Peach Prices in California in the Presence of Technological Change in the Agricultural Pesticide Industry

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I. Introduction

The potentially adverse effects of pesticides in wide use are causing concern to grow in the agricultural community. Minimizing the risks to human health and the environment created by agricultural pesticides has become a very important issue. The United States Environmental Protection Agency (EPA) has set a high priority on registering safer pesticides. According to the EPA, more than 1 billion pounds of active pesticide ingredients are used in the United States each year. Americans are exposed to pesticides every day through food consumption, cleaning products, and home and work environments.

The agricultural pesticide industry has experienced an influx of changes during the past decade. Two of the primary changes affecting the pesticide industry are the introduction of new technology and EPA regulatory changes. On the regulatory front, the EPA requires manufacturers to register and test pesticides before they appear on the market. By 2006, the EPA will review old pesticides to ensure that they meet new safety requirements. These regulatory initiatives have contributed to the industry drive to develop safer and more "environmentally friendly" products for use in agricultural pest control. Technological changes consist of the introduction of new pesticides that are considered to be safer for both humans and the environment. As new technologies and regulatory initiatives are undertaken to ensure an improvement in both the safety of human health and the environment, one must consider how these changes may affect consumers. Specifically, an analysis should be conducted to determine whether or not the technological and regulatory changes have an effect on consumer prices.

The recent developments in the agricultural pesticide industry provide several reasons to believe structural change has been occurring in economic relationships that determine peach prices in California. Therefore, we use a vector autoregressive (VAR) model to forecast peach prices by allowing parameters to vary with time. VAR models differ from standard econometric analyses of structural relationships in that they do not apply the usual exclusion restrictions to specify *a priori* which variables appear in which equations. Instead, a set of distributed lag equations is used to model each variable as a function of other variables in the structural system (Bessler, 1984).

The objective of this paper is to forecast peach prices and evaluate dynamic relationships in the peach industry in the presence of technological and regulatory change. A VAR model that explicitly recognizes structural change will be used to forecast peach prices in California. Changes in dynamic relationships between peach prices and relevant economic variables will be considered.

II. Elements of Structural Change in the Pesticide Industry

New Regulations

As previously mentioned, the EPA has set a high priority on registering safer pesticides. The EPA requires manufacturers to register and test pesticides before they appear on the market. By 2006, the EPA plans to review all conventional pesticides to ensure that they meet new safety requirements. This process has led to negotiations between manufacturers of current conventional pesticides and the EPA. Negotiations have resulted in the removal of commodities from pesticide labels and decreases in the physical amounts of pesticides that can be applied to certain commodities. The results of these actions have been seen first-hand in peach orchards, as growers are faced with replacing their conventional methods with new pesticide technologies, which in some instances are more expensive and less effective. As manufacturers are faced with the potential cancellation of their conventional methods, they strive to advance in research and development of new pesticide technologies. Table 1 shows which active ingredients are focused on in each pesticide class in our analysis. Table 2 shows that active ingredients from different pesticide classes can be used as substitutes for each other.

Table 1
Active Ingredients by Pesticide Class

	Active Ingredient
Organophosphates	Naled
	Diazinon
	Chlorpyrifos
	Methdathion
	Azinphos-Methyl
	Phosmet
Pyrethroids	Permethrin
	Esfenvalerate
BT	BT
Miticides	Formetanate Hydrochloride
	Fenbutatin-Oxide
	Clofentezine
	Abermectin
	Propargite
Microbial	Spinosad

Source: University of California, Statewide Integrated Pest Management Project

Table 2: Peaches
Pest Control Analysis

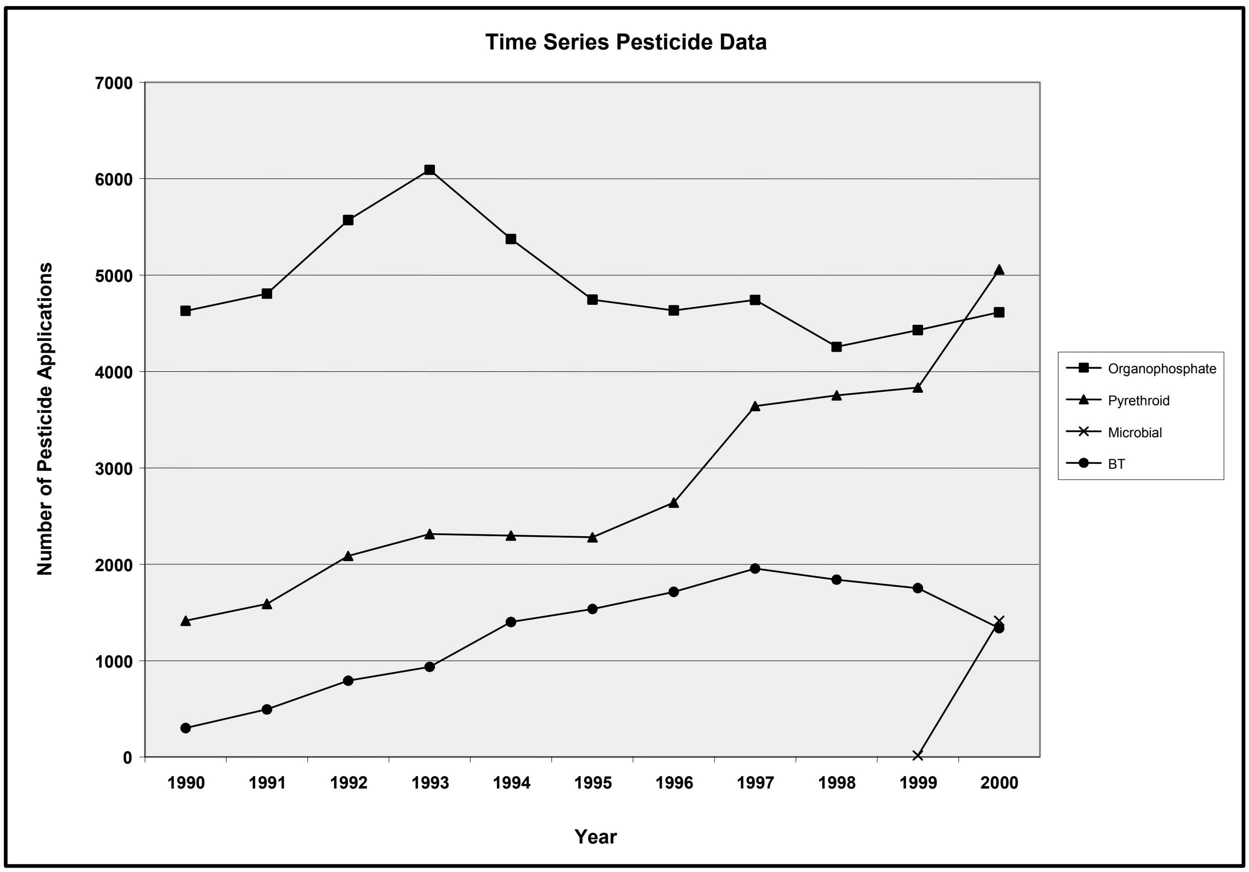
Period	Active Ingredient (Brand Name)	PHI	Restrictions	Additional Limitations
Dormant	Diazinon (Diazinon 50WP)	-	• 5-day worker reentry	• Resistance observed in some populations of San Jose Scale
**	Methidathion (Supracide 25W)	-	• Apply before blossoms open	
**	Chlorpyrifos (Lorsban 4E)	-	• Do not apply more than once during dormant season	• Do not allow livestock to graze in treated orchards • Resistance observed in some populations of San Jose Scale
**	Esfenvalerate (Asana XL)	-	• *Apply during dormant season only*	• *Use ground application equipment with dormant oil for best results* • Postpone oil application to water stressed trees • Dormant season application may result in outbreak of mites • Use as alternative to Diazinon if resistance occurs
	Permethrin (Ambush)	-	• *Limit applications to 5 per growing season*	• Use as alternative to Diazinon if resistance occurs • Dormant season application may result in outbreak of mites • *Apply with or without oils*
**	Spinosad (Success)	-		• Do not treat successive generations of same pest to avoid resistance • Apply w/ narrow range oil to suppress over wintering mite and scale*
Spring	Diazinon (Diazinon 50WP)	21		• Resistance observed in some populations of San Jose Scale • *Apply at petal fall or as insects occur in May and June to control PTB*
	Esfenvalerate (Asana XL)	14	• Only use where resistance to OPs is problematic • Apply during dormant season only in CA	• Not recommended for use in San Joaquin Valley because can cause outbreak of secondary pests • Use as alternative to Diazinon if resistance occurs
	Permethrin (Ambush)	14	• Limit applications to 5 per growing season	• Use as alternative to Diazinon if resistance occurs • Dormant season application may result in outbreak of mites • *Apply with or without oils*
	Spinosad (Success)	14		• Do not treat successive generations of same pest to avoid resistance
	Azinphos Methyl (Guthion Solupak)	21		• May cause spider mite outbreaks

*Applicable year-round **Dormant and Delayed Dormant

New Technologies

During the last five years, various technological improvements have been developed within the agricultural pesticide industry. These improvements include the development of Microbial pesticides or pesticides that are "environmentally friendly." Many growers have begun to adopt the new technologies when faced with the extinction of pesticides they currently use. Evidence of this adoption is illustrated in Chart 1, which illustrates decreasing use of Organophosphates in peach orchards and an increase in the use of Pyrethroids and Microbial pesticides. The most recent introduction of Spinosad (Microbial) further illustrates the adoption of new technology by peach growers.

Chart 1



Although new technologies have proved to be effective at controlling target pests, studies are beginning to provide evidence that the newer pesticides harm the natural enemies of other pests not usually considered problems. Although Bacillus thuringiensis (Bt) is not considered a new technology of the past five years, new scientific developments have led to an improvement in the effectiveness in Bt, leading to increased adoption by growers. Unfortunately, with the creation of new technology comes an increase of cost in pest control. Table 3 illustrates the average costs for multiple pesticides in several categories used in the analysis.

Table 3
Costs per Acre of Alternative Pest Treatments

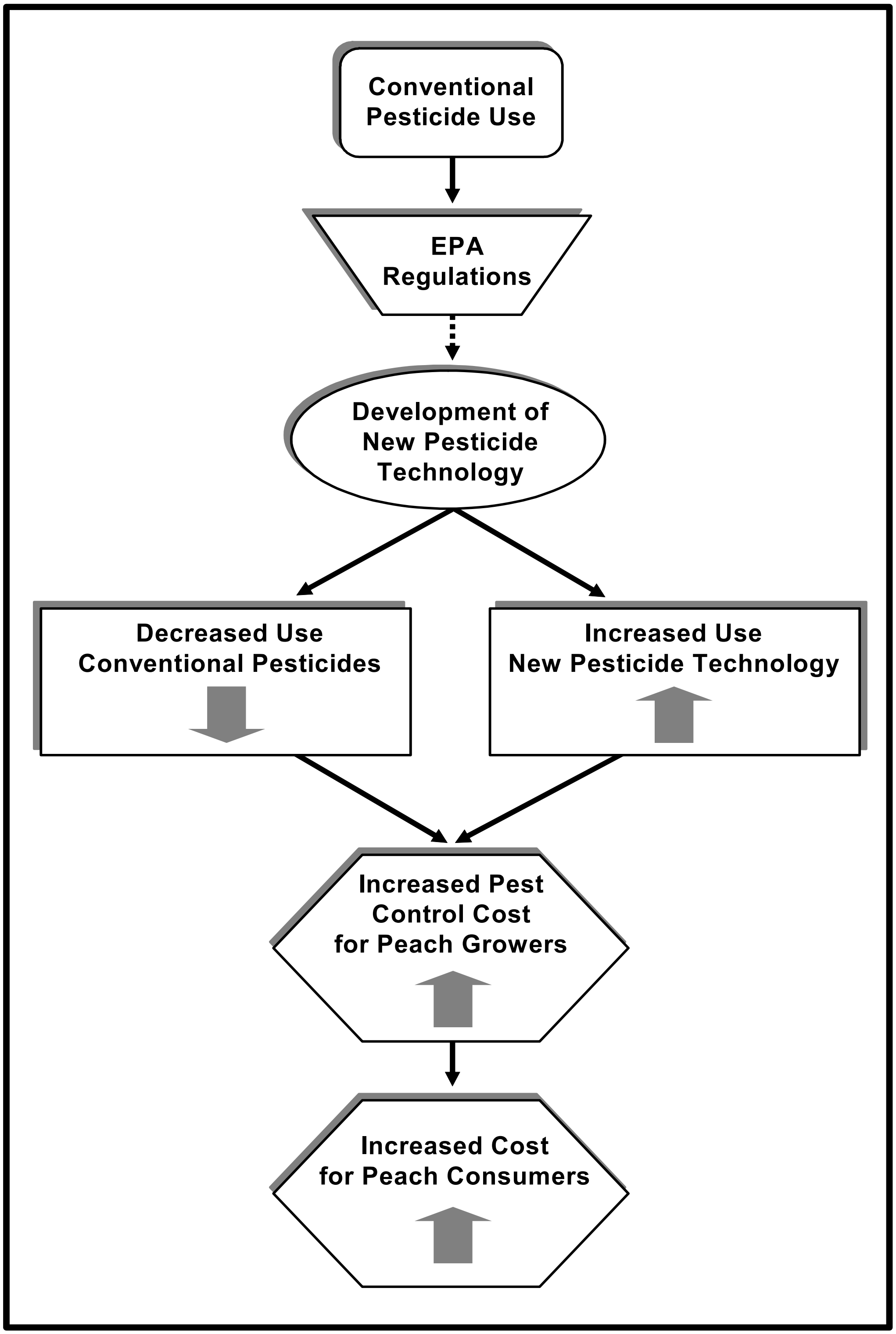
		Chemical Cost
Organophosphates	Diazinon 50WP (diazinon)	$13.95
	Lorsban 4E (chlorpyrifos)	$14.80
	Supracide 25WP (methdathion)	$59.59
	Guthion (azinphos-methyl)	$45.43
	Imidan 70 WP (phosmet)	$29.96
Pyrethroids	Pounce 3.2 EC (permethrin)	$22.92
	Asana XL (esfenvalerate)	$5.00
	Ambush 25SP (permethrin)	$29.76
BT	Dipel (BT)	$13.75
	Javelin (BT)	$10.80
Miticides	Carzol SP (formetanate hydrochloride)	$5.38
	Vendex 50WP (fenbutatin-oxide)	$56.41
	Apollo SC (clofentezine)	$58.27
	Agri-Mek 0.15EC (abermectin)	$126.00
	Omite 30WP (propargite)	$6.01
Soft	Success (spinosad)	$30.00

Source: University of California, Statewide Integrated Pest Management Project

Pyrethroids are often used as a replacement for Organophosphates in peach orchards. Pyrethroids are a class of pesticides that are considered to be safer in the context of both human health and the environment. However, Pyrethroids come at a higher price than the most commonly used Organophosphates such as Diazinon and Lorsban (UC IPM 2002). Likewise, Bt requires considerable training in order to use it effectively. Timing is critical when using Bt; if applied at the wrong time, Bt's use could be completely ineffective. The training comes as an additional cost for most growers, as conventional pesticides did not require such training. In addition, the newer pesticide technology, Spinosad, also comes at a higher price than the mostly commonly used Organophosphates. Therefore, pesticide control eventually comes at a higher price for peach growers. Finally, additional input costs must be absorbed by either producers or consumers.

Chart 2 illustrates the basic theory behind our analysis. Prior to the introduction of new pesticide technologies, conventional pesticides were primarily used in peach orchards in order to control for pests. The EPA then announced their intentions to increase restrictions on conventional pesticide use. This announcement persuaded manufacturers to place more attention in research and development of "environmentally friendly" pesticides. The data shows that the new pesticide technologies are being adopted by peach growers. At the same time the data illustrates the decreasing use of conventional pesticide methods. As previously mentioned, on average the new pesticide technologies come at a higher price as compared to conventional methods. This leads to increased cost for peach growers, which a portion of is then passed on to peach consumers.

Chart 2


Conventional Pesticide Use
EPA Regulations
Development of New Pesticide Technology
Decreased Use Conventional Pesticides
Increased Use New Pesticide Technology
Increased Pest Control Cost for Peach Growers
Increased Cost for Peach Consumers

III. Vector Autoregression Model

Several empirical investigations have utilized vector autoregression (VAR) models to forecast economic variables and provide insights into suspected dynamic relationships. Several examples of authors who have conducted such research include Goodwin (1992) and Bessler (1984). VAR models differ from standard econometric analyses of structural relationships in that they do not apply normal exclusion restrictions, more specifically, specifying which variables appear in which equations.

The VAR model is estimated with average regional peach values per ton from 1980 to 20001 and yearly pesticide use data from 1990 to 2000. Because consumer prices are not immediately available, we utilize commodity values as reported by the USDA. These values reflect prices received by growers.

We utilize the California Department of Pesticide Regulation (CDPR) database developed by the University of California Statewide Integrated Pest Management Program. We develop dummy variables to represent new technologies, Microbial and Insect Growth Regulators. Data regarding when pesticides became available for use were collected from relevant manufacturer's labels.

Geographical Regions

Production and pest management costs vary by region. For example, the Southern San Joaquin Valley requires more use of Miticides due to their warmer climate (Epstein, Bassein, and Zalom 2000). Peach prices, yield, and orchard size can also vary by region. Therefore, the assessment was conducted by dividing the state into regions where prominent peach production was exhibited in the data. The regional classifications are based on Epstein, Bassein, and Zalom (2000). Table 4 shows the regions and counties used in the assessment.

Table 4
Regions and Counties

Sacramento Valley Counties	San Joaquin Valley Counties
Butte	**North:**
Colusa	Merced
Sacramento	San Joaquin
Solano	Stanislaus
Sutter	**Central:**
Tehama	Fresno
Yolo	Madera
Yuba	**South:**
	Kern
	Kings
	Tulare

IV. Preliminary Model Results

Numerous VAR models were run using different combinations of variables. Preliminary results indicate that peach prices in the Sacramento Valley and San Joaquin North regions are independent of all other regions used in the analysis. Table 4 illustrates the results from the Granger Causality Wald Tests conducted after each VAR model. Results are reported at the 90% significance level. The table illustrates whether or not the variables denoted as A are affected by variables denoted as B, numbers are region indicators.

Table 5
Results of Granger Causality Wald Tests
Variable A → Variable B

		A				
		Price	Organophosphates	Pyrethroids	BT	Microbial
B	Price	---		2		4
	Organophosphates	1,2	---	1,2,3,4	1,4	1,2,3,4
	Pyrethroids	2,4		---	1,3	1,3
	BT	1,2,4		2,3	---	1,2,3
	Microbial	2		1,3,4	1,3,4	---

1 = San Joaquin Central
2 = San Joaquin North
3 = San Joaquin South
4 = Sacramento Valley

Preliminary results indicate that peach prices are affected by Microbial, a new pesticide technology, in the San Joaquin North region. Analysis results also reveal various relationships between pesticides and their substitutes.

V. Conclusion

Due to data constraints we are unable to determine the ranges of these affects at this time. Currently, the data only contains two observations with regards to the variable Microbial. This data limitation is due to the fact that the Microbial class of pesticides only recently entered the market in 1999. However, there was a significant adoption of the technology in 2000, which leads us to believe that additional data will continue to support this trend. We anticipate acquiring pesticide use data for 2001, as it should be released by the University of California Integrated Pest Management Project within the next month. Upon receipt of the additional data we will rerun the analysis and anticipate being able to determine ranges at that time. We will provide updated results upon presentation.

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