# Income Tax Reform and California Orchard Development

**Hoy F. Carman**

The effects of requiring capitalization of citrus and almond orchard development expenses on acreage, production and product prices for seven California orchard and vine crops are estimated. Acreage and production of citrus and almonds decreased, as expected. The decreases in orange and lemon acreage, however, were more than offset by increased acreage of walnuts and grapes. The switch of developer and investor interest to walnuts and grapes appears to have added to the cyclical instability of production and prices for these two crops. Perennial crop adjustments to selective changes in tax provisions involve very significant time lags.

Income tax provisions are an important factor in capital investment decisions for orchard, grove and vineyard development. Special farm tax provisions, especially cash accounting and the current deduction of orchard development costs, provide significant development incentives. Termination of much of this incentive for development of citrus groves and almond orchards by federal income tax reform in 1969 and 1970 has had short- and longer-run impacts on citrus and almonds as well as other perennial crops.[1]

The expected impacts of capitalization requirements on citrus and almonds are decreased plantings, decreased total acreage and in the longer-run, decreased production and higher product prices than would have existed without capitalization. For other orchard crops there may be increased plantings, increased total acreage, increased production and decreased prices as development responds to changing comparative after-tax development costs.

## Objectives

Empirical studies of the impact of agricultural income tax incentives and changes in these incentives have utilized budgeted examples and very specific assumptions concerning cost conditions, crop returns, and the income tax bracket of the developer. Thus, they have limited applicability for aggregate studies and, while one can be confident of the general direction of impacts, there is a great deal of uncertainty on magnitudes. There are now sufficient data available to obtain statistical estimates of the impact of the citrus and almond capitalization requirements on acreage, production and

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[1]The citrus provision requires that all expenditures for purchase, planting, cultivation, maintenance, or development of any citrus grove must be capitalized during the first four tax years after planting. The rule applies to citrus trees planted after December 31, 1969, and was extended to almond trees planted after December 29, 1970. The text of the law is in IRC section 278. A Treasury Regulation [1.278-1 (a)(2)(iii)] issued in 1971 provides that section 278 shall not apply to expenditures attributable to real estate taxes or interest, to soil and water conservation expenditures allowable as a deduction under IRC section 175 or to expenditures for clearing land allowable as a deduction under IRC section 182.

prices for California citrus, almonds and related crops.[2]

The specific objectives of this research are to:

1. Describe the utilization of farm income tax provisions in orchard development and present available evidence on the extent of nonfarm investor activity.
2. Specify a model of perennial crop supply response which includes a variable to measure the impact of tax reform.
3. Use this supply response model to estimate the impact of changing cost capitalization provisions on acreage, production and prices for California navel oranges, valencia oranges, lemons, almonds, walnuts, avocados and grapes.

This article is organized in line with the objectives. The analytical portion of the study is restricted to California crops because California has a variety of tree and vine crops as well as published annual estimates of plantings, bearing acreage, nonbearing acreage, yield and price required for the analysis. The three citrus crops and almonds were directly affected by tax provisions changed in 1970 and 1971. Walnuts, avocados and grapes are included to determine if there was a shift in developer and investor interest to these crops, as hypothesized.

## Income Tax Incentives and Orchard Development

The establishment of orchards and vineyards (other than citrus and almonds) offers tax shelter opportunities. The current deduction of pre-production expenses provides deferral while recovery of a high proportion of establishment costs when the property is sold converts ordinary income to capital gains. Since the crops require several years to reach full bearing, the development costs are deductible from other taxable income.

Citrus grove and almond orchard development were popular tax shelter investments during the 1960's. Capitalization provisions effective in 1970 and 1971, however, shifted investor interest to other crops. Since 1971 there have been public offerings emphasizing tax shelter advantages for the development of grapes, avocados, walnuts, dates, figs, olives, pistachio nuts, and kiwi fruit. The public offerings of tax shelter investments in orchard development were effectively terminated, however, by the Tax Reform Act of 1976. The 1976 Act requires farming syndicates to capitalize planting and development costs for all orchards, groves and vineyards.[3] Individual investors, however, can continue to treat orchard development expenses as a current cost to be deducted from other income for all crops except citrus and almonds.

Comparison of the present value of current deduction versus capitalization of pre-production expenses reveals a significant advantage for current deduction whether the orchard is sold when developed or retained throughout its bearing life. Budgeted examples presented by [Carman 1972 and Carman and Kenyon] demonstrate that the tax subsidy varies directly with the income level of the investor and is largest for those investors with the largest income, be it from farming or elsewhere.

### *The Extent of Tax Motivated Orchard Development*

Data related to tax shelter investments in agriculture are very limited. Interstate public offerings to nonfarm investors are registered with the Securities Exchange Commission (SEC). Public offerings sold only intrastate usually must be registered with a state agency. However, neither the SEC nor the comparable state agencies publish data on

[2]Obtaining data to measure the impact of agricultural income tax incentives has been and will continue to be difficult. Krause and Shapiro discuss some of the problems associated with researching tax shelter investments and also comment on research needs.

[3]Sisson discusses the provisions affecting agriculture in the Tax Reform Act of 1976. Those aimed specifically at tax shelter investments include limitation on deductions to amount at risk, limits on deductions for farming syndicates, accrual accounting for large farm corporations, and restrictions on prepaid interest.

the offerings, even though they are registered. Moreover, private placements and small private offerings have no registration requirements.

Scofield found that there were eight limited partnerships to establish orchards and vineyards registered with the SEC in 1970-71. They planned to develop about 22,000 acres with investor capital of approximately $40 million. Jeanne Dangerfield listed a who's who of syndicated farming in 1973 which included offerings for orchard and vineyard development worth almost $53 million on 47,000 acres in California. There was undoubtedly some overlap in the syndicates listed by Scofield and Dangerfield. A large number of smaller syndications sold only within California (or only within other states) and private placements were not included in either report. To place these acreages in perspective, estimated annual plantings of all California tree and vine crops from 1970 to 1972 averaged about 85,000 acres.

*Estimated Impacts*

The development of perennial crops is based on expected profits over the life of the asset where after-tax profits depend on both economic conditions and tax provisions. Expected economic conditions, with expectations based on recent experience, are probably the most important determinant of new tree plantings. The income tax subsidy provided by current deduction of development expenses can be expected to increase tree plantings, total acreage and ultimately, total production. The amount of tax subsidy available to a developer depends on the developer's tax bracket. Thus, the increase in tree plantings as a result of the subsidy is a function of the elasticity of tree planting and developers' tax brackets.

Carman and Youde estimated the acreage response of five California orchard crops to income tax subsidies. Assuming all developers were in the 50% marginal tax bracket, the percentage increase in acreage by crop was estimated as: apples, 2.38%; apricots, 3.20%; avocados, 6.48%; freestone peaches, 1.75%; and olives, 0.14%. Using an economic surplus framework, Carman and Youde estimated that for the five orchard crops considered, combined net returns to consumers, middlemen, and producers as a result of orchard development tax subsidies ranged from $.12 per dollar of subsidy for olives to $15.00 per dollar of subsidy for apricots. While the distribution of gains varied by commodity, consumer surplus was the largest segment of gross social returns for all crops and income tax brackets considered.

A case study of five large California farms using a utility-maximizing risk framework found that farmers would reduce their acreage of tree crops by 16% in response to requiring capitalization of development costs for all orchard crops [Lin *et al*]. This estimate is probably too high for the total situation, given the comparatively high tax brackets of the large case study farms.

To summarize, the available evidence on the impact of tax subsidies on orchard development is incomplete. The current deduction of development costs reduces after-tax costs of development and should expand planted acreage, *ceteris paribus*. The impact apparently varies by crop and can be affected by the tax status of developers. The impact on total acreage of individual crops may be close to zero or as great as 16%. With increased acreage, increased production, lower product prices and probably lower orchard prices would be expected. But, because of extensive lags between planting and production and interactions between prices, plantings and removals, the impacts may not be apparent for a number of years, if at all.

The studies to date are partial analyses based on budgeted examples. Thus, the impacts of tax subsidies outlined above are best regarded as testable hypotheses based on economic theory. In the following sections, empirical models are specified and estimated as a limited test of the above hypotheses for California navel and valenica oranges, lemons, almonds, walnuts, avocados and grapes.

## Perennial Crop Supply Response

Perennial crop development involves extensive lagged adjustments not found in annual crops. Investor and developer expectations are often based on recent production and price relationships. Establishment of the perennial crop then takes several years from planting to commercial production and requires a significant capital investment. Production occurs over an extended period, finally decreasing for "old" plants which are eventually removed. Thus, the production of a perennial crop is a function of lagged planting and removal decisions which combine to determine bearing and nonbearing acreage. Annual production is the product of bearing acreage and yield.

Evaluation of the impact of citrus and almond capitalization requirements on these and related perennial crops requires specification and estimation of a model of supply response for each crop. The theoretical framework for models of producer supply response has been developed by several researchers. Most recent applications and estimated models involve minor modifications and extensions to the basic model presented by French and Matthews.

The French and Matthews theoretical model has five major components. They are: (1) functions for desired production and bearing acreage, (2) a relation between desired and actual planting, (3) an acreage removal equation, (4) relationships between unobservable expectations and observable variables, and (5) a yield equation. Their empirical application of the model was to asparagus.

The French and Matthews model has been modified, extended and further validated for a number of crops. Rae and Carman formulated a revised measure of yield expectations given technical change (semi-dense plantings) and applied the model to the New Zealand apple industry. Baritelle and Price estimated a supply response model for the Washington apple industry. They utilized a polynomial lag formulation to estimate annual net changes in the number of trees. Bushnell developed a supply response component for his optimum control model of the world almond market. Minami, French and King applied a supply response model to analysis of the impact of the California cling peach marketing order. Thor used a similar model to analyze the impact of the California-Arizona orange marketing orders. Each of the above studies assisted in the development and estimation of the supply response model utilized in this study.

### *The Supply Response Model*

A supply response model to estimate the impact through time of capitalization provisions requires components for total acreage bearing acreage, yields and average farm level prices. The structure of the model utilized is illustrated in Figure 1. It is a simple recursive model based on the lagged response of production to prices. Beginning with California production and moving clockwise, the model indicates that current price is determined by current production and demand. Profit expectations are based on a combination of current and past prices (or total revenue per acre) and cost factors. Acreage decisions, involving planting and removals, are a function of profit expectations. Note that existing acreage may be considered in the planting and removal decisions. Acreage decisions may not affect production for several years. Thus, current production is a function of past prices. The cobweb or cyclical behavior of perennial crop production and prices shown in the model was previously demonstrated by French and Bressler.

As shown in Figure 1, annual production is the product of average yield and bearing acreage. Equations are estimated for annual planting and annual change in total acreage. Then, these estimated relationships are used to calculate an estimate of bearing acreage using the following identity:

$$TA_t = BA_t + NBA_t \text{ or } BA_t = TA_t - NBA_t$$

where:

TA is total acreage of the crop in year t.

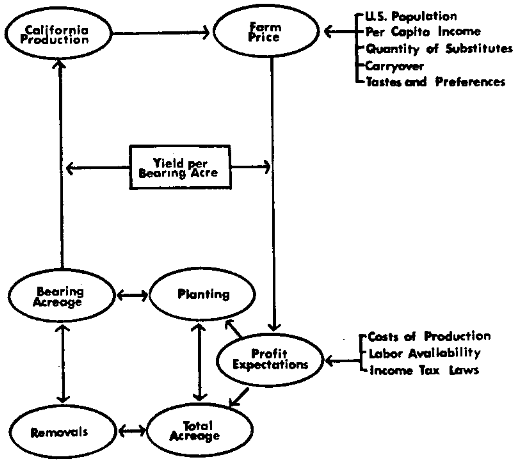


**Figure 1. A Simple Recursive Model of California Perennial Crop Acreage, Production and Prices.**

BA is bearing acreage in year t.

NBA is nonbearing acreage in year t.

Assuming that all plantings reach bearing age, nonbearing acreage is the sum of plantings during the number of years that elapse between the time a tree is planted and classified as bearing. The time required for a tree to be classified as bearing varies by crop, variety and geographic region. The range of times used by the California Crop and Livestock Reporting Service and the times used in this study for a tree to reach bearing size are shown by crop in Table 1. The basic specification of equations for each model component are described in the following sections.

Planting: New plantings of a perennial crop are specified as a function of expected profitability of both that crop and alternative crops. Since these expectations cannot be observed, estimation requires specification of a set of observable variables related to expected profitability.

It is typically assumed that producer expectations are based on recent experience. Thus, empirical models of planting usually include lagged values for prices or total revenue adjusted for costs of production. Simple averages, geometrically weighted averages, and distributed lag formulations of various lengths have been employed. Estimated planting equations have also included variables for urbanization, risk and uncertainty, farm labor availability, returns from other crops, acreage (total, bearing, or acreage in particular size categories), technological change, and changes in tax laws. The availability of land suitable for orchard crops could also affect expectations. Attempts to develop a suitable variable for new irrigated acreage on the west side of the San Joaquin Valley, however, were unsuccessful because of data limitations.

For the crops included in this study, new plantings are specified as a function of lagged average prices or total revenue divided by the index of prices paid by farmers for production items, a dummy variable for income tax reform, farm labor availability, and total or bearing acreage. We expect the price or total revenue variable to be positively related

**TABLE 1. The Number of Years California Fruit and Nut Crops Require to Reach Bearing Age.**

| Crop | Years From Planting to Bearing: Range[a] | Years From Planting to Bearing: Used in This Study |
|---|---|---|
| | ----years---- | |
| Almonds | 4-5 | 5 |
| Avocados | 3-5 | 3 |
| Grapes | 3 | 3 |
| Lemons | 5-6 | 5 |
| Navel Oranges | 5-6 | 6 |
| Valencia Oranges | 5-6 | 5 |
| Walnuts | 5-7 | 6 |

[a]Source: California Crop and Livestock Reporting Service, *California Fruit and Nut Acreage*, annual issues.

to plantings. Note that selection of either lagged price or total revenue and the number of years to be averaged was based on the formulation which provided the best statistical results. We expect the coefficient on the tax reform variable to be negatively related to citrus and almond plantings and to be positively related to plantings of avocados, grapes and walnuts.

Inclusion of a variable for farm labor availability is based on Bushnell's almond study. He reasoned that producers concerned about labor availability would shift to crops which had mechanized harvest. The same argument can be extended to crops such as citrus for which harvest timing is not critical. Citrus can be stored on-the-tree with picking over an extended period. The coefficient on the labor index variable should be negative for crops which have mechanized harvest or which can be easily harvested over an extended period.

The coefficient on the acreage variable should be negative because: (1) increased acreages are associated with potentially larger crops and lower product prices, and (2) orchards are developed on the most suitable land first, and expansion takes place on lower quality land. Each of these two factors are associated with decreases in expected profits.

Changes in Total Acreage: Annual changes in total acreage of a perennial crop can be regarded as net investment whereas plantings are gross investment.[4] Thus, the specification for the annual change in total acreage equation should be similar to the planting equation. In this study, the independent variables included in the two equations are identical. Arguments regarding expected signs on coefficients are also identical for the two equations.

A possible weakness in identical specification of the two equations is that there may be variables associated with removals which are only weakly associated with planting. This problem should be insignificant, however, since the dependent variable in each equation is a function of expected profits and the independent variables are observable variables associated with expected profitability.

Yields: Per acre yields can be influenced by a number of factors including management and cultural practices, weather, varieties, age of trees, application of inputs and technology. For the projections portion of this study, we are interested only in long-term trends in yields. Thus, average yields are specified as a function of time. Both linear and logarithmic forms of the equations were estimated. The linear form provided superior results for all crops except lemons.

Prices: The price equation is a central component of the supply response simulation model. Prices are specified as a function of current production of the crop and competing crops, consumer income, carryover, population and tastes and preferences. We expect prices to be negatively related to production of the crop, production of competing crops and carryover. Each of these variables is expressed in per capita terms. We expect prices to be positively related to per capita income. Changes in tastes and preferences, reflected by a trend variable, may be either negative or positive.

Prices are estimated as a linear function of the variables specified using ordinary least squares methods. Equations were estimated using both current and real prices and in-

[4]Net changes (net investment) in the capital stock of trees can be separated into planting (gross investment) and removals. Consider the relationship:

$$TA_t = TA_{t-1} + N_t - R_t$$

which states that total acreage (TA) of a perennial crop at the end of year t is the total acreage at the end of year t − 1 plus plantings (N) and minus removals (R) in year t. Moving $TA_{t-1}$ to the left side of the equation, we have:

$$TA_t - TA_{t-1} = N_t - R_t$$

where $TA_t - TA_{t-1}$ is the annual change in total acreage. One would prefer to estimate removals directly and use a removals equation to estimate annual changes in total acreage. This direct approach is hampered, however, by serious data problems. Annual removals are not reported and, while they can be calculated, little confidence can be placed in the calculated series.

comes. Current prices and incomes yielded the best statistical results and are used in the simulation model.

*Estimation of the Model*

The time span covered by data used in estimation of the model varies by equation. The yield and price equations are estimated for the period 1960-1978. The planting and change in total acreage equations utilize data to yield estimated values for each of the years 1962 through 1978. Thus, for a crop which uses a three-year lagged average of total revenue, data for the period 1958-1978 are required.

Various formulations of prices and per acre total revenue, including simple averages, weighted averages and distributed lags, were investigated. Simple averages provided the best statistical results. The choice of price or total revenue and the number of years averaged were based on statistical measures. A zero-one variable was utilized to estimate the impact of tax reform. Various lags were investigated for the tax variable since producers and developers may have had development commitments not subject to immediate change. Lemons were the only crop in which a one-year lag of the tax reform variable improved results.

Some adjustments to the planting and acreage data series were necessary. An example for derivation of the new planting series and an explanation of necessary adjustments is contained in [Carman 1980, pp. 76-77]. Acreage data, new plantings, average yields, and prices used in estimating the model for each crop and a summary of variables utilized and data sources is also included in Carman 1980, (pp. 78-86).

## Estimated Model Components

Equations for planting, change in total acreage, yield and price are estimated for each crop. These equations, the components of each simulation model, are joined together and used to estimate the impact of tax reform provisions on each of the seven crops.

*Planting and Acreage Equations*

Estimated equations for annual new plantings and annual changes in total acreage for each of the seven crops studied are presented in Table 2. The estimated equations are generally quite good as shown by the statistical measures included. The tabled $R^2$ values indicate that the variables included in the equations explain from 82 to 98% of the variation in annual plantings and from 66 to 96% of the variation in annual change in total acreage. The Durbin-Watson statistics show no evidence of serial correlation in the residuals. The estimated coefficients generally have the expected signs, most are statistically significant at the 95% level of confidence or greater and most are of reasonable magnitudes.

The coefficients on the lagged average price and lagged average total revenue per acre divided by the index of prices paid by farmers for production items are positive, as expected, and 12 of the 14 are significant at the 99% confidence level. The best statistical results were provided by lagged moving averages of five years for lemons and walnuts, three years for valencia oranges and avocados, and two years for navel oranges and almonds. For grapes, deflated prices lagged one year were utilized.

Comparison of the price or total revenue coefficients for the plantings and change in total acreage equations reveals that the coefficient is larger in the change in total acreage equation for five of the seven crops. This indicates that removals are an inverse function of expected profits for these crops, i.e., higher current prices or total revenue are associated with lower removals. It appears that removals are a positive function of prices or total revenue for the two nut crops. However, there is little difference in the size of the two coefficients for almonds and the change in total acreage coefficient for walnuts is not significant.

Each of the coefficients on the tax reform variable has the expected sign and seven of the 14 are significant at the 95% confidence

**TABLE 2. California Orchards Crops: Estimated Annual Plantings and Annual Changes in Total Acreage Relationships.**

| Crop and Dependent Variable | Variables: Constant | Lagged Average Price | Lagged Average Total Revenue | Citrus Tax Reform[a] | Almond Tax Reform[b] | Farm Labor Index t−1 | Lagged Acreage t−1 | Summary Statistics: $R^2$ | Durbin-Watson |
|---|---|---|---|---|---|---|---|---|---|
| | Coefficients | | | | | | | | |
| Navel Oranges | | | | | | | | | |
| Plantings | 7067 | | 13.91[d] | −2621 | | −110.20 | | .97 | 2.29[k] |
| | (2.45)[c] | | (8.74) | (−4.64) | | (−3.49) | | | |
| △ Total Acres | 10486 | | 18.88[d] | −3068 | | −194.48 | | .96 | 2.47[k] |
| | (2.61) | | (8.52) | (−3.90) | | (−4.42) | | | |
| Valencia Oranges | | | | | | | | | |
| Plantings | −5906 | 1822[e] | | −133 | | 105.03 | −.08[i] | .98 | 1.85[l] |
| | (−1.30) | (3.69) | | (−.25) | | (2.67) | (−3.63) | | |
| △ Total Acres | 19104 | 2735[e] | | −3174 | | −140.32 | −.13[i] | .66 | 2.60[l] |
| | ( .95) | (1.25) | | (−1.36) | | ( −.80) | (−1.30) | | |
| Lemons | | | | | | | | | |
| Plantings | −4609 | | 6.65[f] | −1714[h] | | | | .82 | 2.75[k] |
| | (−4.99) | | (7.98) | (−4.37) | | | | | |
| △ Total Acres | −12415 | | 11.54[f] | −2869[h] | | | | .73 | 3.08[l] |
| | (−5.98) | | (6.15) | (−3.25) | | | | | |
| Almonds | | | | | | | | | |
| Plantings | 77905 | 52.13[d] | | | −1809 | −800.09 | −.05[i] | .88 | 2.27[k] |
| | (4.02) | (7.20) | | | (−.65) | (−5.80) | (−1.79) | | |
| △ Total Acres | 71520 | 45.12[d] | | | −934 | −707.20 | −.06[i] | .81 | 2.36[l] |
| | (3.23) | (5.46) | | | (−.29) | (−4.48) | (−1.85) | | |
| Walnuts | | | | | | | | | |
| Plantings | 48033 | | 86.72[f] | 1755 | | −237.46 | −.32[j] | .93 | 2.06[k] |
| | (5.04) | | (3.16) | (2.40) | | (−6.55) | (10.24) | | |
| △ Total Acres | 98372 | | 25.03[f] | 314 | | −513.09 | −.36[j] | .75 | 2.83[l] |
| | (3.85) | | (.34) | (.16) | | (−5.28) | (−4.30) | | |

**TABLE 2. Continued**

| Crop and Dependent Variable | Variables | | | | | | | Summary Statistics | |
|---|---|---|---|---|---|---|---|---|---|
| | Constant | Lagged Average Price | Lagged Average Total Revenue | Citrus Tax Reform[a] | Almond Tax Reform[b] | Farm Labor Index t−1 | Lagged Acreage t−1 | $R^2$ | Durbin-Watson |
| | Coefficients | | | | | | | | |
| Avocados | | | | | | | | | |
| Plantings | −19922 | | 9.19[e] | | 121.54 | 128.79 | | .90 | 1.70[l] |
| | (−3.55) | | (4.84) | | (.17) | (3.13) | | | |
| △ Total Acres | −20642 | | 10.19[e] | | 58.86 | 118.16 | | .90 | 1.81[l] |
| | (−3.00) | | (4.38) | | (.07) | (2.34) | | | |
| Grapes | | | | | | | | | |
| Plantings | 122905 | 544.01[g] | | | 32454 | | −.29[i] | .85 | 1.77[k] |
| | (4.84) | (3.54) | | | (3.87) | | (−6.14) | | |
| △ Total Acres | 74252 | 696.41[g] | | | 22699 | | −.23[i] | .79 | 2.33[l] |
| | (2.45) | (3.79) | | | (2.27) | | (−4.08) | | |

[a]Citrus tax reform is a dummy variable, 1962-1970 = 0 and 1971-1978 = 1.
[b]Almond tax reform is a dummy variable, 1962-1971 = 0 and 1972-1978 = 1.
[c]Figures in parentheses are t-statistics.
[d]Two year moving average lagged one year.
[e]Three year moving average lagged one year.
[f]Five year moving average lagged one year.
[g]Grape prices are lagged one year.
[h]The effect of citrus tax reform was lagged one year, thus 1962-1971 = 0 and 1972-1978 = 1.
[i]Total acreage (bearing plus nonbearing) is lagged one year.
[j]Bearing acreage is lagged one year.
[k]Accept, indicates that the hypothesis of no serial correlation cannot be rejected at the 1 percent level of significance.
[l]The test for serial correlation is inconclusive at the 1 percent level of significance.

level. These tax coefficients indicate that new plantings and total acreage of citrus and almonds decreased with capitalization requirements while new plantings and total acreage of walnuts, avocados and grapes increased. The variable for tax reform is retained in each of the equations, even when not significant, and the estimated coefficients are utilized in the simulation model to compare results with and without tax reform.[5]

The availability of farm labor as measured by the index of farm labor input in the Pacific Region is related to plantings and changes in total acreage for five of the crops. New plantings and total acreage of navel oranges, almonds and walnuts increased as farm labor decreased. Navel oranges are stored on-tree and harvested over an extended period while almonds and walnuts are mechanically harvested. Thus, availability of harvest labor is not as critical for these crops as it is for many others. Plantings of valencia oranges and avocados as well as total acreage of avocados decreased as the farm labor index decreased.

Plantings and annual changes in total acreage are negatively related to total acreage of valencia oranges, almonds and grapes and bearing acreage of walnuts. This negative relationship is expected and five of the coefficients are significant at the 99% confidence level. The remaining three coefficients are significant at lower confidence levels.

### Yields

Actual yields for each crop are utilized in the model for the period 1970 to 1978 but an estimate is required for the projections to 1985. Average yields for the period 1960 to 1978 are used unless there was a significant trend in yields. Simple trend equations for yield were estimated and the results are presented in Table 3. As shown, only three of the crops, lemons, walnuts and avocados, have a significant trend in yields.[6] The trend coefficient was incorporated in the yield projection for these crops. For the other crops (navel oranges, valencia oranges, almonds and grapes), the average yield in Table 3 was used in the projection.

### Product Prices

Estimated farm level price equations for each of the seven crops are presented in Table 4. Again the results are quite satisfactory. The variables included in the equations explain from 88 to 99% of the annual variation in farm prices for the seven crops, each coefficient has the expected sign and most are significant at the 95% or greater confidence level.

The coefficients on the quantity variable are significant at the 99% level for all crops except valencia oranges which is significant at the 90% level. The coefficients on the carryover variables for almonds and walnuts are also significant at the 99% confidence level. Note that a unit of carryover for either crop has approximately double the impact on prices as does the same unit of current production.

The coefficients on quantity of substitutes for navel oranges and almonds are relatively small and both are insignificant. Efforts to specify substitues for lemons, avocados and grapes were unsuccessful. Variables for production of these crops in other states added nothing to the explanatory power of the equations. Neither did variables for quantities of bananas, apples and pears.

The coefficients for per capita disposable income are significant at the 99.5% confidence level for all crops except lemons and the coefficient for lemons is significant at the 85% level. Estimated coefficients for the time variable indicate that prices have been

[5]One could argue that, if the coefficient measuring the impact of tax reform is not significantly different than zero at a high confidence level, it should not be used to estimate the impact of tax reform in the simulation model. The estimated coefficients are, however, the best estimates available and they are consistent with the theoretical model employed. The reader should note that the confidence placed in the estimated impacts of the tax reform will vary by crop.

[6]A two-tailed t-test and a 95% confidence level was utilized to determine statistical significance.

**TABLE 3. Average Per Acre Yields for Selected California Tree and Vine Crops as a Function of Time, 1960-1978.**

| Crop[a] | Constant | Time Coefficient | $R^2$ | Average Yield |
|---|---|---|---|---|
| Navel Oranges | 207.33 (9.00)[b] | .8088 (.40) | .009 | 215[c] |
| Valencia Oranges | 204.44 (5.72) | 2.7544 (1.38) | .100 | 251[c] |
| Lemons[d] | 5.56 (73.48) | .1475 (4.32) | .520 | 358[c] |
| Almonds | .5492 (6.67) | .0083 (1.80) | .159 | .6900[e] |
| Walnuts | .4530 (8.40) | .0330 (6.98) | .741 | .7832[e] |
| Avocados | 1.8963 (4.51) | .0815 (2.21) | .224 | 2.7116[f] |
| Grapes | 7.1995 (16.21) | −.0126 (−.32) | .006 | 7.0732[f] |

[a]The dependent variable is average yield per acre.
[b]Figures in parentheses are t-statistics.
[c]Boxes per acre.
[d]The lemon yield equation is estimated linear in logarithms, i.e., $\ln YL = \ln a + b\ln Time$ where a is the constant and b is the coefficient for Time
[e]Tons per acre (in-shell).
[f]Tons per acre.

trending upward for lemons and downward for navel oranges, almonds, walnuts and grapes. There was no significant price trend for either avocados or valencia oranges.

Two dummy variables were used to account for unusually high prices for almonds in 1973 and grapes in 1973-1974 which could not be explained with traditional demand variables. Perhaps the unusually high commodity prices during this period, some of which was due to speculation, affected these two crops. Given the purpose of the price equations, it appears worthwhile to include the dummy variables.

## Simulation Results

Model components are joined together within the framework illustrated in Figure 1 to simulate behavior of plantings, acreage, production and prices of each crop both with and without current development cost capitalization provisions for citrus and almonds. The difference between the with and without cost capitalization alternatives is incorporated through the coefficients for the tax reform dummy variables. The sequence of calculations performed for each crop is outlined in Figure 2. Actual values for each of the variables shown in step 1 of Figure 2 are entered for each year during the period 1970-1978. Projections for the years 1979-1985 require insertion of assumed values for the variables in Figure 2. The assumed values of the variables for the projections are as follows:

- Population is the series II projection of civilian population in the 48 contiguous states.
- Per capita income, prices paid for production items, and the farm labor index use 1979 values.
- Carryover and quantity of substitute crops are the five-year average 1975-1979.
- Yield is the trend projection, if significant, or the average yield for the period 1960-1978.

**TABLE 4. Estimated Farm Level Price Equations for Selected California Fruit, Nut and Vine Crops, 1960-1978.**

| | Variables | | | | | | | Summary Statistics | |
|---|---|---|---|---|---|---|---|---|---|
| Crop | Constant | Quantity Produced | Carryover | Quantity of Substitutes | Per Capita Disposable Income | Time | Dummy | $R^2$ | Durbin-Watson |
| | | Coefficients | | | | | | | |
| Navel Oranges[a] | 6.52 | −.0357[e] | | −.0002[i] | .0021 | −.3748 | | .92 | 1.39[k] |
| | (15.67) | (−6.12) | | (−.17) | (7.84) | (−4.33) | | | |
| Lemons[a] | 6.14 | −.0667[e] | | | .0004 | 1.068 | | .88 | 1.36[k] |
| | (7.01) | (−6.66) | | | (1.32) | (1.31) | | | |
| Almonds[b] | 386.93 | −627.60[f] | −1451.84[f] | −24.85[h] | .5280 | −52.50 | 498.97 | .97 | 2.20[j] |
| | (5.02) | (−5.26) | (−4.37) | (−.34) | (8.77) | (−4.80) | (6.30) | | |
| Walnuts[b] | 524.55 | −764.30[f] | −1601.50[f] | −84.65[g] | .2910 | −13.01 | | .95 | 1.80[j] |
| | (8.06)[d] | (−4.66) | (−5.67) | (−1.21) | (7.31) | (−1.29) | | | |
| Avocados[c] | 207.68 | −1888.81[f] | | | .2513 | | | .95 | 1.50[j] |
| | (5.51) | (−12.70) | | | (17.72) | | | | |
| Grapes[c] | 36.71 | −3.01[f] | | | .0550 | −5.15 | 49.53 | .99 | 1.89[j] |
| | (2.23) | (−3.29) | | | (13.06) | (−4.44) | (7.35) | | |
| | | | Quantity of CA Navel Oranges | Quantity of Other Oranges | | | | | |
| Valencia Oranges[a] | 6.21 | −.0103[e] | −.0241[e] | −.0050[i] | .0011 | | | .92 | 2.02[j] |
| | (12.34) | (−1.44) | (−3.85) | (−5.68) | (10.30) | | | | |

[a]The dependent variable is farm price per box.
[b]The dependent variable is farm price per ton (in-shell).
[c]The dependent variable is farm price per ton.
[d]Figures in parentheses are t-statistics.
[e]The quantity variable is boxes per 1000 population.
[f]The quantity variable is tons per 1000 population.
[g]The substitutes are the combined quantity per 1000 population of almonds, filberts and pecans produced in the U.S.
[h]The substitutes are the combined quantity per 1000 population of walnuts, filberts and pecans produced in the U.S.
[i]The boxes per 1000 population of oranges produced in states outside California.
[j]Accept, indicates that the hypothesis of no serial correlation cannot be rejected at the 1 percent level of significance.
[k]The test for serial correlation is inconclusive at the 1 percent level of significance.

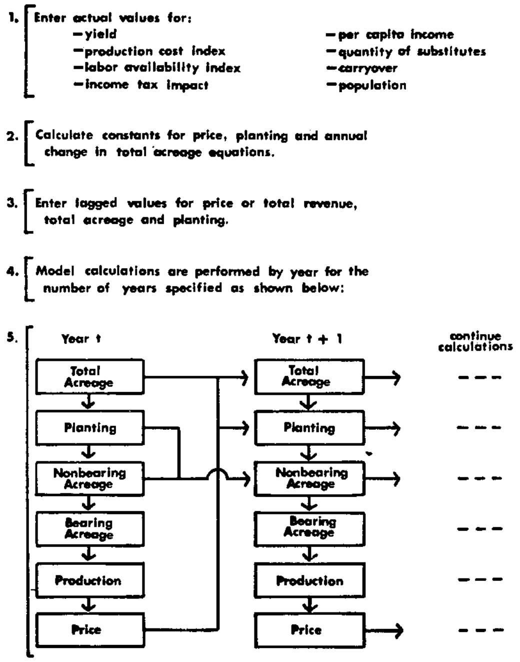


**Figure 2. Sequence of Calculations for Simulation of Acreage, Production and Price.**

Each component of the supply response model has been analyzed and tested for significance but this does not guarantee that the entire model will perform as desired. Since the purpose of the model is to measure the impact of tax reform on acreage, production and prices for selected perennial crops, it must be able to generate estimates of these variables which closely track the actual data series. A comparison of actual and simulated values assuming current tax provisions (with tax reform results) for the years 1970 to 1978 indicates that the model does well at identifying turning points and is able to closely track total acreage, production and prices. Calculation of root-mean-square percent error statistics, as suggested by Pindyck and Rubinfeld [pp. 360-367], yields values ranging from .36% for walnut total acreage to 4.48% for navel orange price (Table 5). The lower the RMSPE the more precise are the model estimates. The model generally does an excellent job of estimating total acreage and production and provides acceptable estimates of farm prices.

The annual estimated impact of tax reform provisions for the period 1970-1985 is mea-

**TABLE 5. Root-Mean-Square Percent Errors for the Test of the Simulation Model, 1970-1978.**

| | Variables | | |
|---|---|---|---|
| Crop | Total Acreage | Production | Farm Price |
| | root-mean-square percent error | | |
| Navel Oranges | .0046 | .0077 | .0448 |
| Valencia Oranges | .0060 | .0084 | .0358 |
| Lemons | .0040 | .0124 | .0416 |
| Almonds | .0045 | .0355 | .0303 |
| Walnuts | .0036 | .0076 | .0313 |
| Avocados | .0153 | .0186 | .0393 |
| Grapes | .0058 | .0045 | .0147 |

Source: Calculated from Carman [1980, pp. 27-59]. The formula for calculating root-mean-square percent error (RMSPE) is:

$$\text{RMSPE} = \frac{1}{T}\left[\sum_{t=1}^{T}\left(\frac{Y_t^S - Y_t^A}{Y_t^A}\right)^2\right]^{1/2}$$

where $T$ = number of sample periods
$Y_t^S$ = simulated value of variable
$Y_t^A$ = actual value of variable

sured by the differences between the two simulated series for total acreage, production and price. The simulation model results indicate that the impacts of development cost capitalization requirements for citrus and almonds vary significantly by crop. There was a large decrease in citrus acreage and production but only a small decrease for almonds. A shift in investor interest to grapes and walnuts resulted in increased acreage of those two crops. The impact on avocado development was barely discernible.

A summary of the simulated percentage impact of tax reform on the seven crops studied for three years in the study period is presented in Table 6. The immediate impact of tax reform on navel orange acreage, production and price was modest. The impact increases through time, however, with a 1978 estimated decrease in bearing acreage and production of 7% resulting in prices 3.8% higher than without reform. Valencia orange and lemon acreage were over 10% lower in 1973 with reform than without. This difference increases through time with projected 1985 production over 27% below what it would have been without reform. This acreage impact is the largest for the seven crops studied. The percentage impact on valencia orange prices is small and probably understated. The projected price increase doesn't include the impact of decreased production in other orange producing states.

The simulated impact of tax reform on almonds is small and is projected to increase very little through time (Table 6). The percentage impact on 1978 and 1985 production and prices is less than 1%. There is a greater simulated impact for walnuts and there is also evidence of increased cyclical production and price behavior with tax reform. Total acreage increases by 9% in 1978 and is then projected

**TABLE 6. Simulated Percentage Impact of Tax Reform on Total Acreage, Bearing Acreage, Production and Prices of Selected California Perennial Crops, 1973, 1978 and Projected 1985.**

| Crop | Years | Total Acreage | Production | Price |
|---|---|---|---|---|
| | | percent difference | | |
| Navel Oranges | 1973 | − 2.78 | − 3.75 | 3.85 |
| | 1978 | − 5.12 | − 7.06 | 3.78 |
| | 1985 | − 7.54 | −10.46 | 7.89 |
| Valencia Oranges | 1973 | −10.10 | −11.69 | 3.34 |
| | 1978 | −17.39 | −21.15 | 3.25 |
| | 1985 | −19.03 | −27.18 | 4.92 |
| Lemons | 1973 | −11.70 | − 7.27 | 6.90 |
| | 1978 | −21.36 | −18.90 | 14.96 |
| | 1985 | −21.04 | −27.42 | 31.81 |
| Almonds | 1973 | − 0.96 | 1.41 | − .33 |
| | 1978 | − 1.96 | .74 | − .21 |
| | 1985 | − 2.11 | − .99 | .49 |
| Walnuts | 1973 | 2.29 | − 3.61 | 4.51 |
| | 1978 | 9.00 | .88 | − .41 |
| | 1985 | 1.95 | 6.12 | − 2.72 |
| Avocados | 1973 | .43 | .88 | − .48 |
| | 1978 | − .43 | .49 | − .56 |
| | 1985 | .14 | 0 | 0 |
| Grapes | 1973 | 9.95 | − 5.69 | 2.01 |
| | 1978 | 14.68 | 10.30 | − 2.37 |
| | 1985 | 14.32 | 12.92 | − 3.40 |

Source: [Carman 1980, pp. 27-59]. All percentage calculations use the without tax reform simulated results as the base.

to decrease. As total acreage decreases, bearing acreage increases with changes in the relative proportions of bearing and nonbearing acreage.

Tax reform has a very small simulated impact on avocados through 1978 with the projection showing no impact by 1985. Model results show that the hypothesized shift in investor interest to avocados was very small.

There was a significant shift to vineyard development associated with tax reform for citrus and almonds. Simulation results indicate that tax reform was responsible for an increase in total grape acreage of 9.95% in 1973, increasing to over 14% in 1978 and 1985 (Table 6). Bearing acreage and production initially decreased in response to tax reform and then increased to 10.3% over the level without reform with a further 2.6% increase through 1985. The estimated 1978 decrease in grape prices due to increased acreage is 2.37%.

## Summary and Conclusions

A perennial crop supply response model is specified and estimated for navel oranges, valencia oranges, lemons, almonds, walnuts, avocados, and grapes. The model is then used to estimate the annual impacts of citrus and almond tax reform on acreage, production and prices for each crop for the period 1970-1985. Navel orange, valencia orange, lemon and almond acreage and production decrease in response to tax reform. The estimated decrease in 1978 total acreage ranges from 21% for lemons to 2% for almonds. Reductions are projected to continue through 1985. Acreage and production of walnuts and grapes increased in response to tax reform for citrus and almonds. The 1978 total acreage increase is 9% for walnuts and 14.7% for grapes. Avocados show almost no response to tax reform for citrus and almonds.

A brief review of testimony on the Tax Reform Act of 1969 reveals an apparent desire to curb citrus grove development by nonfarm investors. The possible shift of investor interest to other crops was not an issue at the time. A year later, however, the citrus provision was extended to almonds because of increased interest in almond orchard development as a tax shelter.

The effects of selective changes in tax rules can be dramatic as investors and developers switch among crops to take advantage of favorable provisions. Model results indicate that 1978 California citrus and almond acreage decreased 46,241 acres due to cost capitalization provisions effective in 1970 and 1971. At the same time, walnut and grape acreage was estimated to be 99,163 acres greater as a result of citrus and almond cost capitalization. Acreage of crops not inclued in the analysis, such as pistachios and kiwi, probably also expanded as investors took advantage of the favorable tax treatment available for these other crops. The problem of nonfarm investment in orchard development simply shifted from citrus and almonds to other crops with the imposition of capitalization requirements. It appears that increased investor interest in grapes and walnuts added to the cyclical instability of production and prices for these two crops. The impacts continue for many years because of the extensive time lags in perennial crop development.

Tax incentives for orchard development certainly increase the demand for land suitable for orchards and increase its price. At the same time, expanded acreage of an orchard crop may result in a lower value for the trees. Tax incentives have significant structural implications. The number of farms growing a particular orchard crop and average acreage are affected. Conditions of entry vary depending on the current income and tax bracket of the developer. High income investors have a decided advantage.

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