ECONOMIC EVALUATION OF ACTION PLANS FOR PATHOGEN CONTROL IN ALMONDS

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Texas Agribusiness Market Research Center (TAMRC) Consumer Product Research Report No. CP- 02-07, February 2007 by Dr. Victoria Salin, Dr. Eluned Jones, and Dr. Gary W. Williams, submitted to the Almond Board of California.

ABSTRACT:
The Almond Board of California proposed to require that all almonds shipped from California handlers be treated to achieve a 4-log reduction in the pathogen that leads to salmonellosis. The Assurance program is expected to add several million dollars to transactions costs in the almond marketing system. There is a wide range in these cost estimates, mainly because of the difficulty in predicting how many firms will be interested in applying for the program.

EXECUTIVE SUMMARY

As a response to two outbreaks of foodborne illness linked with almonds, the Almond Board of California proposed to require that all almonds shipped from California handlers be treated to achieve a 4-log reduction in the pathogen that leads to salmonellosis. An alternative to treatment at the handler level is to allow certain approved buyers to receive untreated almonds so long as the buyer provides satisfactory assurance of treatment before the product reaches consumers. The objectives and key findings of a study of the economic effects of the proposed program are summarized here.

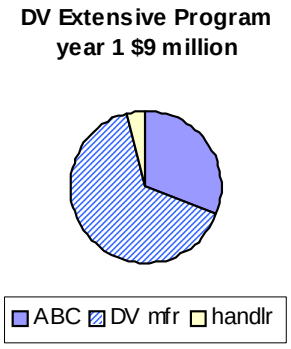
The Assurance program is expected to add several million dollars to transactions costs in the almond marketing system. There is a wide range in these cost estimates, mainly because of the difficulty in predicting how many firms will be interested in applying for the program. Two scenarios are reported, using an estimate of the present value of a program that creates ongoing costs, in perpetuity. The present value estimate of cost is an approximation that is useful for comparing program alternatives for policy decisions; it is not an estimate of budget impact for any given year.

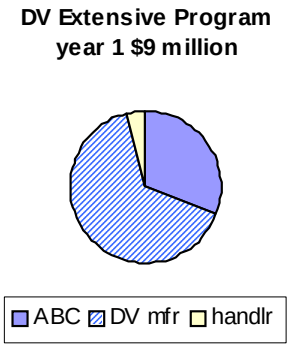
Under an extensive global program (135 manufacturers participating) costs of technology validation are expected to be significant (approximately $20,000 per line) for those manufacturers whose processes are not already proven to control salmonella. The technology validation costs are a key driver in the worst-case cost estimate of approximately $37 million in present value of costs for a fully implemented global program (no sunset).

Some major users of almonds will be able to implement pathogen control technology for considerably less expense, particularly if those manufacturers are blanching or oil-roasting the almonds. A few major buyers (12) use production processes that complementary with pathogen control; that is, these buyers oil roast or blanch the almonds and will be able to satisfy certification agencies at low cost. The total present value of cost is estimated at $7 million under this limited program scenario.

The oversight provided by the Almond Board of California to the Assurance program involve time and effort, and as such are features analyzed with a transactions costs economics approach, to distinguish these costs from direct market price effects. The distribution of estimated transactions costs facing various parties due to the Assurance program is illustrated in the charts below, for the first year of the program.

The Almond Board's oversight expense is the largest share of cost in the first year, under the limited participation scenario. When a large number of manufacturers are assumed to participate (135), those manufacturers together account for a major share of transactions costs.





Depending on the level of participation by handlers, buyers, and their certification partners, the Board's transactions costs are estimated at $3 million to $6.5 million, in present value terms, from a permanent Assurance program. The largest component of the Board's costs are in support to the Technical Experts Review Panel (TERP), which is expected to review the qualifications of many process authorities that will apply to participate in the global Assurance program.

Handlers will not experience a large share of the transactions costs, regardless of the size of the program. While handlers clearly experience the smallest share of transactions cost under the program, the distribution of costs is not uniform across the handling sector. Those handlers who participate will not bear the operating costs of providing treatment. Participating handlers can expect marginally higher costs due to the need to establish traceability of shipments of untreated almonds. Participating handlers will likely benefit from the Assurance program. Those handlers who do not participate will face higher costs from the requirement to pasteurize.

Choices about how to leverage existing global and corporate quality assurance expertise will be critical in determining the ultimate impact of these transactions costs on the market. Feasibility will be enhanced by integration of the assurance requirements with existing, highly-regarded certification agencies and audit services in the global market for high-quality foods. One alternative, to authorize manufacturers' in-house experts to validate technologies that are well-established in pathogen control, and to pre-approve all affiliates of the highly regarded global food certification authorities to support the almond industry's food safety programs. These steps will not only cut the cost of approval of individual auditors, they will also reduce the risk of a bottleneck in participation that could potentially de-stabilize business relationships in the supply chain for almonds.

The existence of the processor's assurance option dampens the demand for handler-level pasteurization services and may deter investments in the facilities and equipment needed to provide an adequate supply of treatment capacity. The number, type, and location of facilities to treat almonds will affect the economic impact of the requirement for 100% pasteurization at the handler level.

The theoretical foundation of transactions costs analysis highlights the difficulties of exchanges involving complex products and services. Markets may not be able to correctly price a good or service so that it can be exchanged in the traditional way, when the product's features involve highly technical or subjective attributes, such as safety. Often, the barrier to exchange is from incomplete information. A key factor in minimizing transactions cost is that trust and credibility of parties to the exchange exist, so that when full and complete information is lacking, the exchange will be able to occur with reasonable assurances. There is a need to avoid program rules that impede trust and do not assign full credibility to established business practices in the area of quality assurance.

One can expect a variety of ways in which agents in the supply chain may internalize or pass along the transactions costs of this program. Where possible, the requirements will be integrated into existing quality assurance practices, thereby minimizing the market impact for buyers that already have well-organized protocols for verifiable production management practices. To the extent that program rules prevent efficient integration, the activities established specifically for the Assurance program might become part of special fees charged against handlers' accounts. In these ways, transactions costs evolve from a general "hassle factor" into real charges or fees that will impact supply and demand of almonds. To the extent that transactions costs are relatively small, any pass-through can be expected to have a correspondingly low economic impact at the market level. Thus, it is critically important to optimally leverage the new rules with existing assurance protocols and associated business practices.

The expected impact on the ABC's budget, which is substantial, must be considered within the context of potential future opportunities for productive promotion or research expenditures, which have subsequent impacts on consumer demand for almonds. And, of course, the ABC budget is linked to payments from growers and handlers, and assessments could affect growers' costs and supply.

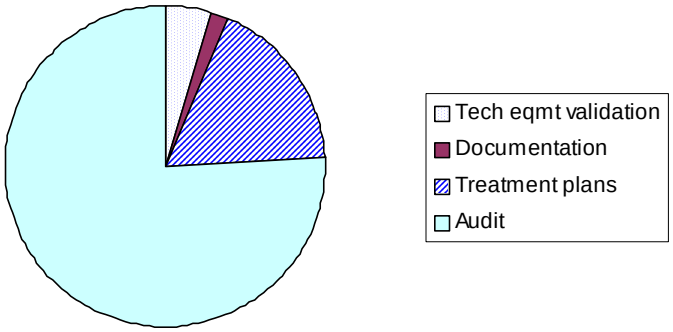
The requirement for pasteurization of all almonds at the handler level is expected to add an increment of $33 million to $35 million dollars to the annual operating cost of handling almonds industry-wide. The relative significance of this cost change is less than 2% of the total value of the almond crop. The total cost in today's terms for the pasteurization program at the handler level is estimated to be $300-322 million. On balance, this is a modest operating cost increase.

We forecast that the short-term market response to additional costs of pasteurization will be approximately 3.5 cents per pound, on average. The ultimate impact will be that handlers increase their marketing margins to cover the marginal cost of pasteurization, through reductions in the prices paid to growers. We do not expect that there will be substantial ability to pass through the cost to customers. Record-high prices for almonds may have already driven some users to the "switching point" in terms of substitution of alternate nuts for almonds, e.g. the percentages in mixed nut products, or broken almonds instead of whole in confectionery. Even a modest increase in prices at the peak of the market could lead to further changes in demand.

In addition to the operating costs of pasteurization, program monitoring will add transactions costs to the system. These costs are partly due to scientific and technical assistance needed to assure safety, and partly due to choices about the compliance routines required by the regulating

agency. Total transactions costs associated with the handler pasteurization are estimated to be approximately $7 million, in present value terms. The Almond Board plans to require that handlers submit treatment plans each year, and be audited frequently in the first year. The 6 audits in the first year account for approximately $1 million in industry-wide transactions costs.

Technology validation is another key driver of the transactions costs estimated for the first year of the 100% pasteurization program. TERP will play an important role in approving technologies so that handlers using them can achieve certification at lower cost. Transactions cost by type, in the initial year of 100% pasteurization at the handler level, are distributed as follows:



A new issue for analysis under the requirement for 100% pasteurization at the handler level is the market for treatment services on an out-source basis. Capacity is coming online rapidly at the time of this report, and our estimates are based on limited data from a market that is in its infancy. The availability of reliable services is a critical determinant in the marginal cost of pasteurization. Constraints on capacity at critical times throughout the year and in strategic locations could affect the ability of some smaller handlers to maintain their competitive position in the almond market. It is also possible to assure enhanced safety of almonds by the combined efforts of manufacture-buyers and handlers. The Assurance program would allow handlers to ship untreated almonds with documentation of a pathogen-control treatment to be undertaken by the buyer.

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Two outbreaks of foodborne illnesses that were traced to almonds in the last 5 years have led to heightened concern among almond growers and handlers about pro-active measures to avoid future incidents. As a result, the Almond Board of California proposed an Action Plan that includes an amendment to the Marketing Order for almonds. The Marketing Order amendment (MOA) would require all almonds shipped from California handlers to be treated to achieve a 4-log reduction in the pathogen that leads to salmonellosis.

During the phase-in of the MOA, an Assurance program would allow certain approved buyers in North America to receive untreated almonds so long as the buyer provides satisfactory assurance of treatment before the product reaches consumers. The pasteurization program is proposed as a temporary option, while capacity for treatment at the handler level is installed.

This study considers the economic impact of the proposed food safety measures with a research approach that accounts for the unique characteristics of the value chain for almonds. The objectives are to investigate:

- the costs to all parties were the Assurance program to be fully implemented (globally) and not eliminated, and,

- the costs to the industry of 100% pasteurization at the handler level, with the elimination of an Assurance program as of August 2008.

The results of the study provide an economic theory-based approach, detailed quantitative estimates of total costs in the short-run, and transactions cost analysis to illustrate the managerially-relevant impacts of the program requirements on various levels of the supply chain.

Pasteurization Alternatives for the Almond Industry

A variety of thermal and non-thermal treatments are available to achieve the pathogen-reduction criteria for almonds (ABC 2006 (a)). Some routine food preparation processes used on almonds, including blanching and oil roasting, accomplish the required pathogen reduction. Other thermal treatments meet organic standards, and both Propylene Oxide (PPO) fumigation and thermal processes can be used on shelled or in-shell almonds.

A PPO treatment involves pre-warming the product to 86°F (30°C), and then exposing it to 0.5 oz/ft^3 of PPO concentration. In the treatment chamber, the product is under 125°F (52°C) for 4 hours. The parameters are specified in the PPO Standard Operating Procedure. Approval of PPO in export markets in Canada and Europe is being pursued. The European Union recently designated PPO as a processing aid which is permitted on food products.

Steam and moist heat technologies involve fluidizing steam for pasteurizing, hot air for drying and chilled air for cooling. The product's surface temperature is less than 210°F (99°C) for less than 30 seconds.

Blanching almonds in hot water achieves pasteurization after a minimum of 2 minutes with a minimum water temperature of 190°F in the blancher. Almond skins typically are removed in the blanching process. Oil roasting also achieves pasteurization in a minimum of 2 minutes, with 260°F being the minimum oil temperature in the coldest part of the oil roaster. Dry roasting processes may reach a 4-log reduction, however this is equipment/process specific.

Other technologies that are in the development stage are feasible (ABC 2006 (b)); however they are not considered in this study because there is no evidence that they will be operational in time for the scheduled implementation of the MOA.

Market Channel for Almonds

Almonds are consumed in various recipes prepared at home or in restaurant meals, as a snack food, and as ingredients in manufactured confectionery and bakery products. Recently, per-capita consumption of almonds in the USA has been increasing (US Department of Agriculture, National Agricultural Statistics Service). Export markets are an important destination for almond shipments (Figure 1), accounting for around 70% of the crop.

Almond supply at the grower level has trended upward over the past 10 years. Production rose from nearly 400 million pounds in 1995/1996[1] to approximately 1 billion pounds per year since 2002/2003. In spite of increasing supply, prices have been relatively high (Figure 2). The current record-high grower price ($3.08 per pound) can be contrasted with a 10-year-average price of $1.58 (US Department of Agriculture, Economic Research Service). The season-average grower price shown in the figure does not demonstrate the typical within-season price variation that is of critical importance to businesses in the supply chain that manage inventory costs against supply requirements.

Almonds are a perennial crop grown in orchards in California. There are approximately 6,000 growers today. Bearing acreage is expected to increase, and as a result, production is forecast to increase 50% in three to five years (ABC 2006 (b)).

The key businesses in the market channel for almonds are shown in Figure 3. The first step in the processing of almonds takes place immediately after harvest. Almonds are handled by huller-shellers, who separate the hull and other components from the kernel. Byproducts are shipped into animal feed markets and kernels are shipped to handlers.

Almond handlers provide marketing services to customers, including sorting, cleaning, and transportation. The handler level is the phase of the market channel at which US Department of Agriculture (USDA) grading and inspection services take place, as required under the Marketing Order for almonds. To become an approved handler, the firm applies annually to the Almond

[1] The almond marketing year begins August 1.

Figure 1: Production, Exports, and Season-Average Grower Prices of Almonds, 1995/96-2005/06

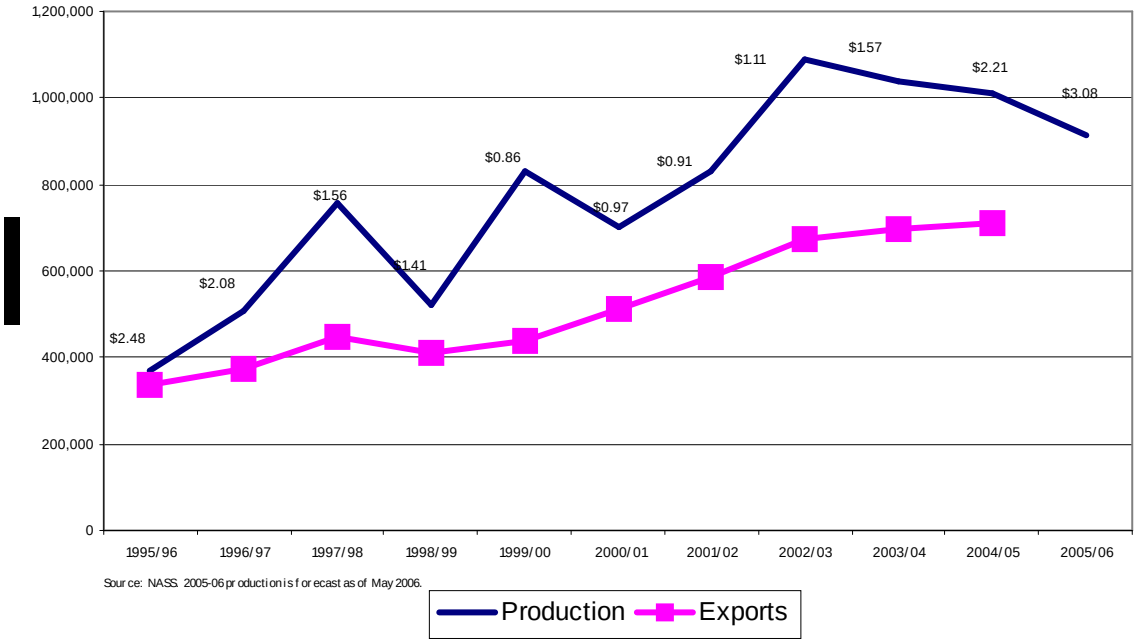
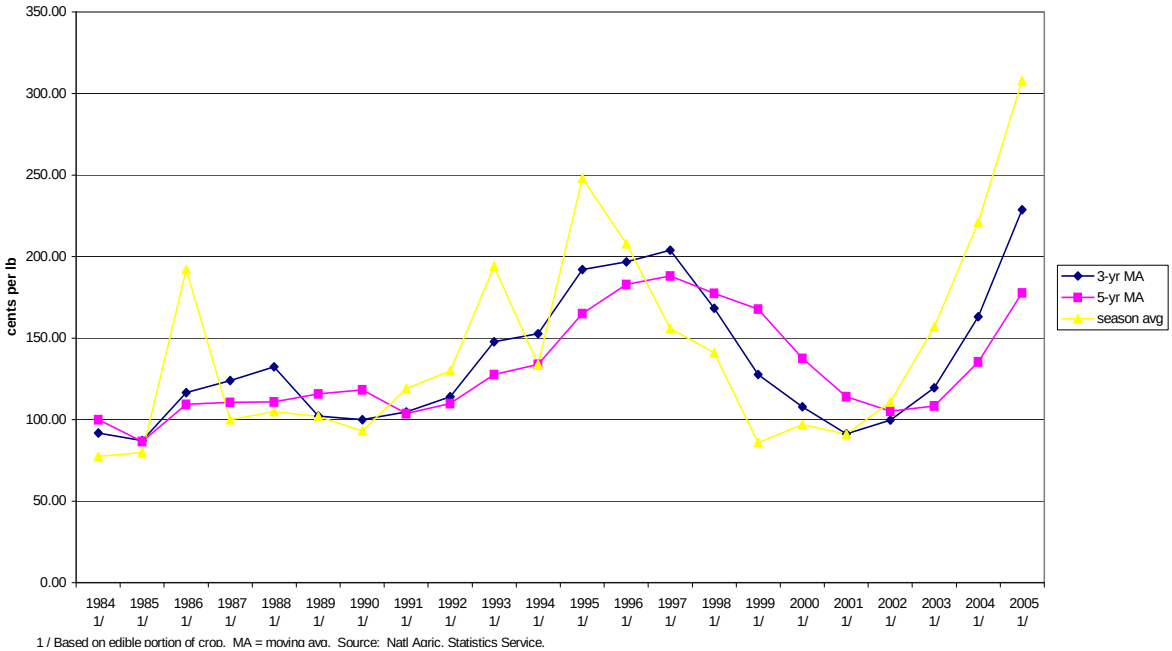


Figure 2: Grower Prices for Almonds, Season-Average and Moving Averages, 1984-2005



Board of California and agrees to USDA inspection of almond shipments as oversight of the terms of the Marketing Order. For the 2006/07 marketing year, 109 handlers are approved under the Marketing Order[2].

Like most market channels involving the processing of agricultural products, the number of firms in the industry decreases from the grower level to the processing level. Among the 109 almond handlers, there is a wide variation in size and business practices. The extent of concentration by size is illustrated in Figure 3. The 27 largest handlers are responsible for 80% of the entire crop; each of those 27 large handlers shipped more than 10 million pounds of almonds in 2004.

The extent to which handlers provide processing functions and marketing functions varies in the industry. Some handlers provide direct sales contacts and manage the transactions. Those direct sales between handlers and buyers account for approximately 35% of total almond shipments. The remaining 65% of almonds are marketed through traders who take title to the product (ABC 2006 (e) p. 2). These shipments through traders would not be eligible for the assurance program.

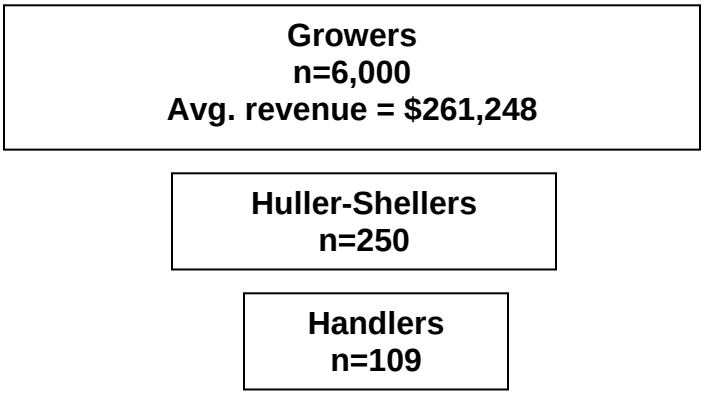
Some handlers provide additional value-added services to meet customer-specific contract requirements. Customer demands vary, with some desiring quality standards above those of the USDA grades. Some handlers are providing processing services, including blanching, slicing, or roasting, as well as custom packing. These services would likely be required by retail supermarket buyers who sell almonds in natural food/produce departments. The major candy and snack-food manufacturing companies have facilities and processes for roasting and packaging under their own brands and typically purchase raw almonds from handlers, year-round. The major buyers often have their own quality assurance procedures, sometimes including audits of handlers' facilities, to assure that standards are met.

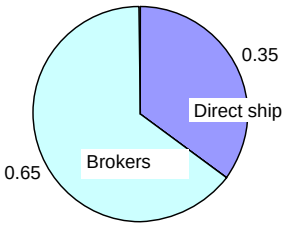
The smaller handlers often specialize in supplying the export market through traders who take title to the products and complete the transactions in the market (See Figure 4 for top 10 export markets). These handlers rely on brokers to manage the export shipping documentation. The specifications of many export shipments are limited to USDA specs. There is typically minimal interaction between handlers and buyers in export markets, and low levels of inspection. Smaller handlers also reportedly take an important role in the domestic market as a competitive force, assisting buyers in price discovery and in providing supplies for spot purchases at key times.

Following the outbreaks of foodborne illness, some almond handlers have begun to routinely ship almonds that have been treated, particularly to customers who intend to use the almonds in products to be consumed in raw form. PPO was the only known available treatment that did not change product form, when the first outbreak occurred. Because PPO treatment is not accepted in certain export markets, the manufacturers have instituted separate inventories of treated almonds in their procurement channels, as distinct from the inventory of raw almonds to be roasted or blanched.

[2] As of May 2006. The number of handlers varies somewhat from year to year, and can vary within a crop year.

Figure 3: Market Channel for Almonds





Extent of handlers' supply chain relationships

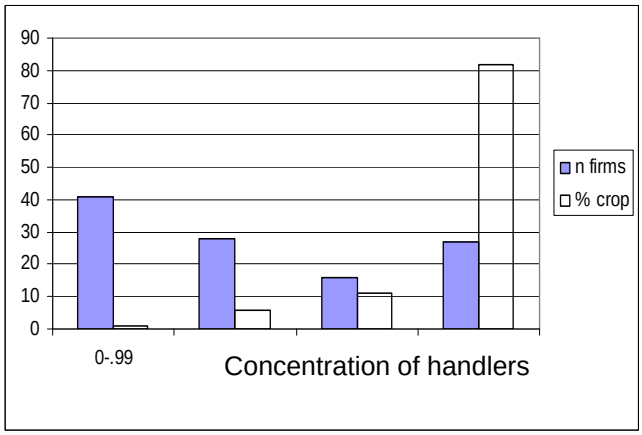


Figure 4: Global Scope of Almond Shipments: Country, Number of Food Quality Process Authorities, and U.S. Almond Exports by Destination (Top 10 Markets), 2004

The top 10 almond-importing countries, number of process authorities in that country in parenthesis, and the amount imported annually is underneath. Selected process authorities by country are:

Austria Österreichische Agentur für Gesundheit und Ernährungssicherheit GmbH **Belgium** L'Agence Fédérale pour la Sécurité de la Chaîne Alimentaire SPF Santé publique, Sécurité de la Chaîne alimentaire et Environnement **Canada** The Canadian Food Inspection Agency The Food and Consumer Products Manufacturers of Canada Societé des Alcools du Quebec (Company of Alcohols of Quebec) Agriculture and Agri-Food Canada **Czech Republic** Ministry of Agriculture of Ceska Republika (CZ), Food Safety Department **Denmark** Institute of Food and Veterinary Research (DFVF) **Finland** Finnish National Food Agency **France** Agence francaise de sécurité sanitaire des aliments (AFSSA) **Germany** Bundesinstitut für Risikobewertung **Greece** EFET Greece **Ireland** Food Safety Authority of Ireland (FSAI) **Italy** Ministry of Health (Italy) **Lithuania** State Food and Veterinary Service of Lithuania **Luxembourg** Comité de Coordination en Matière de Sécurité Alimentaire (Luxembourg) **Netherlands** Voedsel en Waren Autoriteit **Norway** Vitenskapskomiteen for mattrygghet - VKM (Observateur) **Poland** Chief Sanitary Inspectorate (Poland) **Portugal** Agência para a Qualidade e Segurança Alimentar **Spain** La Agencia Española de Seguridad Alimentaria (AESA) (Spain)	Slovakia State Veterinary and Food Administration of Slovak Republic **Sweden** Swedish National Food Administration Swedish Agriculture Board Swedish Chemicals Inspectorate **Switzerland** SGS, SA ISO **UK** Food Standards Agency (FSA) Campden & Chorleywood Food Research Assoc. Chartered Institute of Environmental Health Institute of Food Science and Technology Royal Environmental Health Institute of Scotland Royal Pharmaceutical Society Society of Chief Officers of Trading Standards in Scotland Trading Standards Institute British Nutrition Foundation British Retail Consortium Food and Drink Federation Food Link Foodaware - the Consumers' Food Group General Consumer Council for Northern Ireland Institute of Food Science and Technology National Consumer Council National Consumer Federation FSA Red Meat HACCP Database Scottish Consumer Council The Society of Food Hygiene Technology Sustain - 'the alliance for better food and farming' Welsh Consumer Council USA American Institute of Baking (AIB) American Society for Quality (ASQ) SQF (Safe Quality Food) NSF (Cook and Thurber)

At the manufacturer level, inventories of treated and untreated almonds are managed separately to avoid the expense of pasteurization on the products intended for use as oil-roasted nuts. Safety stocks are managed for two material inputs rather than one. Because manufacturers use advanced technology such as scannable bar codes to document receiving and product order flows, the record-keeping burden is managed relatively effectively. Inventory management is a greater problem. The manager faces two interacting demand forecasting problems, because the pasteurized almonds are a distinct product from the raw almonds. For example, if the company receives an order for roasted product at a time when stocks of raw almonds are unexpectedly short, there is the possibility of paying for a rush delivery of untreated almonds. Or, the stock of treated almonds could be used, at a timing advantage but a higher per-unit cost, because the pasteurized almonds were procured at a higher cost. Therefore, separate inventory management is business practice for many handlers and buyers in the industry.

Economic Model

The economic impact of the proposed Marketing Order amendment for pathogen control is modeled with a short-run analysis of the marketing sector and associated effects on pricing of the raw agricultural product. This approach is standard when the interactions of producers and first handlers in the marketing channel are at issue (Helmberger and Chavas, 1996). The profit function for a handler in the almond industry is specified as:

$$\max_{q} \pi = P_r q_r - \sum_{i=1}^{k} V_i x_i - Pq - TFC,$$

where Pr is the price per unit received by the handler from its customer (the manufacturer or retailer), and qr is the number of value-added units sold by the handler; P is the price the handler pays for raw material farm input; and q is raw material purchased from farmers. In addition to paying for the cost of raw material, the handler also covers the expenses of a variety of marketing services (xi), which cost Vi per unit. The remaining overhead expenses are represented by the term TFC (total fixed costs) in the profit equation. These overheads include equipment, storage facilities, and managerial compensation.

Next, consider simplifying assumptions that will be made to put the basic theory into an operational setting from which to derive the impact of the Marketing Order amendment. The first assumption relates to the physical transformation of almonds at the handler level. The processing of almonds involves sorting and some change in physical characteristics, but little destructive processing. Therefore we assume that the quantity of acceptable grade almonds purchased from growers (or shellers) is equal to the quantity sold to manufacturers (q = qr). This assumption allows us to simplify the production relationship while focusing on the important cost aspects of the handlers' marketing services[3].

[3] The inedible portion of the total almond crop was 1.4% in 2004 (National Agricultural Statistics Service, USDA. Table E-7 in Fruit and Tree Nut Ybk.). This small share of crop loss due to quality sorting justifies the assumption that $q = q_r$ in the model.

In the mathematical and graphical expositions in this section, we are temporarily abstracting from the specifics by which marketing services are applied to transform q raw material into qr, as purchased by manufacturers. That is, we do not specify a detailed production function relating the marketing services to retail product. It should be noted that these costs are retained in the background of the analysis, and are used in the final calculation of the shift in the industry-level cost function that results from pasteurization.

Other simplifying assumptions are:

- farm-level storage is not considered;
- farm-level technology is exogenous; and
- farm production is pre-determined in the handlers' decision.

The handler purchases almonds in quantities that maximize profits. Selecting a quadratic specification for costs results in the following optimization problem:

$$\max_{q} \pi = (P_r - P)q - (aq + bq^2) - TFC.$$

The necessary condition for profit maximization is:

$$\frac{\partial \pi}{\partial q} = (P_r - P) - (a + 2bq) = 0.$$

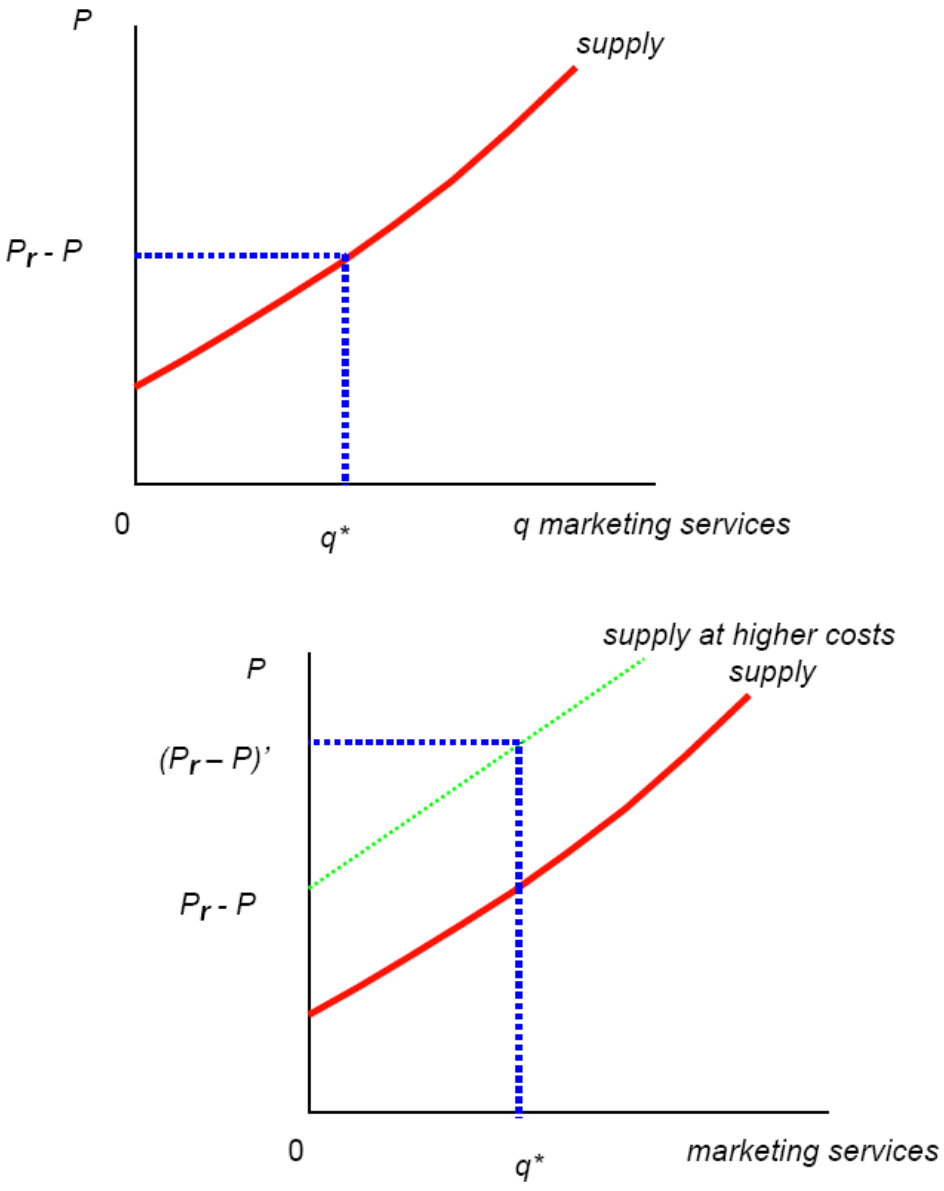
Upon rearranging this condition, we have the well-known determinant of supply (s) in a competitive industry, which states that the profit-maximizing marketing firm will supply an amount such that the price received (Pr –P) covers the marginal cost of the marketing services supplied. Mathematically, the profit-maximizing supply is written as:

$$s = a + 2bq.$$

The dependency of handlers' services on the marginal costs of providing those services is the fundamental principle underlying the supply relationship illustrated in Figure 5 (upper panel). Handlers will supply marketing services at any point along the supply curve, as long as the marketing margin is above the marginal cost. In the firm level model (top panel), suppose a handler can charge a marketing margin at (Pr-P). At this level of margin, handling services q* will be supplied, and the marketing firm just covers the marginal cost and earns zero profit on the next increment of quantity.

This model implies an upward sloping short-run marginal cost function, which results from diminishing returns to fixed plants in the short run. The structure is typical of the realities for processors of seasonally produced crops, where the harvest season is high-utilization and processors' capacity is strained. To accommodate the peak season, the processor hires multiple shifts of labor, paying overtime or adding temporary work crews, resulting in increasing marginal costs if more volume is handled.

Figure 5: Supply of Marketing Services, and Impact of Cost Increase on Supply and Prices



Profit Maximization When Pasteurization is Required

Upon implementation of the Marketing Order amendment, the marginal cost function will change, and consequently, the marketing margin will adjust such that the handler maintains the previous level of profit. This logic is consistent with an environment of perfect competition and long-run zero profits in the marketing sector. First, consider a handling firm that outsources the pasteurization of a share of the almonds shipped (w, where $0 \leq w \leq 1$), at a charge of k per unit pasteurized. The firm-level supply function derived from the optimization is:

$$s = a + kw + 2bq.$$

The marketing margin for the handler will increase by an amount equal to the per-unit cost of treatment, multiplied by the share of the handler's production that is pasteurized under the Marketing Order amendment. Assuming no Direct Verifiable program, and 100% of shipments covered by the amended Marketing Order, w =1. During the transition year, w will depend on whether the handler participates in the Assurance program and whether the handler exports almonds, because exports will not initially be subject to the pasteurization requirement.

The shift in the supply function is shown by the green dotted line in the lower panel of Figure 5. At higher marginal costs, in order to handle the same quantity of almonds from growers, the price received for marketing services must increase to (Pr-P)'.

Adjustments in the marketing margin may fall on either the growers (through P) or the manufacturer-buyers (through Pr). The practice in the almond industry is for handlers to negotiate separate agreements with many growers and buyers: it is not common for the contract terms to be transparent. Sources in the industry differ about the incidence of the cost of pasteurization and whether the costs are borne by growers, handlers, buyers, or final consumers. It has been reported that some buyers have paid part or all of the per-unit increment for pasteurization, particularly when pasteurization had been the buyers' requirement. Given that the contamination issues for almonds began 5 years ago, we believe that most quality-conscious buyers of raw almonds already have begun to purchase pasteurized almonds or would have made other arrangements for treatment within their own manufacturing processes. Because the proposed amendment uses the mechanism of the marketing order at the grower-handler level to require treatment of those almonds not already pasteurized, it is not likely that the incremental costs can be passed on to buyers.

Industry-level Analysis

In order to demonstrate the industry-level impact, aggregate the supply over the 109 marketing firms handling almonds. Define Q = mq, where m is the number of firms. The parameter b' is adjusted for the number of firms operating. The aggregate supply is:

$$S = a + 2b'Q.$$

Industry-level pricing is determined by the interaction of the supply of almonds (after marketing services provided by handlers) interacting with demand from the manufacturers or retailers (Dr) (Figure 6). The initial situation of handlers supplying marketing services leads to a market price at retail of Pr.

Given this relationship between handlers and buyers, the demand function that growers face is derived as follows. First consider the handler-retailer interaction in the upper panel of Figure 6. At point 1, the final consumers' demand for processed almonds (Dr) intersects with the willingness of handlers to supply the marketing services that transform raw almonds into processed forms. On the vertical axis, the equilibrium retail price is determined, marked with the label Pr on the figure.

The equilibrium quantity marketed, and the connection of growers with the retail market are shown by examining the dotted vertical line. Following from point 1 down to the horizontal axis, the upper bound on grower-level demand (DD) is demonstrated. The supply of raw almonds is illustrated on the lower panel in the dotted line (S1). The intersection of the derived demand function (DD) with the supply of raw almonds (S1) determines the price that growers receive (P).

The maximum quantity purchased from growers is Q, the amount that handlers are able to sell to retailers. This quantity depends on the final consumers' demand for processed almonds (Dr) and the willingness of handlers to supply the marketing services that transform raw almonds into processed forms. The interaction of the derived demand function with the supply of raw almonds (S) determines the price that growers receive (P).

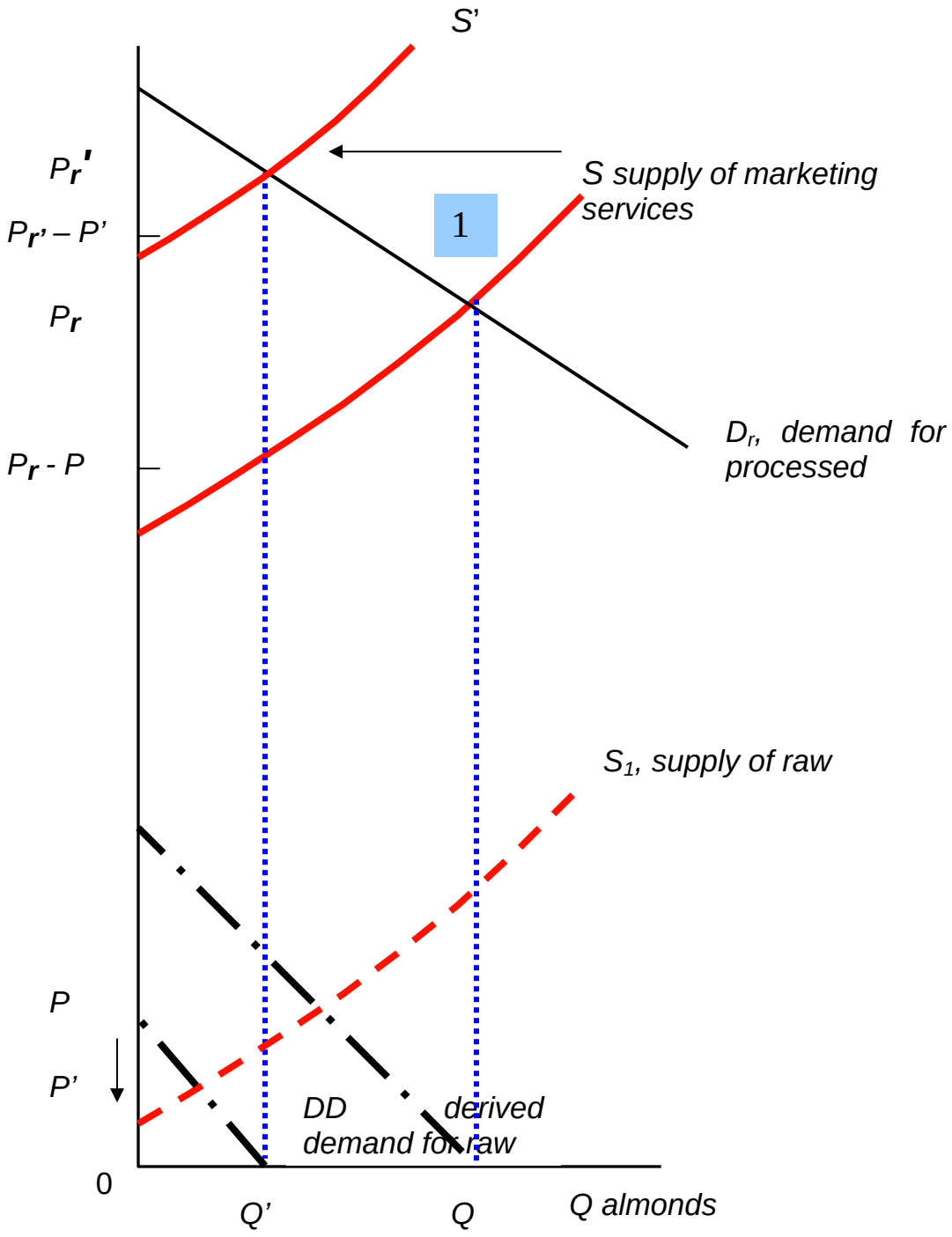
Under the MOA, handlers are required to provide an additional marketing service, namely, pasteurization. The additional marginal cost of the treatment is reflected by a backward shift in the supply function for marketing services (from S to S'). Assuming no change in retail-level demand for almonds, the reduction in supply of marketing services results in higher retail prices (Pr') and lower grower prices (P'), as handlers in the competitive market must cover the marginal cost of the treatment.

A mathematical representation of this graphical analysis is provided in the following section. Equations for equilibrium prices are derived mathematically. There are 4 endogenous variables in the 4-equation system:

$$
\begin{aligned}
Q_r &= \delta Q, \\
MM &= \delta P_r - P, \\
MM &= a + 2b'Q, \\
P_r &= d - eQ_r.
\end{aligned}
$$

The first equation is the physical transformation between the raw crop and the value-added product after marketing services are supplied by the handlers. The second two equations, where MM stands for marketing margin, describe the arbitrage relationship for prices. In competitive equilibrium, handlers' marketing margins are, by definition, the difference between prices received from buyers and the price that handlers pay to growers. The lower bound on the

Figure 6: Determination of Grower Price through Derived Demand



marketing margin is described in the third equation, which states that handlers must receive a payment at least as large as the marginal cost of providing marketing services. The last equation in the system is the inverse demand of retail-manufacturing level buyers. Those buyers will pay handlers a price that depends on the quantity of almonds that are demanded by the final consumer (Qr).

Because farm-level output Q is predetermined and exogenous in this system, and $\delta = 1$, after algebraic solution, the reduced form farm-level demand relationship is:

$$P = d - a - Q(e + 2b').$$

The Marketing Order amendment requires handlers to pasteurize the share of their output that had not previously been subject to that marketing service. The new incremental cost is represented by an increase in the parameter a. From the equation above, grower price is expected to decrease by the full amount of the industry-level shift in marginal cost due to pasteurization. The economic analysis indicates that additional costs which are not specifically requested by customers will be passed back to growers. The extent of the cost increase is estimated in the next section of the paper.

Estimated Cost from 100% Pasteurization at the Handler Level

While it is clear from the previous analysis that the marginal cost of pasteurization affects the equilibrium price received by growers, in order to estimate the effect, handlers' practices must be examined in detail. The procedure is to derive the cost-minimizing optimal demand for the inputs that are associated exclusively with the pasteurization alternatives. The constraint on the optimization problem is that some pasteurization treatment is required on all almonds shipped by handlers. In addition, the utilization of certain types of treatment is constrained by the existing capacity of facilities.

The incremental change in handlers' profit is analyzed, to isolate only those changes that are associated with the Marketing Order amendment (MOA). The "delta" notation is used on the handlers' profit equation to signify that only the changes due to the MOA are relevant:

$$\Delta\pi = \Delta(P_r - P)q - \Delta\sum_{i=1}^{k} V_i x_i - \Delta TFC.$$

To maintain the current competitive conditions in the handling sector, hold the change in total profit to equal zero. Total fixed costs (TFC) are also assumed not to change, because this analysis is for the very short run situation. Therefore, all the adjustments in costs will be balanced by a corresponding change in the marketing margin.

The cost of the pasteurization service enters into the model as new marketing services, represented in the summation term in the equation, where Vi is the cost per unit of various marketing services, xi. For the calculation, we add another subscript to distinguish the marketing services provided in-house from those provided on an outsource basis. Industry sources indicate

that the operating costs of pasteurization with installed equipment differ significantly from the charges for out-sourced pasteurization, because there is no transportation charge and no charge for returns to management on the in-house treatment. There are separate constraints on the model to reflect the existing capacity limitations on the in-house and out-sourced treatment opportunities.

Specifically for almonds, the key marketing services provided by handlers include:

Item
Pasteurization:
Polypropylene Oxide (PPO) treatment
Steam treatment[1] (a)
Steam treatment (b)
Blanch
Oil roast
Other marketing services:
USDA grading
Manufacturers' specifications
Brand
Consistent delivery
Packaging

[1]There are two types of steam/moist heat treatment facilities installed for use by almond handlers.

Each of these activities can be provided either in-house or on an out-source basis. Not every activity occurs for each transaction. The economic model for estimating the incremental costs from pasteurization at the handler level is a linear programming set-up, which identifies the treatments that provide cost minimizing methods for satisfying the MOA. The solution to the model indicates that handlers will use the least-cost treatment until its capacity is reached, then the next lowest-cost alternative will be used, until finally, the remaining required treatments take place as required by regulation, but at relatively high cost. The incremental variable cost from the MOA, at the industry level, is then calculated as a weighted sum of the cost of the treatment option multiplied by the volume that would be treated with that option, under optimal conditions.

Based on information from the Almond Board of California, 81% of the 1 billion pound almond crop is currently shipped without blanching or roasting at the handler level, and therefore would be subject to additional costs as a result of the MOA for 100% pasteurization at the handler level (ABC 2006(b) p. 10). This estimate of the share of the crop affected by the MOA does not take into account that some handlers already pasteurize almonds that are shipped raw (percentage of total crop is not available). At least two large handlers, who were involved with a product recall due to salmonella contamination, pasteurize a portion of their shipments, and others may also be voluntarily pasteurizing. The key economic factor underlying the industry-wide incremental cost estimate is the capacity constraint on pasteurization-specific treatments on almonds shipped in raw forms. The estimated capacities that can be treated are:

Treatment type	*Capacity*
	% total crop
PPO	
In-house	8.0
Outsource	17.0
Steam	
In-house	20.8
Outsource	17.9
Total	63.7

Assuming the current pattern of trade in terms of product forms continues (that is, nearly 20% of shipments blanched or oil roasted by handlers), then existing capacity is estimated to be adequate for approximately 83% of the almonds produced (Figure 7).

Alternatives for Treatment of 100% of Almonds at Handler Level

In order to estimate the incremental cost of 100% pasteurization at the handler level, we must make an assumption about the expected capacity and associated operating costs of treatment facilities that are not on-line today. There is a difference of opinion among industry sources about whether future development of treatment capacity will be in PPO fumigation facilities or in steam-moist heat facilities. Because the decisions to invest in these and other technologies cannot be forecast with precision, the calculations that follow take into account two distinct possibilities: that the new capacity is in PPO fumigation; and alternatively, that steam pasteurization is used for the new capacity needed to enable 100% pasteurization.

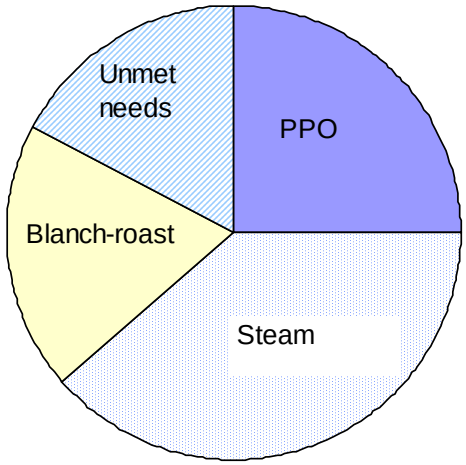
Steam and PPO capacity are estimated to be adequate for 64% of the almonds shipped, with steam treatment facilities' capacity exceeding PPO capacity at the present time (Figure 7). PPO has been approved by FDA as efficacious in reducing salmonella on almonds; steam treatments have not yet been approved by FDA[4]. At the time of this writing, capacity for treatment with steam or moist heat is being installed at a rapid pace. Two facilities are operational and 2 more are expected to be online during calendar year 2006; these facilities are included in the estimates of currently available capacity used in this study.

If PPO is used to treat the raw almonds for which there is not sufficient capacity, the PPO treatment (outsourced) is estimated to cost 7 cents per pound. This estimate is among the highest charges for treatment quoted by industry sources. In using this estimate, we are calculating the worst case situation for the handlers who must ship almonds a considerable distance to access the treatment. The total incremental cost of 100% pasteurization under this scenario is projected at $35.4 million in the first year, or 4.4 cents per pound.

Alternatively, steam treatment could become the option used to develop the capacity to treat 100% of almonds at the handler level. Assuming that steam facilities' capacity grows as the

[4] FDA's approval is necessary for labeling but not necessary for satisfying the proposed MOA.

Figure 7: Estimated Capacity for Almond Treatment Alternatives at the Handler Level, 2006



solution to unmet capacity needs, the incremental cost of pasteurization, industrywide, is expected to be 4.11 cents per pound, or $33.3 million in the first year.

The estimates above are based on capacities calculated with a 100-hour operating week. This is the maximum practical utilization that is anticipated from the almond-treatment equipment. Alternatively, if equipment capacities are assumed to be smaller, then the incremental cost of pasteurization is somewhat greater.

Annual Cost

Overall, the requirement for 100% pasteurization is expected to add an increment of $33 million to $35 million dollars to the annual cost of handling almonds industry-wide. The relative significance of this cost change is less than 2% of the total value of the almond crop ($2.725 billion, according to USDA Economic Research Service). When the per-pound cost is compared with grower prices, the relative impact is 1% to 3%, depending on what price is used for the comparison. The lowest relative impact of the cost change results from comparing the incremental cost of the pasteurization program to the record-high prices that were observed in May 2006. The higher end of the range is obtained from using the 10-year average grower price as the baseline.

Present Value of Costs of Ongoing Program

The expansion of the marketing order generates a repeated annual expense. When the requirement is in place, managers will seek options that minimize the costs; nevertheless, the basic production cost of pasteurization can be expected to recur in each year as long as the program is in place. The economically valid method of estimating the present value of a

repeated cost is a perpetuity formula, which converts an annual cash flow that recurs forever into a single value, discounted to today's terms (Brigham and Houston). The dollar value resulting from a perpetuity calculation depends significantly on the discount rate that is assumed to describe the time preferences of the agent facing the cost. The estimates in this study are calculated with two discount rates, to illustrate the sensitivity of ongoing program cost to the discount rate:

- 5%, which is a short-term rate quoted by industry sources and used in Almond Board draft investment calculations (ABC 2006 (b)), and

- 11%, following prior economic studies for the California nut industry (US Department of Agriculture 2004, Sumner testimony).

The higher discount rate is close to an up-to-date approximation of the cost of capital for US corporations, at 10%, reported in Fortune, July 10, 2006.
Using a relatively high discount rate (11%), the total cost in today's terms for the pasteurization program at the handler level is estimated to be $300-322 million. At a lower discount rate (5%), the present value of the estimated program cost is larger, from $666-708 million.

Limitations on the Estimates

Several simplifying assumptions that have been made in the optimization model of treatment capacity must be kept in mind as the cost information is interpreted. First, and most importantly, the cost estimates for pasteurization treatment are complicated by the fact that several different options are available, and managers can be expected to negotiate for the best terms of service. The handlers with large volumes will likely install equipment, if they have not done so already, and will be able to take advantage of lower marginal costs of treating in-house. Some handlers will be able to negotiate more favorable terms than the worst-case values included in this estimate.

An important factor in this estimate is how much incremental volume of product should be included in the costs attributed to the program. We are working from the assumption that all the almonds that are not now blanched or oil roasted will be pasteurized due to the new MOA, and the costs are attributed to the program. This assumption leads to an overstatement of the impact of the plan, to the extent that some handlers are already pasteurizing almonds before the amended Marketing Order is in place. We know this to be the case, ("increased use of PPO and other pasteurization technologies" is cited by ABC (2006(b) p. 11)) as part of the industry's voluntary action in response to salmonella outbreaks. However, it is not possible to determine the precise share of the shipments that are currently pasteurized without an extensive survey involving confidential business information.

The calculations are based on annual capacities of treatment facilities, estimated for a 100-hour work week. Specifics about location and timing have not been accounted for in this framework, therefore we are not able to draw conclusions about bottlenecks in the availability of services, or variations in the charges for out-sourced services that may arise as capacity is installed in various

locations across the production region. Some variations may be the result of competitive conditions, and others due to different charges for energy or other inputs in the location.

Assumptions about product form are also implicit in the cost estimate. It has been assumed that blanching or roasting will not increase as a means for pasteurization at the handler level, only steam or PPO treatment. There is apparently some excess capacity in blanching, according to industry sources, but the product form is changed to such an extent that we do not expect many buyers to switch to purchasing blanched almonds due to the MOA.

The cost estimates used as the basis for this model are quoted charges for out-sourced services, therefore we expect that service providers have already accounted for the cost of capital and we have not included an explicit charge for a capital rental rate. We have not taken into account the potential tax advantages from owning depreciable equipment. Nor have our estimates factored in potential increases in the costs of fuel or labor, which may lead to growth in the expenses associated with pasteurization.

In addition to the costs of the processing steps associated with pasteurization treatment, there will be costs associated with the management and documentation of the food safety assurance protocols that will become part of the amended Marketing Order. Some of those costs will occur at the handler-level in association with 100% pasteurization. Other costs are specific to an Assurance program, which is a component of the phase-in toward 100% pasteurization at the handler level. The costs of management and documentation of treatment are described in the next section.

TRANSACTIONS COST ANALYSIS

Economic evaluations of programs to assure food safety or quality standards must carefully consider the specific details of the assurance protocol and the management capabilities of the agents charged with implementing the protocol. Recent experience with the pistachio industry is a useful comparison (Alston, Brunke, Gray, and Sumner, 2005; Gray, et al 2005). The pistachio industry initiated a Marketing Order that was implemented at the handler level of the marketing channel. The pistachio Marketing Order set standards and required testing to detect aflatoxin, a mold produced mycotoxin that can cause cancer.

In an economic study conducted prior to implementation of the pistachio program, the testing protocol, associated inspection, and recordkeeping for the pistachio Marketing Order were estimated to cost less than a half cent per pound (US Department of Agriculture 2004, Sumner testimony). Tests were estimated to cost $75 each, with one test performed on each lot of 40,000 pounds for pistachios shipped to the domestic market (2/3 of the production). Recordkeeping was estimated to require 8 hours of staff time per year, based on experience from the peanut aflatoxin certification program.

The concerns about aflatoxin and the subsequent Marketing Order for pistachios are a starting point for understanding the transactions costs of the almond MOA, but key differences are to be expected. The salmonella contamination that has occurred in certain raw almonds over the past 5 years will not be addressed with a protocol based on testing (ABC 2006 (c)). Instead, a process

control approach to assuring safety is proposed in the amendment to the Marketing Order for almonds. A new step in the production technology will be added, with inspection and/or audits to verify compliance. The processing technologies that are acceptable vary, but each requires energy, labor, and transportation or handling. By the nature of the processing steps required to assure sufficient reduction in salmonella, the incremental costs of the proposed amendment to the marketing order will differ substantially from the estimated costs of the pistachio testing program.

Prior to the presentation of cost data, the economic concept of transactions cost is explained. The basic idea is that not all costs can be priced in the market using standard mechanisms to coordinate exchanges. The complication is in assigning dollar values to the most important transactions costs. It is especially difficult to estimate transactions costs with precision because there are many institutions, firms, and standards-making organizations that potentially could assist the industry in implementing safety protocols in a way that minimizes transactions costs, and it is impossible to predict which options the industry will choose for assistance in implementing the amended Marketing Order. Nevertheless, the economic approach of transactions cost analysis is useful in predicting the incidence of the burdens among the various participants in the supply chain.

Transactions Cost Theory

Market institutions are established to enable efficient arbitrage between buyers and sellers over geographic space, time (seasonally rationed supply using storage) and form (quality and safety over the minimum government requirements). Within these markets, if all diverse attributes are described by a single grade, then value is easily communicated through economic incentives (premia associated with desired attributes), and transaction costs associated with discovering and validating these supplies are minimized. Thus the margin between levels, or pricing points, in the supply chain can be explained by the cumulative sum of marketing costs, transaction costs, and quasi-rents.

Markets perform efficiently when price reflects all public and private information and serves as an accurate economic signal or representation of the value of the product being exchanged. If information is incomplete or one member of the exchange possesses more information than another party, then market power is asymmetric and opportunism is likely to occur (Williamson).

Prior to the 1990s, market-determined prices were relied upon to manage the exchange process for most agricultural inputs and products. An evolution has taken place over the last 15-20 years to include exchange mechanisms that are not fully coordinated or vertically integrated but which have some elements of fungibility as well as greater transparency of specific contract requirements for quality and safety (Jones). In increasingly global markets there have been increasing demands for information and assurances that go above and beyond the public sector requirements underlying commodity market exchanges. Coordination through contracts with an increasing number of specific requirements has resulted in proliferation of technology for quick tests for variety genotype and phenotype, residue, and production management practices.

This proliferation of supra-government standards necessitated a private sector response, which internalized the transactions costs associated with meeting market demands. The private sector response was to shift towards process verification rather than inspection as a means of enabling transactions in a more coordinated supply chain. Third-party agencies have assembled expertise to set agreeable standards and certify the process to the satisfaction of buyers and are considered reliable arbiters by both companies. Companies responding to these demands incurred the costs to access the technology for internal processes and record-keeping and the human capital through third-party certifications to gain (export) market access, and gained the potential subsequent quasi-rents if efficiencies and market share were realized.

Arguably a proportion of the transparency, traceability and assurance protocols used to verify contract requirements are based on consumers' perceived concerns rather than scientific constructs. In the market, consumers' perceptions regarding a product or company drive their purchase decisions, particularly in mature market economies.
Events that undermine consumer trust in numerous countries across the globe are quickly transmitted by digital media such that events appear to occur in the consumers' local market. Technical estimates of risk provided by experts rarely influence behavioral responses in the same way as consumers' perceptions of risk (Frewer et al). Slovic et al have demonstrated that consumer perceptions as to whether negative events were perceived as involuntary or accidental, controllable, or potentially catastrophic were more influential in determining consumer response than technical information alone. In multiple studies in Europe and North America, two factors appear to influence consumer trust:

1) the competence exhibited by the communicator and the ability to articulate information on the specific subject, and

2) the extent to which the communicator is honest and truthful in delivering the information.

Thus, consumers link accuracy and transparency of information and the communicators' apparent concern for consumer welfare with 'trust' (Frewer, 1996). The implications of these studies have been demonstrated globally in the past two years in relation to perceived food safety events that did not violate scientific limits of contamination. Coca-Cola Company was forced to withdraw its bottled water brand 'Dasani' almost immediately after launch in the UK market after levels of bromate were detected at above the legal limit, but below the levels of carcinogen considered dangerous by the scientific community. Similarly, in 2005 Nestle faced a dilemma in the Chinese market because certain of its condensed milk products exceeded China's legal limits for iodine but not those established by the World Trade Organization. After an initial "scientific" response to the market, Nestle responded with a recall of all products and replaced them with a product meeting China's limits.

Most recently, Cadbury has come under scrutiny from the EU Food Safety Agency (FSA) for not reporting a low level contamination of Salmonella sp. Montevideo for five months, even though the contamination was well below the company's limit for instigating a recall (Food Standards Agency). In January 2006, Cadbury had located a leaky waste pipe that had dripped into the chocolate 'crumb' mix that was used in a wide range of products. Cadbury did not inform authorities since the level of contamination was 0.3 cells per 100g; significantly below their

company standard alert level of 10 cells per 100g. An independent lab confirmed the presence of Salmonella at low levels. The laboratory forwarded the samples to the UK Health Protection Agency for confirmation of the particular Salmonella strain, but did not indicate the source of the samples. Cadbury decided not to initiate any recall procedures or notification to the FSA since the levels were considered to be too low to be a threat.

The outbreak of 50 cases of salmonellosis (Montevideo strain) in 4 months, versus 14 in a typical year, drew attention to Cadbury's testing program. The Salmonella Contact Group of the independent Advisory Committee on the Microbiological Safety of Food (ACMSF) concluded in June 2006:

> "The presence of salmonella in ready-to-eat foods such as chocolate is unacceptable at any level. End-product testing is not a suitable instrument for guaranteeing the safety of the food and a robust HACCP (Hazard Analysis Critical Control Point) needs to be in place. In order to give assurance about the absence of salmonella or any other pathogen in food a prohibitively large amount of product would need to be tested. However, even this would not guarantee absence of the micro-organism."

> 'Cadbury's risk assessment assumes that a threshold for infection can be estimated from previous outbreak data on levels of micro-organisms in chocolate. Such a threshold is not the same as the minimum infectious dose for salmonella in chocolate; no minimum infectious dose can be defined and infections may occur in consumers exposed to significantly lower levels than that seen in previous outbreaks. Cadbury's risk assessment does not address the risk of salmonella in chocolate in a way which the ACMSF would regard as a modern approach to risk assessment."

Statements in public that countermand the scientific integrity of established standards explicitly undermine a company's position and their ability to sustain consumer trust. Thus, Cadbury announced a (voluntary) recall of seven leading products. The revenue losses will include the lost product sales from recalled products (direct) as well as lost sales due to loss of reputation and consumer confidence and trust[5]. The cases cited demonstrate the fragility of a company's market access when safety standards are not well aligned with consumers' perceptions. The risk that demand may be disrupted justifies the pathogen control objectives behind the proposed Marketing Order amendment for almonds. It must be kept in mind that the various compliance measures are often the source of transactions costs, above and beyond the operating expense of a pathogen-reduction treatment. A key factor in this study is whether transactions costs associated with activities that sustain consumer confidence in almonds are internalized at one segment of the supply chain, shared by participants across the chain, or transferred downstream to the consumer.

[5] J.P. Morgan Cazenove estimate costs of around $9-10 million in recall costs and a further $35 million in lost sales due to the negative impact on reputation and consumer trust.

Furthermore, while there are short run costs of investment in technology, there may be longer run quasi-rents associated with relational governance of the company's supply chain, particularly in markets with more stringent requirements or more knowledgeable and discerning customers. The extent to which relational governance is altered by the specific requirements in the Marketing Order amendment (MOA) will be a key consideration in the efficiency of implementation. Particularly, it is worth noting to what extent the MOA places burdens on the agents in the supply chain that have less management capacity to respond.

Response to accidental contaminations in conjunction with raised concern regarding the potential for deliberate contamination of food supply chains has elicited an engagement of corporate management with risk assessment. Reactive approaches to contamination events involve levels of uncertainty regarding consumer response and potential liability that may put the company at financial risk. Consumers in mature market economies have increasing levels of expectation with regard to the extent of due diligence performed by companies and decreasing tolerance for outcomes that are perceived as protecting revenues at the cost of the consumer.

As the estimated costs associated with lost trust and reputation increase, companies are more willing to invest in proactive strategies regarding food quality and safety that will protect the revenue stream. The resulting public and private protocols have evolved as a mixture of process verification and product inspection (Table 1). Legislation is on many levels:

- global (Codex Alimentarius),

- multi-national (the EU General Food Law in January 2005 as well as the formation of an umbrella EU Food Safety Agency), and

- national (USDA's Agricultural Marketing Service, the Food Safety and Inspection Service and the Food and Drug Administration, or Canada's Food Inspection Agency).

As an example of the global character of these oversight bodies, consider the history of SQF ("Safe Quality Food"). SQF was founded by the Western Australia Ministry of Agriculture, then developed into a nationwide entity in Australia, certifying protocols of food manufacturers. As its reputation grew, SQF was brought to the United States. SQF served as the certifying agency for the Washington apple growers. Later, it went independent of Australia and located in Geneva, Switzerland. This move presumably allowed SQF to enhance its linkages with ISO (International Standards Organization). Most recently, SQF was purchased by the Food Marketing Institute, a trade association and lobbying organization of food retailers. SQF is now headquartered in Washington, DC. Many other reputable standards and certification organizations exist (Figure 4, see page 6), and could play a role in minimizing the transactions costs of food safety assurance in the almond industry.

Public agencies are mandated to ensure safe food and legislation is founded on scientific technical standards that are used to establish thresholds of acceptable risk that can be verified by sampling and inspecting product from segments of the supply chain. In most cases the thresholds are not based on zero tolerance for contaminant presence, and are established based

on the probability of an event occurring and assessment of the severity of the outcome. The information on thresholds and other minimum standards lowers the short run transactions costs associated with facilitating markets. With clear scientific standards, all agents in the market can identify the target, reducing the effort in searching for agreeable measures. Transactions costs with respect to processes by which to attain the standards may still occur, even when standards are agreed.

It is ironic that scientific standards that clarify minimum performance, thus reducing transactions costs, have the potential to become a source of additional transactions costs. The unintended consequence occurs with the proliferation of private standards and certifying entities. Standards proliferation occurs particularly where relatively small industry sectors or regions of production invest in specialized assurance protocols that do not meet the globally recognized standards, such as those in Table 1.

However, full harmonization is not universally desired since many of these protocols create competitive advantage. For example, the Sustainable Agriculture Initiative (SAI) and Fairtrade designations are used to convey additional information over and above that indicated by BRC or SQF, and as a result, generate higher profits from consumers willing to pay for these special attributes.

Business decisions on risk exposure must balance the long run benefit to their reputation, brand names and consumer trust and loyalty, of incurring higher transactions costs to exceed publicly established minimum standards. The result will be to sustain current markets and enable expansion into markets that may have different thresholds for contaminants (Jones, and Bailey and Jones).

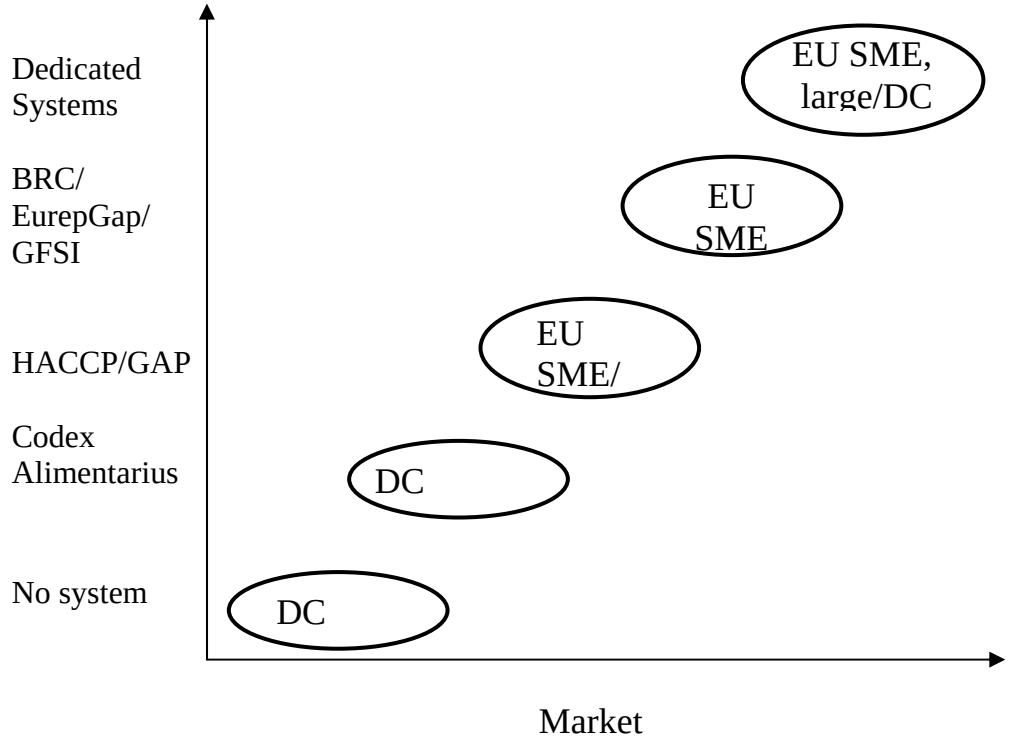
In the global food sector, it is expected that companies in mature market economies have the means of meeting private standards more effectively than those in emerging and developing economies, and that this conveys competitive advantage (Figure 8). Upstream producers and handlers in mature economies have public (tax payer) support to meet minimum standards of food safety and quality, and companies mid- and down-stream therefore have indirect support in meeting higher private standards. In contrast, emerging and developing economies do not have the tax base to fund public assurance of minimum standards and therefore businesses have to cover the entire cost of meeting private standards in order to gain market access.

Before providing estimates of transactions costs expected from the almond MOA, the implementation and administration of the 100% handler-level pasteurization and the assessment program must be understood in detail. Figure 9 illustrates the relationship of the Almond Board in oversight of the handlers and scientific experts to carry out the 100% pasteurization program, which is expected to be in place for 2008 and later. The protocols and processes are described, with special attention to the extent to which third parties' expertise can substitute for handler management and Almond Board personnel without impairing the quality of the assurance system. Because those third-party experts are specifically trained and specialized in quality assurance, they can reduce transactions costs in implementing a new industry-level program.

Table 1: Selected Food Quality and Safety Standards

Generic Standards	Target Segment of Supply Chain	Key Features
Good Agricultural Practices (GAP)	Agriculture – farm level. Focus on technology and management.	Identification and documentation of production, harvesting, storing and transportation practices.
Hazard Analysis and Critical Control Points (HACCP)	Target from farm to retail and food service. Focus on technology and management.	Basis of most assurance protocols, eg. Codex Alimentarius, EU and US food legislation and most private standards. Based on 7 principles to ensure control of identified hazards, avoiding reliance on end-product inspection.
International Standards Organization (ISO)	Independent of any industry or segment of the supply chain. Focus on management.	ISO 9000 establishes procedures for all activities with clear assignment of responsibilities and authority. ISO 22000 is a new standard covering the whole food chain and incorporating both HACCP and GAP requirements.
Private Standards		
Eurep Gap	Focus on upstream management of human and environment resources as well as food safety and quality.	Organization of over 20 large EU retail, foodservice and distribution companies, including Tesco and Ahold, with protocols including environment-friendly, safe, and high quality. Norms are more stringent than EU government legislation.
British Retail Consortium (BRC)	Food processing and distribution.	Formed in 1998 by leading retailers, such as Tesco and Sainsbury, to harmonize criteria/standards and facilitate common inspection across member companies.

Figure 8: Market Access for Producers Using Different Food Safety Standards



where DC = developing country, SME = small and medium enterprises

Source: Trienekins 2006.

Another key consideration is the distinction between initial costs to set up the program, and the costs of renewal. Certain management routines are easily executed, once the planning and engineering of the production processes are in place. The effort is analogous to learning to ride a bicycle; risk and pain during the learning process, followed by smooth sailing once the systems are in place. Other activities generate ongoing costs in each year and the cost difference between the initial year and subsequent years is not substantial. Audits, for example, generate repeated expenses over time which cumulatively adds to the present value of the costs of the program.

In the following section of the report, we outline the transactions costs that are expected with the fully implemented MOA, effective on 100% of almonds with handler-level pasteurization only (no assurance). The information on incremental production costs from the previous section, when combined with transactions costs information, achieves Objective 2, to estimate the costs to the industry, in accordance with the Action Plan, of 100% pasteurization at the handler level, with the elimination of the Assurance program as of August 2008. The transactions cost of the Assurance program are provided in the subsequent section, which achieves Objective 1 of the study.

Methodology of Transactions Costs Estimates

The purpose of the transactions cost analysis is to differentiate the burdens of the program according to the agent in the supply chain who experiences the direct cost. Through negotiated contracts with respect to prices or services, the agent facing the direct cost may be able to pass on the charges to other parties in the supply chain. The extent to which costs can be passed along depend on many factors particular to the business relationship, and we will not attempt to predict them. Nevertheless, the estimates of transactions costs are useful in determining the burden, or "hassle factor," involved with the pasteurization requirement as it is expected to be implemented.

Given that we cannot forecast how many participants there will be, alternative estimates of the transactions costs will be provided for scenarios reflecting a range of companies choosing to participate in the assessment option.

Initial transactions costs of the program in year 1 are presented, along with a separate estimate of the annual expenses of maintaining pasteurization processes and certifications. Some of the most significant transactions costs are in initial validations and in organizing management routines toward the process verification approach. Once these processes are in place, there is less effort in maintaining the routines over subsequent years. This maintenance or renewal cost is converted to a total cost in today's terms using the financial formula for perpetuity. The perpetuity approach has the advantage of accounting for time value when estimating the burden of costs that are expected to persist into the distant future, as would be expected in a program that becomes established business practice. By definition, this calculation assumes the incremental transactions costs persist forever, and as such, will yield an upper-bound estimate.

The dollar value resulting from a perpetuity calculation depends significantly on the discount rate that is assumed to describe the time preferences of the agent facing the cost. The estimates in this study are calculated with two discount rates, to illustrate the sensitivity of ongoing program cost to the discount rate:

- 5%, which is a short-term rate quoted by industry sources and used in Almond Board draft investment calculations (ABC 2006 (b)), and

- 11%, following prior economic studies for the California nut industry (US Department of Agriculture 2004, Sumner testimony).

The higher discount rate is close to an up-to-date approximation of the cost of capital for US corporations, at 10%, reported in *Fortune*, July 10, 2006.

A case study research design was used to identify the complementarity of existing business practices with the requirements of the amended Marketing Order for almonds. A common topic framework for all participants was employed, with open-ended questions and specific follow-up as needed, following Bailey and Jones (2004) and Yin (1994). As with any company-specific research, the limits on the generalizability of these results to the industry must be taken into

account, particularly given the diversity of firm size and management strategies known to exist across handlers and the customers.

A key aspect in the burden of transactions costs is whether the handler has invested in in-house treatment equipment, which will need to be validated and tested on a regular basis. To some extent, the investment choice is related to size of the firm; that is, very small handlers are unlikely to find it economically feasible to install equipment. Separate transactions costs models have been developed for those handlers who invest in owned equipment and those who exclusively utilize pasteurization as an outsourced service. The payments for operating costs of pasteurization services are not included as a transactions cost; instead, they are operating costs as estimated in the previous section of the report. Transactions costs are estimated separately for the Almond Board of California, handlers, and major buyers participating in the Assurance program.

Description of Handler Pasteurization Requirements

To assure that each handler is providing for almonds to be pasteurized before they reach consumers, the Almond Board will require detailed handler treatment plans. Almond Board staff will receive the detailed handler treatment plans and they will be reviewed by staff and USDA. The plans will specify what type of approved treatment that the handler will use, and whether it is in-house or out-sourced. The comprehensive protocol involves a complex review in that it takes into account the movement of the incoming product, the operating environment in which the product is being treated, the HACCP measures to avoid cross or post treatment contamination, labeling, etc. All 109 handlers will be filing these applications for protocol approval with the Almond Board, in May of each year.

For the handlers who plan to utilize their own equipment for pasteurization, protocol approval will include validation of the technology and equipment, to assure that it accomplishes the required pathogen reduction. The protocol approval of the pasteurization technologies is relatively simple because it is well-established which treatment process or processing activities accomplish the required reduction in salmonella pathogens. Handlers will arrange for validation of their technology and equipment by a Board-approved process authority (PA), a science-technology expert. The Board will accept the determination of the PA regarding acceptability of the equipment. Handlers will pay the PA directly for their technical assistance in equipment validation.

Upon approval of the protocol as a scientifically valid method to reduce the risk of salmonella contamination, the task is to assure that the protocol is carried out appropriately. We refer to this aspect of assurance as process verification. Process verification activities are on-going, information intensive, and potentially time-consuming. Inspection or auditing of the pasteurization treatment phase of operations is the primary approach to process verification in the proposed amendment to the almond Marketing Order. Periodic audits may be used instead of on-site inspection. The personnel involved in the inspection or auditing will be the USDA inspectors who currently assure compliance with the Marketing Order for almonds and other quality Assurance programs authorized by USDA.

Estimated Transactions Costs of 100% Pasteurization with No Assurance Program

In terms of documentation and recordkeeping costs of the Marketing Order, the proposed pasteurization amendment is a new component to a previously existing monitoring system. Under the Marketing Order, almond handlers already register annually and report receipts and shipments monthly to the Almond Board of California, so that the additional documentation and reporting requirements for pasteurization will be familiar in some respects. Nevertheless, search and transactions costs are expected to occur as handlers identify technical experts to certify pasteurization processes and document the new activities involved with pasteurization. These costs will be higher or lower depending on whether a third-party audit program is already in place and whether that third party can also serve as the certifier of the new pasteurization activities.

There is wide variation in the current industry practices that are required to gain certifications of standards or processes in handling of almonds. Variation is to be expected when buyers' requirements differ, regulatory regimes in export markets can vary, and handlers compete over costs, services, and quality attributes. As an example of the variation in costs of certification, consider export phytosanitary certificates, which are required by governments in some almond-importing countries. These are supplied at low cost by the county agriculture commissioner, no lab test is usually required, and documentation on a company letterhead is acceptable. By contrast, a USDA quality certificate, which is not required but is requested in some buyers' contract specifications, involves a formal inspection and sampling from a packed load. The cost for this service is estimated at $80-100 per load, plus the time devoted to scheduling an inspector.

Inspections of almonds arriving at handlers' facilities are routine, with a USDA inspector on the premises. These inspections are for grading and compliance with the Marketing Order, and handlers pay the inspection fees. The cost of this service varies with the size of the handlers' operation. Moreover, handlers may choose to use an approved audit-based certification system and substitute in-house staff and management for part of a USDA inspectors' time.

These examples of current industry practice demonstrate that "one size does not fit all" and that the transactions costs reported in this report must be considered as a general guide. The activities for which we estimate transactions costs that will be borne by handlers are:

- technology and equipment validation,
- documentation and record-keeping,
- planning for treatment of shipments, and
- auditing or inspection of treatment activities.

These activities are key parts of a process-verification approach to assurance, which is necessary for a situation where testing of the final product is not feasible for safety under commercial conditions.

Technology and Equipment Validation

The transactions cost of technology and equipment validation for a pasteurization treatment process is estimated in two ways: one for a newly operating facility and another for facilities with substantial operating experience and accepted technology. For new equipment, the transactions cost of the validation is high, because operators and managers are using technical assistance in order to become familiar with operational parameters of the new equipment. In part, the technology validation of a new installation is closely intertwined with training costs, which have been found to be important elements determining the cost efficiency of food safety protocols (Colatore and Caswell, 2000). High levels of scientific expertise are required to validate the effectiveness of pasteurization facilities in achieving pathogen reduction for salmonella. Experimental trials are typically scheduled over several days, to include a range of conditions and satisfy minimum testing parameters. Laboratory tests and materials are a major part of the cost estimate used (up to

$8,500 is estimated, for each validation). Time involved for the senior scientist and laboratory technicians is expected to be at least 70 hours. This time is devoted to experimental designs, tabulation of results, and report-writing, which are all essential for the validation to be auditable. In total, as a worst-case cost estimate, the validation of new technology and equipment is expected to cost up to $20,000, with a typical range of $13,000-$18,000. Costs may be different depending on number of pasteurization equipment lines and other specifics of the equipment installation.

Handlers' staff and management personnel also are expected to dedicate time to assisting the scientist, around 3 days each, as the equipment is validated for the first time. When the handlers' effort is added to that of the consulting technical experts, the estimated industry-wide costs for intensive technology and equipment validation in the first year would range from $0.5 million to $1.3 million. The wide range in this estimate is due to different expectations of the number of handlers choosing to invest in the new equipment. There is no direct technology validation cost assigned for those handlers that out-source instead of installing in-house treatment lines.

The intentions of the Almond Board are to identify acceptable pasteurization technologies so that the high intensity of pathogen control verification described above will not need to be demonstrated. For a modest technical effort in validating that the equipment is meeting specifications of an approved treatment, the initial cost industry-wide for scientific expertise in validation in the first year is estimated to be no more than $200,000.

Renewals to certify the satisfactory performance of equipment in place are less costly than the validation of new processes and installations. It is expected that 10 hours of experts' time and 12 hours of handler personnel effort will be required to maintain the certification status of technology and equipment. The cost per handler to renew equipment certification of an established technology is estimated at less than $2,300 each.

Of course, the number of handlers choosing to install their own equipment by 2008 will be a key driver in the estimated technology and equipment validation cost. The assumptions underlying the scenarios are:

- 27 (the number of large handlers moving volume greater than 10 million pounds per year) (ABC 2006 (b) p. 10), or

- 66 (the number of handlers who indicated to ABC in a survey that they intended to install equipment in-house) (ABC 2006 (b) p. 20).

The industry-wide total technology validation cost estimates vary according to the number of handlers assumed to install equipment (Table 2)[6]. If it is assumed that many handlers install in the first year, and they are all proving new technology, the worst-case transactions cost of technical validation is $1.3 million. A more likely estimate is that technology validation costs are less than $100,000. This lower estimate results from the fact that the technology itself has been pre-approved by TERP to achieve the required pathogen control.

Upon installation, the validation is only to verify operational status, and full-scale pathogen control testing on site is not required. It should be noted that technology validation is an important activity in the first year, with renewals being less difficult in terms of transactions costs.

Documentation and Record-keeping

Approval of a documented traceability program for handlers will be required, adding a modest amount to transactions costs. Lot sizes of almonds to be pasteurized are large (44,000 pounds); hence it is unlikely that there will be substantial detail for documenting a day's work in the treatment step. Record-keeping for machine-controlled processes is not difficult, because nearly all processing equipment has automated computerized controls or can easily be retrofitted with documentation modules.

Documenting product flow in and out of the facility will also be required; this activity involves more individual effort by managers or other staff at the handler. If handlers out-source treatment, then choose to bring pasteurized almonds back into the facility for packaging, there will be a need for separate product lines and inventories for pasteurized or un-pasteurized product. Documentation of separate inventory is not expected to be a significant transactions cost to handlers. In order to comply with the Marketing Order, handlers routinely document shipments of inedible almonds and the ABC compliance personnel verify that quantities are consistent. Moreover, handlers (like all food processors) have obligations under the Bioterrorism Act of 2002 to have a program of one-step-forward, one-step-back traceability. Some handlers are already managing inventory separately in order to ship un-treated almonds under a voluntary Direct Verifiable program.

Due to these industry practices and existing federal law, it is not anticipated that the MOA requirement of documented traceability programs will add substantial new costs. We estimate 3 hours per month of handlers' staff effort for the additional recordkeeping. The yearly cost estimate is approximately $130,000 industry wide ($32,000 for the 27 handlers who own equipment and $98,350 for the remaining 82 handlers using out-sourced services). Time spent

[6] As of August 2006, industry reports indicate that approximately 40 handlers intend to install equipment for in-house pasteurization.

Table 2: Estimated Technology Validation Costs in Year 1 for 100% Pasteurization at Handler Level

Item	Scenario			
Technology and equipment validation	**High-intensity validation**		**Low-cost validation**	
	n=27	n=66	n=27	n=66
---In-house	$0.5 million	$1.3 million	$80,000	$200,000
---Out-source users	$0	$0	$0	$0

on record-keeping is estimated to be the same for small handlers as for large handlers, and the same in each year the program is in effect.

Handlers' Treatment Plans

A major change associated with the MOA will be the requirement that handlers plan in advance for pasteurization treatments that will be used on that year's crop. Handlers will be required to submit annually (in May) a plan for treatment of the crop (to be harvested in August). The handler treatment plans (HTP) will specify:

- what activities will be used to pasteurize almonds,
- which process authorities will validate the technology,
- lot coding system and segregation of treated from untreated almonds, and
- what verification of the treatment will be used.

In order to submit the HTP, handlers' staff will experience search costs of procuring pasteurization capacity (in-house or out-source), planning for technology validation of their in-house treatment activities, and time to write the plan that explains their treatment and its documentation. The drafting of the plan will be a new activity for most handlers' staff. Some will choose to hire a technical expert to complete this task. Other handlers already employ personnel who handle a variety of regulatory compliance tasks, and the time for developing the HTP will become an additional task. ABC personnel expect to require full documentation in the HTP submission. Electronic and paper options for submission will be used.

For large handlers, the cost estimate for developing the HTP is based on 80 hours per year (ABC 2006 (b) p. 23), split between staff and management personnel. Assistance from an outside consultant (20 hours) is also included in the estimate of larger handler's costs to develop and submit HTPs. The estimated cost in year 1 is approximately $6,000 for each handler that operates in-house pasteurization equipment.

Handlers who are out-sourcing all treatment have less complex HTPs, but still report the plans for delivery of product to an approved validated treatment facility. Many handler operations are

small and operated somewhat informally. For example, 2006 is the first year in which every handler used a FAX machine, according to ABC compliance staff. A majority of handlers submit their monthly reports to ABC in paper formats, rather than using an e-mail option. While these small handlers do not account for a large share of production, and the plan may be fairly simple, the burden of writing the plan is expected to be relatively high. The cost estimates are based on at least 20 hours of staff time, and 10 hours for hiring an outside consultant to assist in planning the traceability program to be used. The cost per small handler to develop the HTP in year 1 is estimated at approximately $2,500.

	Handler treatment plans	
	Year 1	
	n=27	n=66
---In-house pasteurization	$81,000	$420,000
---Out-source users	$150,000	$80,000
---Almond Board	$100,000	$100,000
Total	$331,000	$600,000

Auditing or Inspection

The proposed pasteurization requires that handlers have audits of their treatment protocols at very high frequency, particularly when the program is first launched. Audits are monthly, initially, transitioning to quarterly, and finally, a successful handler can expect audits at least every 6 months. Six audits are included in the cost estimates in the first year of the plan, for each handler, and two per year in the subsequent years. This estimate does not take into account the chance that a handler will fail audits and revert to a monthly audit schedule.

Audits will be conducted exclusively by USDA (Federal-State Inspection Service) personnel, which is required under the Marketing Order, according to ABC staff, these personnel are already present in the almond industry in various capacities, inspecting for grades and Marketing Order compliance. The proposed amendment permits handlers to choose to use an inspection program that is certificate based, meaning that an inspector will be required to observe the pasteurization treatment.

An audit-based verification program using USDA personnel is far less costly than a certificate-based inspection (Table 3, ABC 2006 (b) p. 24). For the smallest handlers, a certificate-based program is expected to be more than twice as costly during the first year of intensive audits, for a cost advantage of more than $2,000 in that year. The advantage of audit-based systems is even more significant for larger handlers, around $4,000 for audit-based compared with $510,000 for inspection. The cost difference will be a powerful incentive to maintain satisfactory audit performance, because the penalty for repeatedly failing an audit is to be required to have certificate-based inspection.

In addition to the charges for auditors' time and travel to the handlers' facility, the transactions cost estimates also include operator time and management effort during the time that the audit

Table 3: Expected Annual Cost of Certificate-Based and Audit-Based Oversight

	Size of handler (in pounds)		
	100-2 million	2.1-40 million	More than 40 million
Certificate	$4,080	$81,600	$510,000
Audit			
Hours per audit	3	5	8
Tier 1 (monthly 3 months)	$809	$1,277	$1,979
Tier 2 (quarterly 3 qtrs)	$809	$1,277	$1,979
Total first yr (6/year)	$1,618	$2,554	$3,958
Second + yr (2/year)	$539	$851	$1,319

Source: Author's calculations based on ABC data (ABC (b) p 24).

takes place. In order to be prepared for successful audits, handlers' management must be committed to record-keeping and documentation of the pasteurization operations. For handlers using their own treatment, the automated records of machinery operation will provide an auditable record. Those handlers that out-source to an approved treatment location will maintain documentation of the shipments to the treatment location and the records from the treatment service provider. This is a more complex record, and may be in paper formats that require more time consuming audits. These smaller handlers are expected to devote 5 hours per week to preparing for audits during the busy season (Aug-Dec.) for a total effort of approximately 100 hours. We have estimated that audits take 16 hours each for smaller handlers, allowing extra time for the paper records to be examined. The estimated timing requirements for handler personnel in preparing for audits are shown in Table 4.

Because of the economic incentives in favor of audit-based systems, the cost estimates shown in the summary information in this report are under the assumption that all handlers maintain an audit-based system. The cost of the outside auditor is estimated at $80 per hour, based on USDA sources, which is far below the hourly auditing cost typically charged by other third-party assurance agencies. In spite of the low-cost audit personnel, the planned high-frequency of audits results in transactions costs of at least $1 million in the first year. Once the program is established, audit cost for almond handlers is approximately $400,000 per year (based on 2 audits per year, for each handler).

While it is possible that some inspection of the treatment can be timed so as to occur at the same time as delivery of an incoming shipment, it is more likely that handlers will treat their almonds closer to the time of outgoing shipment. As a result, the transactions cost estimates are based on the premise that inspection or audit of pasteurization is an incremental cost and there is no complementarity with the existing Marketing Order compliance.

Table 4: Annual Hours for Each Handler Assumed in Estimated Transactions Costs of 100% Pasteurization at the Handler Level

		Out-source	In-house
Handler treatment plan (handler staff + hired expert)	Per year	20+10	80+20
Audit (handler staff + USDA auditor)	Per audit	28+16	14+8
Traceback (record-keeping 3 hrs/month + annual mock recall)	Per year	44	44

Some almond handlers have voluntarily established audit-based certifications under general quality assurance standards, including USDA's Fresh Produce Audit Verification Program (US Department of Agriculture, Agricultural Marketing Service) and AIB (American Institute of Baking). These companies have developed management routines that will enable them to comply with the audit program for pasteurization more easily than other firms that are not accustomed to documenting their processes in this way. The firms that reportedly have passed audits to indicate compliance with FDA's "Guide to Minimize Microbial Food Safety Hazards for Fresh Fruits and Vegetables," earning USDA's certification of Good Handling Practices in 2006, are:

- Diamond Walnut Growers
- Farmers International, Inc.
- P-R Farms, Inc.
- Panoche Creek Packing Corp.
- South Valley Farms

Because audits under the proposed MOA can be performed only by USDA personnel, these firms that already have successfully completed audits under USDA's standards will have an advantage in terms of understanding some aspects of the program requirements. The addition of the pasteurization step likely will add minimal cost to these audit programs.

In contrast, the handlers who have chosen other national or international certification programs will face the prospect of a duplicative audit for pasteurization because the audit personnel from other agencies will not be acceptable under the proposed MOA. While we believe that USDA personnel's charges for audits will be the lowest available in the market, it is an economic disadvantage to be required to have an additional audit rather than to incorporate pasteurization as a control point in an audit performed by another reputable third-party certifier.

Summary of Handler Transactions Costs

The total transactions cost associated with the 100% pasteurization requirement are estimated to range from $2.6 million to $6.2 million, depending on numbers of handlers that need to have the technology verified. If capacity needs are satisfied with fewer than 27 new installations, the transactions costs are likely to be significantly lower in the first year of the program. The key driver in the handlers' transactions costs after technology is in place is estimated to be the

auditing program. To the extent that complexity in the auditing system can be reduced, the transactions costs will be lower than this estimate.

While the Marketing Order Amendment for 100% pasteurization is being phased in, un-pasteurized almonds may be shipped to approved customers, so long as there is a pre-arranged program to assure that the almonds will be pasteurized during the customer's production routines. This program is called the Assurance program. Its features and the expected transactions costs of the program will be described in the next section.

Description of Assurance Program

The key businesses involved in this program are the buyers (manufacturers using almonds in further processed products) and the handlers. The buyers' side of the assurance transaction is much more complicated than the handlers' role, because the buyer is charged with providing assurance of the treatment required for product safety. The specifics of the program, as it is currently expected to be implemented, are described in this section of the report (Figure 10). A key consideration is the extent to which buyers' personnel and third parties can substitute for the companies' and the Almond Board's direct time and management without impairing the quality of the assurance system.

Buyer Side of Program (Manufacturers)

Manufacturing firms that wish to participate in the program will be required to demonstrate ability to "ensure untreated almonds will be subjected to a validated treatment process or processes which will achieve a 4-log minimum reduction of Salmonella prior to moving into consumer channels." (ABC, 2006 (d)). Among the specific requirements are (1) to have the treatment protocol approved in advance; (2) to validate the technology and equipment used to provide the required pathogen control; (3) to maintain an ongoing process verification system to assure that the protocol is implemented in a satisfactory way; and (4) to document and maintain records of the untreated almonds received and the treatment processes. Figure 10 illustrates the approvals required for participation in the program.

Protocol approval will take place under the purview of the ABC's technical expert review panel (TERP), by a Board-approved process authority or by the FDA. Because there is flexibility in protocol approval, manufacturers may choose an option that meets their needs most efficiently. The transactions cost estimates depend in part on the share of manufacturers that choose each of the three alternatives.

First consider a manufacturer appealing directly to the FDA for approval of a protocol. The costs of protocol approval will be borne by the FDA or likely recovered via user fees from the manufacturer applicant. A letter issued by the FDA will be acceptable to ABC. A second option for assurance protocol approval is for a manufacturer to retain a Board-approved process authority (PA). Upon acceptance of the protocol by the scientific experts, the manufacturer fills out the assurance application form and submits it to TERP.

Protocols must be renewed annually under a permanent Assurance program. Renewals are expected to be less intensive than an initial application, but it is possible that manufacturers will change operations substantially during the life of the program, triggering a more intensive review of an application for renewal.

Technology and equipment verification is also a part of protocol approval. This phase of assurance will require input from scientific or technical experts, selected by the manufacturer from TERP-approved process authorities. The equipment verification will take place on the assurance user's premises. The global reach of almond shipments suggests that there will be a need for multiple experts to be available in several countries to perform technology validation (see Figure 4).

Upon approval of the protocol as a scientifically valid method to reduce the risk of salmonella contamination, process verification will involve a documented product traceability program and an audit program of the pasteurization treatment. Audits by personnel who have been pre-approved by the TERP will take place at least once a year.

Seller Side of Assurance Program (Handlers)

Handlers wishing to participate in the program do not need a pre-approval process for the Assurance program. The handler will simply request the code from the ABC, which will be available for manufacturers that have previously qualified. There may be instances in which a handler identifies a buyer who has not already been approved for assurance. In those cases, there will be a delay and some transactions cost effort while the handler waits for the manufacturer to qualify for an Assurance program.

Handlers will experience only limited process verification activities under the assurance program. The main role of handlers is in traceability activities, in order to document any shipments of un-pasteurized almonds. On the shipping documentation for un-pasteurized almonds shipped under assurance, handlers must include the user code. The records of the assured shipments must be maintained for two years and are subject to audit by the ABC.

Estimated Transactions Costs of Permanent, Global Assurance Program

An understanding of the transactions costs of participation in this program must take into account the possibility that the participants will have an opportunity to leverage the requirements of other assurance systems that are already in place. Food processing firms are highly sensitive to quality assurance. There are a variety of options for assurance of safety and quality under current law, some of which are government-imposed and others that have been implemented by firms under the oversight of well-known global or national certification agencies.

The major buyers of almonds use them in a variety of products and distribute value-added products through several different channels to reach the final consumer. The estimates of the transactions costs for the permanent, global Assurance program provided in this report do not take into account all of the specifics of implementation, and as such, must be considered as a general guide. The key activities for which we estimate transactions costs of the program are:

- technology and equipment validation,
- planning for treatment of almonds,
- documentation and record-keeping, and
- auditing of processing activities.

Technology and Equipment Validation

Manufacturers' facilities have a record in production, and it is likely that the company's protocols include verification of the operating capabilities of the technology and equipment. Operational checks are likely already being made for a variety of purposes. Temperatures, pressures, and the like are closely controlled in many food manufacturing processes. Equipment is likely to be technologically advanced, with easily accessible electronic documentation as a matter of course.

In spite of being prepared and aware of process control and quality assurance issues, manufacturers will face transactions costs because the specific pathogen-reduction process for almonds will be a new requirement for some firms. Confectionery, bakery, and snack food items have not generally been considered high risk for salmonella. Some manufacturers may be doing little to change product form, instead specializing in branding, flavoring, or packaging, or other activities that do not include a kill step. For these reasons, we do not expect that a specific control for salmonella will be part of some potential assurance users' existing process control programs.

The largest buyers in the domestic market are using almonds in ways that include pathogen reduction, namely oil roasting or blanching. It will not be difficult for a manufacturer to add a control for pathogen reduction for those food items that use oil roasted or blanched almonds because the pathogen control is complementary to the food preparation steps. The expense estimated for establishing the technology and equipment validation is around $3,000 for the established technologies. Two days of company operating personnel and management are expected to be dedicated to the technology validation. This estimate of effort is for a process that is proven to be effective against salmonella, such as oil roasting or blanching, so that a validation of the equipment in place is all that is required.

Other buyers are preparing almonds in ways that do not involve pathogen control, and as such, will require a more extensive technology and equipment validation. High levels of scientific expertise are required to validate the effectiveness of the food production process in terms of a 4-log kill of salmonella. Experimental trials with laboratory facilities are necessary. Some food processing firms might have in-house staff and labs; others would hire a third-party certifier. The estimated cost for the intensive technology validation for participants is up to $20,000, and $2,750 per year for renewals.

A single manufacturer-customer may have more than one line of equipment requiring validation, perhaps at multiple locations. To account for this, we have used 25% more number of technology validations than the number of firms that we expect to participate in the program.

The manufacturer can choose an expert who has abilities and services that are closely suited to its needs because the program guidelines offer a measure of flexibility in applications for approved process authorities (PAs). It is under consideration that manufacturers' employees who have advanced technical education and certifications will be eligible to be approved as PAs. The opportunity to certify the in-house staff to conduct technology validation in the program is likely to reduce transactions costs considerably.

We expect that each program user firm will want access to multiple approved process authorities, which will add to the workload of the TERP in pre-approving the experts. (The TERP component of costs is included below, under the section on Transactions Costs to the Almond Board of California.)

Protocol Approval

The user must develop a protocol for the approved treatment process and its verification in operation on its premises. This is a highly detailed written plan which will be submitted to FDA (for user facilities located in the USA) or an approved Process Authority for acceptance on the basis of scientific efficacy. Subsequently, the application that incorporates the accepted treatment plan will be submitted to TERP. This protocol application is estimated to take 80 hours of manufacturer staff and 15 hours of managerial effort, in the first year of the program. The estimated cost is approximately $6,000 for protocol planning. Renewal is expected to take 20 hours staff time and 10 hours management time, estimated to cost around $1,500 in each subsequent year. The payment from manufacturers to the Process Authority certification agency is estimated to be $5,000-$6,000.

Documentation and Record-keeping

Information technologies are available to link automated food manufacturing processes with company electronic archives, and it is to be expected that the record-keeping technologies of manufacturers choosing to participate in assurance will be advanced. If there is a specific production line for treatment, such as a cooker, blancher, or steam treatment in-house at the manufacturer, electronic files to satisfy auditors can be produced easily. Pasteurization can be documented with time and temperature records at little additional effort. The cost estimate is based on one hour per week of staff time, totaling $1,750 in each year of the program.

Retaining records in-house will require little additional effort due to pre-existing federal rules for traceability and the routine practice of tracing inputs and shipments. To the extent that documentation must be forwarded directly to the ABC, an additional 20 hours per year can be expected. The cost of the documentation will be lessened if the ABC institutes web-ready file transfer protocols so that manufacturers' staff can easily submit their records in the format produced by their systems.

Auditing

Ongoing process verification of the manufacturer will require an audit program, which will be delegated to an approved auditor, with limited oversight by the ABC. Manufacturers will be audited for almond pasteurization annually; more frequent audits will only be required following audit or compliance failures. Total cost to the manufacturer from audits, both in time and in expense of hiring audit staff, is estimated to be $3,125 for each user, per year. This relatively high estimate is assuming that the buyer that does not have an existing HACCP or external certification covering almonds and will need to add an additional audit in order to participate in the Assurance program. If the audits for almond pasteurization can be combined with other audits by a certification agency already involved with oversight of that manufacturer, the incremental time for the audit will be negligible in the years after the program is established.

There are potentially high search costs for auditors who the manufacturers consider to be trustworthy in evaluating internal processes that reveal confidential business information; we have not included a charge for this. Some manufacturers' customers require certification by specific third-parties, and if these third-parties do not seek TERP approval, there is the risk of bottlenecks in terms of the auditing expertise needed for participation in the program.

The pre-approval of auditors by TERP is likely to be burdensome, because we expect that each manufacturer will request at least 3 auditors to be approved, to provide access to back-up audits and to cover multiple facilities. Auditors working for leading global certification agencies will have a strong incentive to obtain TERP approval as well, in order to enhance their value as a food quality professional.

Transactions Costs for Handlers

Handlers involved with the program will expect a modest cost for recordkeeping, in order to provide traceability of the shipments of untreated almonds. User codes will need to be added to shipping documentation, which will not be time-intensive, particularly for handlers using electronic forms preparation systems. The hours that handlers' staff will devote to assurance preparation include 2 hours to obtain a user code and 100 hours for recordkeeping on quality-assured shipments. The estimate for handlers' recordkeeping also includes time for spot audits of documentation, twice per year at 3 hours each. Annual total costs are estimated at $3,300 for each handler. If all 109 handlers participate in the Assurance program, the handler-level transactions cost is $360,000 per year, or almost $3 million in present value of a permanent program.

Summary of Transactions Costs Estimate for Assurance Program

The least known factor underlying this cost estimate is the number of companies that will wish to participate in such a program. One estimate is 135 manufacturers, based on initial findings from a poll of almond handlers about their customers' intentions (ABC 2006 (b)). Other industry sources have projected a much smaller number (as low as 12), on the assumption that only the largest major manufacturers would wish to buy untreated almonds. We use these estimates as

upper and lower bounds on the scope of the Assurance program, for a limited participation scenario and an extensive participation scenario.

Naturally, these wide variations in estimates of participation generate a huge range in the expected implementation costs. Including time for the application procedures, technology validation, and auditing, the transactions cost estimate for manufacturers in the first year of the Assurance program ranges from less than $0.5 million to $5.8 million, in the first year. The low end of the range is from an assumption of 12 buyers participating, and 135 participants is the basis for the high end of the range. Technology approval is the largest component of manufacturers' transactions costs in this estimate.
Should the Assurance program continue with relatively few participants (12 buyers), the renewal and compliance transactions costs for manufacturers are estimated at $2 million in present value terms (discounted at 11%), for a program assumed to continue indefinitely. This estimate assumes that the audit is completely duplicative of existing protocols, therefore it is a worst-case estimate in terms of the audit burden. The perpetuity cost of the assurance to manufacturers is as large as $25 million under the assumption of 135 manufacturers in the continuously operating program.

Handlers' transactions cost under the program range from $1 million to $7 million (lifetime present value), based on the range of 37 handlers to 109 handlers participating. The program will remove the operating cost of pasteurization from handlers, in exchange for some transactions costs. To the extent that manufacturers can accomplish pasteurization efficiently, the program will provide economic advantages to those handlers who can ship directly, compared with the 100% pasteurization program. Those handlers who do not use direct shipments will not benefit.

Transactions Costs to Almond Board of California

The Almond Board of California will be the lead oversight body for the handler pasteurization and the Assurance program. The Board will coordinate the various assurance mechanisms that will be used in implementing the food safety protocols. As such, there will be staff and supervisory tasks that will be added to its existing oversight of the Marketing Order for almonds. The Almond Board has convened a Technical Experts Review Panel (TERP), which will lead in providing the scientific expertise needed to establish a credible infrastructure for the industry-wide assurance system. The need to pay for high-level technical expertise is expected to be a key driver in the estimates of transactions cost for ABC. TERP will approve Process Authorities (PAs) to serve two functions:

1) To annually determine that handlers' treatment processes meet standards for pathogen control, and
2) To determine that Assurance Program users' technology and equipment are achieving the standards in the approved protocol.

Assurance Program Transactions Costs for ABC

TERP will approve PAs who will verify that manufacturers' technology and equipment is adequate for achieving the required reduction in salmonella. An organization may not receive blanket approval for each technical expert with which it is affiliated—instead each individual expert conducting technology and equipment validations will apply for credentials from TERP. Globally, the number of potentially qualified microbiologists/food processing engineers must number in the thousands—any number of them may be interested in qualifying to serve the almond industry in implementing the Marketing Order amendment. For example, SGS, SA, a firm based in Geneva, Switzerland, has 1,000 offices and labs worldwide, and over 39,000 employees. We cite this example because firms in the almond industry have utilized SGS' services for resolving quality disputes involving exports. Among the other well-known and highly regarded firms that could be involved are Campden and Chorleywood, or Silliker Labs. These and similar firms would likely have many hundreds of affiliated personnel to potentially apply for credentialing under the almond Marketing Order.

There is very little basis for us to make a reasonable forecast of the number of applications that TERP will receive. We will estimate costs based on two options: a limited global program, and a limited participation scenario. In terms of time per application, the cost estimates are based on the expectation that TERP will spend 32 hours on each PA application (ABC 2006 (b)). ABC staff support is anticipated to be 16 hours for each PA application, and ABC upper-level management time is estimated at 3 hours per PA application.

TERP will also approve the auditors involved in process verification of the manufacturer. We expect that each assurance user firm will want 3 approved auditors, per location, to be accredited under the Assurance Program to conduct audits. The transactions cost estimate for ABC therefore depends on the number of participants in the Assurance program, which is estimated for a limited program range at 12, and 135 for the extensive program. For each applicant auditor, we assume that TERP will devote 32 hours. ABC staff support will be 16 hours for each auditor application, and ABC upper-level management time will be 3 hours per auditor application.

The cost estimates for ABC are driven by the extent of TERP's role in approving PAs in a global setting. At the high end of the range, we use 282 PAs, 12 for the USA and 3 in each of the 90 markets that import almonds. TERP review is estimated to cost over $1 million in this scenario. Or, should the forecast of PA applicants fall to 42 (12 domestic and 3 in each of the top 10 foreign markets), then approval of PAs for a global Assurance program will account for less than $200,000 in terms of ABC effort.

100% Pasteurization at the Handler Level: Transactions Costs for ABC

It is expected that one new full-time ABC staff (or consultant) will be added to review and approve the handler treatment plans (HTPs). Approximately 5 hours will be dedicated to reviewing each plan, which is estimated to cost the Almond Board nearly $300 in staff effort per handler applicant. When time for staff to examine the traceability system and the oversight of audit reports for handlers is included, a total of 32 hours per handler per year is expected for ABC activities. Most of the ABC time is at the staff level, with some time for management

Table 5: Transactions Costs Estimated for Almond Board Monitoring of Pasteurization Program and Options

No AP, 100% pasteurization		AP, permanent global program	
Year 1	Perpetuity	Limited program (Yr 1)	Limited program (perpetuity)
$0.1 million	$0.7 million	$1.3 million	$3.0 million
		Extensive program (Yr 1)	Extensive program (Perpetuity)
		$2.8 million	$15 million

supervision. The total cost to ABC of managing the handler level pasteurization program is estimated at just over $100,000 in the first year (Table 5).

Once the program is established, estimated costs borne by ABC are expected to be around 30% lower, on an annual basis, because TERP will not need to approve technical experts and the documentation of handlers' traceability systems will not require renewal. The perpetuity cost of monitoring and receiving annual handler treatment plans and a modest level of audit oversight, is added to the first year cost to obtain a total program cost estimate of nearly $700,000 (Table 5).

The expected impact on the ABC's budget is substantial for the assurance alternatives considered here. While the way the program will unfold is impossible to predict, the outlook for ABC expenditures must be considered within the context of its institutional surroundings. The mission of the ABC is to promote knowledge about almonds that will lead to enhanced consumer demand and economic stability of the industry. The food safety action plan is an essential component in preserving the consumer's perception. Upon implementation of any regulation, however, it will be important to consider options that control the impact on the Board's expenditures so as to avoid the need to reduce future opportunities for productive promotion or research expenditures. And, of course, the ABC budget is linked to payments from growers and handlers, and assessments could affect growers' costs and supply.

SUMMARY

The almond production and marketing system will be affected modestly by a requirement that all almonds will be pasteurized before reaching the final consumer. There is a physical operating cost associated with the production process by which pathogen reduction is achieved. In addition, there are transactions costs of the records, certifications, and scientific expertise required to assure all stakeholders that the pathogen control is being achieved.

Operating costs associated with a requirement that handlers to pasteurize all almonds before shipment are estimated to add an increment of $33 million to $35 million dollars to the annual cost of handling almonds industry-wide. The dollar value is equivalent to less than 2% of the total value of the crop. The total cost in today's terms for the continuing 100% pasteurization program at the handler level is estimated to be $300 million to $322 million.

Transactions costs that are expected from assurance and verification of acceptable pathogen control depend significantly on the organization of the program, and the level of participation by various firms. Handlers' transactions costs are dominated by the audit requirements.

Under the Assurance program, handlers are spared from a significant share of the transactions cost. The organization and monitoring of treatment programs become the responsibility of manufacturers. In addition, the ABC oversight role accounts for a significant level of transactions costs. Choices about program organization, including intensity of application processes and audit oversight, will affect the costs that ABC can expect as the program is implemented.

The estimated program costs to manufacturers under the Assurance program did not include significant opportunities for leveraging existing certification programs, particularly in the first year. It was assumed that manufacturers would require a new validation, at high cost. Scenarios for the first year of estimated transactions costs, and for total discounted costs estimate for the continuing programs, are summarized in Table 6. The accumulated costs of annual plans and audits required by the Almond Board contribute to the relatively high total present value of costs in the pasteurization plan without the Assurance program. Under it, manufacturers face substantial set up costs, but renewals are less costly.

MARKET ANALYSIS AND IMPLICATIONS

A new requirement for pasteurization of the entire billion-pound almond crop can be expected to add approximately $33-35 million to the annual operating costs of marketing almonds. While the cost is significant, it is not expected to cause instability in the market.

The impact on market prices of requiring costly treatment can be minimized by providing for the treatment to take place at the level of the supply chain that can most efficiently provide it. Pasteurization services are an integral part of some food preparation activities that are routine for final users of almonds (for example, oil roast for snack foods, or blanching for use in ground products and marzipan). To the extent that these services are already provided by manufacturers, a requirement for additional treatment at the handler level creates economic inefficiencies and contributes little to enhanced food safety.

Transactions costs of assurance of the food safety program are unavoidable, particularly as the program is initially put into place. Transparency and information flows will be essential in laying the foundation for businesses to develop routines and procedures that allow them to work most efficiently to provide safer foods. There is an opportunity to minimize transactions cost of

Table 6: Transactions Costs of Selected Program Alternatives for Almond Pasteurization

	No AP		AP, permanent global program	
	Limited program	Extensive program	Limited program	Extensive program
Year 1:	27 handlers investing in technology, 25 process authorities	66 handlers investing in technology, 25 process authorities	Many process authorities, few auditors, 12 manufacturers, 37 handlers	Many process authorities and auditors, 135 manufacturers, 109 handlers
Almond Board	$0.1 million	$0.1 million	$1.3 million	$3 million
Manufacturers	$0	$0	$0.5 million	$5.8 million
Handlers			$0.1 million	$0.4 million
Of which:				
In-house	$0.5 million	$1.1 million	NA	NA
Outsource	$1.4 million	$0.7 million	NA	NA
Total year 1	$1.9 million	$2.0 million	$1.9 million	$9 million
Total program present value	$7 million	$7.4 million	$7.3 million	$37 million

a permanent program by permitting manufacturers to integrate pasteurization of almonds into their existing quality assurance protocols. Making the Assurance program accessible to more applicants will tend to increase the number of applications to ABC, and the associated direct cost of administering the program. However, if it is burdensome, the result may be that manufacturers choose not to participate. It is not possible to predict whether those who do not participate will avoid using almonds, or whether they will absorb a pass-through charge for almonds pasteurized by the handlers.

There are counteracting economic incentives that could lead one to expect greater or lesser participation in the Assurance program. One cost-related incentive for participation is if the manufacturer can provide pasteurization at less cost than the handler. In addition, a manufacturer may favor continuing to purchase untreated almonds under assurance in order to have full control over the pasteurization processes, to assure safety and quality, as well as cost-efficiency.

Other economic factors specifically related to transactions costs would have a tendency to deter manufacturers' participation in the program. The assurance application, the adjustments to quality assurance protocols, and annual renewals will be a barrier to entry to the program to some participants. A buyer would need a strong commitment to almonds in order to take on significant bureaucratic oversight that is added on to existing quality assurance processes. To the extent that the Assurance program is managed in a way that makes it duplicative of existing

systems, some manufacturers may prefer to purchase pasteurized almonds, or to substitute other products for almonds.

Supply of Pasteurization Treatment to the Handling Industry

For those almonds that are consumed in raw forms, or in goods that do not routinely have a pasteurization step, the economic efficiency of treatment at the handler level is a key consideration. The market for out-sourced treatment services is in its developmental stages, and has several distinctive features in contrast to traditional agricultural commodity marketing. For example,

- The supply of services depends on specialized, capital-intensive equipment,
- The equipment is potentially high-volume, but pressures for traceability may affect the efficiency,
- Equipment providers must have access to expertise for testing, validation, and operation to meet exacting standards.

Providers entering this service market may need to consider changing their business model from a volume-orientation to a high-quality service orientation in order to be successful in optimally utilizing their facilities.

Given the state of uncertainty about the regulatory requirement, many decision-makers will likely postpone investing, making it more difficult to assure capacity for treatment of the entire crop at the lowest possible variable cost.

While out-sourcing of the pasteurization services is possible, the competitiveness of the market for out-sourced treatment is a key issue. Economic concentration of the handlers' segment is observable from the size distribution; a common concern is that the largest handlers may be able to exert market power. The small handlers together constitute an important competitive fringe, according to some industry sources. Therefore, the impact of out-sourcing on the competitiveness of the handling sector merits consideration.

This study has not included a comprehensive investigation of demand, but there is some case-specific evidence that almond users have responded to high prices by reducing the use of almonds. It has been reported that snack food buyers have re-adjusted the proportion of almonds in mixed nut products, and that candy manufacturers have used pieces rather than whole almonds as the market price of almonds has risen. Costs associated with the pasteurization requirement may cause similar responses among buyers. Even if the cost is in time and management effort, rather than in terms of price per pound, there is a risk of de-stabilizing domestic demand by imposing added costs at a time when prices are high.

Integration of the Marketing Order Amendment with Existing Certifications

All parties in the almond industry will rely upon technical experts to develop protocols and provide reliable assurance of the practices that will provide pathogen control in almonds. There is a potential bottleneck in the application and approval procedures of individuals, rather than

accepting credentials of agencies that are well-regarded in the food system. The bottleneck could be reached if hundreds of individuals apply to serve as process authorities or auditors, burdening the TERP directly. Or, the opposite problem could occur. It is possible that well-known and widely used certification agencies will choose not to participate in the almond program, which could inconvenience key customers and the handlers who do business with them.

There is a need for increased transparency in the provisions of the proposed Marketing Order amendment, primarily to rely on the proven ISO-based protocols in place at manufacturers. USDA's tradition of on-site inspection is not consistent with auditable assurance protocols that are today's world standard in food processing. The trend is to move toward process verification rather than inspection. The high-frequency audit and closely guarded approval of auditors could be construed as barriers that generate inefficiencies without truly enhancing the quality assurance of the program. Similarly, the handler-level requirement should be implemented in alignment with existing audit certification programs that are in place, to avoid displacing successful quality assurance protocols used by handlers.

As a new system, there are opportunities to minimize transactions costs of oversight of the almond pasteurization program by using information technology to its greatest potential. ABC has a long history of oversight of compliance with the Marketing Order for almonds, an activity that involves monthly reporting from handlers, interaction with inspectors and other experts, and record-keeping. The level of automation in ABC recordkeeping for the documentation of compliance with the existing marketing order is low, partly as a result of the Marketing Order pre-dating computing technology. The use of paper records is also an effort to meet the needs of the handlers, many of which are small and not equipped with electronic communications.

An opportunity for efficiency in oversight may be found by lost development of web-ready secure application systems at the outset, resulting in systems that can be accessed globally and managed for maximum efficiency. Information systems exist to store handler treatment plans and other applications securely online. Once established, the maintenance of updated documentation is facilitated as needed, and a formal annual submission deadline can be avoided.

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