A closer look at the role of the fruit and vegetable planting restriction provision on land use in the United States

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Abstract

Current U.S. farm programs make payments to farmers based in part on historical base acres planted in particular program crops such as corn, soybeans, cotton, wheat and soybeans. Eligibility for payments includes regulations on the crops allowed to be grown on base acres, and there are restrictions on planting horticultural crops on such base acres. The fruits and vegetables planting restriction on base acres has potentially influenced the number of acres planted to fruits and vegetables over the past two decades. This research carefully examines the effects of planting restrictions applied to vegetables and program crops, using county-level data in the United States in 1982, 1987, 1992 and 1997. The paper employs the difference-in-difference (DiD) approach to estimate acreage response to planting restrictions. The results show that planting restrictions crowded out land used for growing fruits and vegetables, most notably in the Great Lakes region that produces processing vegetables.

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1. Introduction

Some have suggested that government policies have contributed to the problem of obesity in the United States (e.g., Pollan, 2003). Such arguments claim that farm policies encourage higher production of calorie dense foods that use grains and oilseeds as ingredients, and discourage production of healthier crops such as fruits and vegetables. Alston, Sumner and Vosti (2006) have argued that farm policies have little impact on obesity, but their analysis focused only on the major policies that apply to program crops and border measures.

Agricultural policy in the United States encompasses a wide range of provisions including income subsidy programs, land set-asides and trade barriers. Since 1990, the “Fruit/Vegetable and Wild Rice” restriction limits the planting of specialty crops[1] on program acres[2]. The 1990 FACT ACT which regulates planting of any crop except fruits and vegetables was permitted on up to 25 percent of any participating program crop's acreage base. The 1996 FAIR ACT says participants may plant 100 percent of their total contract acreage to any crop, except with limitations on fruit and vegetables. Planting of fruits and vegetables (excluding mung beans, lentils, and dry peas) on contract acres is prohibited unless the producer or the farm has a history of planting fruits and vegetables, but payments are reduced acre-for-acre on such plantings (ERS, 2010). Recipients of direct[3] and counter-cyclical payments[4] have planting flexibility on their base acres[5] except for fruits, vegetables and wild rice. Payments tied to base acres are partially or fully forfeited when fruit and vegetables are harvested. Planting restrictions have the capacity to influence the amount of land that is used to produce program and specialty crops (Johnson et al., 2006), yet the degree of their impact is still being debated. Planting restrictions have been a feature of U.S. commodity programs for many years. According to Young et al., (2007), the restrictions on fruits and vegetables may encourage some program participants to shift acreage away from fruit and vegetables to program crops, such as corn or soybeans. It could shrink the supply of these horticultural crops, thereby increasing grower prices for some fruits and vegetables.

Previous research on the impact of policy on agricultural land use has typically aggregated all crops together; studies that have examined crop specific effects have not included fruits and vegetables in the analysis. In this research, the impact of government policy on fruits and vegetables is estimated in order to better understand the role of planting restrictions on production patterns of horticultural crops. In Figure1a and 1b we show total acre shares used to produce various crops in 1982 and 1997; there does not appear to be an obvious decline in vegetable acres after the 1990 Farm Bill. However, this research will examine the issue more closely with county-level data in four time periods using a difference-indifference (DiD) econometric model.

2. Literature Review

The agricultural economics literature includes several studies that examine acreage response to policy. A seminal piece by Johnson et al. (1950) examined the reaction of aggregate output to falling relative prices under depression conditions and to changing relative prices when resources are fully employed in the economy. Theory suggests that the land supply function has a very low price elasticity in the short run due to the lack of alternative uses outside of agriculture and the supply function of capital assets has a very small price elasticity for downward movements in prices since the quantity of such assets existing at any one time can achieve higher returns in agriculture than elsewhere; in response to upward movements in prices, the price elasticity is higher as new investment becomes profitable to farmers is simply consistent with the observed fact in the depression economy. Houck et al. (1972) estimated acreage supply relationships for corn, the major U.S. feed grain, during the 1948-70 period and developed and tested a general theoretical model for evaluating prevailing government policy (farm commodity) program effectiveness. It found that 95% of the corn acreage variation is captured policy changes. McDonald and Sumner (2003) focused on rice acreage response to market price in the U.S. to develop an approach that uses detailed information about farm program incentives and constraints to identify underlying structural acreage response parameters when the data reflect behavior under complex government commodity programs. They found that the structural acreage response parameter was three to four times the magnitude of that estimated under program rules and showed that incorporating program rules into the model can help understand the relationship between structural supply parameters and the expected acreage behavior under a specific set of farm program rules better.

Lee and Helmberger (1985) focused on comparing supply response under farm programs versus competitive markets, and they used a temporally disaggregated econometric estimation approach. Their results showed a higher supply elasticity for corn and a lower supply elasticity for soybeans under acreage-restricting feed grain programs. Holt (1999) extended the first-order differential acreage allocation model to a levels version; this paper introduced a linear approximate acreage allocation model which is useful for analyzing panel or cross-sectional data. The linear approximate acreage allocation model is useful for maintaining the theoretically appealing properties of homogeneity, symmetry, and adding up conditions. Applying the modeling approach to a panel of state-level corn acreage data for the U.S. Corn Belt region during 1991-95, the estimated model fits the data well and, moreover, appears to be consistent with all of the requirements of theory.

Wu (2000) quantified the effects of U.S. policies on land use using data from the U.S. National Resource Inventory (NRI), the Census of Agriculture, and other county data sources. Gardner, Hardie and Parks (2010) also used these data to examine determinants of land use for crops, pasture, range and forest. Gardner, Hardie and Parks (2010) found that U.S. cropland acreage would have been 89 million acres (22%) less if program payments had been reduced to half their observed level. Both of these studies used NRI and the Census of Agriculture data because they have been collected at the county-level.

Gardner Hardie and Parks (2010) adopt two models to estimate the policy effect. To solve the problem of the endogenous of government payments and the correlation between error terms and measure of soil fertility due to NRI sample error, an instrumental variable (IV) model is developed. However, IV estimates obtained from finite samples are likely to be biased toward OLS according to Nagar (1959), Buse (1992) and others; therefore, split sample instrumental variables (SSIV) models is applied to remove the bias toward OLS estimates but introduces an attenuation bias that tends to pull SSIV parameter estimates toward zero, which increase support for the hypothesis that cropland acreage do not respond to government payments and reduce support for the hypothesis that government payments have caused farmland acreages to expand. The U.S. commodity support programs heavily support and values land and that the only significant long-run result of any reduction in agricultural support is a decline in land values. Contrast to this common view, Gardner Hardie and Parks (2010) found that farm commodity programs have in fact significantly increased the share of U.S. land devoted to crops as compared with the counterfactual situation of no support programs.

An alternative method to examine the role of agricultural policy on land use is to employ a DiD econometric model. The DiD model is gaining popularity in agricultural policy analysis days, and it has been used to examine issues in education, environment economics and agricultural. It is a simpler effective method to show policy impact by comparing the ex post and ex ante results. The DiD methodology has been employed to study student demand responses to the Georgia's HOPE Scholarship program by Dynarski (2000) and Cornwell, Mustard, and Sridhar (2001). Carter (2008) adopted DiD hedonic model to estimate real estate price. Petrick and Zier (2011, forthcoming) adopted this model to analyze the employment effects of the entire portfolio of Common Agricultural Policy measures simultaneously with county level data of three East German States. Previous descriptive statistics or qualitative methods can only focus on single policy instruments in isolation. Using DiD model, they found that expenditures on modern technologies in processing and marketing and measures aimed at the development of rural areas led to job losses in agriculture while agrienvironmental measures induced kept labor-intensive technologies.

3. A Review of Methods Used to Studying Impacts of Policy on Land Use

3.1 Traditional Model

Traditionally, acreage response models used a reduced form approach to understand the impact of producer revenues, producer costs, and government policies on acreage decisions. Typically, a conceptual model took the following form; $A_{ist} = f(R_{ist}, E_{ist}, G_{ist})$. The subscript i denotes a crop (land use), s denotes a county, and t denotes time. Here the acreage A_{ist} is a function of farmer's net revenue R, production cost E, and a vector of government policies. Net revenue is expressed as $\pi = py - wx$, where, $y \geq 0$ is a vector of outputs per acre, $p > 0$ is a corresponding vector of output prices, $x \geq 0$ is a vector of non-land inputs allocated to an acre of land, $w > 0$ is a corresponding vector of input prices.

More recent developments in the literature of acreage response have expanded upon the traditional models to include quality of land and land use shares. The method introduced in Gardner Hardie and Parks (2010) estimate a model with year and regional fixed effects that interact with government payments. In the econometric model, the shares of land use of each category is the dependent variable y_i, which is regressed on the explanatory variable related to farm revenues, expenses, and government policies.

$$y_s = X_s \beta + u_s$$

There are three variables in the explanatory vector X_s. $X_s = (R_{ist}, E_{ist}, G_{ist})$, revenue, expenses and government policies. An econometric model of this nature following in Gardner, Hardie, and Parks (2010) would require acreage data for specific crops including vegetables, corn, wheat, rice, soybeans, cotton and other land use. The model would also need county-level data of fruits and vegetables which may be available from NRI and USDA. To estimate a model similar to Gardner, Hardie, and Parks (2010) would need county data of acreage, revenue, expenses and government policies are needed. Acreage data are available from the National Agricultural Statistics Service of United States Department of Agriculture on a five-year base; however, data are not readily available for revenue and expenses item for specific crops.

3.2 Alternative Model

To first focus on the policy impact of planting restriction on fruits and vegetables, I adopt a DiD model which I believe is a novel way to analyze land use policy in the U.S. The DiD model can be used to directly capture the policy impact of planting restrictions. The DiD estimator represents the difference between the pre-post, within-subjects differences of the treatment and control group. In the acreage model, the treatment group is fruit and vegetable acres in the counties that are affected by the planting restrictions. Hence, major producing states of fruits and vegetables are the treatment group. On the other hand, states that are not affected by the planting restriction, not major fruits and vegetables producers, are in the control group.

Some critics claim that the DiD model is too simple and uses many years of data to focus on serially correlated outcomes. It is also criticized for ignoring that the resulting standard errors may be inconsistent, leading to serious over-estimation of t-statistics and significance levels (Bertrand et al. 2004). However, the DiD approach has many benefits in this case as a traditional model of land use requires a substantive amount of data , much of which is not available.

I exploit an exogenous change in farm policy in order to evaluate the effects of the federal rules restricting farms from planting certain fruits and vegetables crops on base acres. In particular, I observe a change in policy in 1990 to include fruits and vegetables acres and “base acres”. This policy change means that farmers with a history of program crop acreage: (1) can receive program payments on those acres; and (2) are restricted planting fruits and vegetables crops on those acres.

I hypothesize that the addition of base acres reduced fruits and vegetables acreage. An econometric model of fruits and vegetables acreage in a county s, period t can be described as follows:

$$(1) \qquad A_{st}^{FV} = \beta_0 + \beta_P A_{st}^{P} + \beta_T t + \beta_{PT} t A_{st}^{P} + \beta_{TO} A_{st}^{T} + X'_{st}\beta_X + \varepsilon_{st}$$

A_{st}^{FV} (AFV in the econometric model) is fruit and vegetable acreage in county s in period t (t=1982,1987, 1992, 1997). The relative area in county s of program crops (corn, wheat, rice and cotton) is denoted as A_{st}^{P}(APR in the econometric model). A_{st}^{T} is the calculated total acres, which includes the acres of program crops, hay, soybean and fruits and vegetables. A vector of other covariates that influence fruits and vegetables acreage is denoted as X_{st} ; this is a vector of other covariates that influence fruit and vegetable acreage; this includes agronomic conditions such as weather, temperature and rainfall. Lastly, ε_{st} is a stochastic error term that captures unobserved factors that influence fruits and vegetables acreage and the βs are parameters to be estimated.

The time periods are defined such that they straddle the change in policy. Specifically, t is a dummy variable equal to 0 for those years before program crops were included in base acres and equal to 1 afterwards. Thus the least squares estimator of β_{PT} (coefficient of the treatement variable, product of dummy and program acres) may be interpreted as the "difference-in-difference" estimator that measures the effect of the policy treatment, i.e., the base acres, on fruit and vegetable acreage. The DiD estimator relies on two key assumptions: that the treatment—the expansion of base acres–is randomly assigned; and that growth rates in fruit and vegetable acreage, conditional on X_{st}, would have been the same across counties were it not for differences in the base acres. Under these assumptions, the parameter β_{PT} is the treatment effect which measures the impact of base acres on fruits and vegetables acres.

The hypothesis is that the fruit and vegetable planting restrictions crowd out of fruits and vegetables production. Thus, we seek to test the hypothesis:

H_0: $\beta_{PT} = 0$, versus the alternative

H_A: $\beta_{PT} < 0$.

To test the hypothesis, data is required on acreage of program crops, fruits, vegetables, total acreage and agronomic data such as temperature, precipitation and elevation. the next section is going to talk about the data into details.

3.3 Data

Using county-level acreage data from USDA census data that tracks acres planted in various crops from years 1982, 1987, 1992, and 1997, I organized the data into two crop categories: fruit and vegetable crops (total vegetables, citrus and all non-citrus fruit) and program crops (corn, wheat, rice and cotton). Soybeans were not added to base acres until 2002, and therefore are not included as a program crop. In my analysis because the focus is on the pre-2001 period. Considering data availability from USDA, research is focused on two categories of annual crops: fruits & vegetables and the program annual crops. The program annual crops are made of four crops: corn, wheat, rice and cotton. Total acreage used to calculate the relative acreage of fruits and vegetables is calculated includes acreage of hays and soybeans.

There are 3,143 counties and county-equivalents in the United States. The 5 counties in the state of Hawaii and the 27 county-equivalence in the State of Alaska are excluded from the data and therefore, there are 3111 counties in the model. Table 1 lists the acreage land used in fruits and vegetables in the 1990s (average of 1992 and 1997). In addition, to show the relative changes, I calculated the ratio of fruit and vegetable acres to total acres of land including lands for fruits and vegetables, program crops, hay and soybeans. The second and forth column show the actual acreages used to plant fruits and vegetables in year 1992 and 1997. Column three and six are the share of fruit and vegetable acre of total acres in the 1990s.

In this econometric model, the dependent variable, A_{st}^{FV}, is fruit and vegetable acres planted before (t = 0) and after (t = 1) the introduction of base acres. The actual treatment—the area by which base acres expands as a result of the policy change—is unobservable (and is determined simultaneously with A_{st}^{FV}. However, we do observe acres planted to program crops prior to the policy change. Historical program crop acreage is also exogenous. Thus we use as our treatment variable, A_i^P, the area planted in program crops in pre-treatment period (t = 0). Total acre A_{st}^T is also exogenous.

Covariates to be included in the regression; we use X_{st} to describe factors known to influence cross-sectional and time-series variation in county-level fruits and vegetables plantings. These might include regional dummy variables, defined perhaps by state borders or agronomic conditions. Such regional dummies would capture unobserved heterogeneity that could potentially confound estimation of β_{PT}. The agronomic data are collected from Rocky Mountain Research Station of USDA Forest Service. I use the Historic Climate data (1940-2006) for the 48 conterminous States at the county spatial scale based on PRISM[6] (Parameter-elevation Regressions on Independent Slopes Model) climatology (Coulson and Joyce 2010). The dataset contains monthly totals of precipitation in millimeters (mm), monthly means of daily maximum (minimum) air temperature in degrees Celsius (C), and computed monthly mean of daily potential evapotranspiration (mm) and mean grid elevation in meters (m).

I made some adjustment to the agronomic data before using it in the model. First, I summed the maximum monthly temperature and the minimum monthly temperature to get an average monthly temperature. Second, I subtracted evaporation from the precipitation to get the net precipitation. Finally, I summed the monthly observations from March to November (the time period must imported for annual crops to develop annual data. As a result, there are three variables in the X_{st} matrix for each county in each time period.

Table 2 shows the summary statistics of a sample of county-level data. I selected three of the fruits and vegetables producing counties in the state of California to provide a snapshot of the whole dataset used in the model.

4. Estimation Results

To test the hypothesis that the fruits and vegetables planting restriction crowd out of fruits and vegetables, the DiD model is estimated through both panel regression. There are four years data of 3111 counties in the panel (12, 444 observations in total). Regressions are conducted that focus on both fruit and vegetable acres (AFVR), only fruit acres (AFR) and only vegetable acres (AVR) respectively. The right part of Table 3 shows the estimation results for the above three all counties regressions. The estimated coefficients of the treatment variable are not as good as in the expected hypothesis. This might be due to the county fixed effects getting rid of a lot of the variation that captures with program acres variables, so I try to estimate the model without fixed effects, to model the cross-county heterogeneity rather than with county-specific intercepts. The left part of Table 3 shows the estimation results of OLS.

As is often the case in regressions using panel data, the overall R^2 in three panel regression are relatively low due to losing explanatory power from the intercept term, lying between R^2 of within and between. All three models in Table 3 have negative significant coefficients of A_{st}^{P}, APR (the share program crop acres), β_P, because increasing land use for program crops shrinks the land left for planting fruits or vegetables. The treatment variable DAP in the regression model denotes the product of dummy and program crops acre, denoted as

tA_{st}^{P} in the model. The estimated coefficients for the DAP variable, denoted as β_{PT} in all three panel regressions are all significant positive, thereby can't reject the null hypothesis. This might because of the county fixed effects offsets the variation of program acres. Therefore, I try to estimate the three models without fixed effects by OLS estimation. All three OLS estimated coefficients of A_{st}^{P} are negative and significant. The estimated coefficient in the model that includes all fruits and vegetables in all counties is the largest of the three in the left part of Table 3 because it examines the total overall effects. For the treatment variable DAP, the OLS estimator of β_{PT} in the fruits and vegetables and vegetables only model are significant negative, which rejecting the null hypothesis, planting restrictions have crowd out land for fruits and vegetables. Therefore, the base acres crowd out fruit and vegetable production respectively. However, the β_{PT} in the AFR (fruits only) model is positive and significant at the model at 1% level. This might because the fruit producing farms are specialized only in fruit and won't be largely affected by planting restrictions. The estimated coefficients of total acre $\beta_{TO}$are positive since increasing total acres increases the chances of growing more fruits or vegetables.

I also focus on the planting restrictions impact on vegetable acres more closely because it is expected that the provision has a greater effect on vegetable acres (Krissoff et al, 2011). Table 4 displays three regression results that use the share of vegetable acres, denoted variable as the AVR. This time, I only focus on regressions without fixed effects, since the results of all counties regression have indicated the county fixed effects may offset variations of program acres. First, I use county data from seven states in the Great Lakes region. The 2008 Farm Bill introduced the Planting Flexibility Pilot Program (2009 to 2012) to allow up to 75,000 acres of seven key processing vegetables on base acres in seven states – IL, IN, MI, MN, WI, IO, and OH (these seven states comprise approximately 20% of U.S. supply of vegetables producing in the

United States). Therefore a regression was run using data from counties in the seven states. Second, Pilot states plus Pennsylvania and New York (Pilot+2) as they have similar climate as the Pilot states and are also major producer of processing vegetables. Third, to enlarge the region, I use data from Pilot plus three more states. (ie. Pilot+5) Besides Pennsylvania and New York, I also added West Virginia, Missouri, and Kentucky. They all also major producers of processing vegetables. This would emphasis the results on processing vegetables further. Forth, I ran a regression for counties in the Sun Belt region states also known as a NFACT states: New Mexico, Florida, Arizona, California and Texas; these are the major producing states of fruits and vegetables, notably fresh vegetables.

Table 4 shows the adjusted R^2 in these four regressions are higher than models using all county data. This is likely because the policy impacts on land use in these major producer states are more clear and the model is more powerful in explaining the policy impact. Estimated coefficients for variable describing the share of program crop acre, denoted as β_Ps, are consistently negative and significant, except for the significance of one in the Sunbelt model. This might because the Sunbelt region doesn't have lot program acres in the first place. So the effect of program acres compete land with fruits and vegetables are less obvious. I assume that the coefficient in the regression using data from the Pilot states is slightly bigger than regression using data from Pilot+2 and Pilot+5 states because Pilot states are the major leading producers which strengthens the policy impact. Results from the regression for the Sun Belt states has the largest coefficient on the APR variable because fresh vegetable are more common in Sun Belt states and less affected by the PR policy. The estimated coefficients of the treatment variable, denoted as β_{PT}, are all negative for the Pilot and Pilot related states, which again indicates that the planting restrictions crowd out fruit and vegetable acres. These results are prominent in these regions, all being significant at the 99% level. However, the β_{PT} in the Sun Belt model is significantly positive and this might be because the planting restrictions have a smaller impact on fresh vegetables in the Sun Belt states. Instead of vegetables results, the OLS regression on fruits only in Sunbelt region has a significant negative β_{PT}, which implies that planting restriction crowd out land for fruits which are the major products in this region. In addition, $\beta_{TO}$are positive in all the four regressions.

5. Policy Implications

The research outlined in this proposal i) introduce more detail to the line of work that has examined acreage response to government policy provision such as planting restriction in the U.S., and ii) shed some light on the influence that government policy has had on the production of healthy foods, i.e., fruits and vegetables. According to the estimation result, there is evidence that planting restrictions have crowded out fruits and vegetables acres. Specific to vegetable production, process vegetable acres appear to be more affected by planting restrictions than fresh vegetables. This is an important yet understudied topic in the agricultural economics literature. Therefore, major changes to domestic support programs for grains in the United States, such as planting restriction on fruits and vegetables, may have an impact at the production (and consumption) patterns of fruits and vegetables in the United States.

End Notes

[1] Specialty crops are defined as fruits, vegetables, tree nuts, dried fruits, nursery crops, and floriculture. Also referred to as horticulture crops. (ERS, 2010)

[2] Program crops are defined as crops for which Federal support programs are available to producers, including wheat, corn, barley, grain sorghum, oats, extra long staple and upland cotton, rice, oilseeds, peanuts, and sugar. (ERS, 2010)

[3] Direct payment is defined as annual payments based on payment rates specified in the 2002 Farm Act and a producer's historical program payment acres and yields. (ERS, 2010)

[4] Counter-cyclical payment is defined as Payments that vary inversely with market prices and are available for eligible commodities under the 2002 Farm Act whenever the effective commodity price is less than the target price. The payment amount for a farmer equals the product of the payment rate, the payment acres, and the payment yield. Payments are tied to historical base acres and program yields. (ERS, 2010)

[5] Base acreage is defined as farm's crop-specific acreage of wheat, feed grains, upland cotton, rice, oilseeds, or peanuts eligible to participate in commodity programs under the 2002 Farm Act. (ERS, 2010)

[6] These data were developed from PRISM (Parameter-elevation Regressions on Independent Slopes Model) data at the 2.5 arc minute scale and aggregated to the 5 arc minute grid scale. The county means were computed using a weighted mean of the 5 arc minute grids within the county.

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Figure 1a. Share of 1982 Acres for Various Annual Crops
Data Source: USDA NASS data

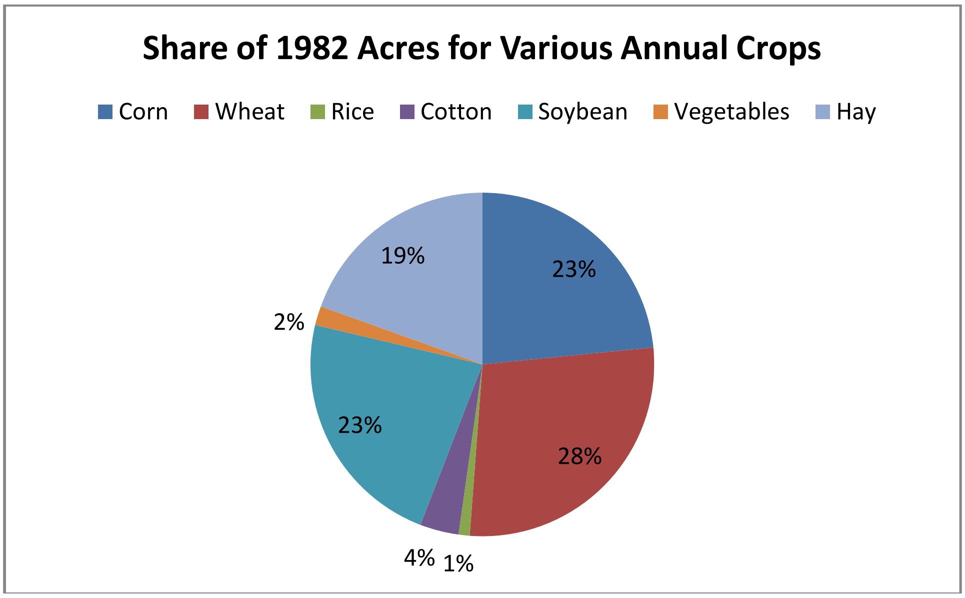

Figure 1b. Share of 1997 Acres for Various Annual Crops
Data Source: USDA NASS data

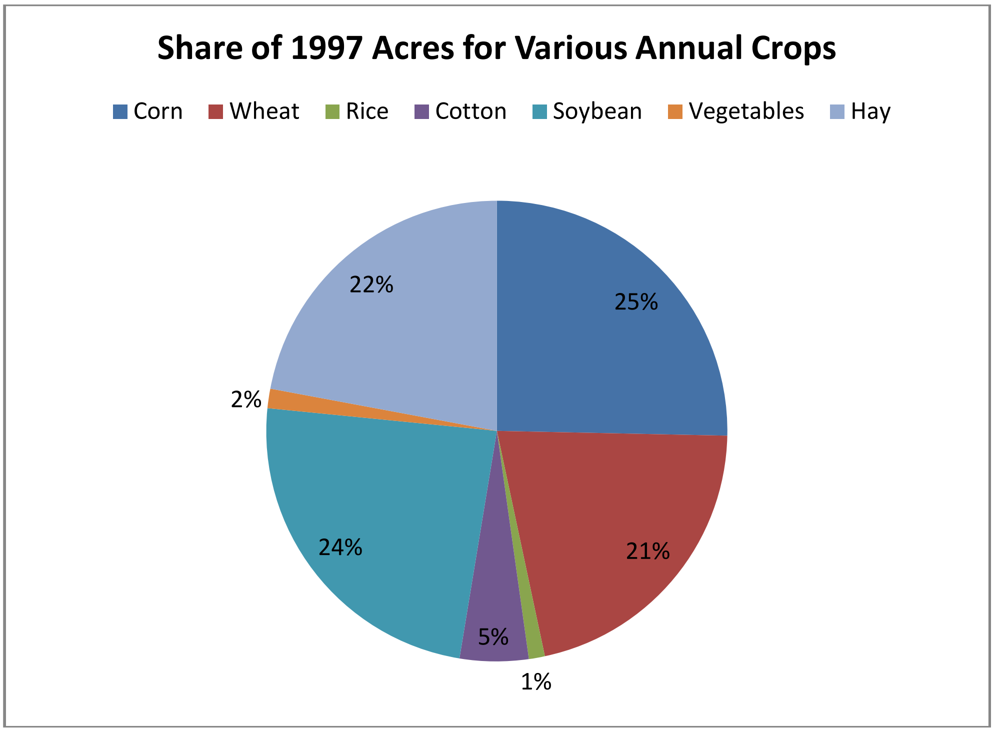

Table 1 Fruit and Vegetable Acreages and Share of Total Acreages in the 1980s and 1990s

State	Fruit and vegetable Acres in 1980s	Fruit and Vegetable Acres as a Share of Total Acres in 1980s	Fruit and vegetable Acres in 1990s	Fruit and Vegetable Acres as a Share of Total Acres in 1990s	State	Fruit and vegetable Acres in 1980s	Fruit and Vegetable Acres as a Share of Total Acres in 1980s	Fruit and vegetable Acres in 1990s	Fruit and Vegetable Acres as a Share of Total Acres in 1990s
AL	24050	0.20%	0	0%	**NE**	795	0.0009%	0	0%
AZ	414302	9%	572484	11%	**NV**	1208	0.03%	0	0%
AR	12268	0.02%	0	0%	**NH**	11580	2%	13632	2%
CA	4062005	14%	5045129	17%	**NJ**	283940	12%	256116	11%
CO	22664	0.80%	0	0%	**NM**	23273	0.50%	0	0%
CT	32913	5%	40004	6%	**NY**	609487	3%	618004	3%
DE	166549	6%	175740	6%	**NC**	54478	0.20%	0	0%
FL	2748101	40%	2472485	47%	**ND**	326	0.0004%	0	0%
GA	58586	0.30%	0	0%	**OH**	108733	0.20%	98803	0%
ID	42040	0.30%	0	0%	**OK**	12230	0.02%	0	0%
IL	297514	0.20%	323284	0%	**OR**	550347	4%	603148	5%
IN	59255	0.09%	59875	0%	**PA**	46079	0.20%	0	0%
IA	7815	0.01%	0	0%	**RI**	6750	11%	6310	10%
KS	4245	0.01%	0	0%	**SC**	31540	0.30%	0	0%
KY	4532	0.02%	0	0%	**SD**	849	1.00%	0	0%
LA	8712	0.04%	1221	0%	**TN**	21445	0.08%	0	0%
ME	41221	3%	44002	3%	**TX**	312544	0.40%	61523	0%
MD	150552	2%	144550	2%	**UT**	6836	0.10%	0	0%
MA	61581	7%	64640	8%	**VT**	6908	0.20%	10652	0%
MI	510774	2%	534050	2%	**VA**	27231	0.20%	0	0%
MN	174687	0.02%	0	0%	**WA**	611011	3%	756218	4%
MS	10963	0.04%	0	0%	**WV**	1195	0.04%	0	0%
MO	12560	0.02%	0	0%	**WI**	1197037	2%	1228048	2%
MT	280	0.01%	0	0%	**WY**	36	0.0004%	0	0%

Table 2 Descriptive statistics of the sample data (top 2 FV producing counties in CA, 4 years)

County	**Year**	***AV***	***AF***	***AFV***	***AP***	***AT***	***dummy***	***DAP***	***elev***	***netppt***	***tep***
Fresno, CA	1982	199626	17952	217578	1558041	2021154	0	0	1022.4	532.6	249.3
	1987	258682	23548	282230	1059577	1715438	0	0	1022.4	169.1	281.1
	1992	287042	24804	311846	1019525	1692235	1	1019525	1022.4	122.5	294.6
	1997	350908	32487	383395	1166131	1915608	1	1166131	1022.4	63.6	291.6
Tulare, CA	1982	12255	80182	92437	654125	998133	0	0	1311.2	520.8	231.5
	1987	8426	86813	95239	504655	1014888	0	0	1311.2	140.5	259.3
	1992	12686	89093	101779	471207	1012027	1	471207	1311.2	88.6	270.8
	1997	13398	109541	122939	344412	1024278	1	344412	1311.2	63.2	269.5
Mean		142877.9	58052.5	200930.4	847209.1	1424220			1166.8	212.6	268.5
Std.Dev.		146163	36818.33	114228.8	419284	452545.5			154.4	197.3	21.4
Min		8426	17952	92437	344412	998133			1022.4	63.2	231.5
Max		350908	109541	383395	1558041	2021154			1311.2	532.6	294.6

Source: Author’s calculation based on USDA census data.

Table 3 Regression estimates on three different dependent variables using 3111 counties data

Explanatory Variable	**Dependent Variable**											
	With fixed effect						**Without fixed effect**					
	F&V		**Fruit**		**Vegetable**		**F&V**		**Fruit**		**Vegetable**	
	Coef.	**P>|z|**	**Coef.**	**P>|z|**	**Coef.**	**P>|z|**	**Coef.**	**P>|z|**	**Coef.**	**P>|z|**	**Coef.**	**P>|z|**
Program Acres	-0.027**	-0.030	-0.005***	-0.006	-0.022**	-0.024	-0.024**	-0.027	-0.003***	-0.004	-0.021**	-0.024
Dummy (t=1 in 1992, 1997)	-201.9	-384.2	-44.6	-137.7	-140.9	-288.8	938.9	321.2	5.9	-195.2	932.9	384.7
Treatment var.	0.001***	0.001	0.000***	0.0003	0.001***	0.001	-0.002***	-0.005	0.00008***	-0.001	-0.002***	-0.004
Elevation	0.473	-0.585	0.706	0.352	-0.016	-0.949	-0.855	-1.538	0.964	0.742	-1.819	-2.426
Net precipitation	0.129	-0.498	0.682	0.371	-0.363	-0.873	-8.199	-9.463	0.996	0.585	-9.196	-10.317
Temperature	13.628	8.206	9.377	7.280	6.532	1.951	28.450	24.256	11.847	10.482	16.602	12.880
Total Acres	0.022**	0.020	0.004***	0.003	0.017**	0.015	0.021**	0.019	0.003***	0.002	0.018**	0.016
Constant	-4110.6	-6214.9	-3509.2	-4329.5	-1358.2	-3139.3	-2501.2	-4305.6	-4500.7	-5088.3	1999.6	398.1
R^2- within	0.036		0.006		0.033							
R^2- between	0.032		0.029		0.030							
R^2-overall	0.033		0.026		0.030							
R^2- adjusted							0.0495		0.0272		0.0514	

Notes: *, ** and *** : significant at the 10%, 5% and 1% level respectively.

Source: Author's calculations.

Table 4 Regression estimates on vegetables acres only using three different region data

Explanatory Variables	**PILOT**		**PILOT+2**		**PILOT+5**		**SUNBELT**	
	Coef.	**P>|z|**	**Coef.**	**P>|z|**	**Coef.**	**P>|z|**	**Coef.**	**P>|z|**
Program Acres	-0.0190**	-0.0232	-0.0167**	-0.0206	-0.0101**	-0.0131	-0.214	-0.2323
Dummy (t=1 in 1992, 1997)	-1194.5	-1914.9	-1150.1	-1766.8	-774.2	-1191.6	-2338.4	-5013.77
Treatment var.	-0.0015***	-0.0039	-0.0015***	-0.0036	-0.0013***	-0.003	0.0050***	-0.0090
Elevation	-22.5054	-26.0962	-19.4	-22.0442	-10.3136	-11.8912	-3.0544	-7.1984
Net precipitation	0.8714	-0.9270	1.0381	-0.5796	0.2266	-0.9498	-7.2184	-11.6546
Temperature	-51.9	-59.5	-50.5	-57.4	-36.6	-40.8	-19.097	-53.5
Total Acres	0.0131**	0.0108	0.0114***	0.0092	0.0068***	0.0052	0.2126	0.1989
Constant	18825.4	16200.4	17866.6	15618.6	12992.9	11577.8	7537.8	-7635.1
R^2- adjusted	0.096		0.0916		0.0875		0.4056	

Notes: *, ** and *** : significant at the 10%, 5% and 1% level respectively.

Source: Author’s calculations.