9	4673.7

Table 21: In-Quota Volume for Imports to the United States and Over-Quota Tariff

Year	In Quota Volume (Metric Tons)	Over Quota tariff (%)	
		In-shell Peanuts	Shelled Peanuts
Base		192.7	155.0
1995	30,500	187.6	150.9
1996	34,900	182.5	146.8
1997	39,360	177.7	142.9
1998	43,860	172.9	139.1
1999	48,360	168.3	135.4
2000	52,906	163.8	131.8



Table 22: Current TRQ charged under WTO

Region or Country	In-Quota Volume	Peanuts, not roasted or otherwise cooked				Blanched and other	
		In-Shell		Shelled		In-Quota	Over-Quota
		In-Quota	Over-Quota	In-Quota	Over-Quota		
MT	cents/kg	percent	cents/kg	percent	cents/kg	percent	
Argentina	43,901	9.35	163.8	6.6	131.8	6.6	131.8
All others, except Mexico							
Carabian Basin, Andean Pact	9,005	Free	163.8	Free	131.8	Free	131.8
Canada		Free	163.8	Free	131.8	Free	131.8
Israel	113	Free	163.8	Free	131.8	Free	131.8
Others							
With MFN status		9.35	163.8	6.6	131.8	6.6	131.8
Without MFN status		9.35	192.7	15	155.0	15	155.0
Total	52,906						

Table 23: U.S. Peanut Production, Exports and Imports

Year	Cleaned Peanuts		Shelled Peanuts	
	Export	Import	Export	Import
1990	53,825	4	181,958	9,331
1991	71,405	52	285,763	12,247
1992	61,866	0	277,258	907
1993	37,847	4	159,891	644
1994	46,426	3,315	264,509	25,123
1995	33,537	3,913	255,835	49,125
1996	36,563	3,170	199,779	43,110
1997	34,089	2,679	206,504	46,172
1998	26,700	2,413	171,081	51,094
1999	24,225	2,423	229,318	58,837

Note:

Units are Metric Tons (MT)  
Based on Agricultural Statistics (2000)

Table 24: Peanut Butter and Paste Quota and Tariff

Country or Group	In-Quota Volume	In-Quota Tariff	Over Quota Tariff
	MT	cents/kg	percent
Canada	14,500	Free	131.8
Argentina	3,650	Free	131.8
GSP	1600	Free	131.8
Other	250	Free	131.8
non-MFN			155.0
Total In-Quot volume	20,000		

Figure 1: National Quota and Production

## National Production and Quota Thousands of Pounds

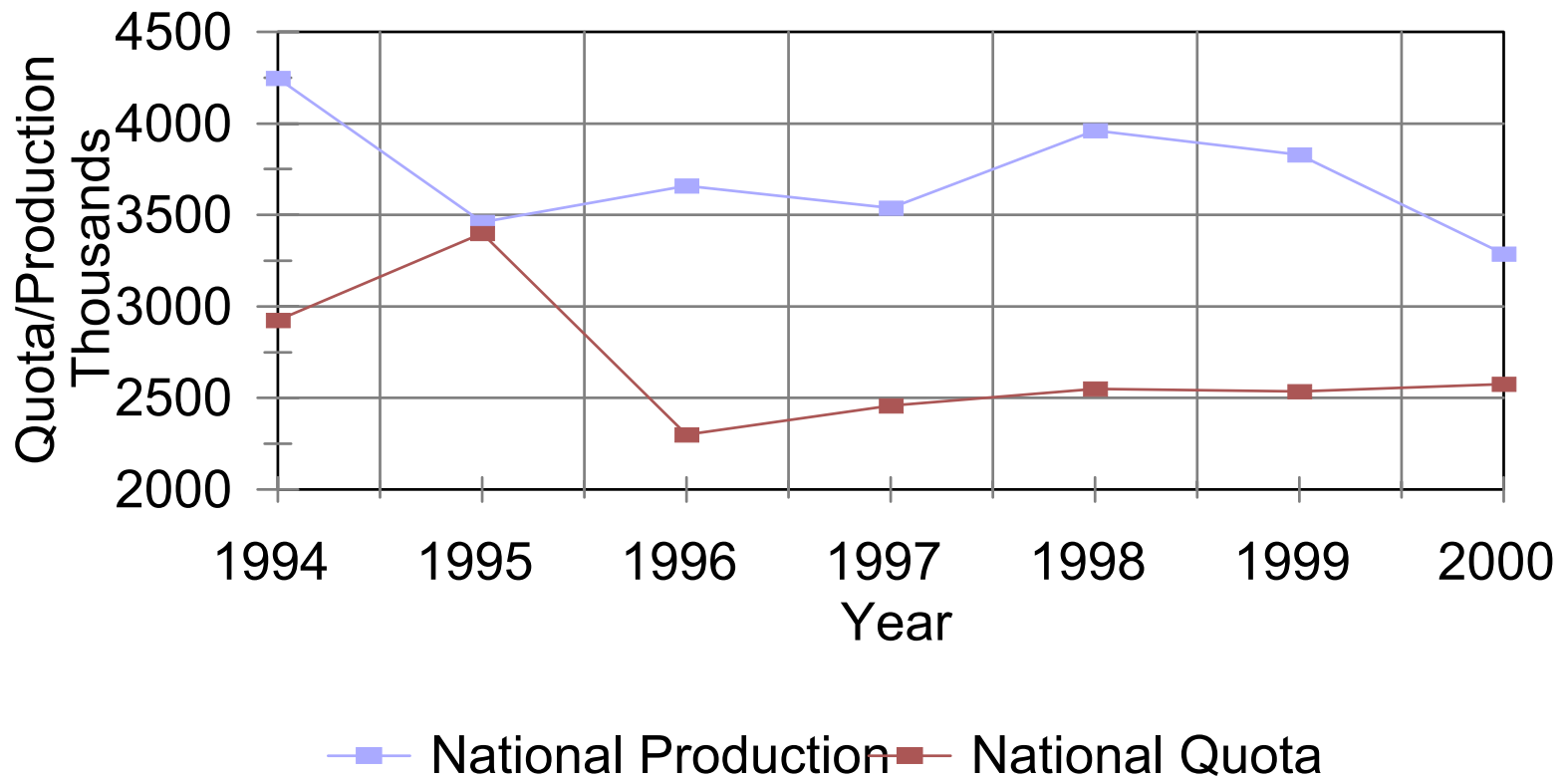


Figure 2: County with Production of Additional

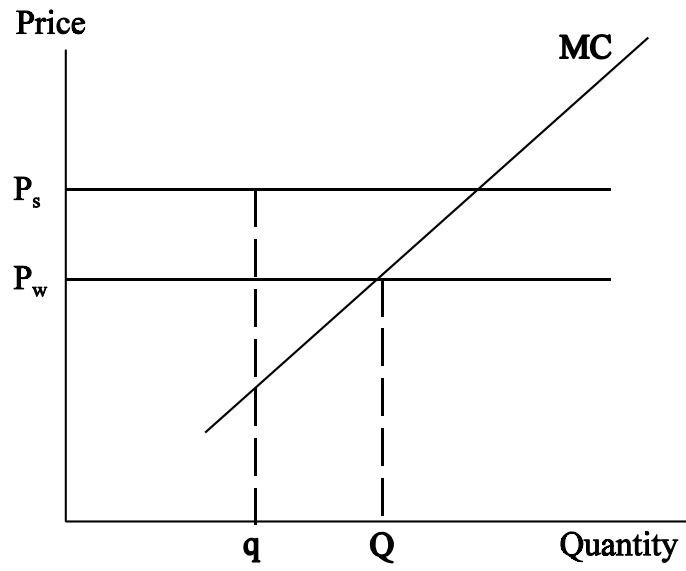


Figure 3: County with Production Less than its Quota

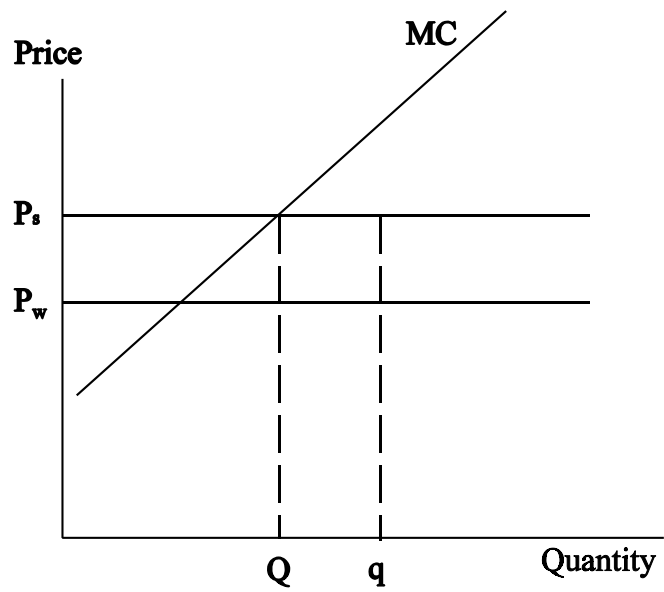


Figure 4: Peanut Production within a County

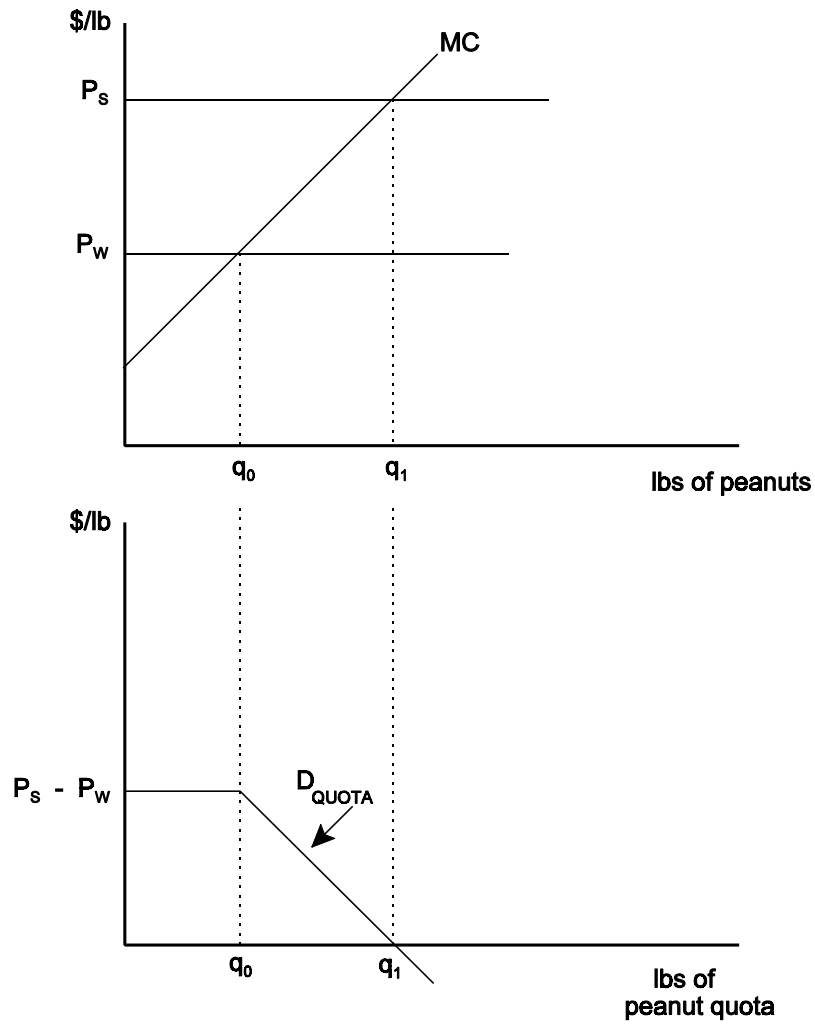


Figure 5. Scatter Plots for the Table 4 (Version 1) Regressions

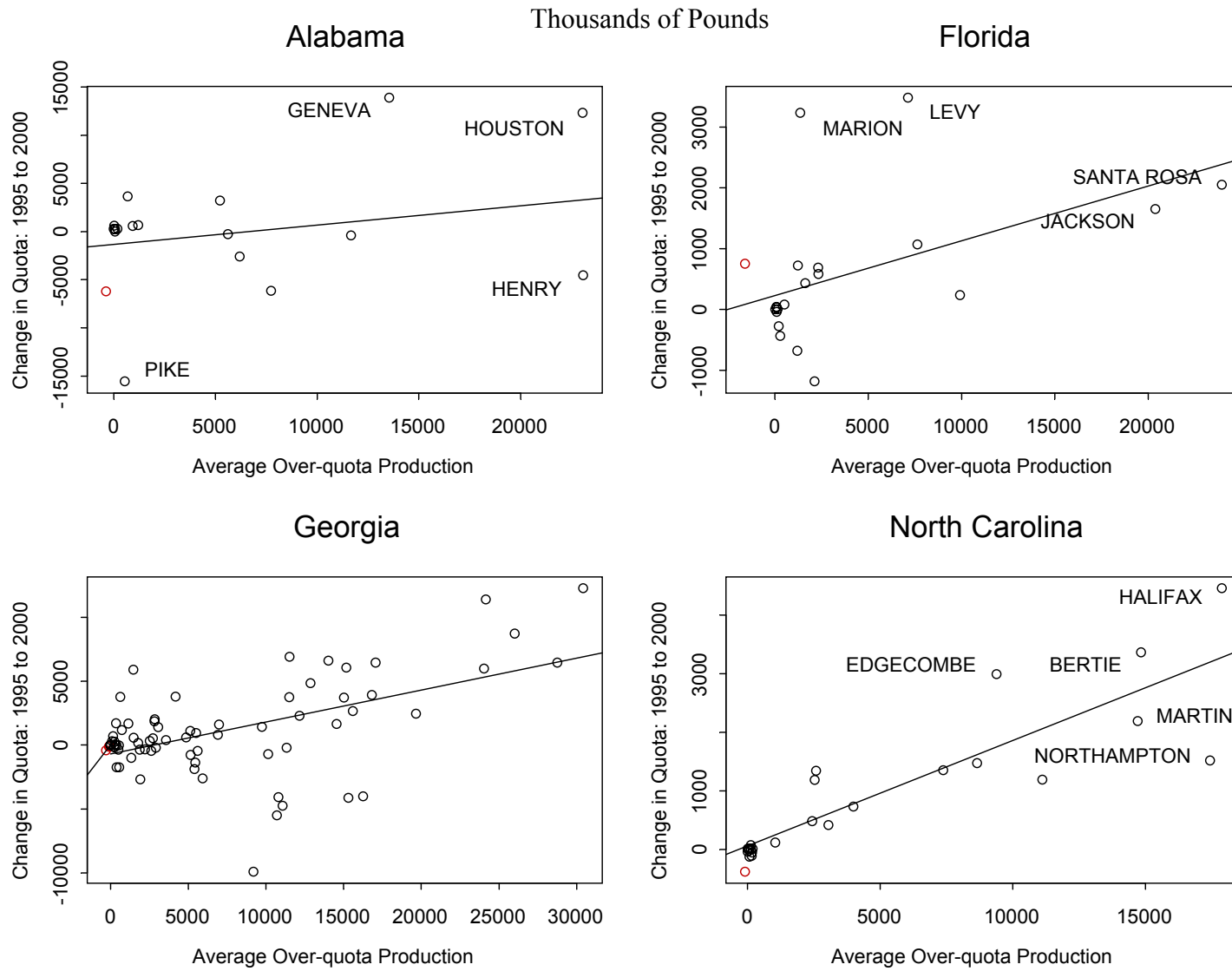


Figure 5—continued. Scatter Plots for the Table 4 (Version 1) Regressions

Thousands of Pounds

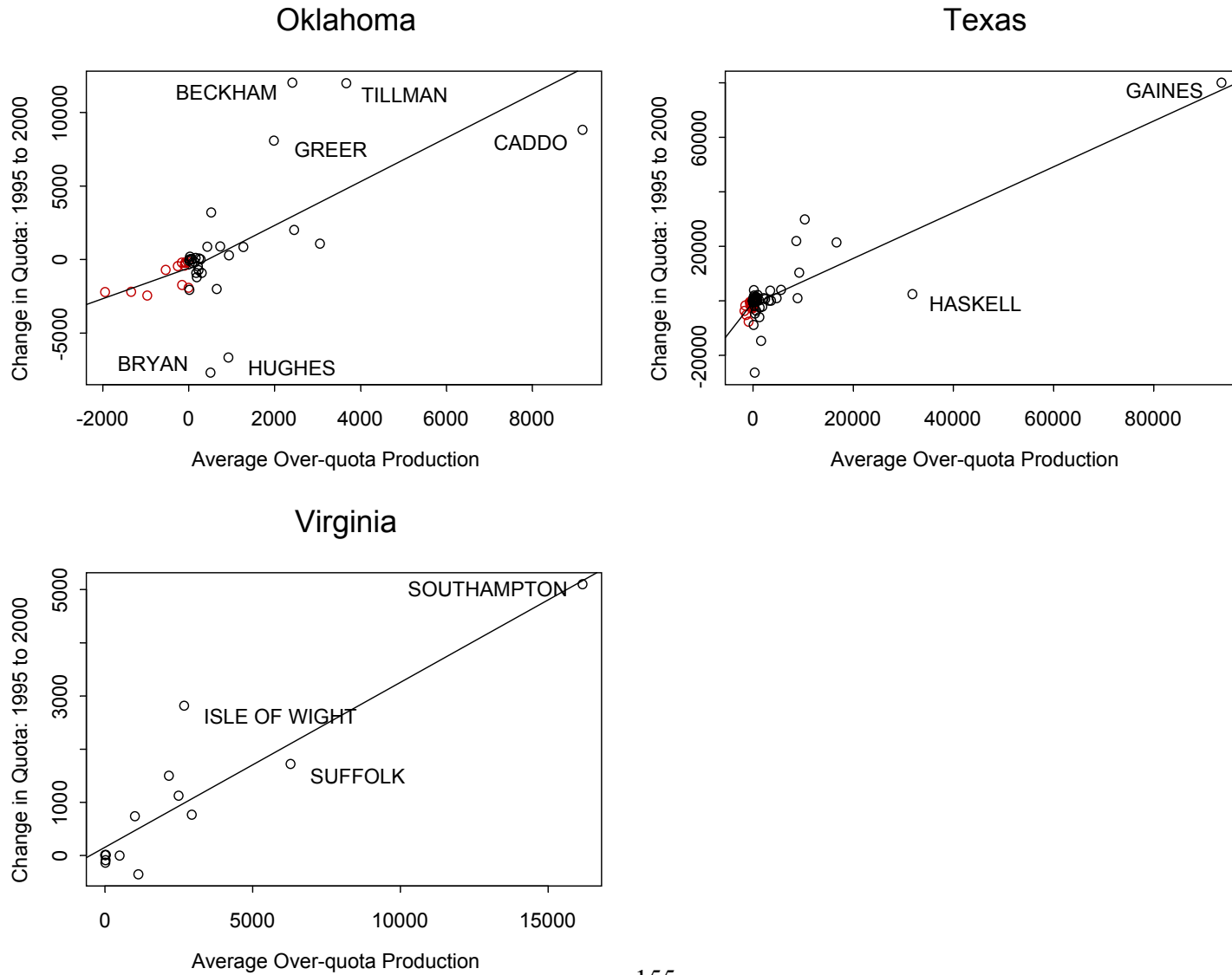


Figure 6. Scatter Plots for the Table 5 (Version 2) Regressions

Thousands of Pounds

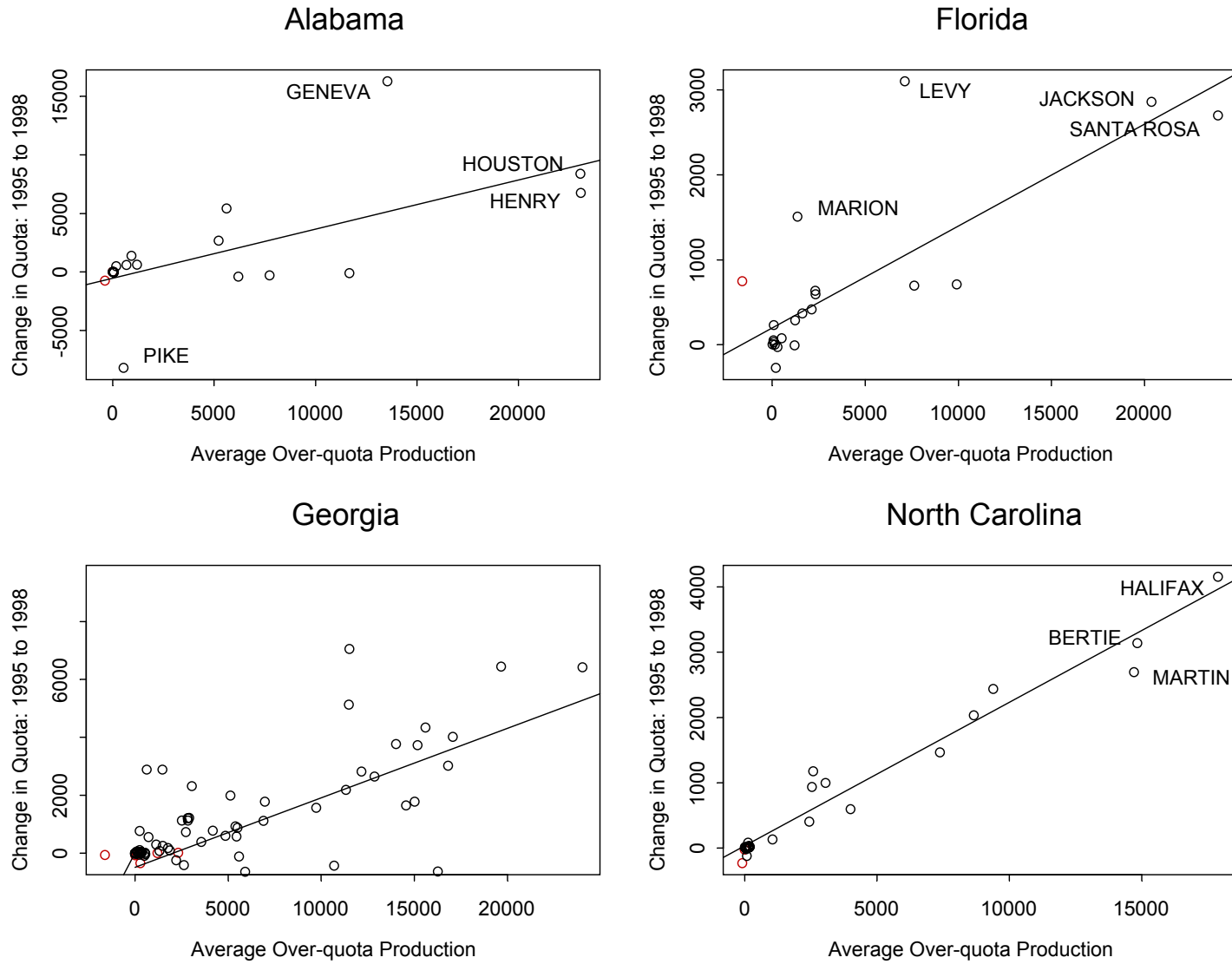




Figure 6—continued. Scatter Plots for the Table 5 (Version 2) Regressions

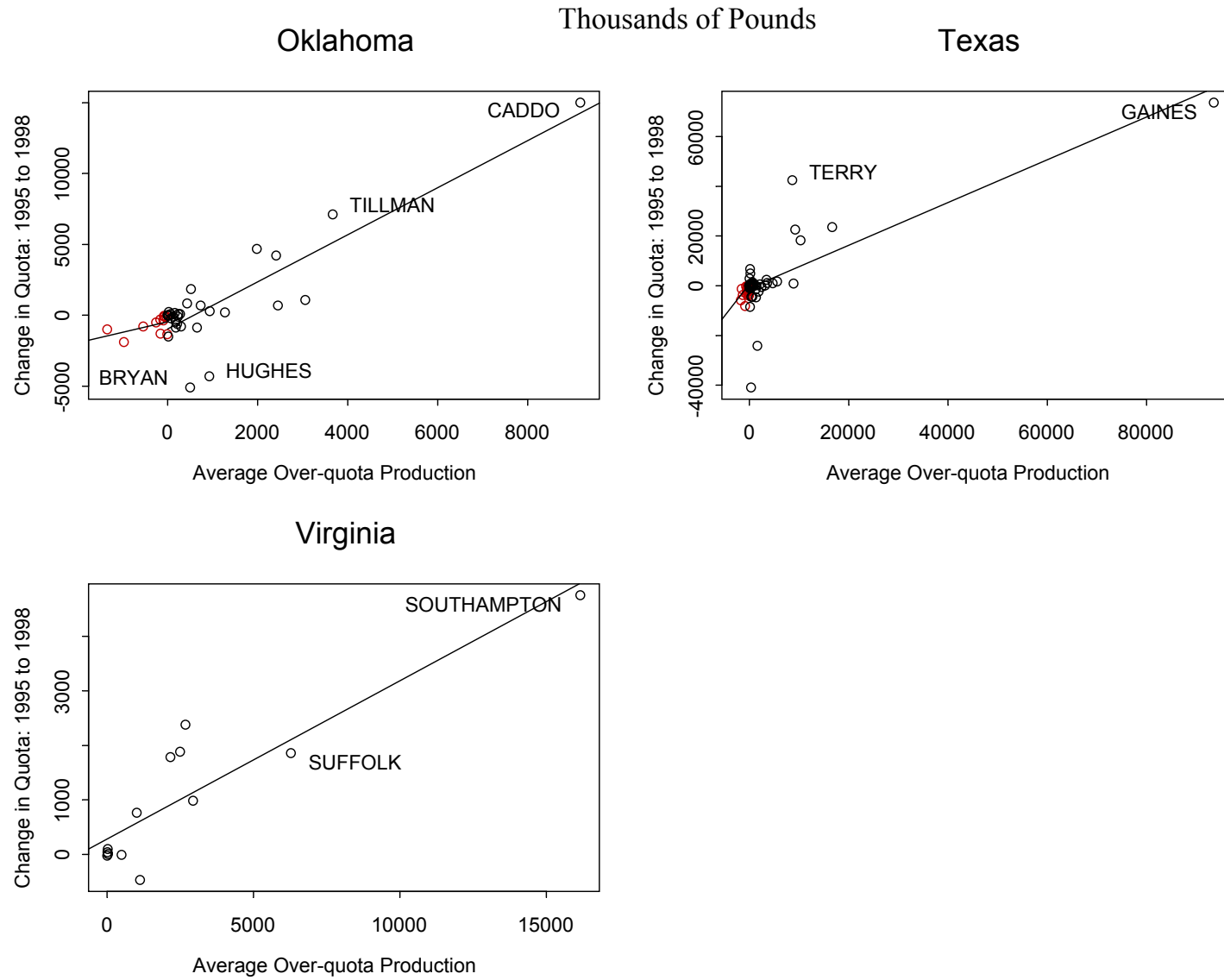


Figure 7: County Peanut Production by Type

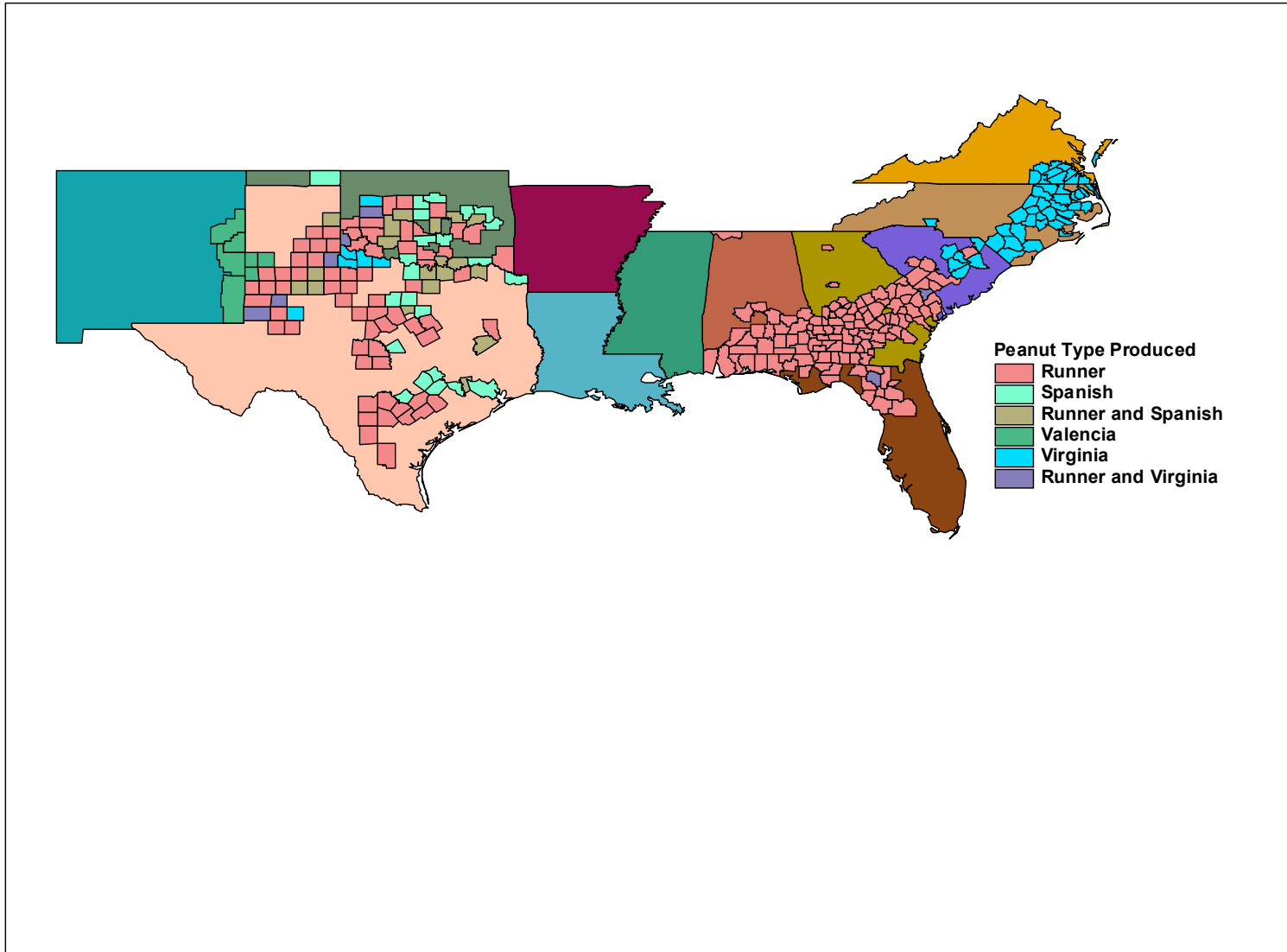


Figure 8: Peanut Producing Counties and Neighboring Counties

### Alabama Over-Producing Counties County Centroid Distance < 30 miles

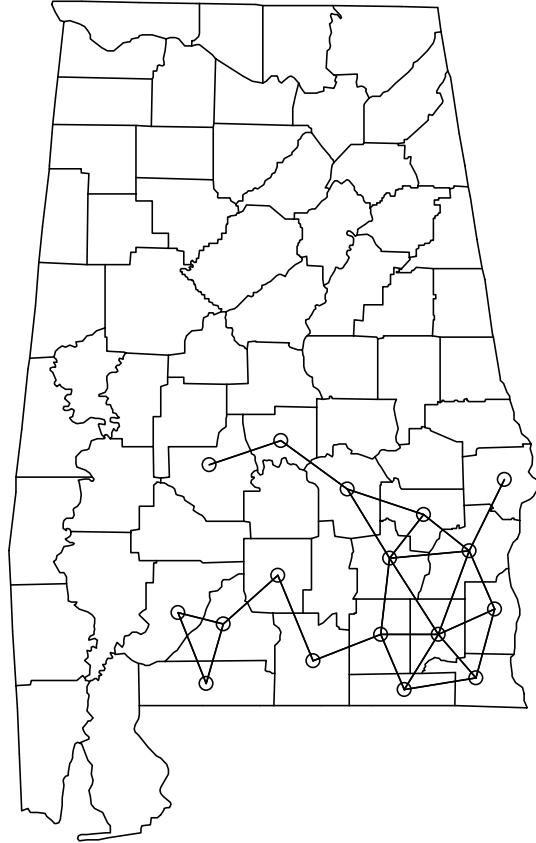


Figure 8: Peanut Producing Counties and Neighboring Counties (Continued)

**Florida Over-Producing Counties  
County Centroid Distance < 30 miles**

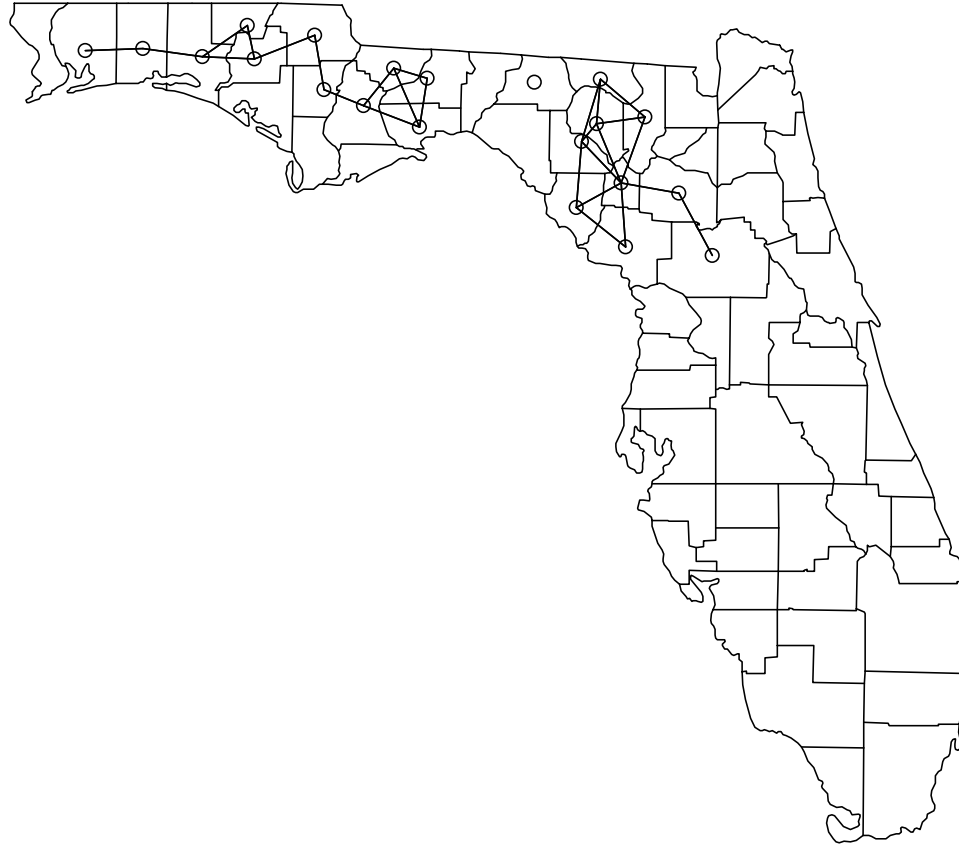
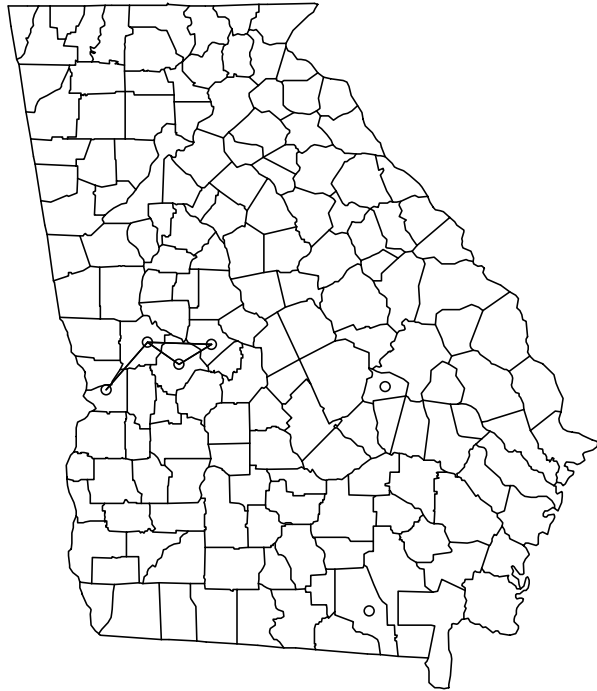
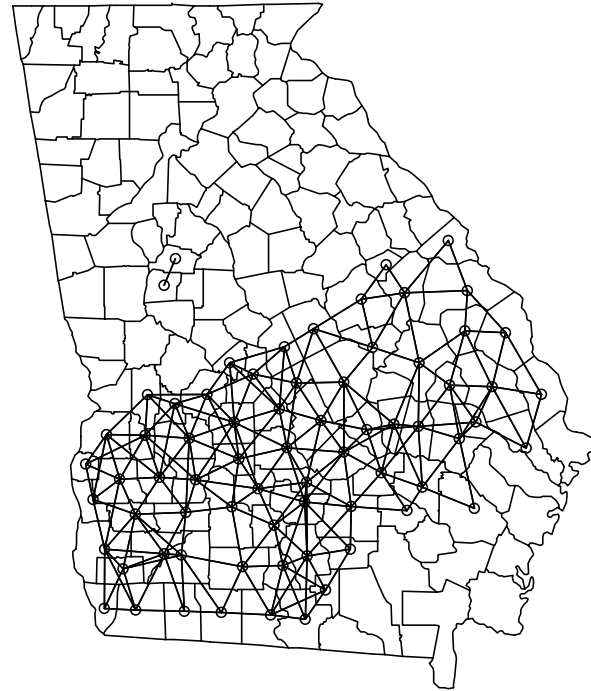


Figure 8: Peanut Producing Counties and Neighboring Counties (Continued)

Georgia Under-Producing Counties  
County Centroid Distance < 30 miles



Georgia Over-Producing Counties  
County Centroid Distance < 30 miles



*Figure 8: Peanut Producing Counties and Neighboring Counties (Continued)*

County Centroid Distance < 30 miles

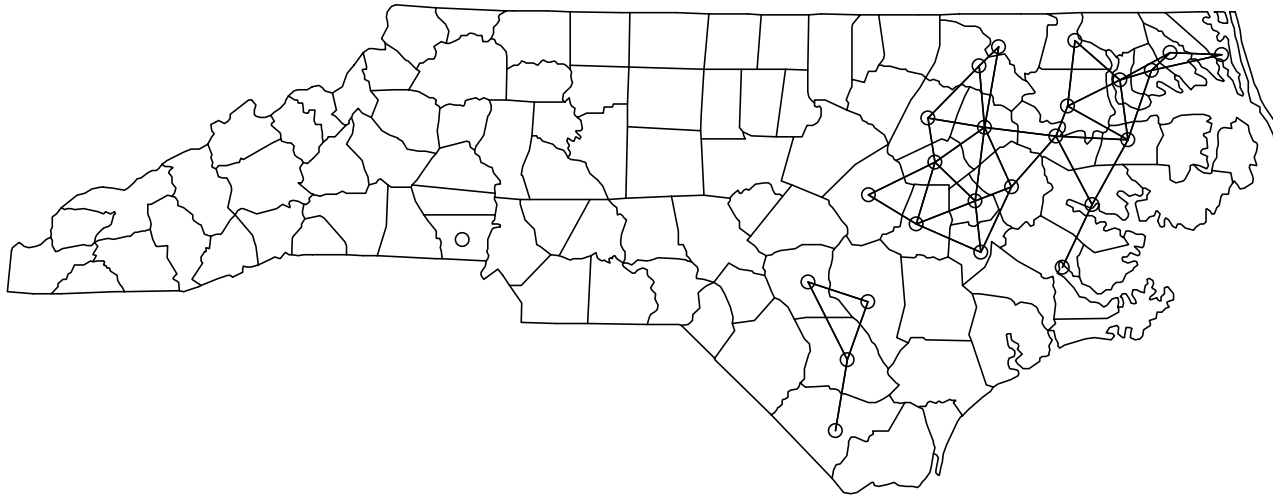
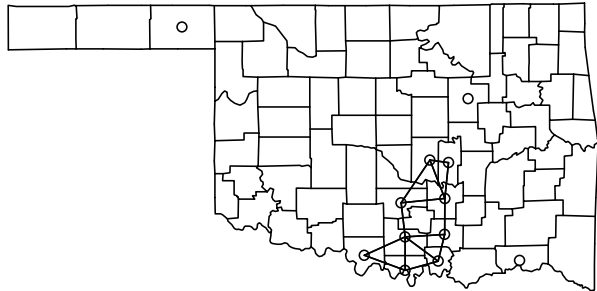


Figure 8: Peanut Producing Counties and Neighboring Counties (Continued)

Oklahoma, Under-Producing Counties  
County Centroid Distance < 40 miles



Oklahoma, Over-Producing Counties  
County Centroid Distance < 40 miles

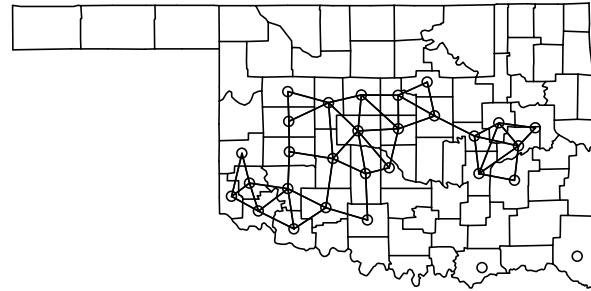
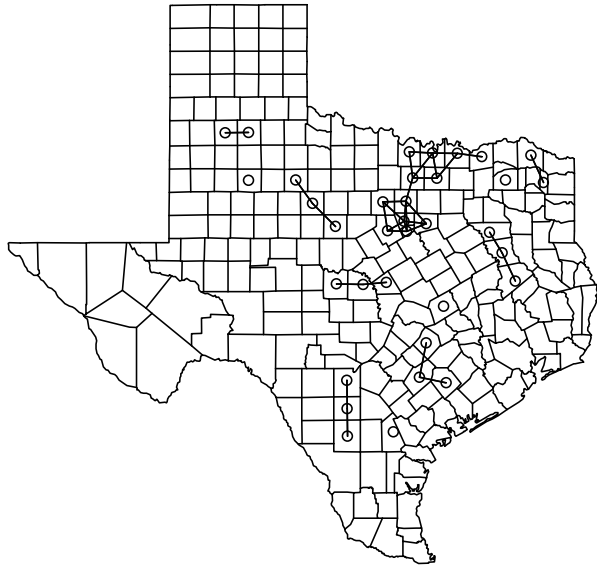
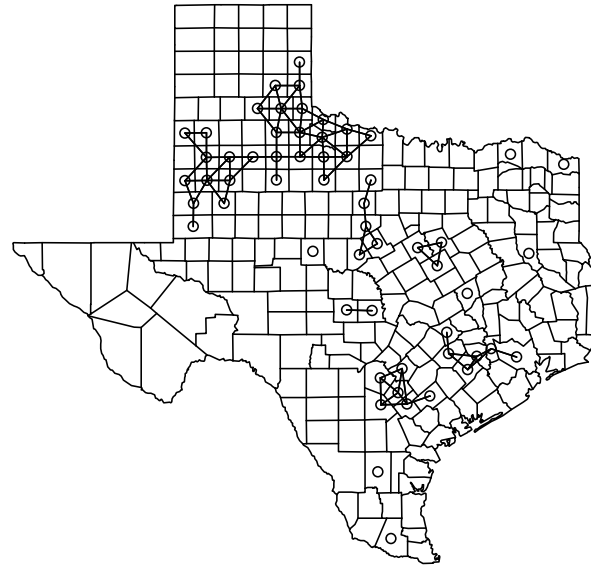


Figure 8: Peanut Producing Counties and Neighboring Counties (Continued)

Texas, Under-Producing Counties  
Centroid Distance < 40 miles



Texas, Over-Producing Counties  
County Centroid Distance < 40 miles





*Figure 8: Peanut Producing Counties and Neighboring Counties (Continued)*

Virginia, Over-Producing Counties  
County Centroid Distance < 30 miles

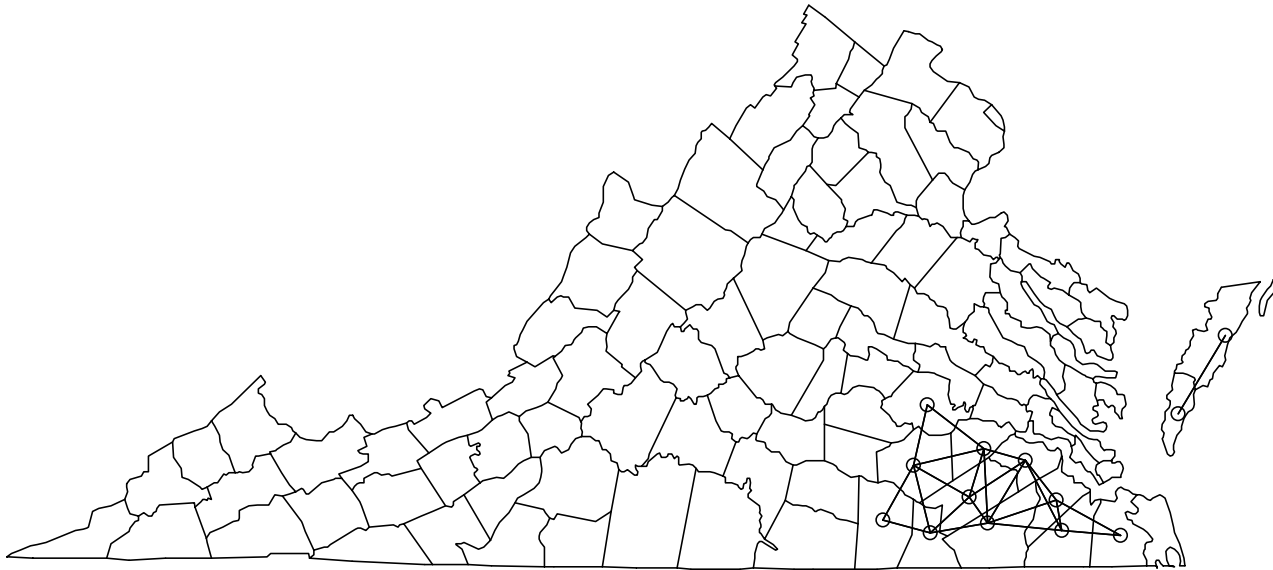


Figure 9: Lease Rate Box Plots

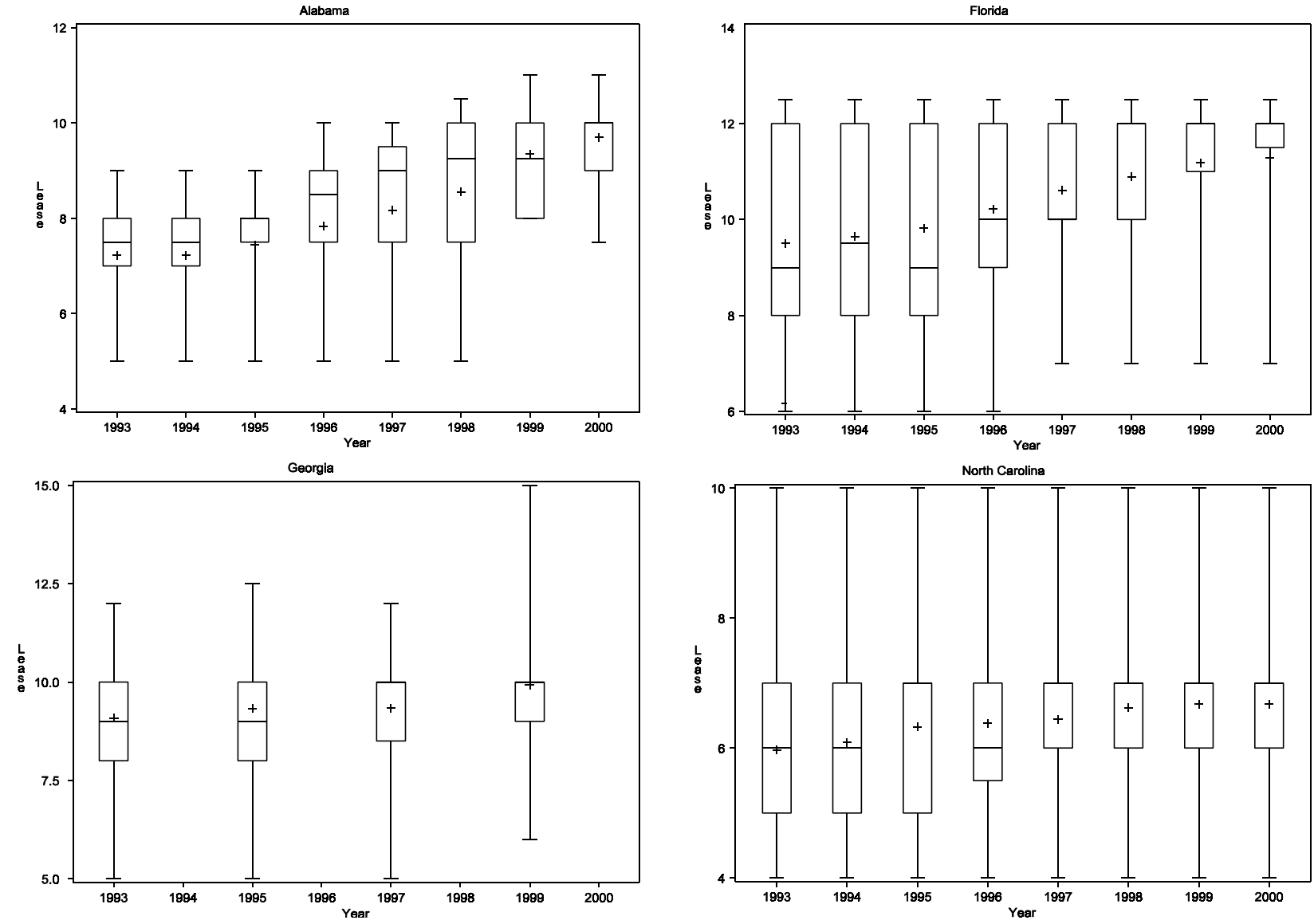


Figure 9: Lease Rate Box Plots (Continued)

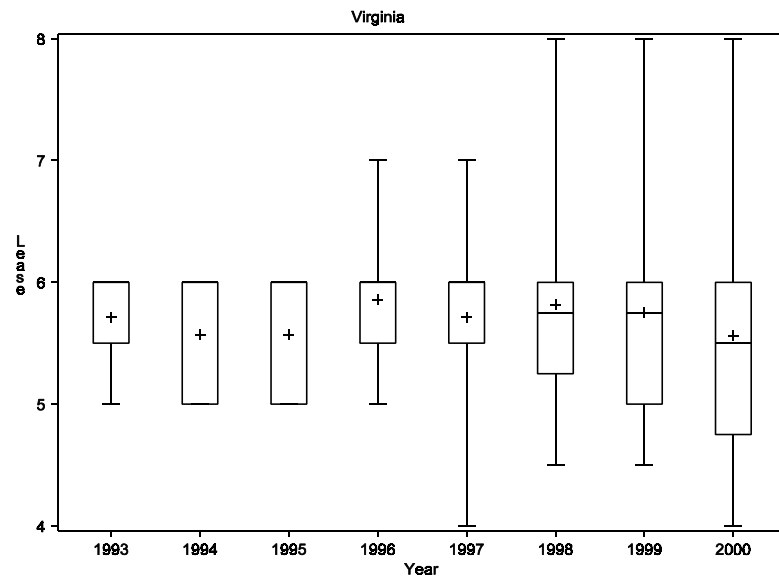
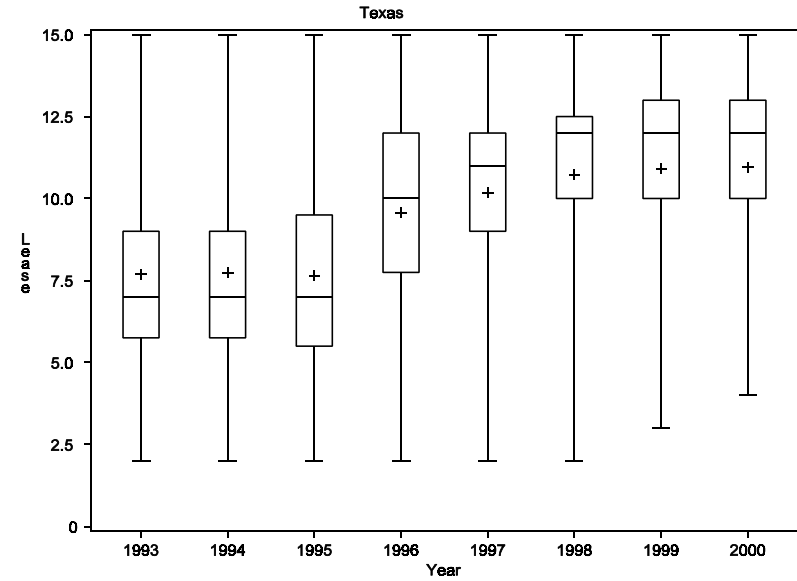
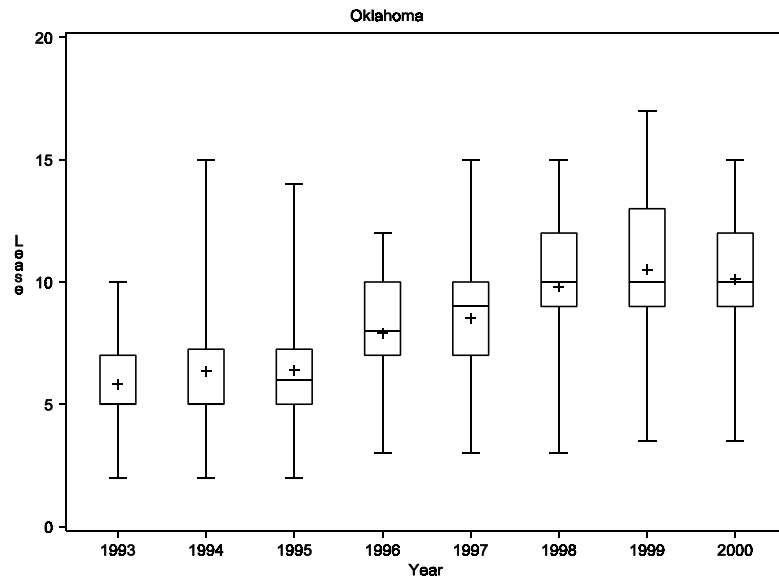


Figure 10: Lease Rate Box Plots without Small Peanut Counties

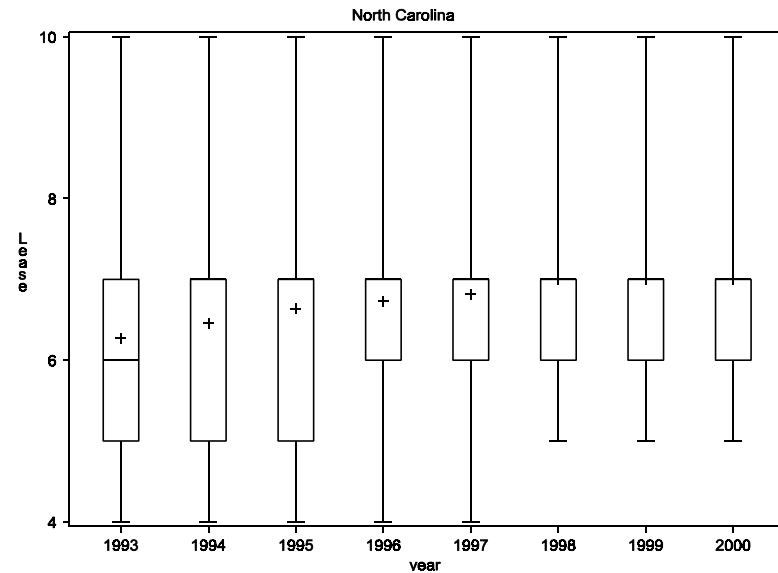
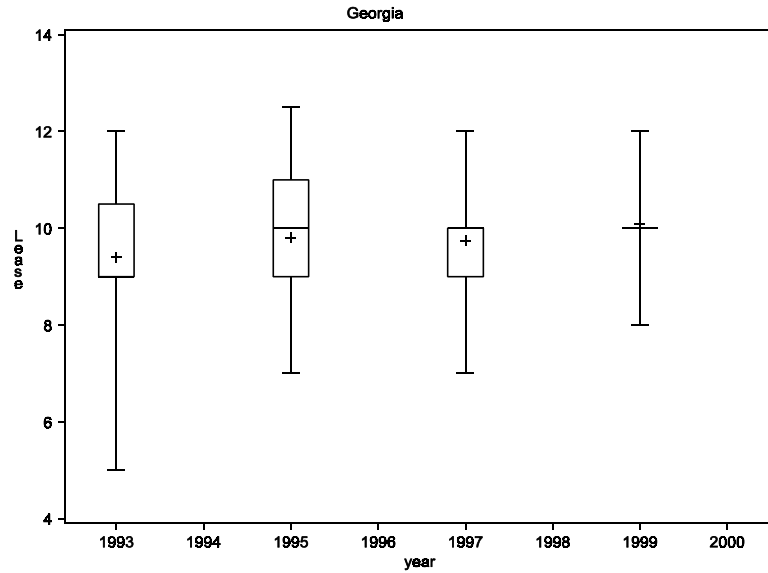
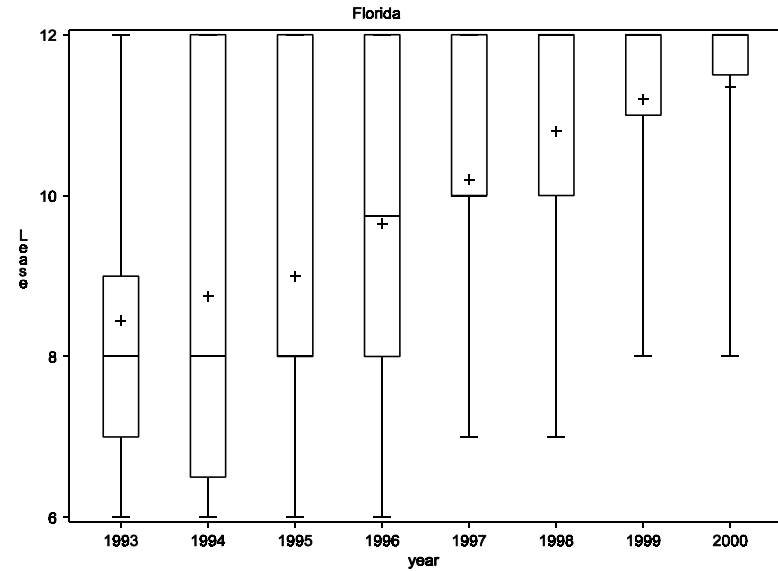
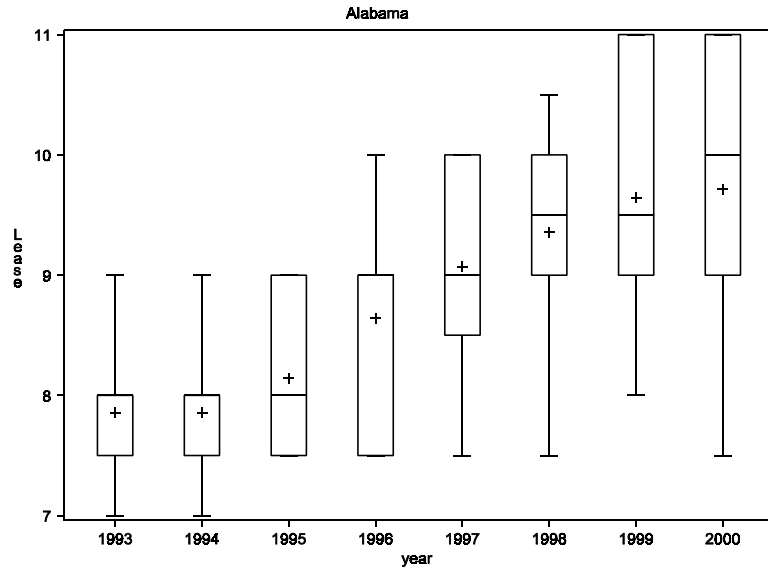


Figure 10: Lease Rate Box Plots without Small Peanut Counties (Continued)

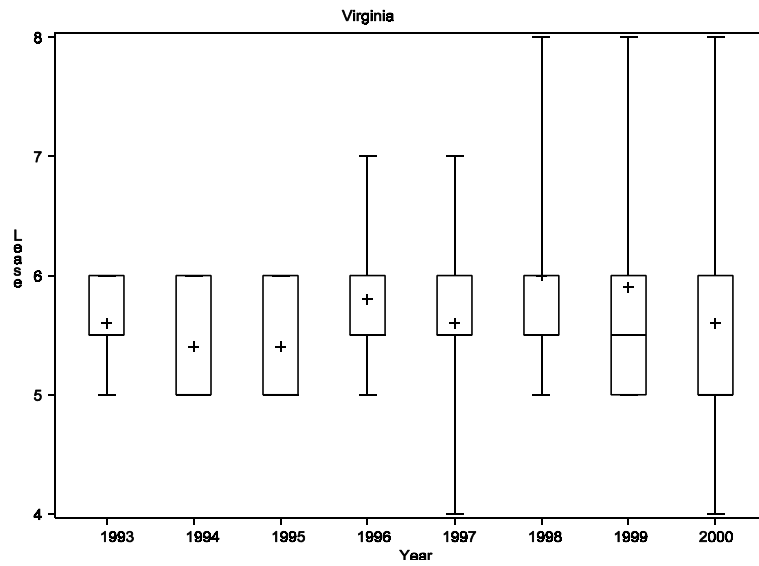
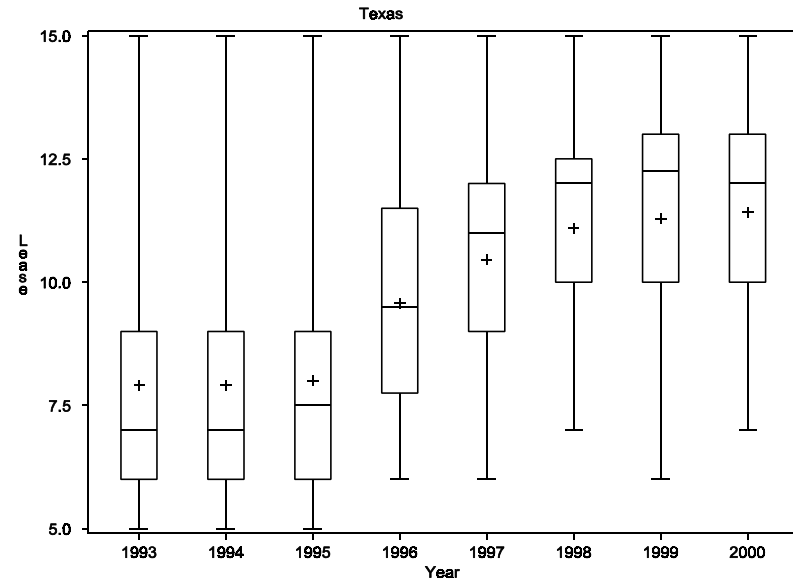
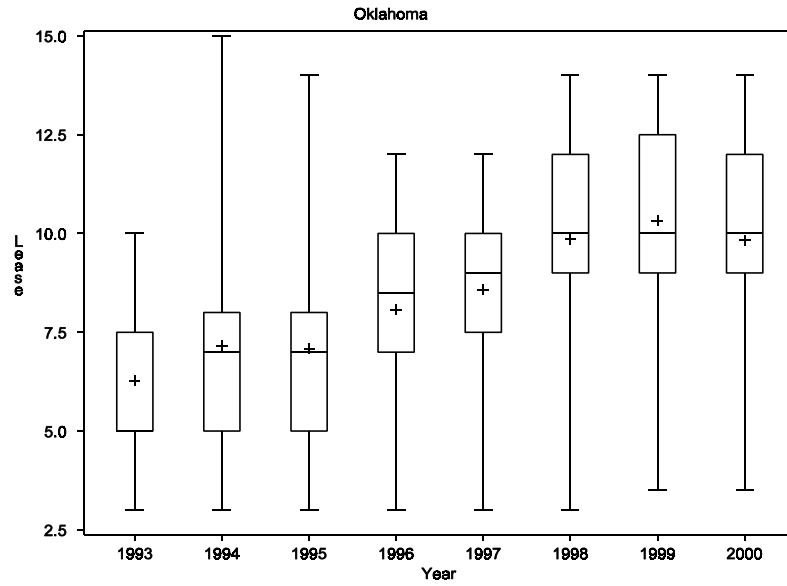


Figure 11: Gains and Losses to Peanut Farmers under New Farm Bill, County producing Small and Large Amount of Additional

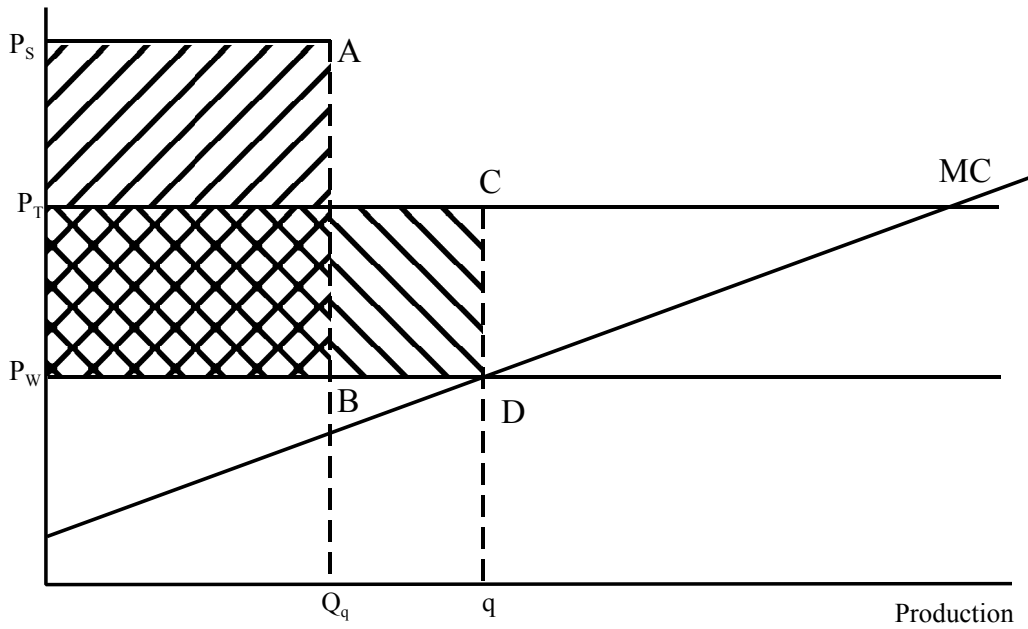


Figure a

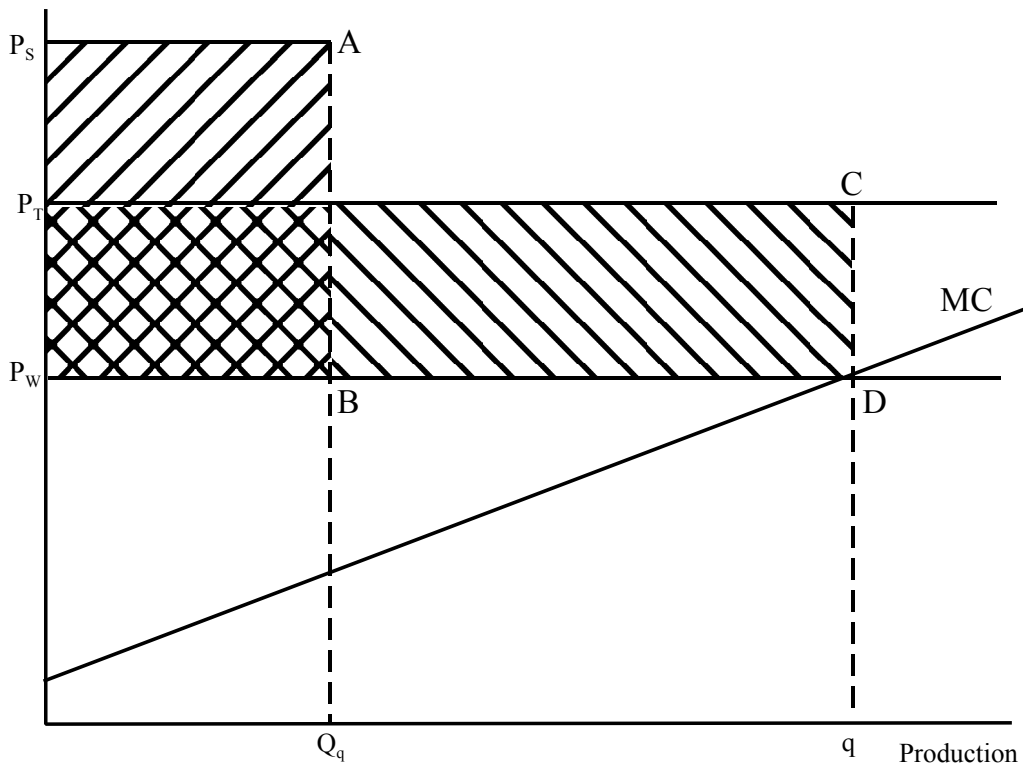


Figure b

Figure 12: Domestic Supply and Demand for Edible Peanuts

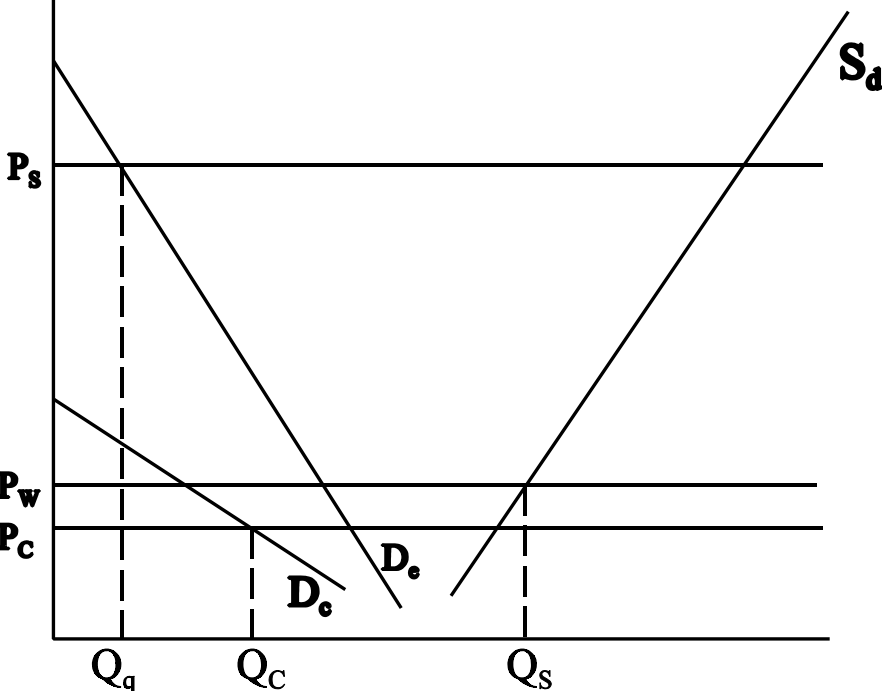


Figure a

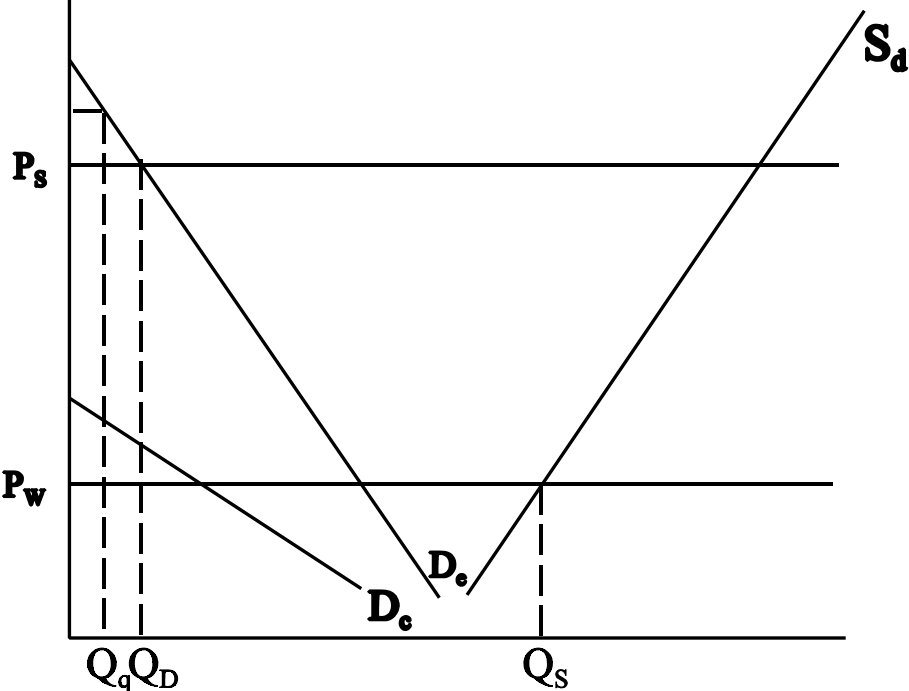


Figure b

Figure 13: Average Pool Price, Quantity of Buybacks and Edible Peanuts Crushed

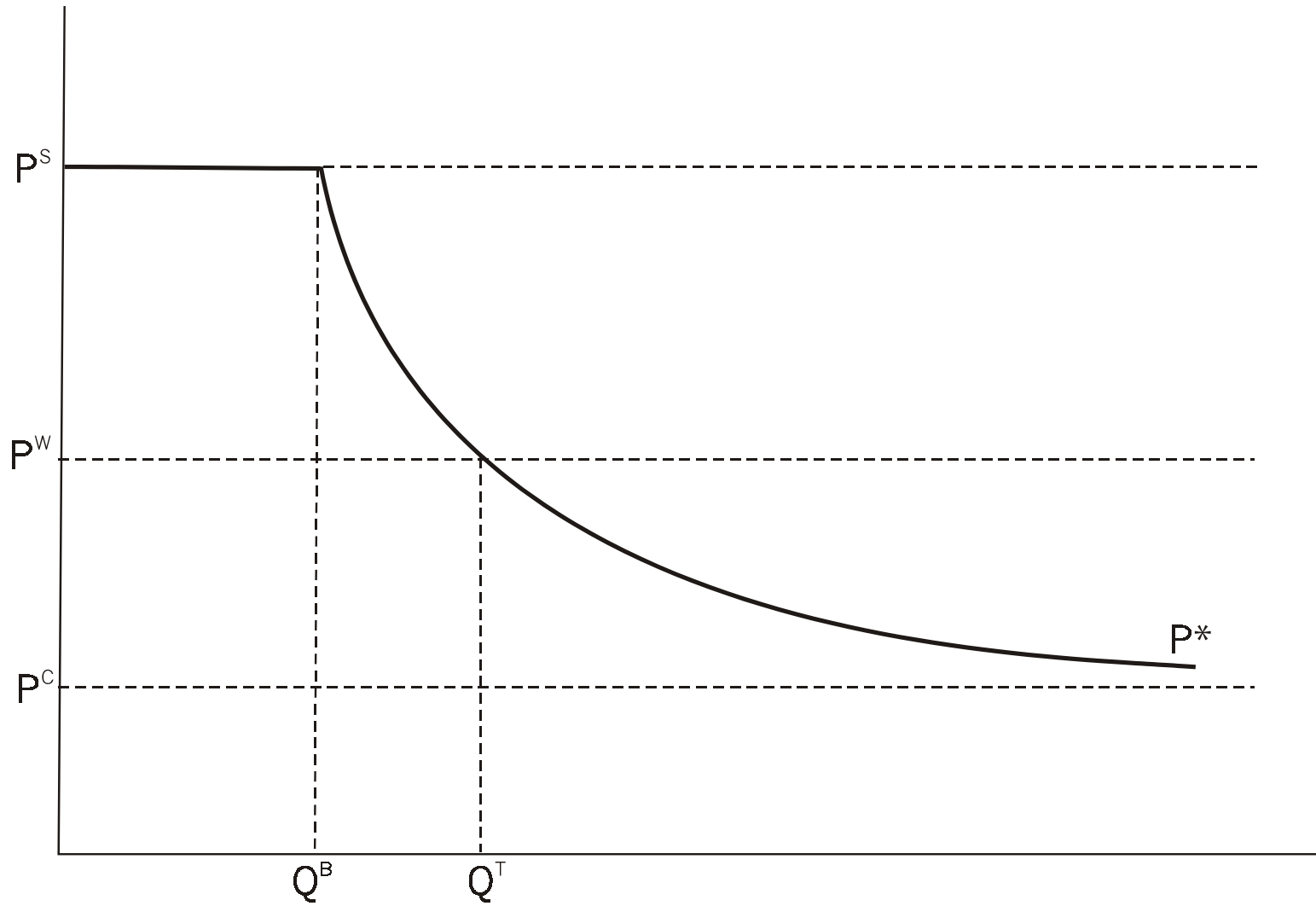




Figure 14: Equilibrium in the Domestic, Export and Foreign Markets - No Errors in Estimated Quantity Demanded by Policy Makers

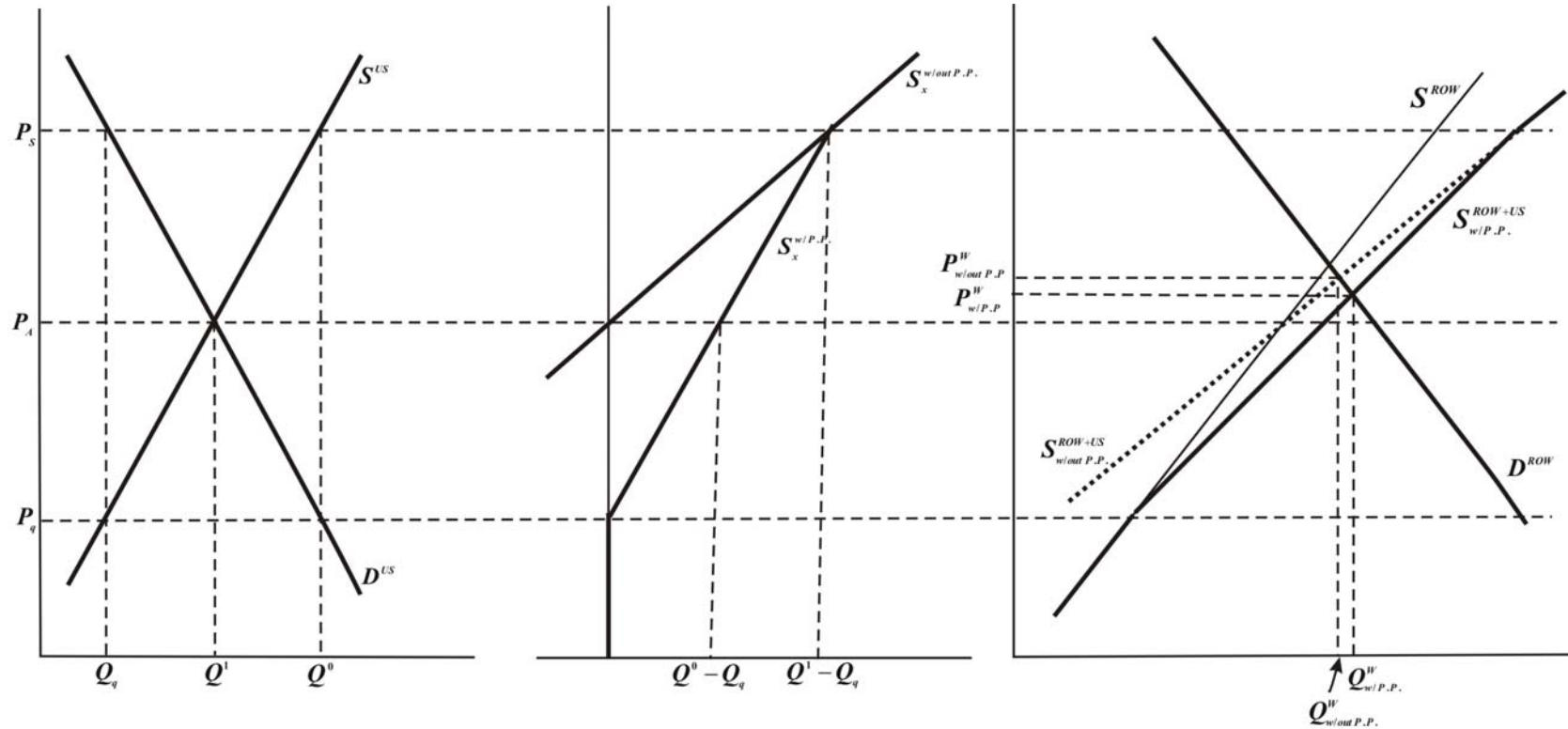
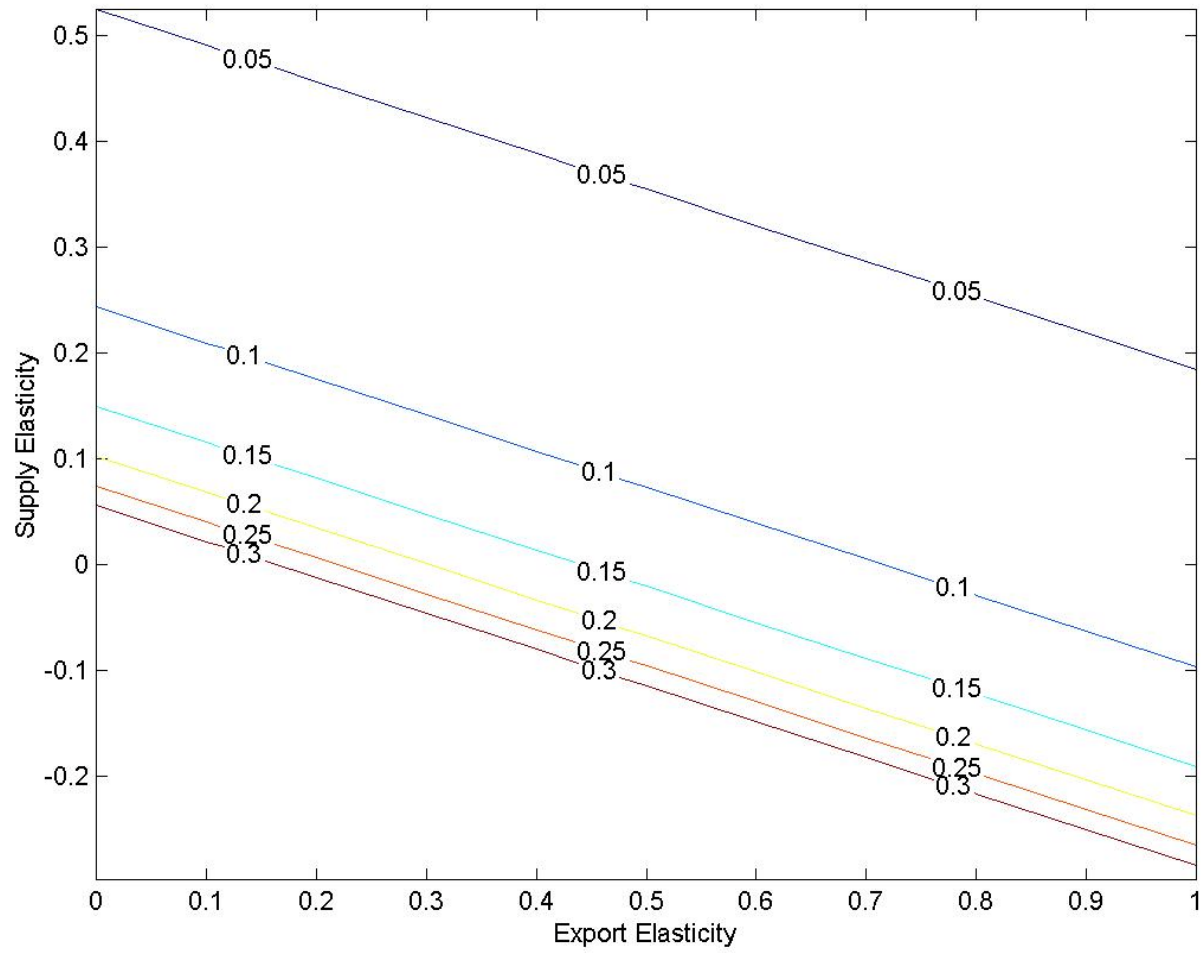


Figure a

Figure b

Figure c

Figure 15: Price Effects of Peanut Program Elimination



Note: Demand elasticity is set equal to 0.2

Figure 16: Equilibrium in the Domestic, Export and Foreign Markets - Errors in Policy, Presence of Grower Association Pools

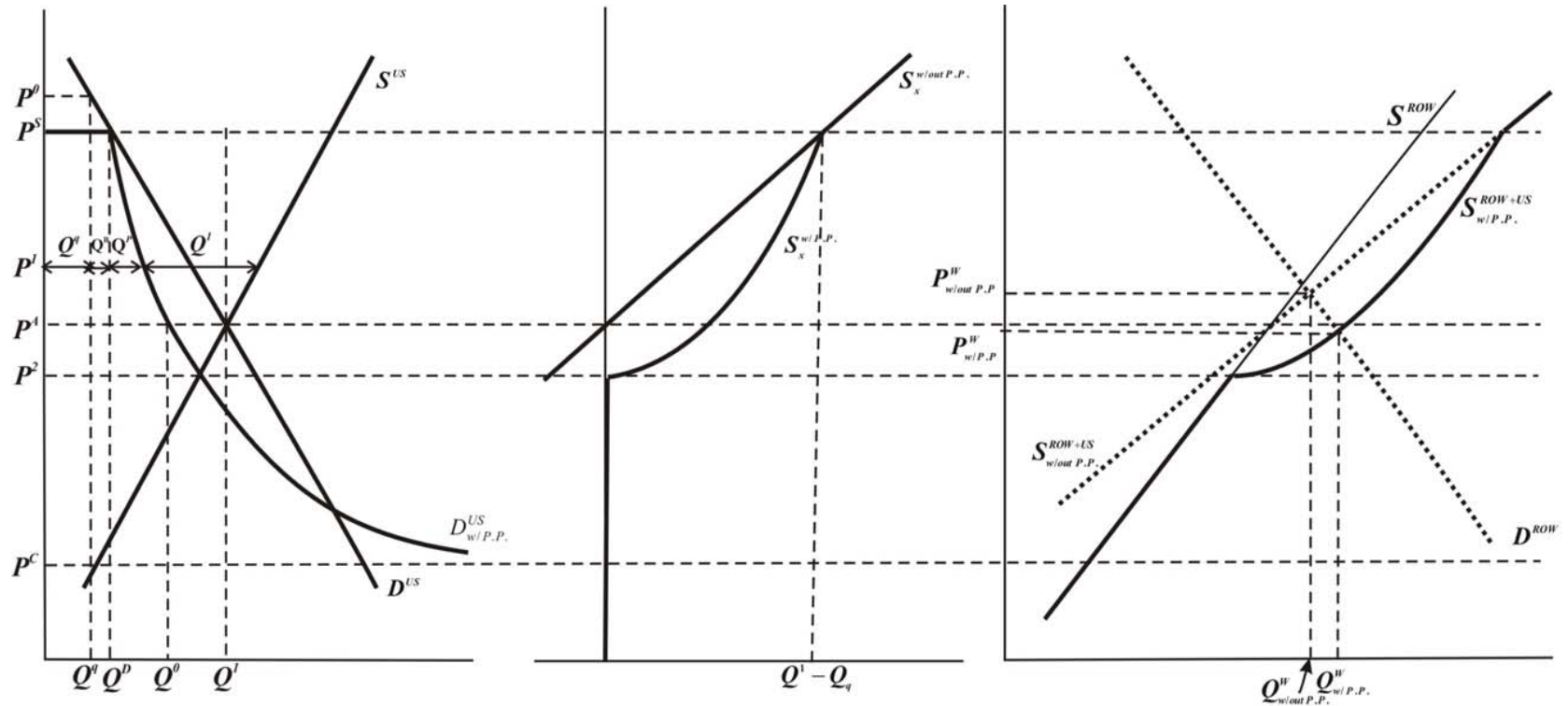


Figure a

Figure b

Figure c

Figure 17: Domestic Demand for Edible Peanuts (simulation)

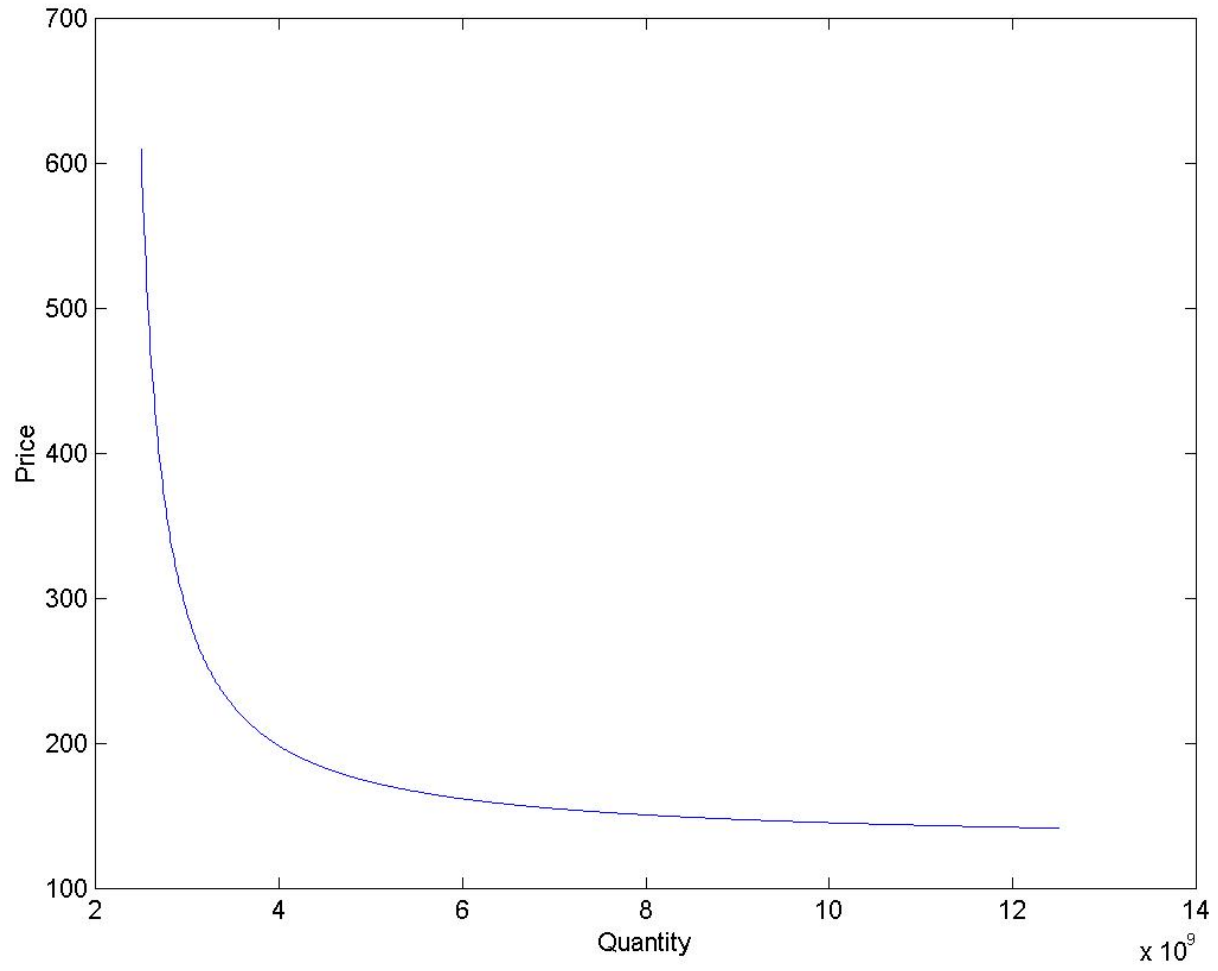


Figure 18: Equilibrium in the Domestic, Export and Foreign Markets - Errors in Policy, Presence of Grower Association Pools  
 Decrease in World Price of Edible Peanuts after the Elimination of Peanut Program

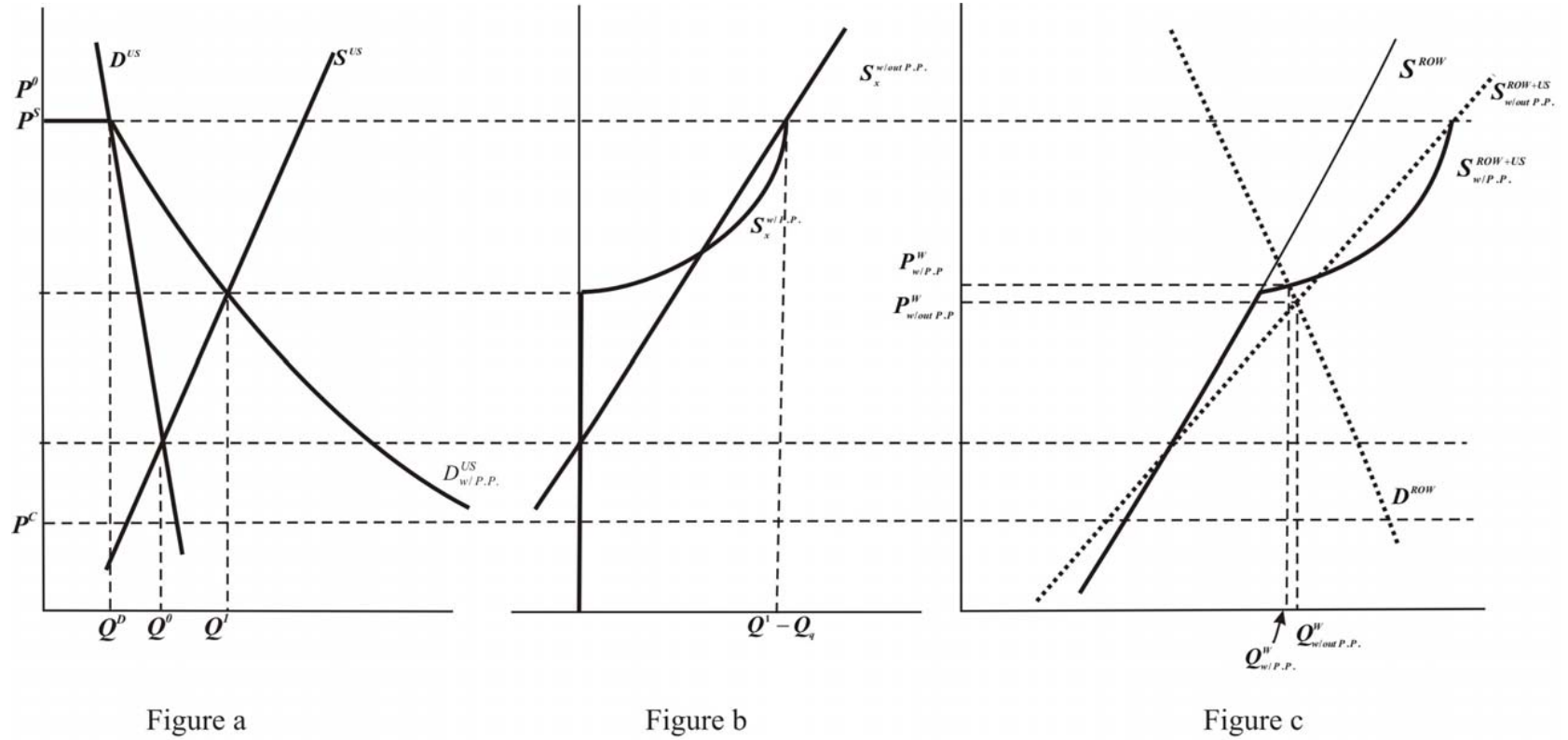
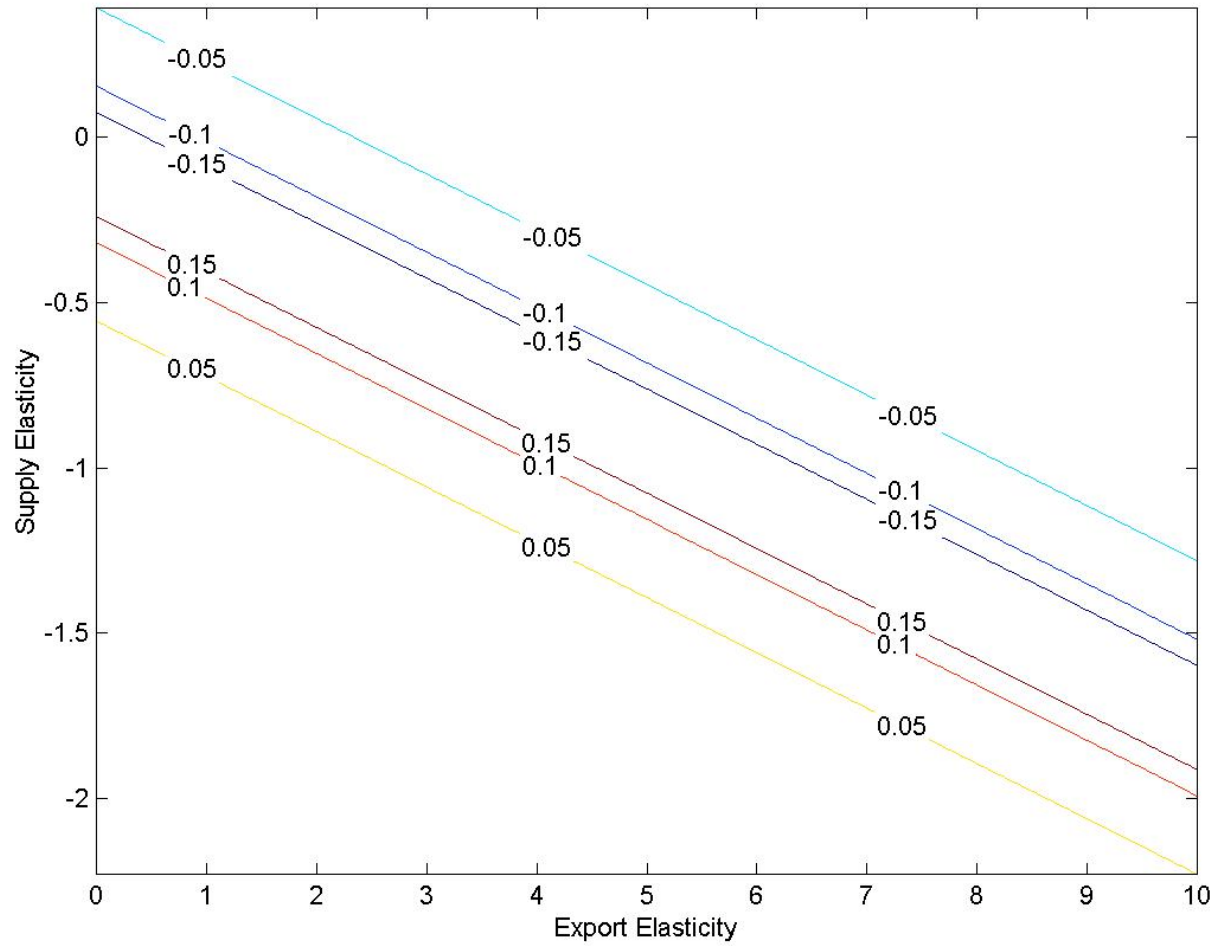
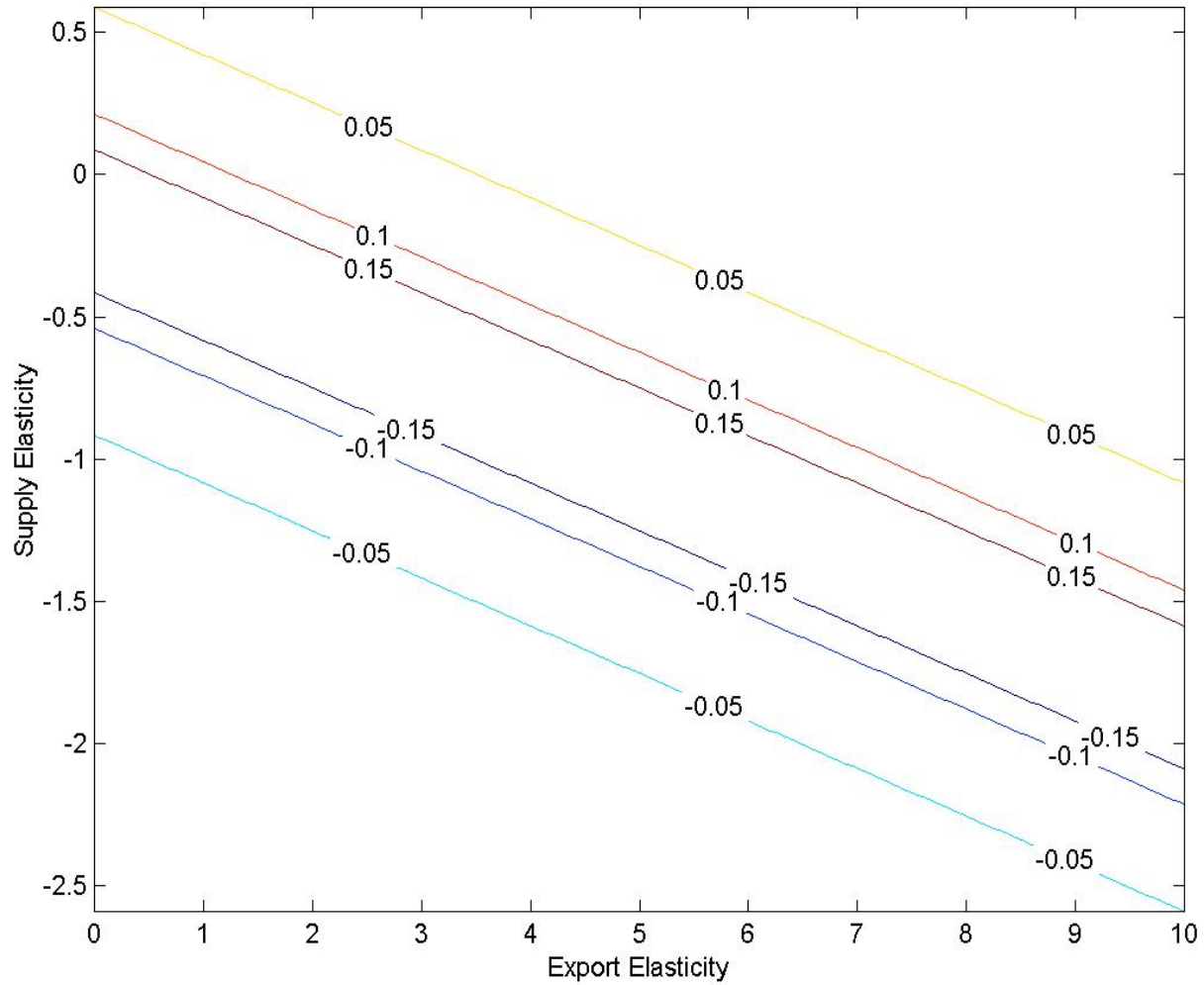


Figure 19: Price Effects of Peanut Program Elimination - Model with Policy Errors and Grower Association Pools, Lower Demand Elasticity



Note: Demand elasticity is set equal to 0.2

Figure 20: Price Effects of Peanut Program Elimination - Model with Policy Errors and Grower Association Pools, Higher Demand Elasticity



Note: Demand elasticity is equal to 0.4

Figure 21: Two Tier Tariff Rate Quotas for Peanuts

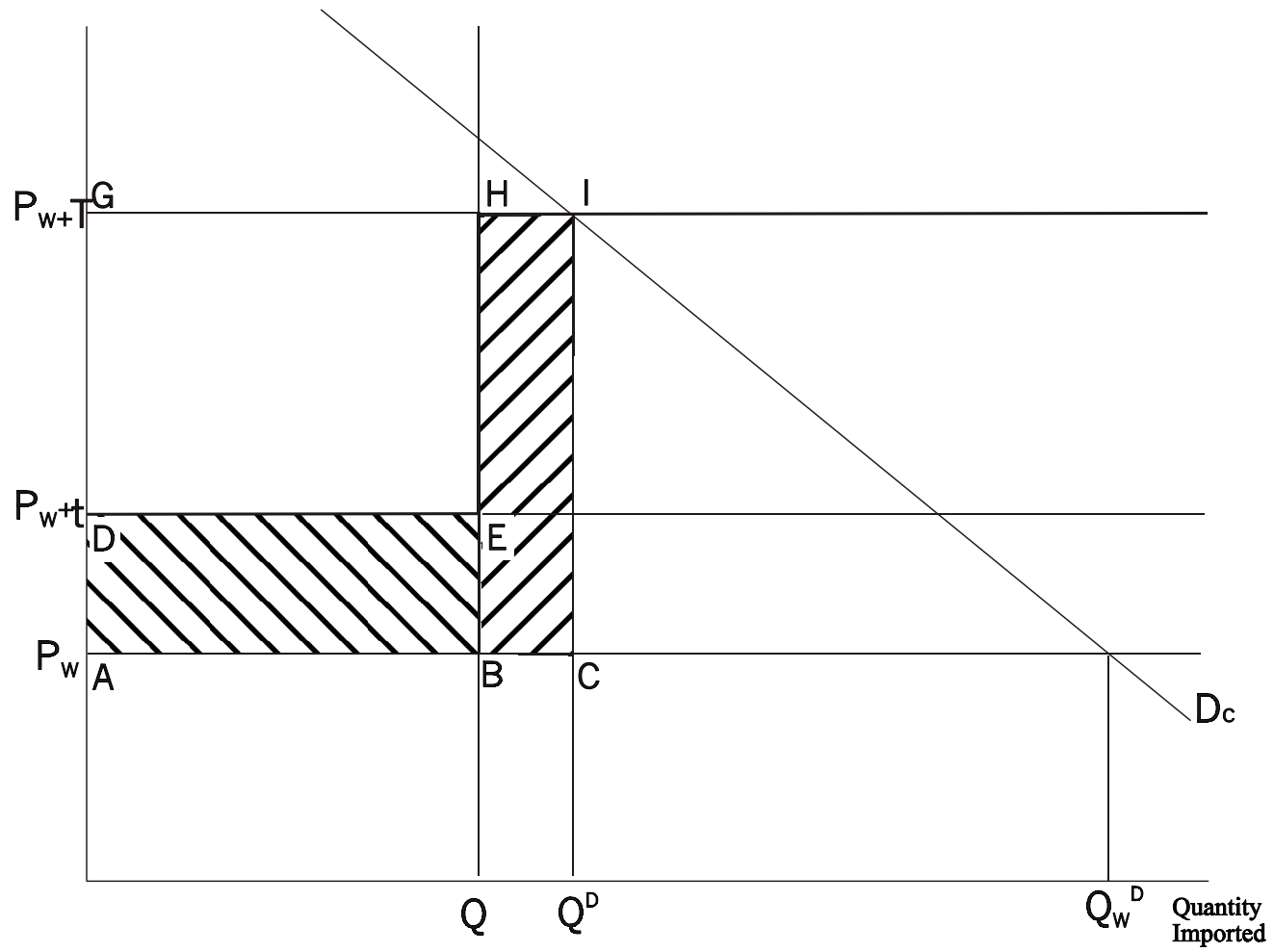




Figure 22: CFTA Tariff for Mixed and Candied Nuts

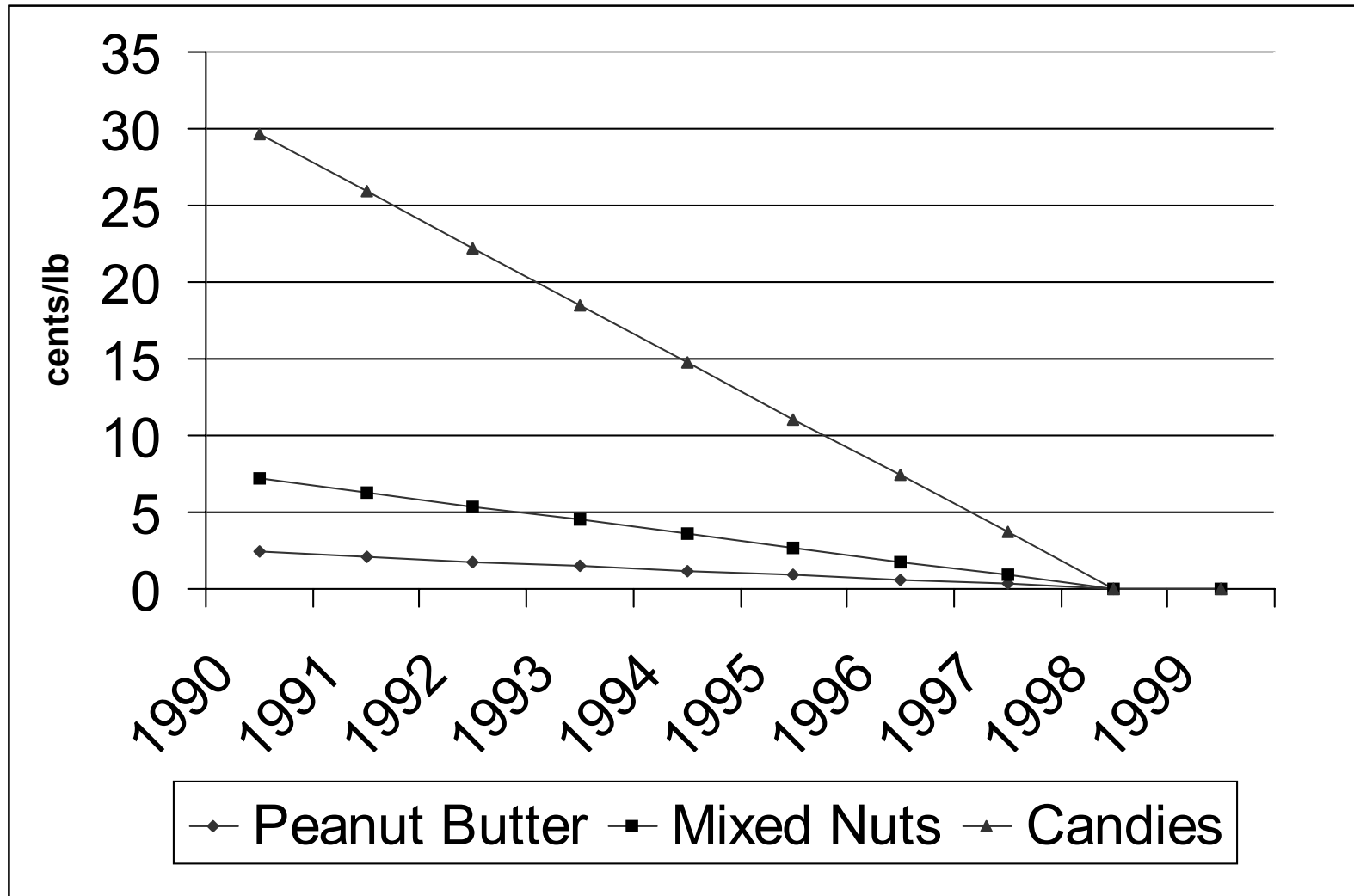


Figure 23: NAFTA Tariff for In-Shell and Shelled Peanuts for Mexico

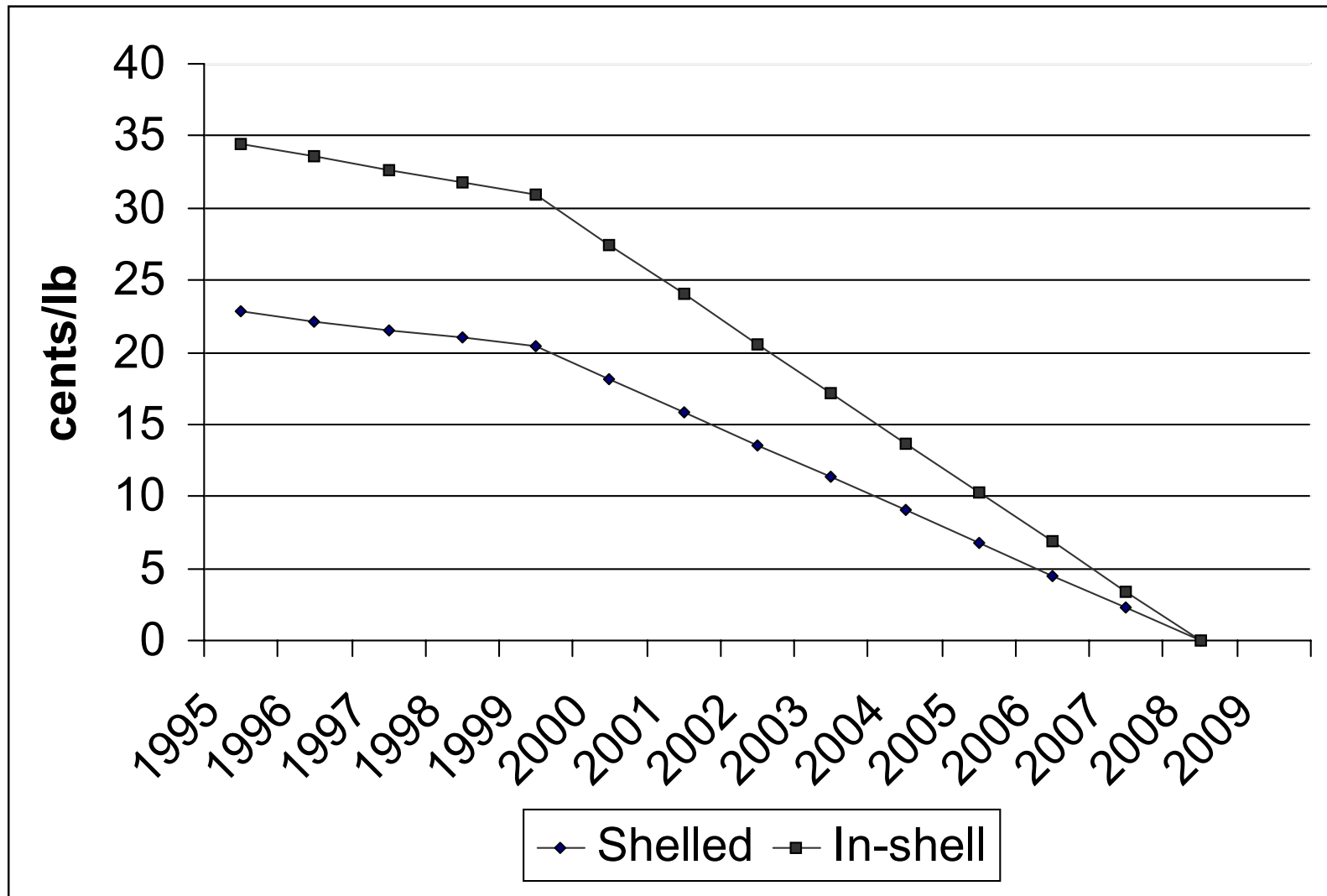


Figure 24: Distribution of Peanut Yield

