An Analysis of the Optimal Percent of Market Contracts versus Open Market Transactions for Salinas Valley Mixed Vegetable Producers

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APPROVAL PAGE

Title:	An Analysis of the Optimal Percent of Market Contracts versus Open Market Transactions for Salinas Valley Mixed Vegetable Producers
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ABSTRACT

The purpose of this research project is to determine the optimal percent contracted production for Salinas Valley mixed vegetable producers in terms of net income and net present value for 2004-2013.

A farm simulation model was developed for a representative Salinas Valley mixed vegetable producer to forecast net income and net present value. Price and yield variables for each crop were stochastic variables based upon the historical variation and correlation among the crops. Net income and net present value were simulated for each year to generate the results in terms of probabilities and probability distribution functions to test the three hypotheses presented.

It was determined 100% contracting gave the highest probability of making between \$300,000 and \$600,000 net income and 40% contracting for making above \$600,000 and below \$300,000 each year. The net present value was maximized with 100% contracting. Further research can be conducted to simulate other crops in different areas using the same techniques and analysis as this research utilized.

ACKNOWLEDGEMENT PAGE

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I would also like to recognize Professor Neal MacDougall and Roland Fumasi for their assistance with the project. Professor Neal MacDougall was essential in formatting the written presentation of the project. Mr. Fumasi took several hours assisting with the development of the model and stochastic variables as well as getting the support from the Salinas Valley producers.

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CHAPTER 1

INTRODUCTION

A unique characteristic of agricultural production is the price and yield risk faced by producers. Perhaps no better example of that characteristic is the fresh vegetable industry. Several characteristics of the fresh vegetable industry increases the risk producers face each year. For example, fresh vegetables are highly perishable and must reach a cooling unit in less than four hours from time of harvest or the crop will spoil. This physical characteristic of fresh vegetables and other highly perishable crops is partially responsible for the fluctuating market prices. It also forces producers to accept the market price at time of harvest or plow their crop under because they do not have the option of storing the crop to wait for a better price. Figure 1 illustrates the price volatility, hence price risk for head lettuce caused primarily by the fluctuating supply.

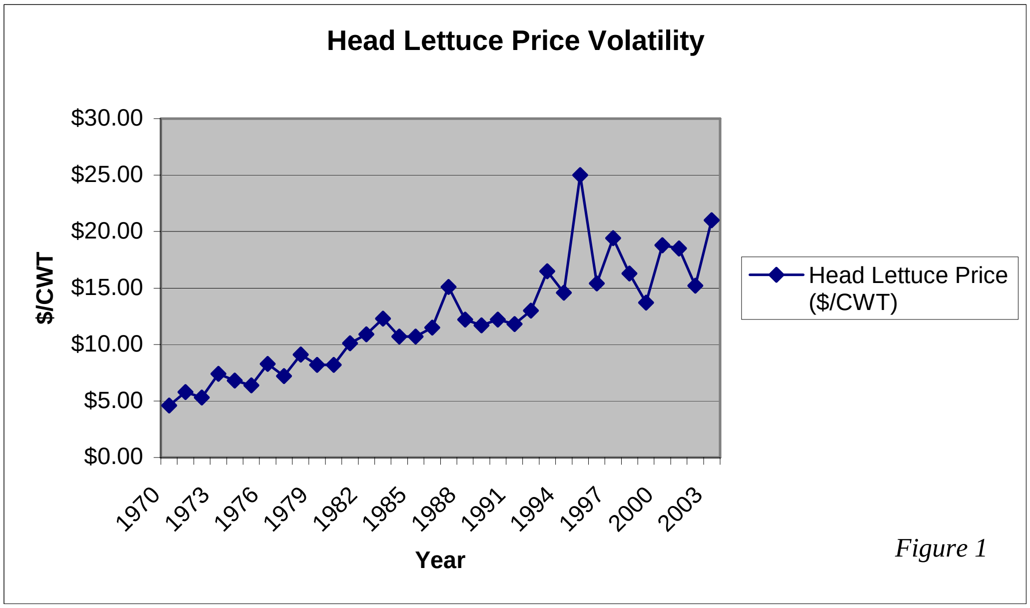

Figure 1

Market prices are determined by daily supply and demand functions. The day to day demand function for highly perishable crops is relatively stable, leaving the supply function responsible for fluctuating prices. The short run supply is a function of the physical characteristic of perishable crops like fresh vegetables. On any given day, the supply curve is perfectly inelastic because the quantity of crop ready for harvest each day must be harvested and sent to the market immediately. The supply curve then fluctuates to the left and right from one day to the next depending on how much quantity is ready for harvest each day between all producers. If the market price is below harvest costs for some producers, even though the crop is ready for harvesting that day, the producer will plow it under instead of selling it on the market to save costs, also creating daily fluctuations of the supply curve.

Figure 2 illustrates the day to day shift of the supply function and its affect on daily prices as a result of physical characteristics. Due to the inelastic, stable demand, and the inelastic supply, a slight change in the supply function, causes a larger change in price, thus leading to dramatic price fluctuations. For example, if supply is at Sa, then price is Pa. However, if the next day not as much crop is harvested and supply drops to Sc, then prices will rise to Pc, and visa versa.

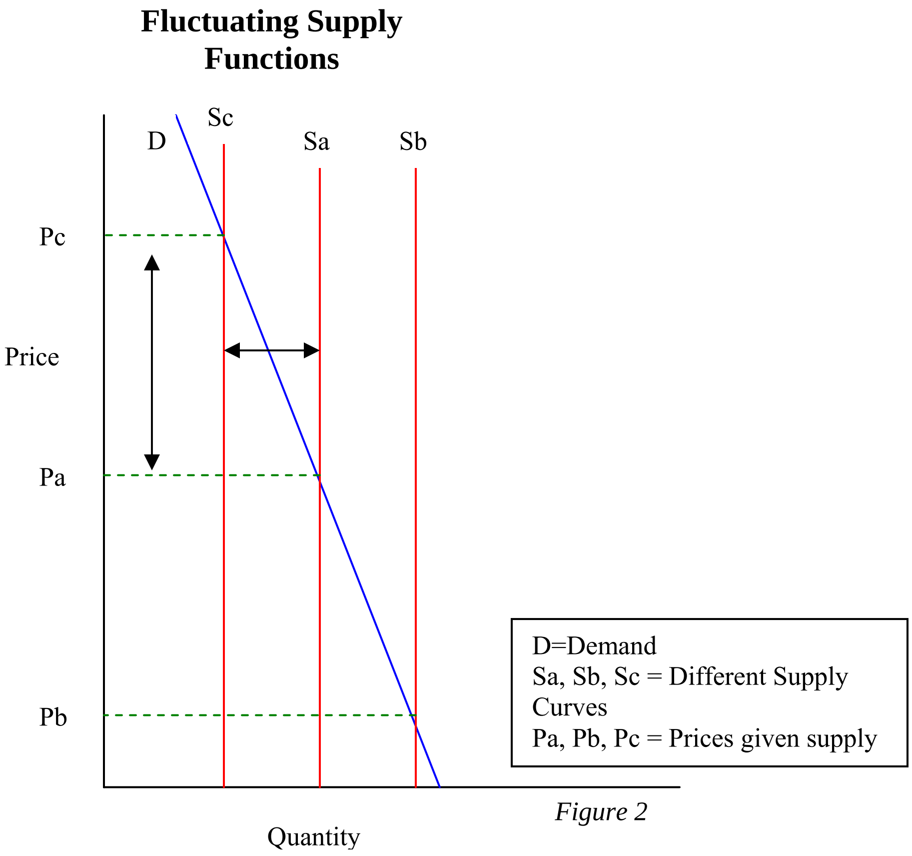

Figure 2

A second physical explanation for some specialty crops like fresh vegetables having more volatile prices is not having the option to store. Storable - vs - non storable crops is also a physical characteristic that creates a fundamental identity between the two crops. The beginning stock each day that determines the supply curve is a function of ending stock, supply, and demand for all crops: Beginning Stock = Ending Stock + Supply – Demand. For storable crops, producers can start and end each day with substantial stock; they can store the harvested crops for a period of time extending beyond the present season before selling on the market. Producers of highly perishable crops start and end each day with minimal stock; they can store the crop but for a shorter period, i.e. a week, due to spoilage. Producers of storable crops can wait to sell until market prices are higher and can affect the market supply by storing during excess supply, or taking out of storage during shortages. However, producers of non-storable crops must accept market prices near time of harvest, or plow the crop under if prices don't cover harvest costs.

In summation, highly perishable crop producers are subject to volatile price changes. Currently the only price risk strategies available to producers of perishable crops are diversification, contracting, and limited use of crop insurance, which do not provide the same extent of income support as government programs. There is a need for a more effective mitigation technique for the highly perishable crop industry or additional information that will enable them to improve their current methods. Forecasted prices, yields, and information on the future industry would enable them to make better business decisions, ultimately reducing risk, which is one objective of this research project.

With contracting, the producer knows the price within some range for their crop prior to planting for a given percentage, but still faces the market volatility for the remaining production. The market price can increase above, and fall below, an expected market price, creating the risk for producers on the remaining production. Thus, also creating the possibility for a producer to make more profit, or lose more, by selling on the cash market. This research attempts to determine if there is an optimal percent production to contract that will maximize profits for individual producers. A study has been conducted to examine the co-existence of cash and contract markets as it would apply to producers and processors attempting to maximize profits[1]. Even though the specifics of the study cannot be applied to highly perishable crops, the general concepts reached can be applied.

PROBLEM STATEMENT

This research project will attempt to answer the question: “What is the optimal percent of production to contract for a mixed vegetable producer in the Salinas Valley over the next ten years?”

HYPOTHESIS

Salinas Valley mixed vegetable producers will have higher average net income and net present value the greater the percent of their production is sold by market contract.

OBJECTIVES

1. Create a representative Salinas Valley Mixed Vegetable Producer’s pro forma financials through information provided by a focus group.

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[1] “Can Spot and Contract Markets Co-Exist in Agriculture?” by Miguel Carriquiry and Bruce Babcock at Iowa State University.

2. Build an accurate and complete stochastic simulation model that is able to simulate and forecast the Net Present Value and Net Income of the producers for years 2004 to 2013

3. Evaluate the Net Present Value and Net Income with varying percent production contracted to either support or reject my hypothesis.

SIGNIFICANCE OF THE STUDY

The results found at the conclusion of the analysis will be useful throughout the California specialty crop industry. First and foremost it can be used to analyze "what if" policy scenarios for mixed vegetable producers. It will provide a baseline model to simulate and analyze various policy scenarios for mixed vegetable producers and other specialty crops in California by simply altering a few components to match the policy or crop in question. The model will also provide an economic tool for policy makers to test the effects of various policies prior to enacting them.

Mixed vegetable producers in California will utilize the forecasted variability in price and yields for the next ten years to make more informative short and long run farming decisions. They will be able to see the effects of altering various variables such as acres planted, labor costs, etc. It will provide useful results for producers when determining the percent production to contract.

CHAPTER 2

FARM SIMULATION

Inherent risks involved in production were examined in the previous chapter. To develop a thorough understanding about the significance and usefulness of this project, current risk management strategies will be discussed as they pertain to and lack effectiveness for highly perishable crop production. This will be follow by a general introduction to a representative farm model capable of providing specialty crop producers an alternative tool that will aid in mitigating risk.

RISK MITIGATING STRATEGIES

Even though specialty crop producers face a more volatile market than commodity crops, they lack the myriad of price risk strategies commodity producer utilize. A few strategies are available include hedging, government programs, diversification, and contracting. Even the most utilized method, government programs, is not inclusive of specialty crops. Mitigation strategies can be categorized as market mechanisms or government support. Market mechanisms include any on site strategies implemented by the producer and usually effects production practices, such as diversification, and can be extremely effective. However, specialty crop producers lack the amalgam of effective strategies, thus needing to expand or improve their mitigation strategies to develop a more effective technique than what is currently available.

Risk in the agricultural industry can be looked at in terms of a continuum because all agricultural commodities face some degree of risk. Storable crops are placed on the lower end, while non-storable crops are at the opposite end of the continuum. For several years, the Farm Bill has provided price and income support programs for commodity crop producers to reduce the risk they face, but has yet to include specialty crops. Currently the only mitigation techniques used by specialty crop producers are diversification and contracting. Contracting is a relatively new technique that is proving to be efficient in reducing price risk, and continues to evolve. Most producers contract a percentage of their production and sell the remainder on the cash market, which is the current market price for their product at time of sell. The market price can vary from one location, or day, to the next, depending on the local supply and demand. However, these two methods of mitigation still leave the specialty crop industry with higher risk than commodity crop producers. A more efficient mitigation strategy focused on the specialty crop industry could prove to help stabilize prices to some extent and reduce overall risk.

Futures/Options Contracts

Hedging on the futures market allows a farmer to determine the price of a crop to be purchased or sold in the future. Although hedging reduces the farmer's risk of receiving lower prices, it eliminates the possibility of capturing an increased price in the future. Options contracts, like hedging, gives the buyer or seller the chance to protect themselves against falling prices, but does not eliminate the opportunity of possible gains of higher price movements (Miller). Hedging is only available for the commodity crops that are exchanged on the Chicago Board of Trade, therefore excluding all specialty crop producers.

Government Programs

As previously mentioned, government programs do not include specialty crops. In fact, the majority of the $27.4 billion dollars in the federal budget for farm service programs goes to five major crops; corn, wheat, rice, soybeans, and cotton (USDA). The money is distributed to the producers through various program payments that aim to support prices and income. One of the major programs is the farm bill, which includes direct payments, marketing loans, and counter-cyclical payments. As summarized by Sumner, direct payments are paid to producers based on historical acreage and yield, marketing loans distribute payments per unit of output when market prices are low, and the counter-cyclical payments are based on historical acreage and paid when market prices fall below a trigger price (Sumner). Other payments are made through various conservation and environmental programs. Unfortunately, the majority of government farm programs only support the prices and incomes of producers producing the five major crops. Specialty crop producers have yet to be incorporated into the farm program, therefore leaving them to other methods of income and price support.

Diversification

One of the most common market mechanisms is the “classic diversification approach” (Boehjle 18). Diversification is the practice of having more than one crop being produced on a single farm. This method helps to reduce the risk of loss from an unforeseen event demolishing one entire crop, or extremely low market prices. A farmer’s gross return on a diversified farm is not affected by a decrease in price or yield of one crop to the same degree as a producer who relies on a single crop. A recent survey conducted by the US Census of Agriculture concluded “in California, all of the surveyed farms with lettuce also grew other vegetables, and lettuce accounted for 55 percent of their total acreage.” Diversifying a specialty crop farm is a well-practiced management strategy and is extremely effective in mitigating risk. For example, if a farmer produced lettuce, broccoli, and cauliflower, a low price for lettuce can be offset by high prices in broccoli and cauliflower, therefore protecting the producer’s revenue from falling as dramatically if only lettuce was produced. Even though a farm is diversified, the “possibilities for risk reduction exist only if the returns from alternative individual investments or enterprises are affected by different forces or are basically more stable than those already in business” (Miller 12). In other words, the market conditions and growing conditions for each crop should not be identical, or a shift in one factor will similarly affect both crops.

Forward Contracting

Forward contracting has proliferated in recent years for crops with extremely volatile prices. Contracting provides a guaranteed market and also eliminates the risk farmers face by selling the crop on the cash market at time of harvest. A guaranteed market to sell a crop to enables the farmer to budget each year's finances more accurately because they will have a good indication of revenue for each crop. However, this does not take into account the yield variability, but alleviates the effect of price volatility. Contracting also eliminates the possibility of producers capturing extremely high prices one season, higher than contracted prices. Therefore, many producers will contract out a percent of their production and sell the remaining percent on the cash market, taking the risk for higher prices. The cash market is simply an open transaction to sell to and the price received is determined by existing market conditions.

Even though the prices and markets are guaranteed through contracting, other risks associated with contracting exist. Personal based market transactions decline with contracting, creating relationship risk, which replaces price risk (Boehjle). No guarantee exists that the relationship between parties will hold even though a farmer is guaranteed a certain price for the crop. For example, the buyer may go bankrupt and not have the monetary means to purchase the contracted crop, thus deserting the contract relationship. Despite newer risks associated with forward contracting, numerous specialty crop producers partake in this market mechanism to reduce price risk as it has proven to be an effective mitigating strategy. The optimal percent production to contract is a question this research project will evaluate with a representative farm simulation model.

REPRESENTATIVE FARM

The representative farm is built using the consensus building process, or a focus group of producers. They provide information and quantitative data on variables such as farm size, in terms of acres, costs of production for each enterprise, overhead and fixed costs, etc. The process starts by selecting farmers who represent a typical farm for the crop in a desired region; not an average farm. The average acres for four farms may be 325 with 500, 500, 200, and 100 acre farms, while the representative acreage is 500. Producers draw from their operations and experiences to create "representative" numerical data for the pro forma financials, which provide the framework for the model. The data gathered for the representative farm are entered into three pro forma financial statements to calculate variables of interest, also known as key output variables, for a representative farm, i.e. net income, debt to asset ratio, net present value.

Pro Forma Financials

The pro forma financials, which include the income statement, statement of cash flows, and balance sheet, are the primary tools for calculating and simulating the key output variables in a farm simulation. Each sheet or statement is an itemized list of various values pertaining to each enterprise and the farm as a whole, which are then summarized via a single numerical value. Each of the pro forma financials is interrelated, that is one value from the income statement goes into the statement of cash flows and so on. Figure 3 shows the basic relationship between the pro forma financials.

Pro Forma Financials Flow Chart

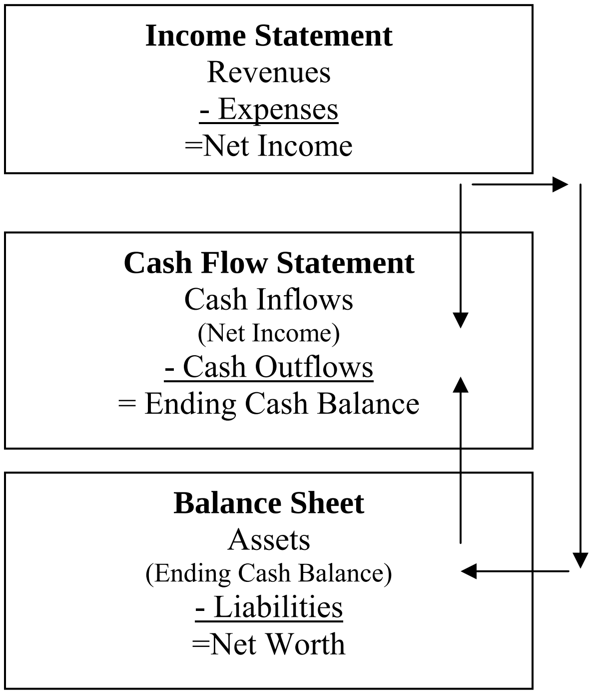

Figure 3

The income statement can be broken down into two categories; revenues and expenses. Revenues include receipts associated with the enterprises as well as any other receipts that can come from other services or off farm income. The sum of these receipts, in dollar value, gives the total income for the farm. The expenses are broken down into subsections such as operating costs, non-operating costs, interest expense, and fixed costs. Operating costs include variable costs that change with production and only occur when production is taking place; some examples include labor, water, fertilizer, packaging costs, etc. Interest expense constantly changes in relation to debt on various loans and includes any annual interest expense on remaining loan principles or operating loans. Fixed Costs do not change with production, as long as the farm remains producing, no matter the amount of production, these costs will be incurred. They include items such as rent, workmen's compensation, depreciation, and overhead expenses. The net farm income before taxes is calculated as the difference between revenues and expenses and is used in calculating the cash inflows on the cash flow statement and the assets on the balance sheet.

The balance sheet has three sections; assets, liabilities and owners equity. Assets include the net cash from the statement of cash flows and any land or capital assets. Liabilities include any short term notes payable and the remaining principle on long-term loans. Owner's equity is the difference between liabilities and assets, and is used to calculate various financial ratios. The final numerical summarizations of the balance sheet are the net worth and net present value (NPV). Net worth is the difference between the assets and liabilities and NPV is a current time value of the sum of income over a given period.

The cash flow statement is segmented into cash inflows and cash outflows, which then determines the ending cash for each year. Cash inflows include sources of cash in a given year. Each year starts off with a beginning cash balance to which net farm income, interest earned, and off farm income is added, totaling the cash inflows for a particular year. Cash outflows include all cash expenses of the farm that year, such as loan principle and interest payments, variable and fixed costs, and any withdrawals. The ending cash balance for each year is then carried over as the beginning cash balance for the next year on the cash flow statement and is included in the asset section of the balance sheet. For a representative farm model, the ending values or numerical summarizations on each financial statement is usually identified as a Key Output Variable (KOV). KOVs are any variables of interest to the decision maker, i.e. the producer, and are evaluated by the model to reach conclusions.

Stochastic –vs- Deterministic

A distinction needs to be made about the representative farm simulation model being developed in this research project. Unlike a statistical regression model that provides a single point estimate with corresponding data, the representative farm simulation model provides an estimated distribution rather than a single value. Stochastic variables are incorporated into the model to simulate the range, or distribution, certain variables can take, hence a stochastic rather than deterministic model. Figure 4 shows the theoretical equations for deterministic and stochastic models; note the difference between the two is captured in the error term, $\hat{e}$, on the stochastic model. According to Ray, "deterministic models are generally limited to providing point estimates of endogenous variable, [while] stochastic techniques provide statistical framework to perform a series of simulations in an efficient and systematic manner" (Ray 3). Each time the model is run, the KOV will take on a different value because the value of the stochastic variables is independently sampled from a predetermined distribution each iteration. Therefore, when summarizing the results, the

Deterministic and Stochastic Theoretical Models

Deterministic Model: $Y = \beta + \beta_1 x + \varepsilon \;\Rightarrow\; \hat{Y} = \hat{\beta} + \hat{\beta}_1 x$

Stochastic Model: $Y = \beta + \beta_1 x + \varepsilon \;\Rightarrow\; \hat{Y} = \hat{\beta} + \hat{\beta}_1 x + \hat{e}$

Figure 4

stochastic model will generate percent probabilities rather than a single value because the error term is not dropped from the stochastic model.

Stochastic models calculate several iterations, which is "one realization of a stochastic model, . . ., one roll of the dice, . . .It represents one solution for all equations in the model using one draw of random variables for all random variables" (Richardson 4.4) A second draw of random variables is taken from the same distribution, or possible range of values, and is independent of the previous and subsequent draws, thus recalculating the system of equations and giving a second solution under the second iteration; 100-250 iterations is sufficient when using empirical distributions (Richardson). Each draw is taken from a previously determined distribution function that accurately represents the distribution of the historical data. The solutions are then summarized by probability distribution functions of the calculated KOV, giving a range of variability instead of a single point estimate.

EMPIRICAL MODEL

Model Design and Construction

The design and construction of the model is the most complex and intricate procedure in the actual data analysis. It is completed prior to the data collection because several variables need to be identified as exogenous, endogenous, stochastic, or a KOV. Once the variables are identified, the design of the model can be constructed to include all necessary data and equations to calculate the KOVs. As noted by several model developers, the most effective way to start the process is by designing the model from the top down and building it from the bottom up (Richardson). This allows the developer to start by visualizing the end results and then design the foundation from there. Figure 5 gives a visual concept of designing from the top down and building from the bottom up along with the labeled levels of construction. The end results are the identified Key Output Variables (level 1), which will be net income and net present value for this project. The intermediate values required to calculate the KOVs are identified next, (level 2) as well as their corresponding equations and calculations (level 3). The exogenous and control variables will be identified through the construction of the equations and calculations of the intermediate variables (level 4), which leaves the developer with the variables identified to be stochastic (level 5).

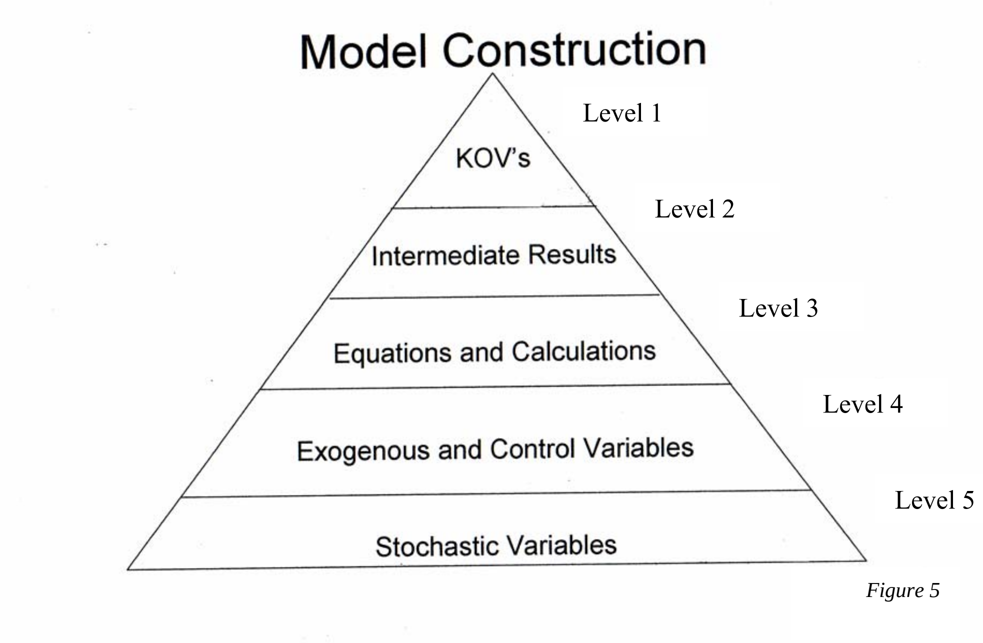

Figure 5

Figure 6 shows the first two levels of the model construction triangle with the related equations and calculation necessary to calculate net income, while a complete flow chart of all the equations, calculations, and variables is given in Appendix A**.**

Net Income Model Pyramid

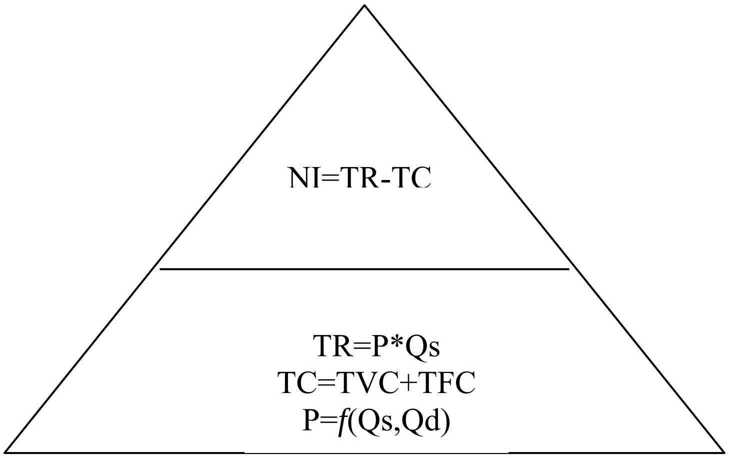

Figure 6

Once the equations and calculations are created, the actual design of the model is identified and based on the KOV. For this research project, the KOV is net income and net present value (NPV). In order to calculate net income and net present value the pro forma financials need to be developed. The next step is to set up the financials in an excel worksheet and input the equations to generate the KOVs. Data can then be collected and entered appropriately, allowing the calculation of the simulated variables to begin.

Key Output Variables

Key Output Variables (KOVs) are the variables of interest and determine what type of model to develop. For example, if the KOV is net income at the farm level, then all the data necessary to calculate the KOV must be incorporated into the model, i.e. pro forma financials (Richardson). Upon completion of the model's simulation, the estimated KOVs "represent an empirical estimation of the probability distribution for the variable and quantifies the risk associated with the variable" (Richardson). For example, if an industry was interested in analyzing the affect a new regulation via net income, the KOV can be simulated with and without the regulation, and then compared by the different probability distributions. The difference in the probability distribution would show the change in net income due to the regulation. The risk represented by the probability distributions is present due to the variation of stochastic variables incorporated into the model, i.e. the price and yield.

Choice of Stochastic Variables

It should be noted the entire model is founded on the stochastic variables, which should be identified carefully. Stochastic variables are "1) variables we are still uncertain about, . . . and 2) those variables the decision makers cannot control or predict" (Richardson). Variables that do not posses these characteristics are usually considered deterministic; they always take on a single value and are predictable. Variables that have quantifiable risk associated with them, i.e. price and yield, are usually identified as stochastic variables. Price and yield vary from one year to the next depending on several factors that are hard to predict but take on values within a give range. Therefore, the historical data for the stochastic variables have to be available because they provide the distribution from which the stochastic variable is sampled. The historical distribution, assuming it will remain constant, is the foundation for calculating the stochastic component of the model.

STOCHASTIC SIMULATION

Simulation modeling is defined as "'the imitative representation of the functioning of one system or process by means of the functioning of another'"(Richardson 1). Economists use simulation models to run various iterations of one experiment, allowing for one or more variable to fluctuate within a predetermined range or distribution. The results of the simulation model, like repeated scientific experiments, "represent an empirical estimate of the probability distribution" (Richardson) associated with risky variables, such as price and yield. Farm simulation is a tool that enables farmers to accurately predict the outcome of variables in a variety of situations. The various situations may be tested by changing production methods, structural organization, or variables such as acres planted or long term investments.

There are numerous applications and advantages of simulation. According to Richardson, simulation allows economists to experiment on real world situations that cannot be tested in a lab because they are complex, involve human behaviors, or the "planning horizons" are so broad. Simulation models test "what if?" questions concerning policy options, and compare various management techniques or decisions. Among the myriad of simulation models, this research project will utilize a stochastic farm simulation model based on financial statements and representative farm data.

Distribution Functions

Determining the type of distribution representative of the historical data is one challenge in developing stochastic models. For the purpose of this research project, empirical distribution will be used for various reasons. The idea behind a distribution function is that it is a mathematical representation of the range of values one variable can possess in any given time period. A distribution function is a function that gives a shape corresponding with the probability of a particular variable taking on a specific value. For example, a Normal Distribution can be classified as having 95% of all the values within plus or minus two standard deviations from the mean, or average value of a given variable. There are several known distributions that naturally occur in many data sets, and include: normal, Bernoulli, uniform, GRKS, and triangular distributions. If the distribution of the historical data represents one of the known distributions, then the probabilities of each value will follow correspondingly with the known distribution. However, if data does not follow a known distribution, or too few observations exist to define the true distribution, empirical distribution can be used.

For an empirical model, the distribution function's overall shape and range is specified by the historical data. As explained by Richardson, if ten historical observations are known for the price of a crop, each being a different value and each being observed one in ten times, then the probability, according to empirical distribution, to observe one of those values is 10%. Therefore, when running the simulation, the stochastic variable will take on one of the ten values each iteration. Once the distribution function is determined, the stochastic calculations and simulation can proceed.

Stochastic Simualtion

In order to calculate the stochastics prior to simulating, three components need to be estimated; the deterministic, multivariate, and stochastic component. The multivariate and stochastic components are combined to generate the error term, noted by ẽ in figure 5, and generate the distribution of possible values for the KOVs. The deterministic component is a point estimate and is determined by an equation to estimate the trend of historical data, as seen in figure 4. The stochastic component is determined by calculating the historical data errors as a percent deviation from the trend, as shown in figure 7. The estimated trend value, $\hat{y}$ is subtracted by the actual historical data, y, creating the error terms and then converted to a percent deviation from the trend. Each percent deviation from the trend has an associated probability of being observed depending on the distribution that best fits the historical observations. When no trend is present, the estimated value is the mean value, creating percent deviation from the mean. The multivariate component is only used when there is a correlation among the error terms of the independent variables, i.e. the price of leaf lettuce

Percent Deviation Calculations

$$\boxed{\begin{array}{l} Error : \hat{e} = (y - \hat{y}) \\ \% Deviation : \left(\dfrac{\hat{e}}{\hat{y}} \right) \end{array}}$$

Figure 7

and iceberg lettuce. If correlation exists, the correlation coefficients are multiplied by a set of independent random deviates to create the multivariate component. Multiplying the stochastic and multivariate component preserves the correlation among the independent variables and generates correlated independent percent deviates, which is multiplied by the deterministic component to calculate the stochastic estimate for one iteration. Several iterations are run and the combined stochastic estimates create the distribution for that variable. The results will then be presented in percent probabilities rather than the point estimates, taking into account the known variability of the stochastic variables. Stochastic representative farm simulation models can be used to analyze and evaluate the impact certain variables have on the farm level. Following are a few examples of how representative farm models were applied to evaluate different scenarios and questions.

EXAMPLES OF REPRESENATIVE FARM MODELS

FLIPSIM

One of the computer programs that perform stochastic simulations is the Farm Level Income and Policy Simulation (FLIPSIM) program. FLIPSIM was developed by professors James Richardson and Clair Nixon at Texas A&M University in 1981. The professors developed several stochastic representative farm simulation models to “analyze the impacts of farm policy on the structure of cotton and wheat farmers in Texas” (Richardson and Nixon 1). They created the concept of a representative farm and base all their simulation models on thoroughly validated representative farms. The basic FLIPSIM model is able to simulate and forecast net incomes for various producers and then expanded to analyze “what if” scenarios by adapting risk management strategies, farm programs, conservation compliance, flex, and marketing loans. Recently this baseline model was applied to “analyze the farm level impacts of numerous alternative program provisions” for the 1995/96 farm bill debate as well as “evaluate the probable impacts of re-instating capital gains treatment, creating a flat tax, and changing the federal estate tax provisions”(Richardson and Nixon 1).

Dairy Farm Immigration Model

Another recent application from 2004 was conducted by Anthony Duncan, James Richardson, and Robert Schwart to determine the probability of success for a Dairy farmer from the Netherlands to immigrate to the United States. To test the hypothesis of a Dairy farmer being successful migrating to the United States, the KOV, net present value, had to be positive. As explained by Duncan, Richardson, and Schwart, “there is no published history of NPV for dairy farms” so “method for estimating NPV . . . is through simulation” (Duncan). The stochastic variables used in the model were yields, prices, and production, and were simulated for 100 iterations generating empirical probability density functions to make a conclusion. Through the representative farm simulation model, they were able to conclude that Dairy farmers in the Netherlands with “adequate equity are better off financially immigrating to the U.S.”(Duncan). Rather than testing a policy variable, this farm simulation was able to determine the economic vitality of a Dairy farmer in the Netherlands versus moving to the United States.

Financial Risk Model

Cole Gustafson from North Dakota State University applied a farm simulation model to farm financial risk when producers by locally versus from a wholesaler with volume discounts. A monte-carlo distribution was used rather than empirical, which is what the former models used. “The model embodied price and yield distributions, tax policy, and financial repayment risks” to “delineate the financial risks involved and value of social capital received in the form of credit forbearance” (Gustafson). Credit forbearance is available when producers buy locally rather than from wholesalers. They concluded the firm would have been bankrupt without forbearance. These are just a few examples of how a representative farm simulation model can be applied to analyze a variety of policy, structural, and market scenarios. The following chapter will go through the detailed steps of applying stochastic farm simulation model to the Salinas Valley mixed vegetable producers to determine the optimal percent of production to contract.

CHAPTER 3

SALINAS VALLEY MIXED VEGETABLE REPRESENTATIVE FARM MODEL

INDUSTRY DESCRIPTION

The specialty crop industry is economically important to California's agricultural. Specialty crop commodities include fruits, nuts, vegetables and nursery products and account for 64% of total agricultural sales in California, or $20.87 billion (Hamilton). The top five specialty crops produced in California are nursery products, grapes, lettuce, almonds, and

Top Five California Specialty Crops			
	Value of Receipts ($1000)	% CA Farm Reciepts	% US Value
1. Nursery Products	$3,312,997	11.9%	21.80%
2. Grapes	$2,299,021	8.30%	89.20%
3. Lettuce	$1,734,120	6.20%	82.40%
4. Almonds	$1,600,144	5.80%	100%
5. Strawberries	$1,118,802	4%	84.70%

Table 1

Source: ERS State Fact Sheets

strawberries respectively. Summarized in table 1 is the total value of each commodity in California, along with percent farm receipts in California and percent value of production in the United States. This table emphasizes the significance of specialty crops to California as well as the United States. California is the sole producer, producing 99% or more, for several crops, the majority being specialty crops. Of the 350 commodities produced in California, approximately 85% are considered specialty crops and eleven counties are primarily responsible for their production. For example, the United States is the number one lettuce producer, producing 82.4% with the majority being grown in the Salinas Valley. As previously mentioned, there is high risk involved with specialty crop production and Salinas Valley lettuce producers have implemented a few strategies. During a grower panel discussion, the producers emphasized the importance of diversification and contracting with shippers, known as the grower-shipper relationship.

Production Mix

A well practiced strategy of lettuce producers in the Salinas Valley is diversifying their production mix. According to Mac Keely of New Star Fresh and Bill Tarp, the majority of lettuce producers grow a combination of vegetables, hence being referred to as mixed vegetable producers. The top five vegetables grown on a representative lettuce farm are head lettuce, head lettuce, broccoli, cauliflower, and celery. The crops are harvested 1.9 times per year. Broccoli and cauliflower are grown mostly for cultural purposes, crop rotation, and to aid in diversifying the farm. (Keely and Tarp) With a variety of crops grown, the producers also offer the shipper a more complete line of vegetables rather than specializing in a single crop.

Grower-Shipper Relationship

Also according to the grower panel discussion, contracting with shippers is an effective risk mitigating strategy implemented by the majority of mixed vegetable producers in the Salinas Valley. The growers and shippers have developed a different kind of contractual relationship than a basic forward contract. With the grower-shipper relationship, the risk is almost split between the two parties. The producer will plant and grow the crop up to time of harvest. Even though the producer handles all the cultural practices, the shipper will pay for half of the planting and cultural costs, giving the money to the grower when it is needed.

By time of harvest, the shipper has already contracted a percentage of the production at a determined price covering the estimated cost of production. The shipper will then come in and harvest the crop at no cost to the producer. The remaining production that was not contracted will be harvested if the open market price will cover the harvest costs; if the market price is below the harvest cost, the remaining crop will be plowed under. The reasoning is this: planting and cultural costs up to this point are sunk and cannot be recovered unless the crop is sold. However, harvest costs have yet to be incurred. Therefore, if the market price is lower than the harvest costs and the shipper sells on the open market, the sunk costs will increase because not all of the harvest costs were covered by the market price. If the market price covers the harvest costs, the entire crop will be harvested and the remaining production sold at the market price.

At time of sell, the shipper receives the revenue and covers all harvest costs they incurred. The remaining revenue is then split fifty-fifty between the producer and the shipper. The end result is the shipper – grower relationship has mitigated the market price risk by contracting a percent of production prior to harvesting at a price that should cover production costs. The risk to the producer pertaining to the remaining production is also reduced as a result of the fifty-fifty cost share. If the market price is below harvest costs and the crop is plowed under, the impact has been lessened by half because the shipper also takes half of the risk. If the market price is above harvest costs, but still does not cover all production costs, they still recover some of the production costs, but here again, the production costs are half of what they would have been without the grower-shipper relationship.

DEVELOPING THE EMPIRICAL MODEL

The Salinas Valley mixed vegetable model is based upon the pro forma financials to calculate the key output variables, net income for 2004-2013 and net present value over the ten year period. In order to calculate net income, all sources of costs, revenues, assets, and liabilities, needs to be identified along with any other data necessary to calculate the key output variables and then forecasted for 2004-2013. All the theoretical equations and calculations for the key output variables are seen in appendix A. Price and yield are the stochastic variables and will be developed based on historical data, time series analysis, and an empirical distribution, which will be discussed in detail. The majority of data will be gathered through the representative farm grower panel or government data.

The foundation of this model partially relies on the accuracy of the information gathered by the representative farm grower panel, which has proven to be one of the most effective ways in building a farm simulation model. In the end, this model will have the capacity to test the impact of various variables, such as labor and energy costs, percent contracted production, policy issues, on the key output variables for 2004-2013.

Within this research project, the model will be constructed and scenario testing of the percent production contracted will be conducted to determine the optimal percent for a Salinas Valley mixed vegetable producer to contract. This chapter will go through the steps of creating the demand side, or revenue on the income statement, the cost side, developing the balance sheet and statement of cash flows, and end with the stochastic simulation process.

For crops entirely sold on the cash market, costs and revenues on the income statement are simple to calculate. Costs would be the yield in CWT per acre multiplied by the costs of production per hundred weight (cwt) and acres planted for each crop. Revenue is the price per cwt multiplied by the yield and total acres; reaching net income by revenues minus costs. However, for producers who participate on the cash market and contract, like mixed vegetable producers, there are several situations that alter the calculations of costs and revenues.

Demand Side

Cash markets, as previously noted, is the price a producer receives on the open market given the current supply and demand. Cash market prices fluctuate from day to day and week-to-week because supply is never constant and demand can change. At time of harvest, supply increases, which drops the price, causing producers to accept a low cash market price, assuming demand remains constant. The contract market sets a price for the producer in advance, therefore reducing the risk on the cash market. Because most specialty crop producers participate in the contract market, the revenues on the income statement are calculated slightly different than commodity crops, as seen in figure 8 below.

Revenue Formulas for Contract and Cash Markets

$$\begin{aligned}
&\mathrm{TR} = \mathrm{Revenue}_{\mathrm{Contract}} + \mathrm{Revenue}_{\mathrm{Cash}}\\
&\mathrm{R}_{\mathrm{contract}} = \%\mathrm{contracted}\bullet\mathrm{yield}\\
&\mathrm{R}_{\mathrm{cash}} = \begin{cases} (1-\%\mathrm{contracted})\bullet\mathrm{yield}, \ \$_{\mathrm{market}} \geq \$_{\mathrm{harvesting}} \\ 0, \ \$_{\mathrm{market}} < \$_{\mathrm{harvesting}} \end{cases}
\end{aligned}$$

Figure 8

On the income statement, revenue is separated into cash market and contract revenues, and then summed for the total revenue. Contract revenue is a given percent of contracted production multiplied by yield and the contract price. Many contracts include a sliding scale of premiums and discounts that directly correspond to the market price. If the market price goes above or below a certain price, the contract price incrementally increases or decreasing with the market price.

For example, if the market price for lettuce is at \$30 per CWT, which is \$4 above the expected market price when the contract was made for \$29 per cwt, then the contract price will increase by 25¢, or visa versa if the market price $4 below the expected. Conditional statements were used to alter the contract price if the market price were to increase or decrease within given ranges.

The contract prices for 2004 were collected from the grower panel and then annually increased in relation to the increases cost of production. If the open market price is more than the harvest costs, then the remaining production will be harvested and sold on the open market, otherwise it is plowed under. If it is harvested, the cash market revenue is the remaining percent of the yield multiplied by the market price. If the yield is plowed under, no revenue is generated on the cash market. To simulate the situation, conditional statements were used in the model to determine when revenue is generated from the cash market and when it is not.

Price and Yield Forecasts

To calculate cash and contract revenue for 2004-2013, price and yield forecasts for all five crops, head lettuce, head lettuce, broccoli, cauliflower, and celery, are needed. The forecasts will be generated by developing time series models based on historical data. The California Agricultural Statistic Service (CASS) provides an average historical California price per unit and yield per acre for a myriad of crops, including the five on a representative Salinas Valley mixed vegetable farm. Therefore, CASS data was be used to develop the time series models as well as provide the distribution for the empirical model, which will be discussed in more detail later. Each crop's price and yield are forecasted using different time series models depending on the historical data. Each of the final models used for forecasting were determined by the lowest Akaike Information Criterion[2] (AIC) value.

When generating the forecasts, several time series models were taking into consideration which included regression, single and double exponential smoothing, and autoregressive moving average (ARIMA) models. Each data set was considered independently when creating the time series models. The majority of the data sets showed statistically significant linear trends with the residuals having some autoregressive and moving average trends. Therefore, the single and double exponential smoothing models, after several were attempted, proved less accurate than a combination of regression and ARIMA models.

All price and yield forecasts, except head lettuce were generated by a combination of a regression model and an ARIMA model. Linear regressions were able to explain the majority of the variability of either price or yield, capturing the linear trend in each data set. The residuals were then stored and examined through the autocorrelation functions (ACF) and the partial autocorrelation functions (PACF) to give some direction as to the most accurate ARIMA model for the residuals. To accurately evaluate the ACFs and PACFs, the data must be stationary; the data must have constant variance and cannot have a statistically significant trend. Therefore, prior to observing the ACFs and PACFs, the data was differenced in all models. Differencing is as follows: $y_t = y_t - y_{t-1}$, which causes the data set to have one less observation.

The price of head lettuce, for example, had an R-squared adjusted of 76.2% from the following linear regression: $price = -1.45 + .195t + \tilde{e}$ where t is a time index with 1920 = 1.

---

[2] Akaike Information Criterion -

The residuals is then modeled by an ARIMA (3,1,2), which first differences the data shown by the "1", and has three autoregressive and two moving average terms. The ARIMA model is as follows:

$$z_t = -1.608z_{t-1} - 1.3397z_{t-2} - .2565z_{t-3} + a_t + 1.011a_{t-1} + .9477a_{t-2}, \begin{cases} z_t = e_t - e_{t-1} \\ a_{t+1} = z_{t+1} - z_{t+1|t} \end{cases}$$

Figure 9 contains the time series models for all the crops in the representative Salinas Valley

Time Series Models

Prices:

Head Lettuce $= -1.45 + .195t + \tilde{e}$ where t is a year index 1920=1 and ẽ=ARIMA(3,1,2)

$$z_t = -1.608z_{t-1} - 1.3397z_{t-2} - .2565z_{t-3} + a_t + 1.011a_{t-1} + .9477a_{t-2}, \begin{cases} z_t = e_t - e_{t-1} \\ a_{t+1} = z_{t+1} - z_{t+1|t} \end{cases}$$

Broccoli = ARIMA (3,1,0): $z_t = .449 - .259z_{t-1} + .141z_{t-2} + .058z_{t-3} + a_t, \begin{cases} z_t = y_t - y_{t-1} \\ a_t = \text{ white noise} \end{cases}$

Cauliflower = ARIMA (3,1,0):

$$z_t = 2.58 - .20z_{t-1} + .228z_{t-2} + .205z_{t-3} + a_t, \begin{cases} z_t = y_t - y_{t-1} \\ a_t = \text{white noise} \end{cases}$$

Celery = $-.5 + .16t + \tilde{e}$ where t is a year index 1920=1 and ẽ=ARIMA(4,1,0)

$z_t = -.769z_{t-1} - .446z_{t-2} - .144z_{t-3} - .282z_{t-4} + a_t, \{z_t = e_t - e_{t-1}$ and a_t is white noise

Leaf Lettuce = mean price = \$27.31

Yields:

Head Lettuce = $58.4 + 3.53t + \tilde{e}$ where t is a year index 1921=1 and ẽ=ARIMA(2,1,2)

$$z_t = .3395z_{t-1} + .2646z_{t-2} + a_t - .5685a_{t-1} - .1335a_{t-2}, \begin{cases} z_t = e_t - e_{t-1} \\ a_{t+1} = z_{t+1} - z_{t+1|t} \end{cases}$$

Broccoli = ARIMA (1,1,0): $z_t = 2.136 - .361z_{t-1} + a_t, \begin{cases} z_t = y_t - y_{t-1} \\ a_t = \text{white noise} \end{cases}$

Cauliflower = 78.8 + 1.54t + ẽ where t is a year index 1959=1 and ẽ= ARIMA(3,1,2)

$$z_t = .4429z_{t-1} - .1747z_{t-2} + .5305z_{t-3} + a_t - 1.27a_{t-1} + .496a_{t-2}, \begin{cases} z_t = e_t - e_{t-1} \\ a_{t+1} = z_{t+1} - z_{t+1|t} \end{cases}$$

Celery = 158 + 7.17t +ẽ where t is a year index 1920=1 and ẽ=ARIMA(2,1,1)

$$z_t = -1.2838z_{t-1} - .4238z_{t-2} + a_t + .9706a_{t-1}, \begin{cases} z_t = e_t - e_{t-1} \\ a_{t+1} = z_{t+1} - z_{t+1|t} \end{cases}$$

Leaf Lettuce: increased annually by a yield factor of 1.1%: $y_t = y_{t-1} * 1.011$ where t is a year index 1992=1

Figure 9

mixed vegetable farm, excluding leaf lettuce and appendix B contains the historical, predicted, and a graphical presentation of the data. Unfortunately there was only ten years of CASS data available, which are not enough observations to develop an accurate time series model to forecast price and yields. Therefore, the mean price and yield value for leaf lettuce was used as the forecasted values.

The price and yield forecasts were generated from CASS data, that is they were California prices and yields, and this model is for Salinas Valley. Based on past research completed by Roland Fumasi for the California Institute for the Study of Specialty Crops, Salinas Valley price and yield multipliers were developed to alter California values to represent Salinas Valley more accurately. Overall, Salinas Valley yields are slightly higher than California Yields, therefore prices are slightly lower. A price factor of .95 and a yield factor of 1.16 were used to decrease prices and increase yields for Salinas Valley mixed vegetable production. Once the forecasted price and yields have been multiplied by the corresponding factor they will feed into the income statement to calculate revenue for the demand side, leaving the cost side to complete to calculate net income.

Cost Side

As previously discussed, the cost side on the income statement is broken down into variable, fixed, and interest. To recap, variable costs are directly related to inputs for production, fixed costs include overhead, rent, taxes, etc., and interest is the interest expense from long and short term loans. To accurately represent the costs for a Salinas Valley mixed vegetable producer two steps were taken. Extensive cost studies from U.C. Davis were completed for a producer in each of the five crops. These studies were an itemized list of the fixed and variable costs, which were broken down to cultural, harvest, and post-harvest costs. The initial cost data entered into the income statement came from the UC Davis cost studies; however there were discrepancies between the location in the cost study and Salinas Valley costs. Therefore, a grower panel of Salinas Valley mixed vegetable producers gathered to help redefine the costs of production for each of the crops and provide other missing data such as the representative acreage for a mixed vegetable producer.

The producers were asked to come to a consensus on a value fore each variable that seems to represent a typical Salinas Valley mixed vegetable operation. Once a consensus was reached on all the variables, they were entered into the corresponding input table (Appendix C) or pro forma financials (Appendix D). The data entered in the input table includes information related to the overall structure and operation of the farm. Items include the number of acres farmed, owned, leased, the value of land, and other farm income, off farm income, and family living expenses. Data related to any operating or real estate loans will also be entered into the input table and includes items such as the principle borrowed, the length, the interest rate, and the origination year of the loan. The input table will also record the depreciation and any other tax deductions that a farm may incur.

Beginning with the income statement, see appendix C, data for each vegetable crop grown on the representative farm will be collected. The variable costs are broken down into two sections; cultural and harvesting. Cultural costs include energy, labor, irrigation, herbicides, pesticides, water, transplant, etc. per acre. Harvest costs include the cutting, packing, and hauling costs, which are combined together, and the cooling and selling costs, also combined.

The variable costs are separated due to the fact that even though a producer may incur the cultural costs, if the market price does not cover the harvesting costs, then the firm will decide to plow the crop under rather than incurring those costs as well and not fully recovering them. Therefore, conditional statements were used to determine the harvest costs dependent on the market price. Figure 10 shows the conditional equations for calculating total costs. Total cost is a function of cultural, harvest and fixed costs. Cultural costs are the cultural cost per unit multiplied by yield in the same unit. If market price per unit is greater than the harvest cost per unit, then the harvest cost is the harvest cost per unit multiplied by the yield. If the market price is less than the harvest cost per unit, then the harvest cost will be the harvest cost per unit multiplied by the contracted yield because the contracts still have to be fulfilled.

Cost Calculations

$$
\boxed{
\begin{array}{l}
\text{TC=Cost}_{\text{cultural}} + \text{Cost}_{\text{harvest}} + \text{Cost}_{\text{fixed}} \\
\text{Cost}_{\text{cultural}} = \text{Cost}_{\text{cultural}} / \text{unit}\bullet\text{yield} \\
\text{Cost}_{\text{harvest}} = \begin{cases} \text{Cost}_{\text{harvest}} / \text{unit}\bullet\text{yield},\ \$_{\text{market}} \geq \text{Cost}_{\text{harvest}} / \text{unit} \\ \text{Cost}_{\text{harvest}} / \text{unit}\bullet\%\text{contracted},\ \$_{\text{market}} < \text{Cost}_{\text{harvest}} / \text{unit} \end{cases}
\end{array}
}
$$

Figure 10

The focus group also indicated the amount of fixed costs on the operation as a percentage of the total costs. Costs were only gathered for 2004 because the growers do not have the 2005 costs and the model is forecasting out to 2013. Therefore the costs gathered by the grower panel are increased by national inflation rates for labor, fuel, and other costs to accurately forecast costs in 2013. With all the costs collected and validated by the grower panel, the income statement is completed, leaving the balance sheet, statement of cash flows and a tax table to be constructed to complete the model.

The balance sheet will calculate net worth and net present value from the assets and liabilities of the farm. Assets will include the net income from the income statement and the value of capital assets. The capital assets include the land, buildings, equipment, tractors, and vehicles. The liabilities would include any outstanding loan principles and accounts payable, however through the grower panel loans were not representative because most producers rent land and accounts payable were included in the overhead costs. Net worth is assets minus liabilities, which is used to calculate the net present value for the ten year period, one of the key output variables. Net present value is the discounted sum of income over the period with a discount rate of 12%.

The statement of cash flows calculates the ending cash balance for each year and is segmented into cash inflows and outflows. Cash inflows starts with the beginning cash balance, which is the ending cash balance from the previous year. In 2004, the beginning cash balance is zero because there is no accurate way to estimate a representative producer's beginning cash. Beginning cash is added to net income before taxes from the income statement plus any adjustments that need to be made for non-cash expenses deducted in the income statement, i.e. depreciation. The cash outflows includes income taxes and any investments made during the year, the most common being machinery. The net of cash inflows and cash outflows generates the ending cash balance for each year, which becomes the beginning cash balance for the next year.

Taxes are a substantial expense for mixed vegetable producers and are taken out of net income on the income statement. A federal tax table for corporations is replicated at the bottom of the model to calculate the income tax as income changes due to the stochastic variables. The tax table is set up in a way that the incomes before taxes, minus any deductions, for each year is looked up in a range of incomes by excel. Each range has a corresponding base tax and additional tax percent. Income tax for each year is the base tax for the range in which the net income falls between plus the dollar amount net income is greater than the lower boundary of the range multiplied by the additional tax percent. Tax is calculated for each year by the same table and fed back into the income statement to calculate net income after taxes. With the income statement, balance sheet, statement of cash flows, and tax table completed and connected with equations, the model is ready for the stochastic simulation to take place.

Creating the Simulated Prices and Yields

Prior to the actual simulation of the stochastic variables, the stochastics for each variable need to be develop; in other words, the distribution of values each variable can take. The first component to estimate is the deterministic component. In this model, the deterministic components are the regression equations that best explain the linear relationship between the historical price and year, and yield and year. The statistical output, r-squared adjusted, will determine if there is a direct relationship between the two variables. If a direct relationship exists, the trend is used to predict the deterministic component of the stochastic variables. However, if a relationship does not exist for a particular crop then the mean value is used. In the statistical output from the regression equations a formal t-test value with its corresponding p-value is given. The p-value gives the probability that, by chance, we would see the same strong linear relation between the independent and dependent variables as are present in the historical data. Therefore, if the probability is lower than a determined significant level, alpha = 0.05, there is enough evidence to conclude the regression equation explains the strong linear relationship between the variables.

After the deterministic component is estimated via the regression equations, the deviations between the historical data from the estimated are transformed into percent deviations from the trend. The deviations from the trend are the basis for capturing the variation in price and yield from one year to the next and are completed individually for price and yield and for each crop. These deviations preserve the observed variability in the historical data to the simulated values, assuming the future variation remains constant with the historical. Each value will have a corresponding probability of being observed, which is used to create the empirical distribution. As previously mentioned, correlation also needs to be preserved in the simulated values, and is captured by a correlation matrix.

A correlation matrix determines if there is any correlation that exists between the crops' prices and the crops' yields. Proper t-tests and corresponding p-values will be generated in the output to determine if there is significant correlation. If correlation exists between at least two crops, as seen in the correlation matrix, then a multivariate empirical distribution will be used; otherwise a normal or empirical distribution will be used. Due to existing correlation between the vegetable crops on a representative farm, the multivariate empirical distribution will be created.

The next step is to simulate the empirical distribution, which can be completed in a few different ways. The procedure used in this research project will consist of two steps; first to generate a vector of correlated uniform random deviates and second to generate the correlated random deviates for each individual crop given the empirical distribution. The correlated random deviates are calculated by creating a vector of independent random deviates and multiplying the vector by the correlation matrix to preserve the correlation among the various crops for each stochastic variable. The empirical function will be used to create the correlated random deviates for each individual crop. These are generated by multiplying a vector of historical data by the corresponding correlated random deviate, previously generated, based on the probabilities previously generated by the historical data.

The final step in creating the simulated price and yield for each crop consists of the correlated random deviates for each individual crop and the forecasted values generated by the time series models to create forecasted stochastic variables. Since the correlated random deviates are in percentages, add one and multiply by the forecasted value to create the simulated prices and yields. The simulated prices and yields created for each crop will feed back into the income statement providing the values used to calculate revenues and costs for 2004-2013.

SIMULATION PROCESS

The actual simulation process is an internal computation within the software. In general, it calculates the KOVs a determined number of iterations in one simulation. The number of iterations can be any number decided on by the developer, according to Richardson; 100 iterations will be used for this model. Net income will be calculated 100 different times with the stochastic variables changing each iteration for 2004-2013. The deviations from the forecasted values will be independently sampled from the empirical distribution created previously by the historical data, causing the KOV results to differ each iteration within the distribution. All the results for the 100 iterations and the ten years for net income will be stored on a worksheet within excel for further evaluation; all 100 iterations for the one net present value will also be stored on another worksheet. From the worksheets with the stored results, the probabilities or cumulative probabilities for the KOVs to take on certain values can be generated and presented in several different ways including cumulative distribution functions (CDFs), probability density functions (PDFs), and stoplights, which will later be explained in further detail.

MODEL VALIDATION

Even though all the stochastics and simulations have been calculated and results are available, the model needs to be validated for the results to be considered accurate. Two tests are conducted to validate the model's accuracy. First, the correlation between the simulated price and yields cannot be statistically different from the correlation between the historical prices and yields. A student t-test is conducted to determine if the correlations are statistically equal. The null and alternative hypothesis are stated below in figure 11a where is the simulated correlation coefficient between the ith and jth crops and ρ_{ij} is the correlation coefficient of the historical data. If the calculated student t-test is less than the critical value, which is 3.00 for both price and yield correlation matrices for this project, the correlation coefficients are statistically equal. Both price and yield correlation matrices, which are shown in figure 11b, have the majority of the correlation coefficients less than the critical value, therefore the results validates the model. The values in bold are more than the critical value, therefore not statistically equal.

Correlation Hypothesis

$$\boxed{\begin{array}{l} \mathrm{H}_0: \hat{\rho}_{ij} = \rho_{ij} \\ \mathrm{H}_a: \hat{\rho}_{ij} \neq \rho_{ij} \end{array}}$$

Figure 11a

Correlation Coefficient Validation Results

Test Correlation Coefficients				
Confidence Level		100%		
Critical Value		3.00		
	Cauliflower Price	Broccoli Price	Celery Price	Leaf Lettuce Price
Head Lettuce Price	2.60	1.29	1.99	2.41
Cauliflower Price		**3.66**	0.35	1.71
Broccoli Price			2.95	**3.85**
Celery Price				**7.72**

Test Correlation Coefficients				
Confidence Level		100%		
Critical Value		3.00		
	Cauliflower Yield	Broccoli Yield	Celery Yield	Leaf Lettuce Yield
Head Lettuce Yield	0.47	0.21	0.58	**4.41**
Cauliflower Yield		1.79	0.29	**5.45**
Broccoli Yield			0.26	0.79
Celery Yield				**832,262,529.83**

Figure 11b

The second test is to validate time series models developed for forecasting prices and yields. Arizona State reported forecasted price and yields for several vegetables and broke out California prices and yields from national, including those in the representative farm model. Through a statistical comparison of the individual series, the forecasted values for price and yield for each crop can be validated. The null and alternative hypothesis are stated below in figure 12 and the test results are seen in appendix E. Each test compares the mean and variance of the series.

Mean Value Hypothesis

$$\boxed{\begin{array}{l} \mathrm{H}_0 : \overline{x_1} = \overline{x_2} \\ \mathrm{H}_a : \overline{x_1} \neq \overline{x_2} \end{array}}$$

Figure 12

A t-test with the corresponding p-value is reported. If the p-value is less than the alpha level of .05, then the null hypothesis is rejected. All price and yield forecasts were statistically equal to either the Arizona State University forecasts or another generated forecast.

In conclusion, the simulated correlation matrices and forecasted prices and yields were statistically equal to historical correlation and ASU forecasts respectively.

ASSUMPTIONS:

1. The price and yield factors used to create Salinas Valley lettuce prices and yields from California prices and yields are accurate.

2. The representative farm truly represents a Salinas Valley mixed vegetable producing farm operation in terms of costs and variables.

3. The historical data of prices and yields provides the true distribution of prices and yields in California.
4. The historical variation of prices and yields represent the future variation.
5. The time series models created to forecast prices and yields for 2004-2013 are accurate.

LIMITATIONS:

1. The input gathered came from a small panel of mixed vegetable producers, possibly limiting the accuracy of the data.
2. The accuracy of the predicted prices and yields will be compromised if the variability in the future changes from the past.
3. This model is limited to a producer who has a fifty-fifty cost share contract with shippers.

CHAPTER 4

DEVELOPMENT OF THE STUDY

DATA COLLECTION PROBLEMS

During the data collection processes, there were a few challenges that came about unexpectedly. First and foremost was the difficultly of getting together a grower panel in one room to help build the representative farm model. Time is a major concern for a lot of producers, making it difficult for them to give a day up to meet. When faced with this situation, those who were able to make it reached a consensus for all the necessary data and were more than willing to share additional information. Although there were not many producers available to guarantee the data was representative, after doing some cross reconciliation with other studies, the numbers appear representative and typical for a Salinas Valley mixed vegetable producer. It was through the panel meeting that another challenge developed.

The second challenge was focused in on the relationship between growers and shippers. Initially, the price data was for FOB shipper price, not grower. The assumption had been made that the grower will harvest and ship the produce to the retailer or processor, which was a false assumption. In actuality, the shipper makes the contracts to retailers and processors and pays for all the harvesting costs. The revenue comes directly to the shipper, who then covers all the harvesting costs and splits the remainder with the producer. The producer also charges the shipper for half of all the production and operating costs, known as a 50/50 cost share relationship. This caused problems in the way the revenues and costs were initially calculated. After understanding the relationship between the grower and shipper, the net revenue to the grower was able to be calculated more accurately. Besides those two main challenges, the remaining data was gathered without any complications.

ANALYSIS

Result Presentation

The simulated net incomes for 2004-2013 for each percent contracted production are best summarized in percent probabilities while net present value is more informative in probability distribution functions (PDF). The percent probability for each year and each percent contracted production are presented in PDFs and stoplight graphs. Stochastic dominance with respect to a function analysis (SDRF) has also been conducted to finalize the results. The cumulative distribution function (CDF) presents the probability for the KOVs to be at or below all possible values. For example, if the CDF intersected the vertical line indicating \$100,000 profit at .30, it can be stated that there is a 30% probability of making a profit of \$100,000 or less.

The probability density functions are one of the most comprehensive and complete method of presenting the results and are visually summarized in the stoplight graphs. Probability density functions show the probability of the KOV to take on a given value for all possible values; the integral of the PDFs sums to one or one hundred percent. In comparison to the CDF, if the PDF intersects the vertical line indicating $100,000 profit at .30, it can be stated that there is a 30% probability of making a $100,000 profit.

The stoplight graphs are a representation of the PDF with upper and lower cut-off values. The graph is a vertical bar that totals 100%, and is completed for each percent contracted production each year with the same upper and lower cutoff values. For example, figure 13 tests the probability of making a profit more than $100,000 for 2004 at 7 different

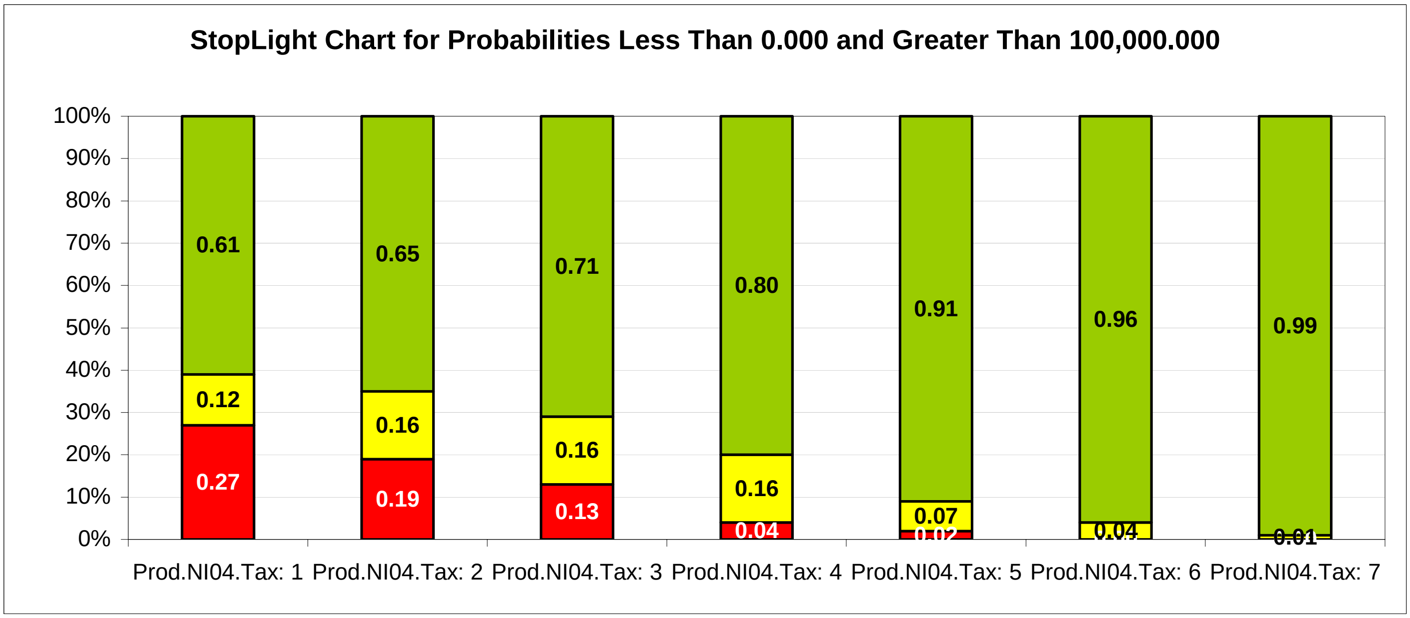

Figure 13

percent contracted productions: 40%-100% at 10% increments. The upper cut-off is $100,000 and the lower cut-off is $0 to give the corresponding income range. The red section is equal to the percent probability of making less than $0; the yellow is the percent probability of making between $0 and $100,000, and the green section shows the percent probability of making more than $100,000. As seen in the figure, contracting 40-60% all have a 16% probability, the highest probability, of making a profit between $0 and $100,000. The cut-off values can be changed to any number depending on the hypothesis being evaluated. Different upper and lower cutoff values were used to test the hypothesis for each income range.

Stochastic dominance with respect to a function (SDRF) can rank risky scenarios to determine the most preferred scenario. It is a method that compares the CDFs at all net incomes by taking the difference between the two CDFs. For example, to test if 40% contracted production is preferred to 60% for the income range of $0 to $100,000, the 60% CDF is subtracted from the 40% CDF at each income within the range, then summing the differences. If it is a positive value, 40% dominates 60%; a negative value indicates 60% dominates 40%; a sum of zero means they are indifferent. In this case the scenarios are the percent contracted production and SDRFs are completed for each income range to determine the percent that dominates the others. By examining the PDFs, stoplight graphs, and SDRFs, the percent contracted production for each income range is identified: the CDF and SDRF identifies the preferred percent contracted production in terms of net present value.

Following are the key numbers presented in tables that determined the results of this research. Although not all values are presented in the text, they are available in the appendices. Tables containing all the probabilities at each percent contracted can be seen in appendix F, while the significant values are shown below. The following tables have the favorable percent contracted production for each year along with its corresponding calculated probability; there is a table for each of the income ranges. The lowest probability when possibly losing money is the most favorable, whereas the opposite is true when making a profit.

Table 2 indicates that a producer is least likely to lose money the more production they contract. Table 3 and 4 illustrates the highest probability of making between $0 and $300,000 requires contracting that ranges from 50-90%.

Probability of Losing Money		
Year	% Contracted	Probability
2004	90%-100%	0%
2005	70%-100%	0%
2006	80%-100%	0%
2007	90%-100%	0%
2008	80%-100%	0%
2009	80%-100%	0%
2010	90%-100%	0%
2011	100%	0%
2012	100%	0%
2013	100%	1%

Table 2

Probability of Making Between $0-$150,000		
Year	% Contracted	Probability
2004	70%	28%
2005	40%	18%
2006	60%	27%
2007	60%	24%
2008	50%	24%
2009	50%	29%
2010	60%	28%
2011	80%	37%
2012	80%	48%
2013	80%	44%

Table 3

Table 5 shows contracting 100% will give the highest probability of making between $300,000 and $450,000. Even though table 6 goes back and forth between 40% and 100% contracting, the majority of the years shows 100% contracting will return the highest probability of making between $450,000 and $600,000.

Probability of Making Between $150,000-$300,000		
Year	% Contracted	Probability
2004	100%	70%
2005	100%	54%
2006	80%	45%
2007	80%	41%
2008	80%	42%
2009	70%	44%
2010	80%	44%
2011	90%	60%
2012	90%	51%
2013	90%	58%

Table 4

Probability of Making Between $300,000-$450,000		
Year	% Contracted	Probability
2004	50%/100%	22%
2005	90%	40%
2006	100%	53%
2007	100%	60%
2008	100%	58%
2009	90%	52%
2010	100%	60%
2011	100%	53%
2012	100%	47%
2013	100%	41%

Table 5

Probability of Making Between $450,000-$600,000		
Year	% Contracted	Probability
2004	40%	7%
2005	50%	19%
2006	40%	10%
2007	100%	17%
2008	100%	22%
2009	100%	41%
2010	100%	21%
2011	40%	1%
2012	70%	5%
2013	100%	2%

Table 6

Probability of Making Between $600,000-$750,000		
Year	% Contracted	Probability
2004	50-60%	2%
2005	40%	14%
2006	50%	4%
2007	80%	3%
2008	50%	4%
2009	40%	3%
2010	50%	4%
2011	40%	1%
2012	50-70%	2%
2013	50,70%	1%

Table 7

Table 7, 8, and 9 all show that 40% contracting for the majority of the years will have the highest probability of making between $600,000 and $1,500,000. These tables provide an initial suggestion as to what is the optimal percent contracted production. Because not one income range has a single answer for each year, the SDRF results provide the final data to make a conclusion.

Probability of Making Between $750,000-$900,000

Year	% Contracted	Probability
2004	40%	1%
2005	40,60%	3%
2006	40%	2%
2007	50-70%	2%
2008	40%	2%
2009	60-70%	1%
2010	50%	1%
2011		0%
2012	40%	4%
2013		0%

Table 8

Probability of Making Between $900,000-$1,500,000

Year	% Contracted	Probability
2004		0%
2005	40%	3%
2006	40%	1%
2007	40%	3%
2008		0%
2009	40%	1%
2010	40,70%	1%
2011		0%
2012		0%
2013	40%	1%

Table 9

The following table, table 10, shows the dominating contracted percent according to the SDRF output, which ranks the contracted percent based on overall dominance for the ten years.

SDRF Output

Income Range	% Contracted	% Contracted
<$0	40%	40%
$0-$150,000	40%	40%
$150,000-$300,000	90%	90%
$300,000-$450,000	100%	100%
$450,000-$600,000	100%	100%
$600,000-$750,000	40%	40%
$750,000-$900,000	40%	40%
$900,000-$1,500,000	40%	40%
NPV	100%	100%

Table 10

In other words, the dominating contract percent is most likely to generate a net income within the corresponding range. The RAC (Risk Aversion Coefficient), another factor in determining the SDRF results, limits the amount risk used in determining the dominating percentage. All SDRFs have a lower and upper RAC of 0, representing a risk neutral producer.

As noticeable in the table, a producer who does not want to risk losing any money should not contract 40% because it is most likely to generate a negative income. The SDRF results for a negative income showed that 100% contracting was least likely to cause a producer to lose money; therefore 100% contracting rather than 40% is preferred for that income range. A producer who contracts 40% is also most likely to have a net income between $600,000 and $1,500,000. A producer who is willing to take the risk of losing money, or making little income ($0-$150,000), for the possibility of having a higher net income should contract at 40%. A producer who does not want to take risk, but would rather be confident in having a net income between $300,000 and $600,000 should contract 100% production. The income range of $150,000-$300,000 has 90% contracted production dominating. This shows that a producer can still contract less than 100% and have a high probability of making around the same income. When combined with the information provided in tables 2-9, it can be concluded that a variety of contract percentages can generate the same income; the SDRFs shows the contract percentages with the highest probability.

To analyze is the net present value (NPV) for the ten years, cumulative and probability distribution functions are given. Figure 14 shows the cumulative distribution functions and figure 15 shows the probability distribution functions for each contracted percentage. As seen in Figure 14, 100% contracting (NPV:7) dominates the others; it has the

Figure 10

highest probability of generating the highest NPV for the ten years. This is also supported by

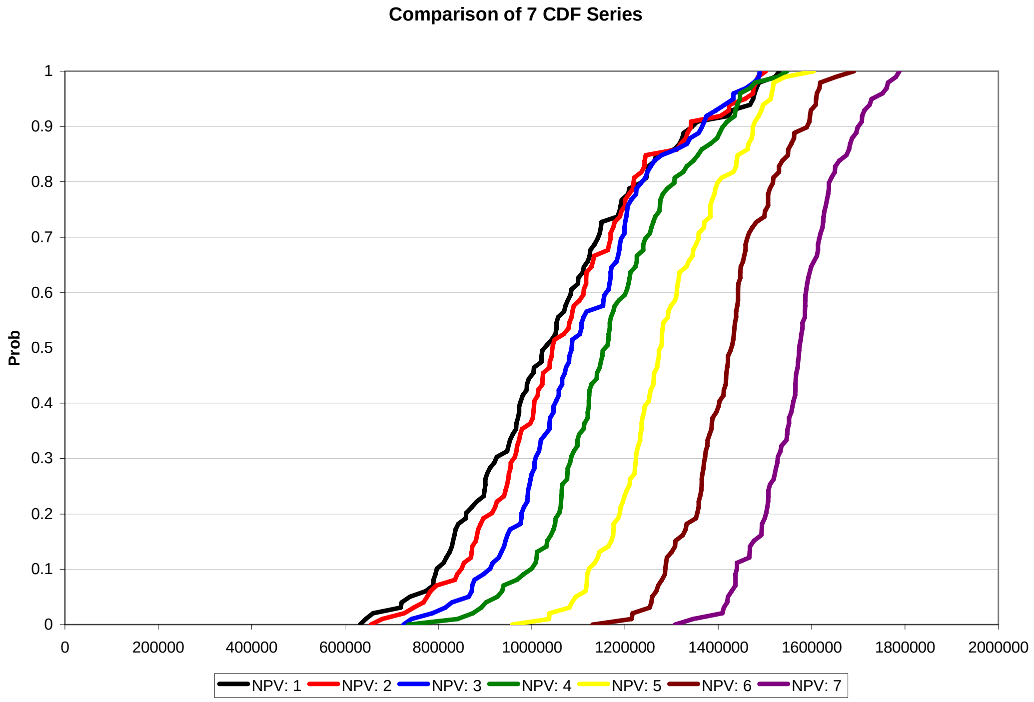

Figure 14

the SDRF results, seen in table 10. For example, there is a 60% probability of having NPV between $1,300,000 and $1,600,000 with 100% contracted.

Figure 15 below shows the probability density function (PDF) of generating a NPV

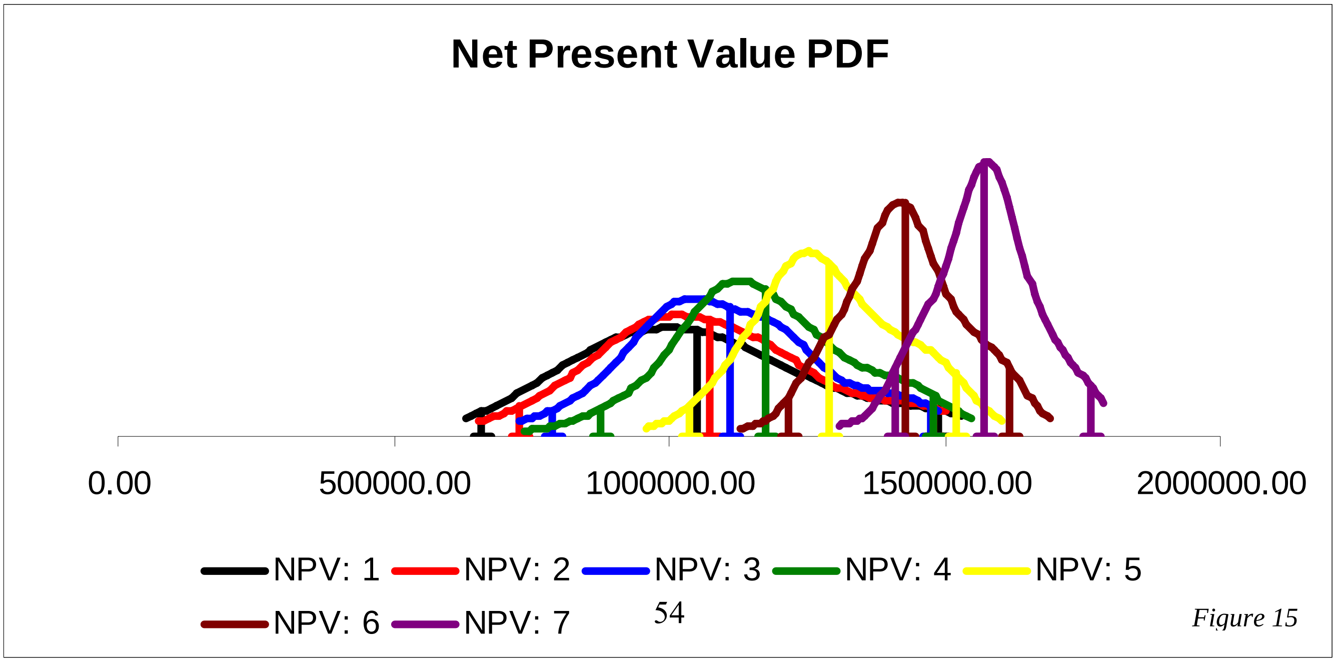

Figure 15

over the ten years. As noticeable, contracting 40% (NPV:1) has the widest and lowest distribution, showing that 40% contracting has a small probability of taking on any value in a wider range, up to almost $1,500,000 and below $6,500,000. In contrast, NPV:7 is 100% contracting, and has the narrowest and highest distribution; in other words it has the highest probability of being within a smaller range of values, with the highest probability of making around $1,570,000.

STATEMENT OF CONCLUSIONS

To determine the optimal percent contracted production for mixed vegetable producers in the Salinas Valley, all generated results were taken into consideration. Although all results hinted towards the same conclusion, the SDRF results were the determining factor because it mathematically compared all CDFs based on a risk neutral producer. I hypothesized producers will have a higher average net income and net present value the higher percent contracted production. To reach a conclusion, I considered net income and net present values separately.

The higher end of the net income ranges is a profit, after taxes, between $900,000 and $1,500,000. According to the probability density functions and stoplight graphs, 40% contracted production has the highest probability of generating the highest net income. This was again confirmed by the SDRF results, which concluded 40% contracted production to be preferred over all other percentages for the same range. Even though I reject my null hypothesis, a trend is noted in the results that makes logical sense. Focusing primarily on the SDRF results, 40% contracted production was preferred for the income ranges at the lower and higher end while 100% contracted production dominated the range of $300,000 to

$600,000. Contracting is a market mechanism used to reduce risk and stabilize received prices and income, which these results support. Income is most stable, within $300,000 to $600,000 when 100% production is contracted. 40% contracted production leaves the majority of production to be sold on the open market, capturing the higher and lower prices. Therefore, 40% contracted production dominates the higher and lower income ranges as market prices fluctuate around the expected price. A producer willing to take more risk for the opportunity to generate a net income above $600,000 should contract 40% knowing there is a possibility of generating a net income less than $300,000 and possibly losing money.

To make a conclusion regarding net present value, the CDF, PDF, and SDRF results were examines. The CDF for 100% contracting dominates all other percentages without any crossovers. The right side tail on the CDF is furthest to the right, having the highest probability of generating the highest net present value. The left tail is also furthest to the right, showing that 100% contracted production will always, with 95% confidence, generate the highest net present value. A similar conclusion is reached looking at the PDF. Although there is some crossover with 80% and 90% contracted production, 100% is still the furthest to the right, its maximum point is also furthest to the right, and it has the smallest width. Being furthest to the right, and the peak being furthest to the right, indicates the highest probability of having the highest net present value. The peak indicates the net present value that has the highest probability of occurring with 100% contracting. The smallest width, $21,478.97, shows 100% contracting will have a net present within the smallest range. That coupled with being furthest to the right concludes 100% contracted production as dominating all other percentages. This was also supported by the SDRF results for Net Present Value, seen in table 10. Therefore, I fail to reject my null hypothesis stating the higher contracted production, the higher the net present value.

CHAPTER 5

SUMMARY, CONCLUSION, AND RECOMMENDATIONS

SUMMARY

Through this research project, a farm simulation model for 2004-2013 was constructed and analyze for a Salinas Valley mixed vegetable producer. The process started with developing the pro forma financials representative of a producer in the Salinas Valley. This was accomplished by gathering values from a panel of producers for all the variables in each of the financial statements. They also provided additional insight about the grower-shipper relationship and how contracts are constructed. Inflation rates for fuel, labor, interest rates, other costs, and CPI were used from government sources to increase costs accordingly up to 2013. Historical prices and yields for each of the crops were used to create time series models, forecasting the prices and yields for 2004-2013. The historical variation and correlation of prices and yields for each crop were preserved in the simulated values. Price and yield were the stochastic variables simulated based on the historical variation. Together, the data and stochastic variables calculated net income and net present value for a producer in years 2004-2013.

The data was then analyzed at different percent contracted production, i.e. 40%-100% at 10% increments, to determine the optimal percent contracted production for risk neutral and risk taking producers. The percent contracted productions were evaluated by the probability of generating a net income within different ranges of $150,000 increments. The contract percent with the highest probability in each range was noted and then combined with information provided by SDRF results. Stochastic Dominance with Respect to a Function determined the percent contracted production that dominated the given income range in terms of probabilities. Net present value was also analyzed through cumulative and probability distribution functions to determine if one contract percent dominated the others. All data and results were used in combination to reach conclusions about the hypotheses.

The first hypothesis stating 80% contracted production to be optimal for a risk neutral producer was rejected by a 100% contracted production. However, the second hypothesis was accepted; 40% contracted production is optimal for a risk taking producer. The last hypothesis was also accepted, concluding that 100% contracting will provide a NPV within a smaller range of higher values and 40% contracting will allow NPV to vary over a wider distribution of values.

CONCLUSIONS

A few conclusions about Salinas Valley mixed vegetable producers' industry can be made based upon the data previously presented. The optimal percent contracted production is best represented in the probabilities of making a net income within varying ranges. The conclusions were based upon the combination of percent contracted production over the ten year period that returned the highest probability of being within the given range and the SDRF results. However, upon further evaluation of the results, a few other noticeable trends are worth noting, that aid in validating the model's results.

If a producer were to contract 100% production for the next ten years, very rarely would they expect to lose money; the model returns those results as seen in appendix X. The only time a producer seems to lose money with 100% contracting is when yield falls below the expected value. The cash market is characterized by its price fluctuations above and below the expected price. To mitigate the price risk present in the cash market, producers would opt to contract 100%, leaving yield fluctuation as a risk. However, a producer is going to want to capitalize on the market prices when they exceed their contract prices, generating more revenue than expected. Leaving a percent of yield vulnerable to the cash market generates the risk mitigated by contracting but creates the opportunity to possibly capture a higher market price. Therefore, a producer who leaves some yield to sell on the cash market (i.e.40% contracted production) captures the highest and lowest net incomes. In other words, a producer wanting to possibly make more than $600,000, and is willing to take the risk of making less than $300,000, including negative net income, should contract around 40% of production.

It should also be noted that in each income range there is more than one percent contracted production returning the highest probability for a particular year. This indicates that even though 40% and 100% contracted production dominate the income ranges, an approximate percentage has a relatively close probability of returning the same results. If a producer were to contract 40%, there is still a probability of making a net income within the $300,000 to $600,000 range, and visa versa with 100% contracting production. Also, contracting 80% production does not mean that there is no probability of making above $600,000. Appendix X shows the complete results of the varying probabilities for generating a net income in each range. Only on the extreme ends are there 0% probabilities, which are also subject to error.

As each year is forecasted out, the probability of making a positive net income diminish for each percent contracted production. Since, the model increases the contract prices at relatively the same increments, it can be concluded that the cost of production is increasing at a faster rate than market prices. The mixed vegetable industry in Salinas Valley will either have to transform to contracting almost all the production, see a dramatic increase in market prices, or decrease in costs, to continue production.

The results found for net present value are not surprising. A producer who contracts at 100% has a small probability of losing money each year and the highest probability of a high net present value. Even though a producer contracts around 40% may make more income than the previous producer one year due to high market prices, that same producer may lose more money the following year, reducing net present value. The fluctuation in the cash market also supports the conclusion that higher contracted production, the more stable net present value is expected. Net present value is never negative, which is to be expected. If a produce does not expect to have a positive net present value ten years in the future, they would opt to get out of the business and invest elsewhere.

Each percent probability calculated in the model is made with 95% confidence. Even though 95% of the time, the probabilities will be accurate, there is room for error (i.e. ±3%).

It should be recognized that the forecasted values for price, yields, and costs, were all based historical data. Therefore, as values are forecasted out to year 2013, there is more room for error than the values forecasted for 2005.

RECOMMENDATIONS

Use of the Study

For those interested in using the information found with this research project, a few recommendations should be considered. First and foremost, do not use these values without taking into consideration personal situations and experience. This model was developed for a representative Salinas Valley mixed vegetable producers with 1600 acres leased and producing 5 crops. There are several other factors used in the model than can alter the results depending on individual situations. A few examples of those factors include any loans currently being paid off, location of production, production costs, relationships with shippers and/or contractors, contract prices, etc. It should also be mentioned, as previously stated, there is an increasing margin of error each consecutive year forecasted. Every forecast was calculated from a time series model base from historical data, if one years forecast is extremely off, the following years will be influenced by a misleading forecast. Even though all ten years are accurately predicted and simulated, the most accurate, in terms of margin of error, are the first few years.

Continuation of the Study

Some aspects of this research project were not expanded, or in depth, as much as possible. Recommendations for future study would be to include possible changes in demand for mixed vegetables. This model assumed no change in demand for ten years, and as nutritional awareness continues to increase, demand may increase as well. Imports and exports were excluded from influencing the market prices. Adjusting marketing prices for exported production and imported products may alter the end results. The information presented by this model will be extremely useful for the producers in the Salinas Valley whose individual situations resemble what is captured by the model. There is a need for models such as this one that can be altered to represent other production areas and crops. By generating this information for producers of varying crops in varying areas of California would aid in mitigating the overall risk specialty crop producers face each year. The value of this model and its results would increase tremendously if it is made available to individual producers. Individual producers would be able input their personal information directly into the model's input tables and run the simulations, generating results directly representative of their operation. Availability and usefulness of this model can provide valuable information to specialty crop producers statewide, aiding to mitigate risks faced in agricultural production.

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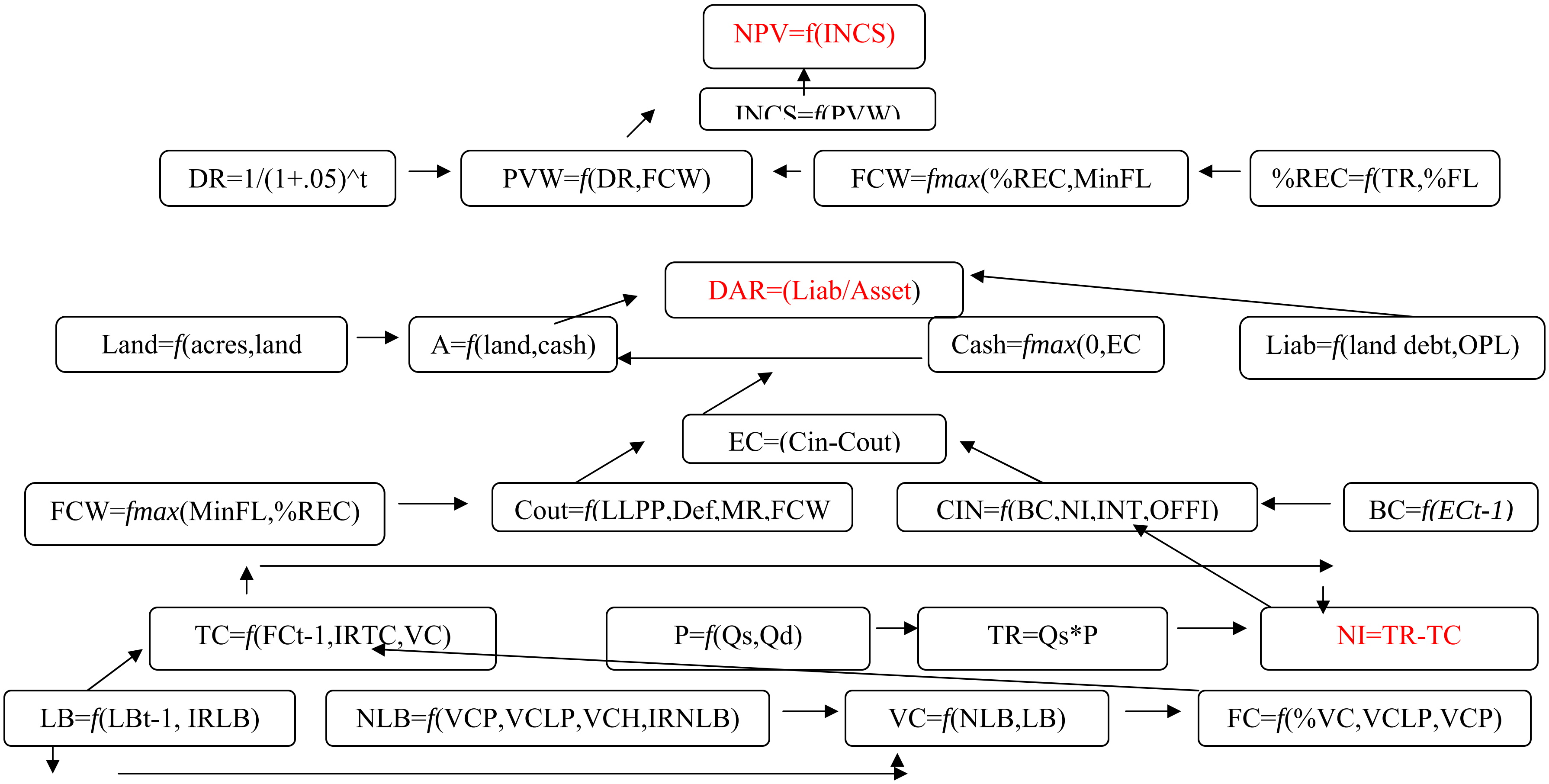
Appendix A : Model Design Flow Chart



NI=Annual Net Income
R=Annual Revenue ($/acre)
C=Annual Costs ($/acre)
FC=Annual Fixed Costs ($/acre)
VC=Annual Variable Cost($/Acre)
P=Market Price
Qs=Domestic Supply
Qd=Domestic Demand
VCP=Variable Cost of Planting/growing ($/acre)
VCLP=Variable Cost of Land Preparation ($/acre)
VCH=Variable Cost of Harvesting ($/acre)

NLB=Annual Non-labor Costs ($/acre)
BCt= Beginning Cash in year t ($)
Ect=Ending Cash in year t ($)
Cin=Annual Cash Inflows (4)
Cout=Annual Cash Outflow ($)
INT=Interest Earned ($)
OFFI=Annual Off farm income ($)
LLPP=Annual Land Loan Principle Payment ($)
DEF=Deficit Payment ($)
MR=Annual Machinery Replacement($)
FCW=Annual Family Cash Withdrawals ($)

%REC=Percentage of Annual Revenues ($)
A=Annual Assets ($)
Liab=Annual Liabilities
OPL=Remaining Operating Loan Principle ($)
REL=Remaining Real Estate Loan Principle ($)
DAR=Debt to Asset Ration
INCS=Income Stream ($)
PVW=Present Value Withdrawal ($)
DR=Discount Rate (%)
NPV=Net Present Value ($)
IRLB=Labor Inflation Rate (%)