ECONOMIC RESTRUCTURING AND INCOME INSTABILITY
IN CALIFORNIA AGRICULTURE

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the Requirements for the Degree of
Doctor of Philosophy

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ABSTRACT

Since 1970, California agriculture has experienced a sudden and unexpected increase in the volatility of revenue growth. Traditionally, such instability has been explained as resulting from forces primarily beyond the control of producers. This research presents an alternative view, based heavily on theories derived in industrial sectors. According to this **regulation theory** alternative, destabilization of California agriculture is largely attributable to a strategic restructuring of the industry by producers. The salient features of this restructuring include increased targeting of export markets and the transformation of mass production toward enhanced **product-mix flexibility**, in which growers exercise improved factor mobility to shift production between a wider range of crops in response to rapidly changing markets. Most important to this improved flexibility have been advances in irrigation, chemical use, and specialized breeding that have permitted a land to be planted in wider range of crops.

Using the cotton sector as a case study, I show that, although increased exporting and product-mix flexibility have provided the basis for rapid expansion, they have also destabilized markets in key ways. Internationally, restructuring has reduced buffer stocks that formerly stabilized world prices, while simultaneously increasing growers' exposure to international price shifts. Domestically, flexible strategies have encouraged erratic acreage movements which, in key crops, contribute at least as much to revenue variability as the exogenous forces identified in traditional theory.

Over the longer-term, the flexible strategies is very uncertain. Revenue volatility associated with rapid acreage shifting threatens continued investment. At the same time, increasing public outcry over the fiscal and environmental implications of current agricultural technologies make it almost certain that the technological base of flexibility will be forced to change dramatically. Finally, increasing mobility by global capital seems as likely to encourage capital flight as ongoing economic development within California.

This research supports a shift in policy focus away from current administered pricing and trade policy, toward explicit state efforts to reform production. I present a series of specific proposals to improve labor policy, technology policy, treatment of small farms, and the coordination of production across the industry.

The agricultural experience also contradicts the perception of many regulation theorists that competitive strategies based on increasing flexibility lead to geographical concentration and a revival of small operations. Indeed, flexibility may have just the opposite effect. The agricultural experience also indicates that the state plays a more central role in promoting and helping to control flexibility than usually acknowledged. Finally, while regulation theory has tended to see flexible strategies as a means to improve worker skills and reform archaic forms of labor relations, my research indicates that the adoption of flexible strategies, by themselves, do not create the basis for cooperation between workers and management.

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TABLE OF CONTENTS

Chapter 5: Exporting, Flexibility, and Instability in the Cotton Sector

Chapter 6: Conclusions

Appendices

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION

By almost any measure, California has one of the healthiest agricultural industries in the United States. Despite two very serious droughts, the state's agriculture has grown rapidly since 1970, and has avoided the worst of the credit crisis so visible in other regions. California producers have continued to increase their share both of total U.S. production and U.S. exports in a wide variety of crops. In addition, the state's industry has the reputation of being very progressive with respect to both management and technological innovation.

Despite this favorable image, California agriculture experienced a most tumultuous ride in the 1970s and 1980s. This can be seen most clearly in income statistics. In the 1970s, there was a marked increase of short-run volatility around the trend rate of growth. Then, beginning in the 1980s, there was a significant and prolonged downturn in revenues. While recent trends suggest the downturn has stopped, there is no apparent end in sight to heightened short-term instability.

Even though incomes are supplemented by government payments in some crop types, farm profitability remains primarily determined by crop income. Thus, heightened income instability is one indicator of general distress in the industry. Although growers in the state have fared better than those in other regions, this instability has cost hundreds of millions of dollars and threatens the economic livelihood of tens of thousands of people.

There are other reasons why we should be concerned about instability in agriculture. Because incomes are supported by government, instability is very costly to the public. To give a sense of just how extreme these costs have become, between 1980 and 1988 constant dollar government payments to California farmers increased from \$17.1 million to \$283.2 million.[1] In addition, instability can act as a disincentive to long-run investment. Finally, volatility is never borne evenly across the industry. Thus, any increase in instability inevitably means greater hardship for marginal farmers, especially those operating at a small scale. In some cases, these small growers may be genuinely inefficient. However, in many other instances, their only fault is that their revenue base is too small to weather hard times.

Instability is an old problem in agriculture and the U.S. is no exception. As a result, the problem has been well-studied by agricultural economists. Chapter 1 describes two largely distinct efforts to explain agricultural instability in the U.S. In both of these theories, instability is interpreted as arising from forces beyond the control of growers. In the first case, instability results from overcapacity caused by long-term developmental forces in the broader economy. In the second case, it is the result of volatility in a series of exogenous variables such as government policies, business cycles, and international exchange rates.

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[1] Over the same period, payments nationwide increased from \$1.6 billion to \$12.2 billion. Figures in 1982-1984 dollars, deflated by the Consumer Price Index for all items. Statistical Abstract of the United States 1990. Table 1126.

Unfortunately, these conventional explanations offered for instability are unconvincing. The problem is not primarily overcapacity. Many key crops have grown at rates far surpassing industrial sectors of the economy for a prolonged period with virtually no sign of longer-term real price declines. Nor is the problem simply volatility in exchange rates or business cycles, since neither of these explain large amounts of variance in revenues. Finally, the problem is not mainly one of overly restrictive and inconsistent government policy. If anything, government policies toward agriculture are far less restrictive than they once were.

My research takes a very different view. Borrowing from industrial theories developed to explain the modern crisis in U.S. manufacturing, I argue that growers have contributed to instability in concrete and important ways. To be sure, the economic environment within which growers operate today is less predictable than it once was. Factors such as shifting exchange rates and changes in government policy <u>are</u> important. However, what is even more important is how these forces interact with the development of mass production in the industry, a process which is constantly redefined by growers seeking new competitive advantages.

This thesis focuses on two specific ways in which California growers have reorganized competition in their industry. The first such strategic shift was a dramatic move into foreign markets, as California growers sought to expand markets for standardized output under mass production. The second major trend examined is the effort by producers to increase flexibility. Specifically, this means enhancing their ability to move between a wider range of crop types with greater ease in response to changing markets. Both of these strategic changes by growers have important implications for the type and degree of instability experienced in the industry after 1970.

Internationalization provided the basis for unparalleled growth. However, by moving into foreign markets, California growers also increased their exposure to exogenous demand shifts. Furthermore, increased exporting was predicated on reforms in domestic farm programs that themselves actually contributed to the destablization in foreign markets. For its part, increased flexibility has helped growers increase base capacity without depressing longer-term real prices. It has also helped growers survive economic downturns. However, this flexibility has evolved with little coordination between growers. As a result, unusually large and sudden capacity shifts have repeatedly destabilized revenues.

From the perspective of policy formulation, this reinterpretation of agricultural instability is very important. Currently stabilization policy focuses on creating a predictable environment within which growers can operate, while purposely avoiding involvement in the production decisions of growers. My research suggests that, although useful, this is not enough to promote reliable growth in the industry, because the most important forms of instability come from the actions of farmers themselves. Instead, policy should explicitly aim to create a more competitive U.S. agriculture by encouraging improvements in product quality, marketing, labor relations, and the management of new technologies.

This research also has important implications for theories of industrial development. Today, many observers believe that the most serious challenge facing U.S. industry is to find ways to move beyond traditional mass production toward competition targeting smaller, high value markets that change rapidly. To pursues these new strategies, producers must increase flexibility in their organizations and resource use to allow them to rapidly change markets and adopt new technologies as they become available (Dertouzas, Lester and Solow, 1990; Piore and Sabel, 1984; Best, 1990).

However, modern researchers promoting greater flexibility have based their analysis on overly simple descriptions of mass production. Likewise, increased flexibility, by itself, cannot restore competitiveness. Finally, the particular ways in which flexibility is achieved help determine whether growth is reliable, and whether flexible strategies may be maintained over the longer-term.

Efforts to increase flexibility in California agriculture do not represent a rejection of mass production as some industrial researchers would suggest (Piore, 1986; Sabel, 1982). Quite the contrary, flexibility and mass production have been evolved together, because the technological base that has allowed growers to increase their flexibility is also characterized by significant scale economies. This implies that flexibility need not necessarily be centered in small firms, as many industrial theorists have argued. This is important, because it raises the possibility that capacity may be moved in very large blocks, creating instability in the industry. There is no obvious reason to expect that this conclusion is unique to agriculture.

Also, increasing factor mobility can be used in very different ways, with drastically different implications for regional economic development. The same features that make it possible for firms to pursue competitive strategies based on flexibility may also lead to capital flight, unless those resources which create flexibility are firmly grounded in resources unique to specific communities. Similarly, unless the state intervenes, increasing flexibility may result in a new assault on the position of labor.

Despite these weaknesses, emerging industrial theory adds much to the traditional explanation of revenue instability in agriculture. By making it very clear that there is no single path of appropriate development, this alternative viewpoint provides a starting point for new and creative new policies that can simultaneously tear down old antagonisms and restore stability to the industry.

In Chapter 1, the exact nature of instability in California agriculture is defined and theories traditionally used to explain that instability are introduced. Chapter 2 outlines an alternative theory of instability in industrialized agriculture that is based on industrial regulation theory. In the following chapter, I explain specific and tangible ways in which restructuring of the industry has promoted unstable revenue growth. Chapters 4 and 5 apply the argument to a case study of the cotton sector, traditionally California's single most important mass production crop. Finally, Chapter 6 summarizes the argument and its implications for policy and theories of industrial development.

CHAPTER 1

INSTABILITY IN CALIFORNIA AGRICULTURE

California's farm industry has led the nation in agricultural income throughout the post-war era and the state is generally regarded to have the healthiest farm economy of any region in the country. Representing less than 3% of the United States' harvested cropland in 1987, California nonetheless produced 22% of the nation's cotton; 39% of its vegetables; and 53% of its fruits, nuts, and berries.[1]

Beyond its importance as a large producer of key crops, the state has also led the nation in the rate of growth of its farm industry. Between 1959 and 1984, agricultural income in the state grew at an annual rate of 2.8%. While this was slightly below the growth rate of the national economy over the same period (3.0%), it was well above the rate of growth for agriculture in other regions of the country (2.1%). By 1980, real annual crop income in the state had surpassed $10 billion, approximately double its value in 1960 (Figure 1.1).[2]

Most important of all, until about 1970, this growth was exceptionally steady. Throughout the 1960s, this stability encouraged considerable new investment in the industry. Between 1959 and 1978, harvested cropland increased by 9.8% in the state, nearly five times the national rate of 2.0%. Interestingly, much of the expansion of

---

[1] Based on value of crops marketed. U.S. Census of Agriculture, 1987.

[2] Crop revenues and prices are consistently deflated by the USDA Index of Prices Received by Farmers - All Crops and presented in 1984 dollars. Revenue, acreage, and prices collected from the Annual Reports of the County Agricultural Commissioners of California. See Appendix 1.5 for an explanation of this database.

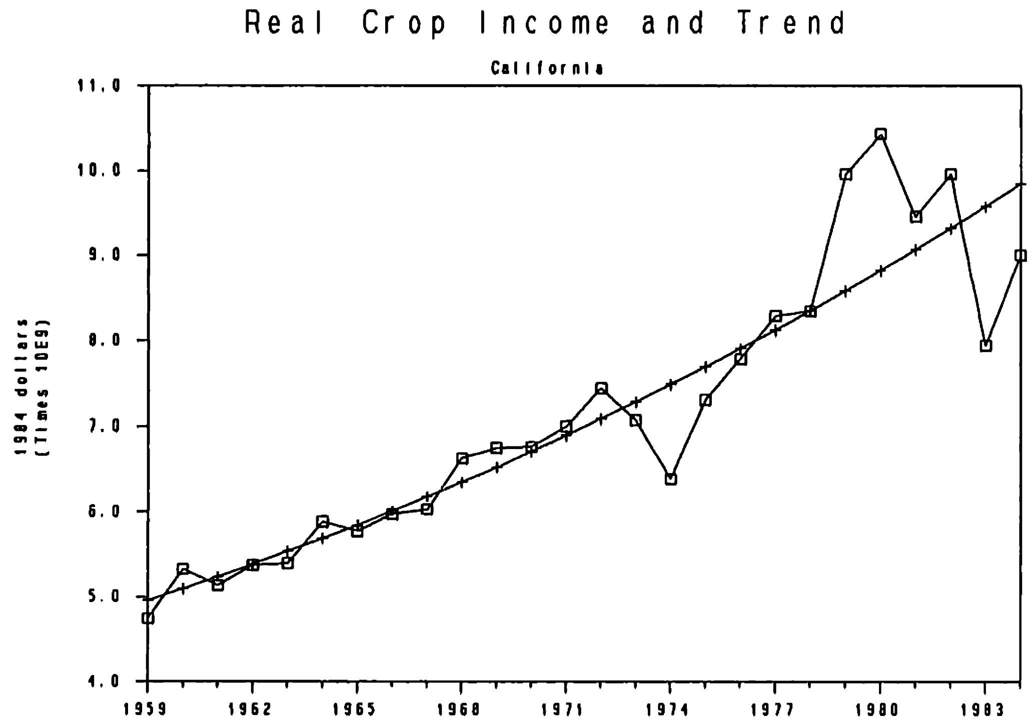

Figure 1.1

California agriculture was made possible by a large influx of investment capital from other, more industrialized sectors. This was especially ironic, given that experts in regional development routinely teach that farming should decline in importance as region's industrialize. One after another, large firms such as Coca-Cola, Tenneco, Borden, Bangor-Punta, and others bought up the state's most successful farm operations. By the early 1970s, many parts of California's agricultural production were well integrated with the business decisions of the largest corporations in the country.

In the early 1970s, the stability of this growth ended abruptly. This can be seen most clearly by examining the yearly percentage deviations of real crop income from a trend regression (Equation 1.1).

$$\underset{(290.76)}{LN(Y) = 22.30} + \underset{(15.34)}{.03(t)} \qquad \bar{r}^2 = .89 \tag{1.1}$$

Statistically, we can think of this transition from a period of relative stability to one of relative instability as a sudden increase in the variance of the residuals (Figure 1.2).

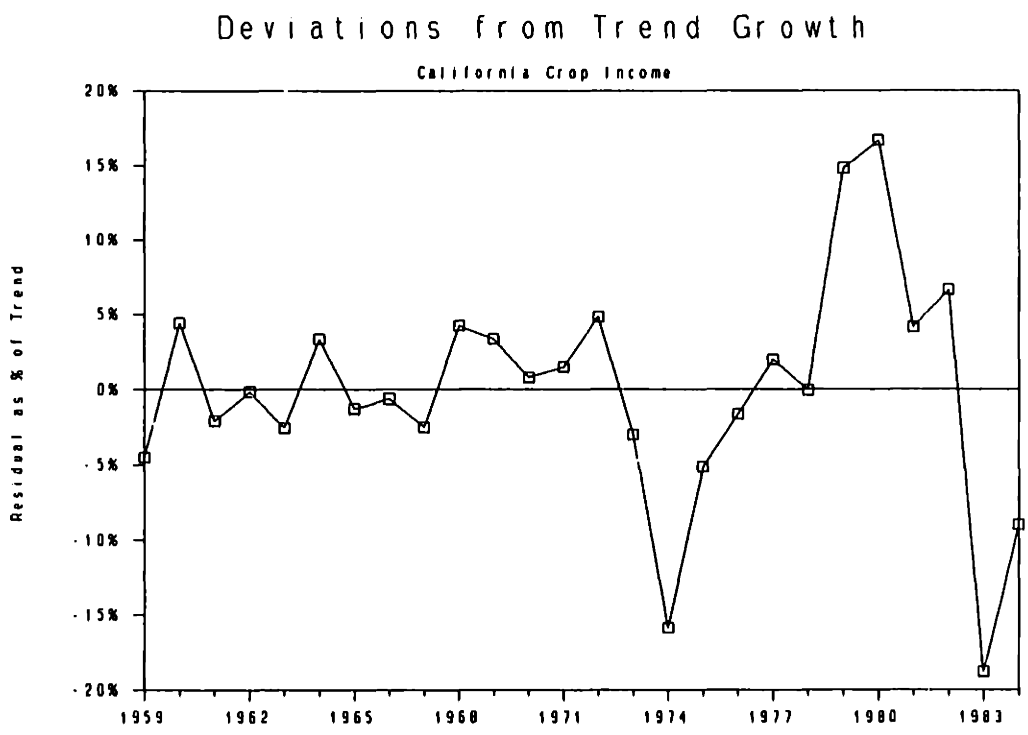

Figure 1.2

It is possible to fix the date of the transition more precisely by determining when this variance increased most rapidly. In doing so, I will work with standard deviations instead of variance to make the interpretation of the results more intuitive. Dividing the 1959-1984 period into two segments so as to maximize the difference in the standard deviations of the residuals between the two periods, a logical dividing line is established between 1972 and 1973. Prior to 1973, the standard deviation from trend growth was 2.8%. In other words, the average deviation around the trend was approximately the same as the trend rate of growth itself. After 1972, this standard deviation from trend soared to 9.3%, more than three times the underlying growth rate.

Early in the 1980s, after a decade of markedly increased instability, growth in California's farm industry took another turn for the worse, as the trend itself turned downward. This can be demonstrated by estimating a piecewise linear model using a modified dummy variable known as a "spline" variable, that takes on values of zero up until the date of the hypothesized change in trend in the early 1980s. Thereafter, the variable increases incrementally (1,2,3,...,n).[3] Adjusting the "knot" of the spline over time so as to maximize the variance explained by the model, the underlying growth trend is determined to have turned downward after 1981 (Equation 1.2). The null hypothesis that the period of 1981 to 1984 follows a time trend identical to earlier years is rejected. Indeed, the trend after 1981 is for revenue decreases of approximately 4% per year (Figure 1.3).

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[3] All variables used in the dissertation are defined in Appendix 1.6.

$$LN(Y) = 22.27 + .03(t) - .07(S81) \qquad \bar{r}^2 = .92$$
$$\quad (352.84) \quad (15.80) \quad (-2.53)$$

(1.2)

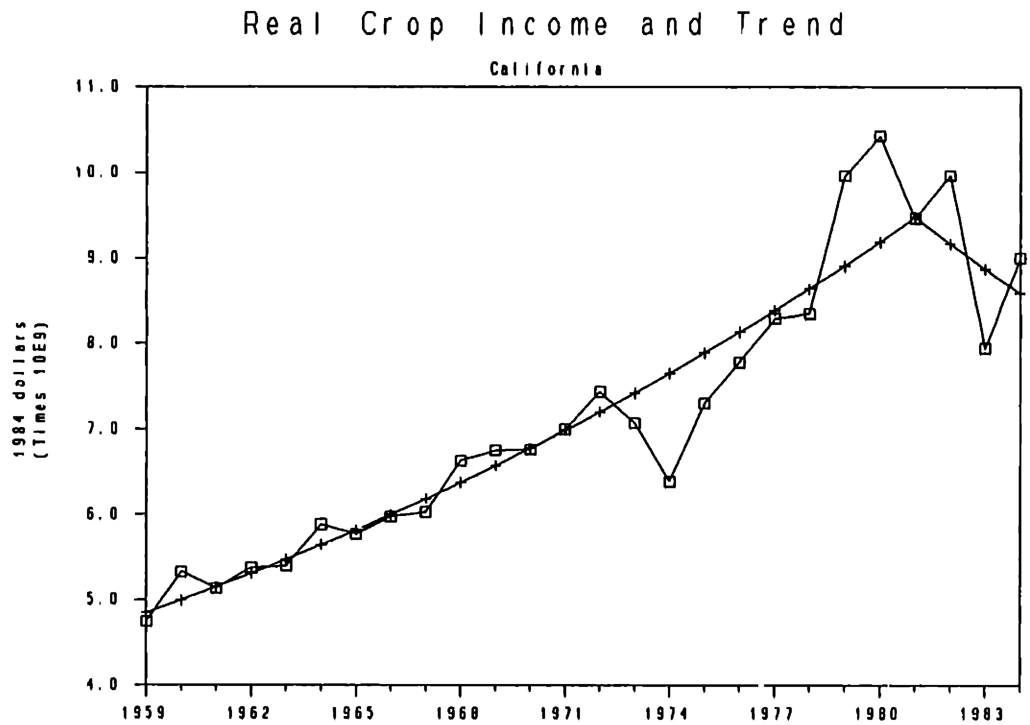

Figure 1.3

Recognizing that these state level data are extremely aggregated, it is reasonable to question whether or not they are representative of the experiences of growers at the local level. In particular, it may be that a few counties with very large revenues have experienced growing instability and are excessively influencing the aggregate results, while most regions are experiencing stable income growth.

To examine this possibility, I conducted an analysis at the county level, employing the same data sources that were used for the aggregate level analysis. Because many of California's counties have relatively insignificant levels of agriculture, a subset of all counties was used that included only the top twenty-five agricultural counties in the state. In every year of the study period, these counties accounted for more than 90% of California's total crop income.[4]

In attempting to draw general conclusions about income using county data, it is especially important to distinguish between changes in trend growth and changes around the trend. The reason for this is that if we simply pool the income observations for the top 25 counties, any observed increase in income volatility for individual counties could be overwhelmed by variability between counties. To account for differences in the underlying growth trends between counties, separate piecewise linear time models were estimated for each of the 25 counties in the sample.[5] Standardizing the residuals as a percentage of the trend, and comparing their standard deviations over time, the change in regimes between 1972 and 1973 is confirmed.[6] Using these pooled county data, the variation around the trend is observed to increase by 57% between the two periods (from .76 to 1.20). This is far less than the trebling of variation observed in the aggregate data. Nonetheless, there was a distinct increase in volatility around the trend at the level of individual counties (Table 1.1).

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4 Counties were ranked both by average annual crop income and by average annual percentage growth. Those counties included in the analysis scored highest based upon an index that combined these dual rankings in equal weights.

5 These models and the technical details regarding their estimation are described in Appendix 1.2.

6 This standardization consisted of dividing each residual by the standard deviation of the residuals for that county model.

Table 1.1

Increasing Revenue Volatility
Top 25 Counties[7]

County	Increase in Standard Deviation of the Residuals (1959-72) -> (1973-84)
Stanislaus	+266%
Monterey	+230%
San Luis Obispo	+186%
Glenn	+107%
Yolo	+104%
Kings	+102%
Butte	+ 98%
Fresno	+ 93%
Ventura	+ 93%
Santa Barbara	+ 87%
Imperial	+ 75%
Tulare	+ 68%
Madera	+ 66%
Solano	+ 64%
Colusa	+ 63%
Siskiyou	+ 62%
Yuba	+ 58%
Kern	+ 45%
San Diego	+ 42%
Sutter	+ 36%
Sacramento	+ 35%
Orange	+ 3%
Riverside	- 3%
Santa Cruz	- 26%
San Joaquin	- 27%

Examination of the county data strongly supports the argument that growing income instability was not unique to just a few regions, but was widespread. Running a similar analysis at the level of individual crops gives similar results (Table 1.3).[8] Although we should not overlook

[7] Regressions may be found in Appendix 1.3.

[8] The top 25 crops were chosen based on their average total income over the 1958-84 period. There was no ranking made based on growth, because, unlike the county observations, several crops that saw rapid growth remain a extremely small

importance differences between individual crops and counties, the evidence overwhelmingly supports the conclusion that revenue volatility has increased significantly.

Table 1.2

Increasing Revenue Volatility
Top 25 Crops

County	Increase in Standard Deviation of the Residuals (1959-72) -> (1973-84)
Wheat	+197%
Walnuts	+188%
Rice	+173%
Field Corn	+155%
Almonds	+120%
Lemons	+109%
Wine Grapes	+ 99%
Cotton	+ 94%
Lettuce	+ 74%
Table Grapes	+ 65%
Alfalfa	+ 62%
Dry Beans	+ 60%
Plums	+ 57%
Celery	+ 56%
Cantaloupes	+ 51%
Strawberries	+ 40%
Barley	+ 20%
Process Tomatoes	+ 15%
Sugar Beets	+ 12%
Oranges	+ 12%
Raisins	+ 10%
Prunes	+ 8%
Peaches	+ 2%
Fresh Tomatoes	- 22%
Potatoes	- 38%

What had happened? In particular, we might ask if the observed increase in instability was really just a normal market correction. Agricultural

relative to other crops.

economists have long argued that excessive capacity existed in the industry due to such varied factors as high government price supports and imperfect information acquired by farmers regarding the extent of markets (Johnson and Quance, 1972). If this was a shakeout, it was like none seen before. Certainly, the income losses of the early 1980s were closely associated with changes in productive capacity. Between 1982 and 1983 alone, California growers reduced their harvested acreage by 1.5 million acres (15%). However, this did not represent a re-establishing of equilibrium. The very next year, nearly all of the lost acreage was back in production. After more than a decade of instability, there was still no evidence of order being restored.

A second reason to believe this instability was more than a normal shakeout of excessive capacity was that losses were not born predominately by small farmers whom we would expect to have relatively higher costs of production. While it is true that very large farms persistently gained a larger share of total productive capacity, very small producers actually maintained their ground better than medium-sized farms. Whereas farms under 100 acres increased their share of total acreage slightly from 8.8% in 1974 to 9% in 1982, farms between 100 acres and 1000 acres actually declined as a share of the total from 38.3% to 34.5%.[9]

In summary, the examination of agricultural income in California yields two robust results: first, volatility in income around the trend rate of growth increased significantly early in the 1970s; second, trend

[9] Based on harvested, irrigated cropland. U.S. Bureau of the Census, Census of Agriculture, 1982

income itself turned downward in the early 1980s. The prolonged nature of this instability; the wide range of areas, crops, and farms affected; and, the extreme severity of the income swings involved, all suggest that the revenue instability faced by California growers since the early 1970s is neither a statistical illusion, nor a normal market adjustment. Let us now consider possible explanations of these events that have been offered by previous research.

The Traditional Model of Instability in Agriculture

The rising income volatility observed in California agriculture during the 1970s was sudden and dramatic. Still, instability as a general agricultural problem is not new. Although instability has been defined in different ways, severe volatility in farm revenues and prolonged periods of falling real prices have been recognized by researchers since at least the 1920s. There have been explicit governmental policies to mitigate such problems since the Great Depression.

The first academic theory of agricultural instability was not formulated until the 1945 publication of Agriculture in an Unstable Economy by Theodore Schultz. U.S. agriculture in the 1930s and 1940s was highly unstable, having gone from the midst of the Great Depression to very high prices brought about by war demand. Schultz's main concern was whether severe price declines that had plagued agricultural incomes prior to World War II would return when the war was over. He concluded that they would, identifying three structural characteristics of agricultural markets that tended to create overcapacity.

First, technical advances created rapid increases in the productivity of labor and land. Second, the demand for agricultural goods grew slowly, because the income elasticity of demand for farm products was low. Together, these forces resulted in differential growth between output and demand that placed persistent downward pressure on real prices for agricultural output. This tendency toward overcapacity was made all the more severe by a third structural characteristic—the relative immobility of labor and land. In the face of overcapacity, factor immobility prevented underutilized resources from being shifted to other areas of the economy where they could earn higher returns. Although it was technically possible to slow productivity growth, Schultz argued that doing so would be contrary to the goal of maximizing aggregate growth in the economy.

In the case of slow demand growth, the problem was more complicated. Schultz considered the problems of domestic and foreign demand separately. He believed that export demand growth would be of secondary importance for several reasons. First, Schultz argued that there would be renewed international surpluses of key commodities once devastated nations restored their agricultural base after the war. Second, he noted that export crops tended to be crops that were highly exhaustive of the soil, a lesson that had not been forgotten from the Dust Bowl years of the 1930s. As a practical matter, Schultz noted that exports had been declining as a share of total crop income throughout much of the first half of this century.

Schultz believed that long-run domestic demand growth was constrained by the low income elasticity of demand for agricultural products, a factor determined exogenously. Assuming that demand for agricultural products came mainly from households employed in industrial sectors of the economy, this implied that growth rates in industry had to be several times greater than growth rates in the agricultural sector to generate demand sufficient to absorb increasing output from agriculture.

> Much of the farm problem that loomed so large in the years between the two wars was not the result of maladjustments in agriculture but of poor and erratic performance elsewhere in the economy. The remedy, for the most part, did not lie in agriculture, in curtailing the output of food, feed, and fiber, but in attaining an expanding and steady production by other producers.
>
> Schultz (1945:136-7)

Short-run volatility in Schultz's model was determined mainly by fluctuations in aggregate demand. This led to the conclusion that Keynesian policies aimed at moderating the business cycle would have a stabilizing effect on agricultural incomes. However, Schultz's real concern was over longer term instability.

Here, he argued that the only permanent solution to agricultural instability was sectoral transformation that shifted resources out of agriculture and toward industry. His analysis focused on labor resources, because labor constituted the largest share of production costs at that time. Schultz identified two major constraints on the intersectoral migration of labor between agriculture and industry. First, most farmers used family labor which was not easily reallocated. Second, slow industrial growth provided relatively few job opportunities outside of agriculture. In the end, the most effective way to relieve agricultural instability was therefore to promote steady growth in the industrial sectors of the economy so as to encourage the intersectoral transformation of the economy.

More Recent Contributions to Mainstream Instability Theory

Through most of the post-war era, Schultz's model remained the foundation for our understanding of agricultural instability (Brandow, 1977). The literature about instability that has emerged in the post-war era is extremely diverse. Yet, I would argue that the bulk of this research can be interpreted as a response to the industrialization of farming in the U.S. As part of this industrialization, several of the basic propositions that Schultz took for granted changed. First, labor became a much smaller part of total resource requirements. Second, the government took on a much broader regulatory role than it had in prior years. Finally, trends toward the use of wage labor and increasing vertical coordination under industrialization helped to integrate agricultural markets in fundamentally new ways, challenging Schultz's basic premise that growth rates in agriculture and industry were poorly coordinated.

Despite these changes, at least two of Schultz's main themes have continued to the present day. First, continuing industrialization of the broader economy is seen to act on the supply side by pulling resources out of agriculture so as to lessen overcapacity. Second, government intervention in the economy is seen to have large effects on both supply and demand, but as with Schultz, there is a special focus on the role of governmental macroeconomic policy in determining demand.

Changing Labor Use:

In the 1950s and 1960s, it was widely agreed that there was considerable overcapacity in key crops. At the same time, technological change shifted input use dramatically away from land and labor toward capital, energy, and chemical inputs (Binswanger, 1973; Hayami and Ruttan, 1971; Antel, 1984). Together, these continued increases in output and a plummeting farm population raised serious doubts about the validity of Schultz's assertion that overcapacity resulted mainly from labor immobility.[10]

One result of these trends was that research turned away from any focus on labor. Glenn L. Johnson argued that agricultural resources, especially capital, tended to be very immobile due to high transaction costs. These included, not only legal costs associated with transferring ownership, but such things as obsolescence brought on by rapid technological change. The effect was to lower the salvage values of assets relative to their acquisition cost, locking farmers into resource use patterns they could not easily abandon (Johnson, 1958; Johnson and Quance, 1972). This theory was generally consistent with the empirical research of Nerlove and others indicating that the responsiveness of supply to price changes was generally small, but tended to be greater over the long-run (Nerlove, 1958; Askari and Cummings, 1977; Binswanger, 1990).

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[10] In 1945, the total farm population was 24.4 million. This had to declined to just 15.6 million by 1960 (Statistical Abstract of the United States, 1973, Table 973). Between 1947 and 1960, total farm output, as measured by the USDA Farm Output Index increased by 31% (Economic Report of the President, Table B-97, 1988).

A second theoretical response to declining labor use in agriculture was to try and explain why technological change took the qualitative directions it did. Schultz argued that U.S. commodity programs which controlled supply by restricting acreage encouraged farmers to increase application of other inputs, especially fertilizer (Schultz, 1945:172). This argument continues to be popular despite numerous studies indicating that the effect of farm policy on input use is negligible (these are summarized in Brandow, 1977:257). The argument basically takes two forms. In one version, the problem is mainly one of policy design. Because government payments to farmers are based on total output, but land is restricted, producers can maximize revenue under federal programs by applying more fertilizer (Smoley, 1987:28). In the second version, restricting land raises its price and encourages substitution of land-saving inputs (Rossmiller and Larsen, 1971:37).

This latter view is representative of a broader theory of technological change in agriculture generally attributed to Hayami and Ruttan (1971). Applying Hicksian induced innovation theory to the farm sector, they argued that farmers adopted technologies that saved on their relatively expensive factors (Hicks, 1932, 1967). Recognizing the importance of government-sponsored research to agricultural innovation in the U.S., Hayami and Ruttan extended the theory to the public sector. They alleged that farmers used their political power to direct government research toward the development of technologies that saved on scarce factors, a view that tends to be confirmed by case studies (Hightower, 1973; Peterson, 1969).

In principle, induced innovation theory made technological change endogenous, assigning farmers a greater say over their own destiny (Hayami and Ruttan, 1971:73; Koppel and Oasa, 1987:36). In practice however, relative factor prices were treated as exogenous. Thus, for instance, fertilizer costs declined due to technological advances in the chemical industries such as nitrogen fixing (Brandow, 1977:219). Likewise, land costs rose due to acreage restrictions forced on agriculture by government (Schuh, 1974:8). Most importantly, rising labor costs were due to economic growth in non-farm sectors of the economy that drove up wages. In short, although they came at the problem from different directions, both induced innovation and Schultzian overcapacity saw agricultural development as being dictated by industrialization outside of the farm economy.

Increased Governmental Regulation:

Schultz discussed governmental involvement in agricultural markets in a variety of contexts. He generally argued that macroeconomic stabilization and distribution functions were legitimate areas for state activity. Thus, Schultz favored Keynesian policies to stabilize aggregate demand and compensatory payments to farmers in times of low prices. However, like most other neoclassical economists, he believed that direct state intervention in the production decisions of farmers was an improper intrusion into the market. Accordingly, he had a strict aversion to policies based on restricting acreage, making farmland available to veterans, and subsidizing small family farms.

Although there is not strict agreement, later agricultural economists have tended to remain within this tradition. Most researchers agree that government has been a major force in determining agricultural supply. Using corn as a case study, Houck and Ryan (1972) argued that 95% of annual acreage shifts were explained by changing government policy. A few authors have consistently supported supply controls (Tweeten and Quance, 1977). Most, however, have argued against strict supply controls, asserting (among other things) that they tend to lock in inefficient resource use patterns and have large inequities associated with them (Paarlberg, 1980). The most widely accepted supply side intervention by the state has been the maintenance of large buffer stocks by the U.S. government to stabilize short-term price fluctuations (Tweeten, 1983; Piore and Sabel, 1984).

Focusing more on the demand side, many authors argued that government policies have priced our exports out of world markets by imposing a price floor above world prices (Schultz, 1945:139; Paarlberg, 1980:34-38). This has enabled foreign producers to undercut us in world markets. In some cases, it has also encouraged buyers to adopt substitute products. This argument has been made most forcibly with respect to cotton, where high support prices arguably allowed producers of synthetic fibers to enter the market with lower cost products such as rayon and polyester (Starbird, 1985)

Growing Market Integration:

Within orthodox instability theory, the increased focus on the state as a barrier to factor mobility and the declining emphasis on labor went together. That is, state policy replaced labor immobility as the fundamental supply-side barrier to transferring resources out of agriculture. On the other side of the market, the state had always played a major role. After all, Schultz maintained all along that macroeconomic stabilization policy could reduce agricultural volatility by buffering shifts in demand.

In 1964, Robert Firch econometrically tested Schultz's hypothesis that agricultural revenues were positively associated with aggregate demand. He found that the role of business cycles, although important in the 1930s, played a very minor role in determining income changes in the post-war era. Indeed, he argued that macroeconomic stabilization policies at the national level had reduced business cycle activity to such an extent that they no longer affected farmers significantly (Firch, 1964:334-338).

In Schultzian theory, business cycles were important because periods of slow industrial growth caused overcapacity in agriculture. Consequently, this declining role of business cycles fit in well with a growing sense by many authors that Schultz's transformation of agriculture was nearly complete (Paarlberg, 1978:771; Hathaway, 1981:779-780; Marion, 1986:2). In contrast to Schultz's concern over lack of coordination between industry and agriculture, farming was seen to be closely integrated into national markets (Marion, 1986). Farmers relied heavily on purchased inputs and sold their output to firms that were often vertically integrated and geographically dispersed.

In the late 1960s and 1970s, market integration was extended internationally. First, price floors under U.S. commodities were lowered to below world prices. Then, the dollar was devalued successively in 1971 and 1973. The result was an opening up of international markets and a distinct transformation of prior theory. No longer did overcapacity seem to matter. Instead, instability theory became overwhelmingly dominated by concerns for international markets and state policy. In 1974, Edward Schuh challenged the prevailing view that price supports had kept U.S. exports constrained. Instead, he argued that the U.S. dollar had been consistently overvalued since the early 1950s. This overvaluation, he asserted, was at least as important in harming U.S. agricultural exports as were price supports.

By the late 1970s, short-run volatility in agricultural income was once again a major concern. Schuh's analysis provided the starting point for mainstream efforts to understand the sudden resurgence of revenue instability. Schuh argued that the devaluation of the dollar in the early 1970s and the accompanying move to floating exchange rates marked a fundamental structural shift in agricultural markets which would renew the competitiveness of U.S. producers internationally. Later empirical studies have supported the argument that devaluation resulted in price increases for U.S. traded commodities (Grennes, Thomas, and Thursby, 1980; Chambers and Just, 1979).

There has been considerable agreement among authors that exchange rate shifts have added to the instability in revenues (Firch, 1977; Bredahl, et. al., 1979; Chambers and Just, 1979; Gardner, 1981). However, there has been considerable debate among authors about how exchange rate movements should be modelled from a methodological perspective, and it is unclear exactly which of the various parts of exchange rate restructuring have been most important. Most authors have tended to focus on annual changes in the value of the dollar (Chambers and Just, 1979; Grennes, Thomas, and Thursby, 1980). In contrast, Gardner (1981) argued that the vast majority of variance could be explained by a dummy variable representing the shift to floating rates in 1973. Finally, Bredahl et. al. (1979) argued that government trade policies which tended to insulate farmers from exchange rate shifts made a huge difference in how such shifts actually affected prices.

This focus on exchange rates also encouraged authors to reexamine the role of other macroeconomic variables in determining revenue instability. Firch (1977) determined that business cycle fluctuations had reemerged as a potential source of instability between 1966 and 1975, even after accounting for the effects of exchange rates. In a similar vein, Paarlberg (1980:65) argued that inflation would be the major issue of the 1980s. By and large, empirical studies have demonstrated the role of inflation in direct revenue destabilization to be small (Firch, 1977; Gardner, 1981).[11]

Empirical Evidence on Destabilization

In this section, I will argue that mainstream theory does not explain the destabilization of agricultural incomes in California since 1970. Specifically, I will focus on the role of business cycles and exchange

11 It remains possible that changes in price have affected the agricultural economy in other ways, especially by discouraging productivity growth (Griliches, 1988; Johnson, 1980; Lee, 1980) or by changing the value of land (Feldstein, 1980; Houck, 1980).

rates. Government policy does matter and will be considered in more detail later.

The Role of Business Cycles:

The belief that the level of national economic activity affects farm revenues through the demand side has been a consistent theme of mainstream instability theory. Empirical studies suggest that any association between business cycles and crop income tends to be inconsistent, but occasionally very important (Firch 1964, 1977; Tweeten 1977; Gardner, 1981). Gardner (1981:873) argues that agriculture tends to be especially sensitive to national recessions.

How well do these results hold at the regional level? Applying the same technique that was used earlier to detrend the agricultural income data series, the natural log of GNP is regressed on time. The residuals from this operation (GNP') represent annual percentage deviations from trend growth in GNP, a simple measure of the business cycle.[12] To statistically test for association between GNP variation and shifts in California crop revenues, the detrended income series is regressed on our measure of the business cycle in equation 1.3. Based on this test, variations in the level of national economic activity do not appear to explain a significant amount of variance not already explained by trend

[12] In general, I will use GNP as my measure of national economic activity. The detrended data are based on the following regression:

$$\underset{}{LN(GNP)} = \underset{(694.05)}{22.237} + \underset{(28.11)}{.030(t)} \qquad \bar{r}^2 = .97$$

growth.[13] It may be true that behavior of the national economy has strong impacts on local crop income. However, if this is the case, the relationship would appear to be more complicated than is often assumed.

$$Y' = \underset{(0.00)}{0.00} + \underset{(1.01)}{.36}(GNP') \qquad \bar{r}^2 = .00 \tag{1.3}$$

To be consistent with prior studies by other researchers, we might ask if the role of the business cycle, although not consistently important, had any significance during the most recent period of destabilization. Both Firch (1977) and Gardner (1981) argue that, after having declined in importance in the 1960s, business cycles once again became important in the 1970s. If this is the case, it would suggest that there has been structural change in the relationship between agriculture revenues and aggregate activity in the economy. To find out if this is true, I ran the same test again, this time allowing the GNP' series to take on values of zero before 1972 so as to model the effect of a structural shift. It made virtually no difference.[14]

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[13] This model uses a two year moving average of the business cycle variable, a specification which maximized variance explained. The basic conclusion that crop income is unrelated to business cycles is unaffected by the particular lag structure assumed.

[14] Again, this is based on a two year moving average of GNP, and the lag structure made no appreciable difference. The revised regression yields the following result:

$$Y' = \underset{(0.00)}{0.00} + \underset{(1.21)}{.68}(GNP') \qquad \bar{r}^2 = .02$$

The Value of the Dollar:

Unquestionably, the most widespread explanation of slow and inconsistent growth in the farm economy in recent years has been tied to the increased role of international trade. In an attempt to test this belief, I modelled trade effects using the real, multilateral trade-weighted value of the dollar. In order to incorporate the effect of the structural change to floating currency rates, the measure was assigned values of zero for years prior to 1973. Examining the results of this analysis in equation 1.4, exchange rates appear to have played a significant role in destabilizing crop income in California since 1970, explaining roughly one-quarter of the variance not already explained by trend growth.[15]

$$\underset{(0.00)}{Y' = 0.00} - \underset{(-3.14)}{.40(\text{DOLLAR})} \qquad \bar{r}^2 = .26 \tag{1.4}$$

To test Gardner's hypothesis that the majority of exchange rate effect was actually a one-time structural shift, I repeated his test using a (0,1) dummy variable to model the shift—it was insignificant.[16] In short, currency shifts did matter; it was not simply structural change.

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[15] Because no simple time trend in the value of the dollar could be detected, the variable was normalized as percentage deviations from its mean value. Again, this is based on a two year moving average of the variable.

[16] The estimated equation is:

$$\underset{(.10)}{0.01} - \underset{(-0.57)}{.02(\text{DUMMY})} \qquad \bar{r}^2 = .00$$

Sectoral Level Analysis:

Up to this point, our conclusions have been made based on data aggregated across all crop types. These aggregate results may not be representative of the experience of large segments of California agriculture for several reasons. First, California producers grow a large variety of crop types and our aggregated results may not fit any single crop very well. Second, changes in crop mix may influence the relationships between aggregate income, GNP, and the value of the dollar. At a minimum, we ought to expect that exchange rate effects are greater for export-base crops than for domestic crops. If there is a shift from domestic crops to export crops, this should increase the aggregate responsiveness of income to exchange rates, even though each individual crop sector is behaving the same as it always has. Finally, it may be that a few large and influential crops are exerting undue influence on the results.

To gain a better sense of how the influence of business cycle and exchange rate effects might vary across different crop types, I ran a series of individual regressions on each crop type with both the business cycle measure and the value of the dollar included. According to most theory, we should expect positive shifts in GNP to be associated with gains in agricultural income. On the other hand, increases in the value of the dollar should choke off demand and lower farm revenues. Lag structures were allowed to vary between crop types to reflect the different response structures of different crops. The results of this analysis are summarized in Table 1.3.

Table 1.3

The Effect of GNP and Exchange Rate Movements on Crop Income

Crop	Coefficient on GNP'	Coefficient on DOLLAR'	$\bar{r}^2$	Export Share
Cotton	-6.97	-2.56	.65	67%
Rice	2.19	-1.18	.54	42%
Wheat	-4.23	-2.83	.40	74%
Barley	1.60	-0.89	.44	(-)
Process Tomatoes	4.73		.40	(-)
Field Corn	2.35		.19	(na)
Strawberries	-1.66		.26	7%
Wine Grapes		-1.57	.12	(-)
Potatoes		1.51	.20	(-)
Walnuts		-1.48	.18	25%
Peaches		- .75	.31	7%

Crops for which neither GNP' nor DOLLAR' are significant (with export share):

Celery (9%)	Alfalfa (-)
Cantaloupes (na)	Sugar Beets (-)
Almonds (56%)	Fresh Tomatoes (8%)
Prunes (36%)	Table Grapes (27%)
Lettuce (7%)	Dry Beans (10%)
Lemons (34%)	Oranges (24%)
Plums (14%)	Raisins (22%)

Notes:

1. (-) = less than 5%.
2. (na) = not available. This usually implies that exports are minimal.
3. DOLLAR' = percentage deviations from the mean of the real, trade weighted value of the dollar between 1973 and 1984. The variable is set to zero before 1973.
4. GNP' = percentage deviations from time trend in GNP.
5. Coefficients are only shown if significant at the 95% confidence level.
6. Equations can be found in Appendix 1.4.
7. Export Shares = percentage of revenues from exports, valued at farm gate. Source: California Dept. of Food and Agriculture "Exports of Agricultural Commodities Produced in California," published annually.

By and large, the results for the exchange rate variable are consistent with our expectations. The value of the dollar is most significant for those crops with the highest export shares. In each case, the sign is negative, indicating that an increased value of the dollar leads to decreased income. Of special importance are cotton, rice, and wheat. Still, there are several notable export crops which are surprisingly unaffected by exchange rates, most notably prunes, lemons, and almonds.

At the other end of the spectrum, the value of the dollar is generally of low significance in crops with low export shares. The exceptions to this are barley and wine grapes. The most likely explanation of this is that the final products (beer and wine) are exported. It may also be because domestic wine and beer compete with foreign imports. However, this is far from certain, since such a large part of California wines are in non-premium grades facing minimal import competition. Indeed, why don't we see a larger role for exchange rates in the case of fresh tomatoes, where growers have actively protested foreign imports and where the quality of imports and domestic product are clearly quite similar (Cook and Amon, 1987)? Finally, we should note that potatoes showed an association with exchange rates of the "wrong" sign. Presumably this is because potatoes are often used as a substitute crop for cotton. Thus, low international demand for cotton would encourage expanded acreage (and revenue) in potatoes.

In short, while exchange rates behave basically as expected, important questions remain. First, why are some crops so export-oriented to begin with? Second, why do some export crops show much greater sensitivity to exchange rates than others? Finally, why are some domestic crops affected by exchange rates when there is no obvious foreign substitute for them and when they are not inputs into a exported commodity?

The results with respect to the business cycle variable are much more problematic. In 7 of the 25 crops shown, the business cycle measure is highly significant. Yet, there is no consistency to the sign.[17] This is most perplexing in the case of cotton. Because cotton is an industrial input, we would expect a positive relationship with business cycles, but just the opposite is true. This suggests that different crops are affected by business cycles in fundamentally different ways, a conclusion which existing theories of instability simply do not prepare us for.

Overall, the results of the individual crop analysis suggests that, while important, the general focus on macroeconomic variables may be overstated. At a minimum, the relationships between macroeconomic variables and agricultural performance are more complicated than may be easily portrayed by any simple regression. In total, of the 25 crops tested, only two (rice and barley) show both GNP and the value of the dollar to be significant with the signs expected. Only two crops (rice and cotton) have more than half of their variance explained that has not already been explained by trend growth.

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[17] One possible technical explanation of this is that there is unexpected interaction between variables. I am inclined to discount this possibility for two reasons. First, correlation between the detrended GNP and dollar series is very low ($r = .15$). Second, at least in cotton, wheat, and rice, if there were strong associations between the variables, we would not expect to see both variables significant in the regression.

Critique

Sometimes, analysts have defined revenue instability as short-run fluctuations around a trend. In other instances, they have worried about longer-term real price declines. In either case, the cause for concern is an inability of agricultural economies to achieve revenue growth not beset by undue volatility. Clearly, any theory of agricultural instability must therefore begin with an idea of how farm economies grow over time. Schultz provided us a strong foundation from which to proceed. His theory was one well-grounded in a theory of economic growth and how agriculture fit into the broader economy.

However, Schultz made two critical mistakes. First, he envisioned the structural features of his model as given. That is, rapid technological change, low resource mobility, and low income elasticities of demand were taken as being beyond the control of producers and unchanging. Second, he chose too narrow a model of economic development. Like so many of his contemporaries, Schultz defined economic development as a relatively straightforward process whereby growing economies inexorably moved away from agriculture toward manufacturing industries. As a result, he never seriously considered the possibility that agriculture itself might industrialize.

In fact, agriculture did industrialize, with the result that many of Schultz's structural features changed. Consequently, Shultzian predictions did not fare very well. Business cycles were often unimportant in determining volatility and overcapacity remained prevalent despite huge declines in labor use. Unfortunately, later efforts to overcome these theoretical weaknesses have, by and large, "thrown the baby out with the bath water." In trying to adapt to changes such as the declining labor use on farms, the shift toward international markets, and greater integration between agriculture and other sectors of the economy, modern theories have essentially turned away from any focus on production.

In modern theory, structural relations specific to farming no longer have any importance to determining instability. To the extent that economic structures matter, they are macroeconomic features such as exchange rate regimes, not relations between producers and those they do business with. The end result is a theory of instability which portrays the farmer as a victim of forces beyond her control. This is well expressed by Hathaway:

> Now once again instability will be a policy issue in the next decade. On the cost side, commercial agriculture finds itself at the mercy of OPEC, U.S., and world monetary policy, and world industrial price policy for inputs such as steel, fertilizers, and chemicals. On the market side, there is unstable demand, unstable exchange rates, unpredictable U.S. government trade policies and unpredictable foreign government policies regarding imports (sic). In my view, U.S. producers are only beginning to understand the nature and extent of this instability and the adverse consequences it can have upon their economic well-being.
>
> Hathaway (1981:786)

The problem with this view of the world is that, in its extreme, it can lead to policy paralysis. If the sources of agricultural instability really do lie in foreign markets and macroeconomic relations, then there is relatively little that farmers can do to better (or worsen) their situation. Likewise, it is impossible for government to formulate meaningful stabilization policy. The alternative is to do nothing—to wait for the international and macroeconomic environment to improve. Yet, unstable growth has plagued California agriculture for more than two decades and stability has yet to be restored.

Instability is not strictly exogenous. Changes in international markets and the macroeconomic environment do matter. However, producers have a great deal of influence over whether their industries grow predictably or not. In the next two chapters, I shall present an alternative explanation for the destabilization of California agriculture since 1970. In this explanation, instability is viewed, not as an anomaly, but as inherent to the industrialization process. In Chapter 2, I shall trace the origins of this body of theory from its roots in industrial sectors of the economy and discuss its general application to agriculture. In Chapter 3, I will present a more detailed description of what has destabilized California agriculture.

CHAPTER 2

REGULATION THEORY AND THE INDUSTRIALIZATION OF AGRICULTURE IN CALIFORNIA

California agriculture is not the only industry that has faced severe instability in recent years. The 1970s and 1980s were marked by industrial crisis throughout many advanced economies. The exact symptoms vary from country to country, and by sector. In the United States, this poor industrial performance has been characterized by the following trends:

1. Overall growth rates which are slow and erratic.
2. Unemployment which was initially high by historical averages, then dropped, but shifted toward temporary and part-time employment, much of which was involuntary (Harrison and Bluestone, 1988; Tilly, 1991).
3. Low real investment (Friedman, 1988).
4. Low productivity growth (Griliches, 1988; Olson, 1988).
5. Prior to the deep recession of the early 1980s, high unemployment was combined with rampant inflation (Weitzman, 1984).
6. The U.S. lost market share in sector after sector of its key industries, especially in, but not limited to manufacturing (Thurow, 1985).
7. There were major geographic shifts in production domestically, which often left entire regions economically devastated (Sawers and Tabb, 1984; Storper and Walker, 1989).
8. Real incomes failed to increase, and in many cases declined. At the same time, income distribution in the U.S. became less equitable, a notable reversal from earlier trends (Harrison and Bluestone, 1988; Thurow, 1987)

Interestingly enough, the mainstream explanations that have arisen for this failed growth are remarkably similar to those in agriculture.

According to most economists, the problem has been a combination of failed macroeconomic policy and bad luck. Beginning with the 1960s, fiscal policy was overly expansionary as President Johnson tried to fight both the war in Vietnam and the War on Poverty at home. These inflationary forces were further spurred by the decline in U.S. wheat stocks associated with the Russian wheat deal (1973), and by the oil shocks of 1973 and 1979. Concurrent to these inflationary forces, U.S. exporters were being subjected to disturbances in international currency markets, as the world moved to floating exchange rates and the dollar was devalued (Piore and Sabel, 1984:170-179).

In the 1980s, analytical focus shifted more heavily to domestic tax and fiscal policy. Critics argued that, by running perpetual fiscal deficits which kept real interest rates high relative to our major trading partners, the U.S. government both choked off domestic investment and kept demand for the dollar high. This overvalued dollar, in turn, stymied efforts by U.S. producers to export (Friedman, 1988).

Overall, the similarities between this industrial literature and agricultural theories of destabilization are uncanny, going well beyond their common concern for international trade in the 1980s. In each case, instability is seen as a temporary disturbance from an otherwise smooth process; in each case, the explanation of unstable growth is seen to be poor policy and exogenous shocks to the economy. The view is well summarized by the official report of the Organization for Economic Cooperation and Development (OECD),

> ... the most important feature was an unusual bunching of unfortunate disturbances unlikely to be repeated on the same scale, the impact of which was compounded by some avoidable errors in economic policy.
>
> (McCracken, et al, 1977:17)

By no means is this explanation of unstable industrial growth in OECD countries accepted universally. In this chapter, I shall describe an alternative explanation for unstable growth that has arisen within the industrial literature. Central to this body of theory is the idea that modern industrial growth is inherently a disequilibrium process. Within this process, the competitive strategies adopted by producers are critical to determining the developmental trajectories taken by specific industries and their subsectors. In large part, the possibilities for sustained growth are determined by these trajectories.

In attempting to apply this body of theory to the problem of agricultural destabilization in California, I break with prior theory on several points. First, agriculture and "heavy" industry are not juxtaposed to one another. Rather, California agriculture is viewed as an industry not fundamentally different from steel, autos, or computers. In each, it is not <u>what</u> is produced that is critical, but <u>how</u> it is produced. In California, agriculture has tended to be organized as a mass production industry. As such, it has had to overcome a series of constraints on growth common to all such industries. This has propelled the industry in somewhat different developmental directions than farming regions elsewhere in the U.S., and has had a major influence on the forms taken by instability in the state. This is not to imply that the California experience is so unique that it cannot provide useful lessons to other regions. Quite the contrary, California agriculture has tended to be a leader in the nationwide industry and its competitive strategies often represent best practice technology and management techniques. Thus, lessons learned in the state are especially valuable to farmers elsewhere considering reproducing these approaches to competition elsewhere.

Much of the remainder of this chapter is dedicated to describing the process of industrialization in California agriculture during the post-war period. In Chapter 3, I describe how this developmental path has contributed to instability in very specific and identifiable ways.

Regulation Theory

While most economists were describing failed industrial growth as a result of "unfortunate disturbances," a very different explanation of industrial instability was emerging among French scholars on the Left. Collectively, these works have come to be known in English as "regulation theory" (Aglietta, 1979,1982; Boyer, 1979; Coriat 197[illegible]). According to regulation theory, economic growth at any point in time may be constrained by a variety of forces, many of which are sectorally specific. In some cases, these may be supply constraints, like the inability to obtain labor of given quality. In other cases, the limits on growth may come from the demand side, as weak aggregate demand, or as failing markets for specific products. In either case, constraints on growth at any instant result as much from the existing structure of the industry as from exogenous forces.

The ability of an economy to overcome these constraints is what determines its potential for growth. In attempting to gain competitive advantage, producers are seen as constantly experimenting with new types of technology, resource use, labor relations, marketing strategies, etc. If enough producers adopt similar competitive strategies, they may become institutionalized as regulatory mechanisms operating at the scale of entire sectors or industries. Accordingly, the theoretical focus is not so much on economic agents as in neoclassical analysis, but on how the actions of producers as a group act to redefine their competitive environment.

If producers are successful in reorganizing competition to overcome existing constraints on growth, they may enter a prolonged "regime of accumulation," during which widespread growth is possible. If constraints on growth cannot be overcome by large segments of producers, the sector or even the broader economy may fall into crisis. Most important, in overcoming one set of constraints, producers may create new challenges. Rather than tending toward equilibrium, capitalist growth is interpreted as being inherently unstable, as producers alternately leap between periods of crisis and accumulation.

According to regulation theory, the U.S. crisis of the 1970s and 1980s can be interpreted as the collapse of an unusually prolonged period of accumulation associated with organization of the economy around mass production. Domestically, this period of growth was regulated by a series of institutions collectively known as "Fordism." Under Fordism, aggregate demand was supported by tying wage increases to growing productivity. In this way, domestic purchasing power was maintained without cutting profits significantly.[1] Purchasing power was supported further by countercylical fiscal policy and various forms of social welfare legislation.

On the supply side, the success of mass production was predicated on an ability to maintain uninterrupted production. Because capacity utilization had to be kept high to maintain new investment, labor militancy had to be severely constrained in order to avoid work stoppages. The stabilization of labor relations was based on a "social contract" between management and labor. Organized labor was granted rights to collective bargaining and closed shops in return for a guarantee by union leaders that they would control labor militancy.[2] In nonunion sectors (including agriculture) militancy was avoided by using very vulnerable groups of employees (Doeringer and Piore, 1971).

Also on the supply side, the presence of powerful oligopolies served to control capacity growth. These industry leaders had the incentive and ability to restrict production and keep prices high. They also had the power to successfully restrict the entry of new firms into the market.

Domestic Fordism was supported internationally by several forces that combined to give U.S. producers clear hegemony in world markets

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[1] Fordism gets its name from automobile maker Henry Ford. As the story goes, Ford claimed that the reason he paid his workers a high wage was so they could afford to buy his cars.

[2] Often, this agreement is seen as being institutionalized in the 1948 contract between General Motors and the United Auto Workers (Piore and Sabel, 1984; Kochan, Katz, and McKersie, 1986). Its basic elements spread rapidly throughout the economy as unionized employers sought to fend off job actions.

(DeVroey, 1984). First, the U.S. was the only industrialized nation to emerge from World War II with its productive capacity fully intact. Second, under the Bretton-Woods system of international monetary agreements, foreign governments had to maintain their currency value relative to the dollar, severely constraining their freedom to make domestic macroeconomic policy (Piore and Sabel, 1984:170-174).

The Crisis of Mass Production:

By the 1970s, the ability of domestic Fordism to support aggregate demand and maintain investment was being called into question in a dramatic way. Ironically, many of the new constraints on growth that emerged were directly descendent from prior successes. First, wage agreements based on automatic cost-of-living-adjustments (COLAs) were highly inflexible, causing considerable internal tension between the need to maintain aggregate demand and the ability to control inflation. Second, the costs to the state of supporting incomes at a level high enough to absorb expanding production was prohibitive (O'Connor, 1973). Third, overconcentration of the economy in mass produced consumer durables made it increasingly difficult to expand demand fast enough to prevent overcapacity (Piore and Sabel, 1984:184)

Internationally, U.S. hegemony began to collapse as well (DeVroey, 1984). In Japan and Western Europe, producers steadily replaced their capacity destroyed in earlier wars. Moreover, that capacity was newer and more efficient than in the U.S. In part due to their enormous international power, entrenched oligopolies in the U.S. concentrated on maintaining barriers to entry rather than on new innovation (Markusen and Carlson, 1989:47). At the same time, developing countries were becoming dissatisfied with their role as consumers of U.S. products (Lipietz, 1986; Piore and Sabel, 1984). Initially, these nations reduced their demand for U.S. capital goods by adopting import substitution policies. By the 1970s, a growing number of newly industrializing countries (NICs) were aggressively competing in capital goods sectors where economists had traditionally argued they had no competitive advantage (Amsden, 1989).

When the collapse of the Bretton-Woods system and conversion to floating exchange rates came in 1973, it was only the icing on the cake. Certainly, macroeconomic mistakes were made. Tight monetary policy and related high interest rates <u>did</u> force a major recession domestically. Expansive fiscal policy and generous tax breaks <u>did</u> contribute to the twin trade and budget deficits. However, many of the events that triggered the crisis were microeconomic in nature, including such firm-based actions as the transfer of technology to our competitors, an excessive expansion of scale, and the inflexible allocation of resources at the level of the individual plant.

As the collapse of the post-war system of regulation initiated the industrial crisis of U.S. industry, responses of firms, by and large, worsened the situation. Rather than invest in productivity improvements, U.S. firms tried to restore short-term profits through purely financial restructuring as the merger wave of the 1980s came into full swing. Rather than pursuing innovation in new product lines, U.S. firms increasingly acted as marketers for European and Japanese goods in product lines where the U.S. was unrepresented at the level of production. Rather than seek cooperation with labor that could have maintained domestic purchasing power and restored flexibility to wage structures, U.S. firms embarked on a full-blown war against labor that lowered the real incomes of most U.S. consumers consistently for more than fifteen years (Harrison and Bluestone, 1988).

Areas of Consensus within Recent Industrial Theory

As the crisis of U.S. manufacturing industries has dragged on, at least a few parts of the regulationist explanation have been accepted into the mainstream. In the late 1980s, economists across the political spectrum came to agree that U.S. industrial firms have contributed to their own problems. Where the two sets of theory continue to diverge is in the extent to which they see the problem as an internal collapse of mass production. The critique by neoclassical analysts focuses on the inability of U.S. industry to adapt to changing international conditions, with these conditions being determined exogenously (Dertouzos, Lester, and Solow, 1989).[3] The regulationist critique continues to focus on the failure of mass production strategies (Piore and Sabel, 1984).

Nonetheless, despite these significant differences, there is a surprising degree of consensus about what needs to be done to get U.S.

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[3] This view is seen most clearly in product cycle theory (Vernon, 1966; Storper, 1985). Authors such as Reich and Thurow, both strongly influenced by product cycle theory, have advocated a shift toward high-end production for specialized markets. At the same time, firms need to focus on continual innovation to overcome the enhanced ability of developing countries to copy even sophisticated goods (Amsden, 1989; Thurow, 1985; Reich, 1983).

industry back on track. At the center of this accord is a common vision of a new industrial organization characterized by mobile firms specializing in the production of high value goods and services. The hallmark of this new industrial organization is said to be its increased level of flexibility. Following Atkinson (1985), most researchers have classified flexibility into several categories. Functional flexibility refers to qualitative changes in the relations of production, including such things as supplier relationships, job redefinition, worker skill levels, and the adoption of new technologies (Wood, 1989). Numerical flexibility refers to increasing freedom to alter the numbers of employees hired at any time through the use of part-time and temporary labor, and through outsourcing (Kelley and Harrison, 1990). Wage flexibility refers to the ability of employers to alter the terms of the wage contract through such mechanisms as two-tiered wages, bonus systems, and even givebacks by workers to troubled firms.

All of these production shifts are believed to contribute to product-mix flexibility, a heightened ability to shift between a greater number of potential output types in a shorter time period (Wood, 1989). In its most idealized form of "flexible specialization," producers are argued to develop an ability to move between an a nearly unlimited number of alternative markets (Piore and Sabel, 1984). This highly idealized concept of flexible specialization can be broken down into a series of concrete and specific reforms which have prompted serious discussion among both academics and officials attempting to design regional economic development strategies. To list just a few of the more important elements:

1. Marketing Strategies: Rather than producing long runs of standardized products, firms compete based on their ability to rapidly switch output so as to move into new (generally higher value) markets as they become available (Piore and Sabel, 1984; Best, 1990).

2. Organization of Firms: Instead of large, vertically-integrated firms, there is a trend toward vertical disintegration. This encourages a resurgence of small firms. Many believe that U.S. firms need to adopt Japanese practices of maintaining more permanent and cooperative relations with contractors (Dore, 1986; Dertouzos, Lester, and Solow, 1989).

3. Spatial Tendencies: As vertical disintegration proceeds, small firms tend to become linked horizontally through complex contracting relations and the sharing of highly mobile labor resources. This favors concentration of small firms into industrial districts to gain external economies of scope and scale (Scott, 1988; Sabel, 1990).

4. Labor Relations: Firms remove the sort of strict job classifications and rigid work rules found under industrial unionism. Worker training is reoriented to teach basic skills of problem solving necessary to move between the production of different goods. Adversarial relations between management and labor are replaced by more cooperative relations, as firms shift toward treating labor as an asset, rather than simply as a cost to be minimized (Kochan, Katz, and McKersie, 1986; Thurow, 1985).

5. Managing Technology: Firms are seen to be forward-looking. While not all firms can have large research and development efforts, even small firms are working to become more capable at rapidly adopting new innovations. Part of this effort includes the firm recentering its effort on areas where it has the greatest expertise (Piore, 1986; Dertouzos, Lester, and Solow, 1989).

Of course, much of this discussion is strikingly similar in both form and content to the long-standing dialogue over factor mobility. Yet, there are two features that make the modern call for greater flexibility qualitatively different. First, there is a overriding concern for organizational issues. Increasingly, economists have concluded that the greatest limits on productive mobility are not physical. Rather, flexibility is constrained by archaic management techniques, poor worker training, bureaucratic unions, and other institutional or organizational failures (Piore, 1989; Peters, 1987).

Second, flexibility differs from standard factor mobility in that it is explicitly strategic in nature. Whereas traditional regional economics sees factor mobility as a means of improving market efficiency, modern liberal analysts and regulation theorists see it as the key to new competitive strategies—strategies that can arguably restore competitiveness in the U.S. economy (Best, 1990). Not surprisingly, these latter analysts have been more open to the concept of activist industrial policy than their more conservative counterparts. In liberal neoclassical circles, this has been manifested as increasing calls for the creation of an industrial development bank and efforts to speed restructuring of "mature" industries (Thurow, 1985; Reich, 1983). In some cases, policy has actually aimed at creating industrial districts. Organizationally, these efforts often incorporate some form of tripartism, wherein regionally-based governments work closely with industry and organized labor in an effort to create competitive niches for local producers, help them manage new technologies, and restructure them organizationally to become more flexible (Sabel; 1990a, 1990b).

In practice, discussions of flexibility have often been highly idealized, and it has proven difficult to find "pure" examples of flexible specialization (Harrison, 1990). In examining the U.S. experience, Piore (1986:25) argues that what we tend to see instead is an intermediate form he refers to as "flexible mass production." In this model, producers develop the ability to move between several distinctly different outputs, but within a decidely limited range of possible variation. In the short-run, these goods may continue to be highly standardized and production may be conducted at a relatively large scale, even though producers seek to reform labor relations, flatten managerial organizations, and adopt new strategies for marketing and managing technological change. However, over the longer run, Piore and Sabel believe that flexible mass production is inherently unstable, because increasing flexibility requires a fundamental rejection of mass production principles. Once started, the reform process is not easily halted and the gains to be made from increasing flexibility are simply too great to ignore. Accordingly, flexible mass production exists primarily as a transitional form on the way to flexible specialization (Piore, 1986:28-30; Sabel, 1982).

My research presents a different interpretation. Tracing the development of California agriculture, I shall try to demonstrate that increased flexibility and mass production are not necessarily at odds. In fact, they may be mutually supportive. Likewise, there is no necessary inherent logic that pushes the industry toward disintegration into smaller production units. Even within an environment of greater productive flexibility, there may be powerful forces that encourage an expansion of scale. Finally, as we shall explore in a case study of the cotton sector, flexible mass production may be unstable. However, the sources of that instability are not simply a failure in mass production. They also arise from the particular forms in which increasing flexibility is manifested.

Regulation Theory and Agriculture

Agriculture is not fundamentally different from other sectors of the economy. As a mass production industry, California agriculture has faced several broad challenges to ongoing growth. First, it has required a stable supply of inputs to maintain capacity utilization and support continued investment. Accordingly, California growers have adapted a unique series of institutions to regulate supplies of labor and water, both of which were historically scarce in the state. Second, stable growth required an ongoing coordination of supply and demand, and some ability to create the uniquely large and predictable markets necessary for mass production. In addition, there were various forms of non-market rationing systems that helped prevent output expansion from swamping markets.

Throughout much of the post-war era, these industrial structures provided for ongoing growth that was moderate and steady. However, by the early 1960s, key elements of the system of regulation began to break down, laying the foundation for the chaos that has been California agriculture since 1970.

The Industrialization of California Agriculture:

Schultz believed that economic activities in agriculture and industry were poorly coordinated, leading to a major misallocation of resources between sectors of the economy. In California, the industrialization of agriculture narrowed this schism in two ways. First, California agriculture adopted many of the same mass production principles that dominated nonagricultural sectors of the economy (Vogeler, 1981; Pisani, 1984; Fellmeth, 1973). At the level of production, the industrialized agriculture in California was characterized by the following features:

1. Increased scale of production based on an effort to achieve scale economies. This has also resulted in greater horizontal integration of production.

2. Increased capital and energy intensity, with capital being substituted for both labor and land.[4] Specifically, there has been the emergence of technology based heavily on the combined effect of chemical use, irrigation, and plant breeding.

3. Reliance on hired labor rather than family labor, with a tendency to shift from piece rates to wage-based income.

4. A deepening division of labor between managerial and production tasks.

5. An increasingly diversified output mix, but with strong standardization within crop types.

In addition, there was growing coordination between production decisions in agriculture and non-farm industries. In part, this occurred through arms-length market transactions, as agriculture became increasingly dependent on purchased inputs and complex industrial markets. However, agriculture also became integrated with other sectors of the economy in more complicated ways. Most important among these, agriculture and other industries became linked through:

1. Ownership integration between producers and buyers.

2. Organization of producers into cooperatives.

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[4] Following the method of Johnson and Quance (1972), capital is defined to include agricultural chemicals, which provide an ongoing investment in land.

3. Forward contracting between otherwise independent buyers and sellers.

Within this industrialized agriculture, continued growth was dependent on a series of institutional structures which helped stabilize input supplies and coordinate supply and demand.

Stabilizing Labor Relations:

In neoclassical analysis, labor constraints exist mainly as fixed regional resource endowments of labor possessing given skill levels. These limitations can be overcome through increased factor mobility or through worker training aimed at altering existing skill levels. Schultz focused on the fact that farmers used family labor, which could not be laid off or hired easily when capacity adjustments were required.

Rather than divesting from farming by transferring labor out of the sector, California farmers replaced family labor through mechanization and the use of hired labor. Still, this has not eliminated labor constraints as a source of concern. The ability to mechanize has varied tremendously throughout the industry. Especially in high value fruits and vegetables, it has often proven difficult to build mechanical harvesters that do not damage plants or output in the process of harvesting.

More importantly, where mechanization has been instituted, it has not eliminated labor constraints, but changed their nature. Mechanization required the adoption of breeding and cultural practices that allowed crops to mature more evenly. This necessitated precision schedules for thinning, chemical application, irrigation, and harvesting. As a result, labor demand became less evenly distributed over the season, requiring greater numerical flexibility in the labor force. Simultaneously, the precise nature of production scheduling made the system more vulnerable to work stoppages than in the past, much as in mass production factories.

Prior to the mid-1960s, California growers met these specific labor needs by using politically vulnerable migrants, by maintaining tight control over the labor process, and by using explicitly noncompetitive means to keep labor costs down. During World War II and immediately thereafter, Mexican migrants were allowed to enter the state under a series of temporary programs. These were succeeded in 1951 by the more permanent "Bracero" program. Throughout the following decade, tens of thousands of workers entered California under the program, making up 30% of the hired labor force in 1960, and a much higher percentage of peak labor during harvest periods (California Employment Development Department, 1981).

To strengthen control over the workforce, growers centralized management functions very tightly, developing a strong separation between management and labor, with management fighting tenaciously to keep unions out of the industry (Fischer, 1953). Also, agricultural workers were excluded from the social contract that developed in industrial sectors of the economy. Field workers were denied rights to collective bargaining and migrants were subject to deportation if they tried to organize. Nor did field workers benefit from the Fordist tying of wages to productivty growth. In order to keep labor costs down, growers fixed wages overtly by having growers' associations announce wages at the start of the season (London and Anderson, 1970:104; Galarza, 1964). In addition, the Bracero program legally separated urban and rural labor markets by prohibiting Bracero workers from seeking work in other industries (Fisher, 1953). Overall, these labor market institutions based on close collaboration between growers and the state were critical to preventing unionization, keeping wages low, and maintaining control over the labor process.

Stabilizing Water Supply:

Typically, agricultural economists have interpreted the technological shift toward irrigation as a gradual process of factor substitution away from relatively expensive land resources (Johnson and Quance, 1972:7). However, this vastly oversimplifies technological change in farming. In fact, irrigation was at the heart of a greater complex of technologies, working in concert with mechanization, improvements in plant breeding, field preparation, and chemical application. Moreover, this complex of technologies created very specific types of demands for water that had to be met for production to be proceed without interruption. Most obviously, the amount of water needed grew tremendously, requiring expanded and affordable water supplies. This would have been true even if crop mix had remained constant. However, changes in crop mix exacerbated this need. Many of the crops grown today have been introduced in significant acreage only after irrigation became available. Second, reliability of supply became critical due to the large fixed expenses associated with on-farm irrigation investment.

Given the extreme cost of reservoir construction, California growers have historically been unable to develop permanent and significant agricultural water supplies without public assistance (Worster, 1985; Pisani, 1984). The first giant publicly funded irrigation system in the state was the federal Central Valley Project (CVP), built largely during the 1950s. The CVP heavily subsidized the costs of water delivered to farmers (Bain, Caves, and Margolis, 1963).[5] In order to provide growers with the stability necessary to justify large investments in on-farm delivery systems, these contracts were written for long periods (in the case of the CVP, usually around twenty years).

However, the use of federally subsidized water raised other constraints. Under the provision of federal reclamation law, water could only be delivered to relatively small farms. Thus, large farms wishing to receive federal water were required to divest their landholdings above 160 acres.[6] If implemented, this 160-acre limitation posed a serious threat to industrialization based on expanding the scale of production. An ongoing and concerted effort by large growers prevented the law from being seriously implemented for more than eighty years. At the same time, growers often placed holdings into artificial corporations or turned them over to family members and employees so as to meet the strict rules while continuing to manage legally distinct properties as a single unit and consolidate profits (Fellmeth, 1973).

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[5] Even when farmers did not contract directly from the project, they often benefitted from raised groundwater levels (LeVeen and Goldman, 1978)

[6] Actually, the limit was 160 acres per family member, up to a limit of 640 acres. For a thorough review of the issue, see Chapter 6 of Worster (1985).

Over the longer run, the most significant way of overcoming the 160-acre limitation was to find another water supplier. In the 1960s, the State of California started its own State Water Project (SWP). This water was also heavily subsidized, and it was delivered free of acreage restrictions (Taylor, 1975). To deliver water to the area of the very largest farms in the southern San Joaquin Valley, state and federal governments formed a joint venture to build the San Luis Project, with water going south to be designated "state water" free of restrictions (Worster, 1985:292). In short, irrigation was central to the technological base of mass production, and the state played the state played a pivotal role in promoting affordable and predictable water supplies.

The Coordination of Supply and Demand:

Economists traditionally describe supply and demand as forces which are coordinated by market institutions, except in cases of market failure. In regulation theory, there is no such idealized vision of perfect markets. Instead, there is a huge variety of competitive forms and institutional arrangements possible. It is precisely because of this variability that different sectors can experience such different patterns of growth. In most existing theory, instability is viewed as being independent of producer activities. Because supply is assumed to be relatively inelastic, exogenous demand characteristics consequently determine revenues mainly through price movements. To Schultz, it was low income elasticity of demand that prevented market extension. To later authors, demand shifts originate mainly in foreign markets or business cycle activity. In practice, demand structures are far from independent of producer strategies. At the most basic level, these strategies fundamentally dictate that producers seek specific kinds of markets. At the same time, producers routinely affect consumer demands through their marketing strategies and technological choices.

In California, mass production created tremendous growth in output associated with the move to irrigated farming and increased scale. This forced California growers to expand markets on an unprecedented scale. Moreover, these markets took special forms. First, output was very uniform. Second, because production scheduling was tightly controlled, output tended to come on the market in surges. This was especially a problem in perishable crops and crops with restricted growing seasons. Small localized buyers and processors could not easily handle this expanded peak production. Even in crops that were not perishable and where processing could be postponed, this required greater inventorying capabilities and inventories had to be coordinated with marketing to prevent excessive stockpiles. On the other hand, large buyers had to have some way of evening out production so as to fully utilize their equipment.

In domestic markets, California growers expanded primarily through vertical integration with buyers. This gave them access to sophisticated mass marketing networks, helping to differentiate their products and target new markets with growth potential. It also helped solve the problem of seasonality in production by allowing growers to shift output toward alternative markets, especially for frozen or processed foods.[7]

In some cases, vertical coordination was achieved internal to the firm through direct ownership. Especially in the national merger wave of the late 1960s, agricultural operations were favorite takeover targets for food processing firms.[8] From the perspective of the parent firm, farm operations without access to mass marketing networks were undervalued assets ripe for the taking. Also, integration provided the parent firm a chance to diversify its product line in existing outlets. Thus, integration allowed Coca-Cola and Hublein to sell California wine through their beverage marketers; Tenneco sold almonds in its gas stations; Castle and Cooke (Dole) sold Salinas lettuce as well as Hawaiian pineapples, etc. (Cordtz, 1972). Finally, although it was not usually enough to make investment in farming lucrative by itself, farming often offered generous tax breaks and opportunities to reap large capital gains on speculation in land, especially on land about to be brought under irrigation for the first time (Fellmeth, 1973).

In other cases, vertical coordination was achieved externally, by forward contracting between farmers and food buyers (Roy, 1972; Collins and Mueller, 1959). Contracts typically guaranteed farmers a set price

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[7] Over time, fresh and process markets have tended to become more separate. However, in many crop types, output can still be diverted toward either a primary fresh market or a secondary process market (usually at a lower price).

[8] To give a few examples: In 1968 Interharvest lettuce was purchased by United Brands (formerly United Fruit Company) and Bud Antle (vegetables) was purchased by Castle and Cooke (Dole Pineapple). In 1969, Pic 'n' Pac Strawberries were bought by S.S. Pierce and Allied grapes were bought by Hublein.

for their output of a given quality from a prespecified amount of acreage. Contracting firms also usually provided access to working capital. This was especially important because of the large variable expenses associated with chemical use, hired labor, and irrigation in modern farming. In return, growers accepted a generally lower price than they might otherwise receive in a good year on the spot market (Roy, 1972; FitzSimmons, 1986). Unless they leased capital and/or farmland, contracting also shifted medium- and long-term risk to farmers by forcing them to carry the cost of fixed investments.

Backwards integration allowed buyers to stabilize their input streams. This was especially important to food and fiber processors trying to sell to large mass retailers. In a particularly fascinating example, FitzSimmons (1986) describes how lettuce shippers dispersed their contracts spatially among growers with different harvest schedules. This effectively integrated production geographically, allowing shippers to offer year-round reliable supply to eastern supermarket chains.

Between the external approach of contracting and the internal approach of ownership, marketing cooperatives formed a third type of vertically-coordinated operation. Most cooperatives allowed their members to run their on-farm operations independently. Yet, by pooling their output, individual growers gained significant scale economies. This not only saved on processing and inventorying costs, but it was necessary before growers could coordinate their marketing decisions. In this sense, growers gained economies of scope by being able to engage in market research, strategically target specific markets, and control the flow of output over time. This control over output constituted overtly oligopolistic behavior and relied on the fact that agricultural cooperatives were exempted from key provisions of federal anti-trust legislation under the Capper-Volstead Act (Marion, 1986:396-399).[9]

Compared to later years, export markets were of secondary importance for most crops throughout most of the 1950s and 1960s, and direct private sector activity in foreign markets was limited.[10] Nonetheless, U.S. hegemony in foreign markets was critical to the disposal of federal government surpluses obtained under various farm programs. The most important government export program was Public Law 480, the "Food for Peace" program. P.L. 480 provided for surplus disposal overseas and allowed the U.S. government to subsidize exports in several ways.[11] First, sales of commodities could be made overseas at below cost. Second, foreign buyers could take out low interest loans to purchase U.S. products. Third, surplus output could be distributed overseas as

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[9] A few cooperatives actually came to resemble vertically integrated firms. The most notable case of this is Sunkist, which both processes and markets citrus for its member-growers. Sunkist also acted to stabilize the income streams of growers much as the government did in other sectors. They did this through payment plans whereby part of the income from a crop in a good year was retained and allocated to a "reserve pool" for later years. In the event of weak prices in a later year, this pool was paid back out to growers as an income supplement.

[10] Of the major crops in the state, only asparagus, prunes, and canned peaches earned more than a third of their revenues from exports in the 1960s, and none of these earned a majority of their revenues overseas (State of California, Dept. of Food and Agriculture, 1964.). There were also early efforts to expand by the cooperatives to expand into foreign markets. As an example, Sunkist (citrus) and Calcot (cotton) worked aggressively to establish foreign markets well before other parts of the industry.

[11] To give a general sense of the scale of these programs, between 1960 and 1965, roughly two-thirds of all U.S. wheat exports came through government exports (USDA/ERS Agricultural Statistics 1972, Table 11).

relief. Finally, agricultural products could be purchased by foreigners through barter (USDA/CCC, 1964).

A final means of extending markets is technological change. Technological change does not act strictly on the supply side. It also provides the basis for continual product redefinition and improvement critical to the creation of new markets (Storper and Walker, 1989). This is crucial to emphasize in the case of agriculture, because there is a popular image of agricultural output as qualitatively fixed over time. In fact, agricultural products have undergone dramatic quality alterations.

Crops have often been bred to improve harvesting, storage, and transportability of output. Canning fruits and vegetables, for instance, are bred with tougher skins to protect them from the rigors of mechanical harvesting (Hightower, 1973). Crops are also routinely bred to create new markets based along qualities desirable to end users. Common examples include breeding grapes and other assorted fruits and vegetables to eliminate seeds, improve visual character, and improve taste. In cotton, plants are bred to improve fiber characteristics for spinning and weaving (Turner, 1981).

Technological change for marketing purposes also incorporates improvements in cultural practices, harvesting, storage, and processing. The most dramatic improvements in this area, of course, were due to improvements in refrigeration and freezing which allowed crops to be sold over great geographical distances well after the harvest season. Likewise, the export market for alfalfa grew tremendously as the result of converting the crop into pellets, making it possible to economically transport the product as far away as Japan for cattle feed. More recently, the shift to use of pallets, shrink wrap, and other advances have helped California fruits and vegetables in the market (Linden, 1985; 1984).

Regulation of Output:

In neoclassical analysis, output regulation occurs through the market as inefficient producers are forced out of business and price changes force growers to alter supply levels. Prolonged overcapacity exists only in cases of market failure. To Schultz, market failure took the form of structural characteristics unique to agriculture. To later authors, the problem was not structural at all, but related to imperfect information, exogenous events and poor government policy (Johnson and Quance, 1972:39; Schuh, 1974; Paarlberg, 1980:34-5).

Overcapacity is neither unique to agriculture nor abnormal. Expanding output is absolutely central to capitalist growth. In dynamic industries with rapid technological change, output growth is almost always pressing against some form of demand constraint. That is why the constant expansion of demand is so important. Yet, overcapacity is a difficult concept to define. Implicitly, it has often been thought of in terms of declining real output prices, even though driving down real price is the very basis successful competition in mass production systems. Declining real prices are mainly a problem when prices are falling relative to costs.[12] The critical issue is whether or not the

[12] This notion is, of course, is well captured in the traditional concern for falling profit margins as expressed in parity ratios. The parity ratio is a comparison between indices of prices received and costs incurred,

pressure between expanding output and demand constraints jeopardizes the viability of the existing production system.

Rationing of production occurs in all but the most rapidly growing markets, whether that rationing is done through competition or by government. In nonagricultural industries, output growth was controlled mainly by oligopolies which restricted output and entry of new firms. By and large, agriculture has never developed the level of concentration seen in manufacturing industries. Instead, responsibility for output regulation was assumed by the state, with the active cooperation of growers.

U.S. agriculture turned to the state for regulation as early as the 1930s.[13] In basic commodities such as cotton, wheat, rice, barley, and small grains, output was controlled directly through federal commodity programs (see Tweeten, 1977 for a review). Under this system, output was restricted by use of grower-approved marketing quotas. In return for passing quotas on themselves, growers received price supports. Quotas took the form of specified acreage from which growers could produce output for sale. Total acreage for each crop was determined by the Secretary of Agriculture, within narrow bounds specified by Congress. Each grower then received an allotted share of

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where both are expressed in real terms. In U.S. practice, these are tied to the base period 1910-1914. Aside from technical questions surrounding the use of parity measures, however, this concern misses the point that firms may compensate for declining margins in other ways, especially by expanding total volume sold (Wessel, 1983, Vogeler, 1981).

[13] Agriculture, of course, was not the only industry to seek state regulation of cutthroat competition. The Interstate Commerce Commission was originally created as a means of mediating competition and preventing overexpansion in the railroad industry.

the total acreage, based on historical planting patterns. Acreage allotments were nontransferable between producers. In addition, there was often some form of land bank, conservation, or diversion program. Under these programs, growers could receive additional payments for withdrawing additional land from production. This land could not easily be converted to other crops, but had to be idled completely or diverted to other crops preapproved by authorities.

For crops that were not basic commodities, including a large variety of fruits and vegetables, output controls took the form of marketing orders (Garoyan and Youde, 1975) These were crop-specific regulations on marketing that controlled both quantity and quality of output marketed. Again, they had to approved by growers. Administration was by state and federal Departments of Agriculture (depending on the particular crop).[14] Historically, there were cases of marketing orders that controlled output directly, by allocating acreage between producers that acted much as federal commodity programs, or by providing for the destruction of surplus output. However, these methods were limited to a relative few specific crop types (most notably, brussels sprouts and cling peaches) (Jamison, 1966).

It has been more common for controls on the quantity of output to take the form of quality grading (Bockstael, 1984; Jesse, 1981). Even today, quality controls are used to restrict the marketing of fruit that does not meet certain standards for size, color, or maturity and may provide the basis for redirecting nonconforming produce to secondary

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[14] As of 1981 there were 47 federal marketing orders and 42 state orders in place in California (French, 1982:916).

market (almonds, dates, walnuts, raisins). Because imported produce is required to meet domestic quality standards, marketing orders also serve as a non-tariff barrier to imports that might otherwise compete with U.S. producers (Bredahl, Hillman, and Schmitz, 1982).

Market orders also operate by controlling the flow of output onto the market (French, 1982). In crops that can be stored for moderate lengths of time (walnuts, almonds, and raisins), they may employ various pooling systems that hold some share of output off the market until later in the season. If prices are strong, the output may then be allowed to enter the market. Otherwise it may be redirected to another market or destroyed. In other crops (especially citrus), flow control is accomplished through "weekly prorates," which explicitly determine the amount of produce that may be marketed in any given week. Relative consistency in pro-rates from year to year is actually translated into planting schedules over the longer run. Another variation (also commonly used in citrus) is the "shipping holiday," a published set of dates on which marketers will not accept output (French, 1982).

The Collapse of Regulation in California Agriculture

On the whole, mass production in California farming provided amazingly stable growth throughout the 1950s and much of the 1960s. Strong government/grower cooperation provided for a reliable stream of inputs necessary to promote mass production. At the same time, markets were gradually extended to meet new production based on increasing vertical integration domestically and expansion overseas.

However, in the late 1960s and early 1970s, the ability of these institutional mechanisms to stabilize input supplies and provide for continual market growth became increasingly problematic. To some degree, this regulatory collapse was influenced by changes in the economic environment beyond agriculture. However, it was not simply an inability of agriculture to adapt to international or macroeconomic events that caused the system to collapse. Rather, those very institutions that had contributed to growth began to conflict with further development in the sector based on mass production.

The Collapse of Stable Labor Relations:

Through much of the post-war era, growth in California's agricultural industry was predicated on producers' ability to keep organized labor out of the fields. By the late-1950s, this antagonistic approach toward labor relations began to backfire as field workers fought tenaciously to organize themselves (London and Anderson, 1970). Initially, unionization efforts were led by organizers from large industrial unions, and were restricted to packinghouses.[15] Due to their vulnerability to deportation, migrant field workers were considered impossible to unionize. When growers responded to successful organization of packinghouses by shifting packing operations to the fields, it became abundantly clear to organizers that a broader approach to unionization was needed. It was in this void that Cesar Chavez and

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[15] Especially active in the organization of agricultural labor were the especially the AFL-CIO and Teamsters.

others formed the United Farm Workers Organizing Committee (UFW), the first union to focus its efforts explicitly on the organization of field workers. The Bracero Program was the major barrier to unionizing field labor, and termination of the program became the primary goal of the union.

At the same time, as growers continued to mechanize the harvest, the need for labor provided under the Bracero Program declined in key parts of the industry. By 1960, for instance, the vast majority of the cotton harvest in the U.S. was mechanized. When Texas cotton growers withdrew their critical support for the legislation, California interests were left to fight alone and the future of the Bracero program was sealed (Craig, 1971:180-182). The official end of the Bracero program in 1964 marked a change in the structure of labor markets that sent a major shock through California agriculture. No longer were agricultural workers permanently prevented from seeking work in the urban economy.

The first effect of this change was to raise real wage rates by roughly 50% between 1965 and 1972 (California, Employment Development Department).[16] Still, the increase in wages was only part of the problem for growers. By 1970, more than 70,000 workers had joined the union (California Farmer, Aug 15, 1987). Unlike the industrial unions involved in agriculture, the UFW directly challenged management prerogative in ways that threatened the very basis of mass production. Consistently, workers sought steady employment and work rules that

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[16] By 1975, farm workers were given also included under minimum wage and collective bargaining legislation, although the minimum wage had little direct effect, because wages were already substantially above minimum requirements.

limited growers' ability to lay off workers in non-harvest periods. Workers also attempted to restrict the use of certain pesticides that had become a central part of everyday production techniques. Finally, by invoking consumer boycotts to support its election campaigns, the union focused its tactics where the industry was most vulnerable—demand.

The Collapse of Output Controls:

At approximately the same time that grower control over the labor force was deteriorating, the system of output controls that had maintained prices was undergoing severe stress. This was particularly true in commodity crops where the adoption of mass production had proceeded most rapidly. This stress came from two main sources. First, by capping total acreage and not allowing farmers to transfer allotments, commodity programs created a considerable institutional barrier to growers' efforts at increasing operational scale.

Second, commodity programs relied on price floors set above world prices to entice growers into passing acreage limitations on themselves. This provided a price umbrella that allowed many relatively high cost producers overseas to increase their production. This opportunity was welcomed by a growing number of developing countries, eager to replace their imports of U.S. agricultural goods with domestic production. This effectively cut into U.S. export markets for many goods, hindering expansion into foreign markets necessary to absorb output increases. As early as 1963, wheat farmers nationally rejected further mandatory acreage controls, despite an all-out effort by the Kennedy administration to salvage the system (Hadwiger, 1965). Over the next decade, the federal commodity programs were redesigned, making controls more flexible and encouraging production for export. The most basic change was that mandatory supply controls were replaced with a voluntary system under which farmers were paid for diverting acreage. Equally important, price floors for most crops were lowered to world prices. Finally, various inequities in the system were addressed and rules were adjusted to give growers greater control over what they could grow on diverted acreage.

SUMMARY

I believe that regulation theory offers several potential advantages over existing theories of instability. In contrast to Schultzian theory, it provides a ready means to move beyond a world dominated by family labor, domestic markets, and low factor mobility. Unlike Schultz's successors, regulation theory's disequilibrium approach readily acknowledges the possible presence of alternating periods of stability and instability without having to resort to factors outside the basic model. Likewise, because the competitive strategies of growers are central to the growth paths of industrial sectors, the theory provides an easy point of departure for explaining the vast differences in instability experienced by different crop sectors.

As a mass production industry, stability of growth in California agriculture has been highly dependent on its ability to stabilize input supplies and create expanding markets for highly standardized output that is produced with extreme temporal discontinuities. Until the mid-

1960s, these needs were fulfilled by a complex series of institutional arrangements, although these differed considerably between crop sectors. Like many other industries, vertical integration and U.S. hegemony in world markets were of central importance in extending markets. However, in contrast to regulation theory models arising from manufacturing, Fordism was never a dominant part of this system, since low income elasticity of demand made wage increases a poor stimulant to demand. Instead, growers aggressively transformed their products qualitatively to create new markets. In some sectors, this process of upscaling was enhanced and augmented by state efforts to create new market outlets, especially overseas.

On the supply side, regulation in agriculture also differed from the manufacturing case, due mainly to an absence of powerful oligopolies capable of restricting entry and output. Instead, agriculture relied on close cooperation between producers' groups and the state to control entry of new firms and growth of output.

When several of these key regulatory institutions began to fail in the mid-1960s, it was not due to events that were either purely exogenous or purely endogenous. The collapse of the Bracero system, for instance, was greatly aided by political movements with constituents well beyond agriculture. Nonetheless, the program also failed in part because of the severity with which growers had treated agricultural labor in the past. Similarly, when output controls failed, it was partly due to more aggressive efforts by nations elsewhere to cut their imports of U.S. agricultural goods. Yet, it was also due to the fact that strict supply controls and high price supports hindered further efforts to pursue mass production. In the section that follows, I will consider how grower responses to these institutional failures contributed to instability.

CHAPTER 3

RESTRUCTURING AND UNSTABLE GROWTH

As the institutions that had supported steady growth in California's mass production agriculture collapsed in the late 1960s and early 1970s, California growers were confronted with both challenges and opportunities. The end of the Bracero Period threatened costly wage increases and a growth in the power of organized labor. Likewise, the demise of federal commodity programs forced growers to confront demand-side volatility more directly than in the past. On the other hand, declining federal regulation vastly increased the potential for exporting and allowed growers to expand scale to an extent previously unheard of.

In short, the outcome of institutional change was far from predetermined. Although it is true that markets became less certain in the 1970s, growers could respond to uncertainty in very different ways. At one extreme they could try to reassert stability, for instance, by making labor relations more regular and extending vertical integration. Alternatively, they could try to live with instability by becoming more flexible. In fact, the responses of California growers were never entirely one approach or the other. Without question, growers deepened their commitment to mass production based on scale increases and very specific forms of technological change. However, these did not always imply greater regularity or predictability. In key instances, the deepening of mass production was paralleled by a marked increase in the ability of growers to shift resources toward new types of output and adjust output levels in the short-run. In fact, these parallel movements toward mass production and flexibility in production often supported one another.

Restructuring Labor Relations

The diversity of ways in which California growers reacted to institutional change is well illustrated by their responses to the decline of the Bracero Program. Freed from strict governmental regulation of acreage, growers' attention turned toward thwarting the inroads made by organized labor. Given greater uncertainty in the availability of low cost, compliant labor, growers could either try to attract workers by stabilizing employment, paying higher wages, and offering better benefits; or, they could try to live with instability by relying more heavily on part-time and temporary workers. To thwart labor militancy, growers could take the approach of manufacturing industries, adopting some form of implicit agreement that encouraged workers to trade off militancy for increased job security; or, they could continue the adversarial relations of the past by using irregular workers to undermine the strength of organized labor.

The Formalization of Work:

In some cases, growers responded to the end of the Bracero program by trying to make relative peace with their workers, either by tolerating a union presence, or more often, by trying to preempt union organizers by offering relatively generous pay and benefit packages. Faced with a prospect of potentially severe labor shortages, many growers sought to convert former Braceros to permanent resident (green card) status. To qualify for legal residency, workers were required to have a guaranteed job for a specified period, forcing growers to offer them stable employment.

To attract workers not bound by residency requirements, growers increasingly provided benefit packages that were previously unavailable, including such things as housing, paid vacations and health plans. This growing formalization of work was paralleled by creation of internal labor market structures for the recruiting and advancement of workers (Wells, 1981). Recruiting tended to be through kinship and personal ties (Thomas, 1985). Still, strong barriers between field work and management continued to restrict occupational mobility. For workers who remained under piece rates, the main form of advancement was to move from a crew of low productivity to one of higher productivity (Friedland, Barton, and Thomas, 1981). For wage workers, advancement was often tied to seniority (Wells, 1981; Mines and Anzaldua, 1982). Although it came very late to agriculture, by the mid-1970s, California farm workers were given the right to bargain collectively and were provided access to most public assistance programs available to industrial workers.

In general, the creation of internal labor markets also created strong incentives for productivity gains, making workers accountable for job performance. Under worker-based recruiting, for instance, field workers were often held responsible for the performance of those workers they brought into the crew (Thomas, 1985). In her study of the lettuce sector, FitzSimmons (1986) has observed that these social mechanisms promoted a significant productivity gain among field workers. Moreover, these gains helped to keep mechanization out of large parts of the sector.

Clearly, field work has changed since the 1950s. Just the same, these reforms were inherently limited in their scope. For one thing, green cards were restricted in absolute numbers. More importantly, the hiring of permanent residents was very expensive. Because green card workers were free to seek work outside of agriculture after a few years, growers were forced to entice workers to stay in agriculture by offering higher wages and benefits. This cost tended to restrict the formalization of work to crops where mechanical harvesting was not yet feasible, to high value crops, and to sectors where increased prices could be passed onto consumers (Friedland, Barton, and Thomas, 1981).

Employment of Undocumented Workers:

In cases where high-cost union or resident workers were not suitable, growers took an entirely opposite approach to labor relations. Rather than try to stabilize employment, growers hired more part-time and temporary labor. Of course, this was not altogether a new occurrence, since California growers had always relied on workers to provide flexibility in production. Still, growers significantly increased their use of politically and economically vulnerable undocumented migrants in an effort to avoid any capitulation to organized labor. Thus, between 1970 and 1975, the number of illegal farm workers apprehended at the border annually by the Immigration and Naturalization Service (INS) soared from 56,000 to 115,000 (INS, Form G23.18). While no one really knows how many undocumented laborers work in California fields at any given time, the INS estimated the minimum number to be 122,000 by 1974.[1]

As with green card workers, the use of undocumented workers was not without its problems. Wage increases in the resident labor force tended to influence wages among illegal migrants. Furthermore, while recent Mexican migrants were less likely to be militant, they were also relatively immobile due to their illegal status and reliance on crew chiefs who spoke English. Crew turnover among illegal migrants was also extremely high, acting as a barrier to productivity growth (Mines and Anzaldua, 1982).

Restructuring Technology

Over the longer run, the preferred methods of dealing with labor organization were mechanization and other forms of labor-saving technological change. As Table 3.1 shows, this had begun years before. Again however, that effort accelerated after the end of the Bracero period in 1964. This view was expressed by the California Farm Labor Service in 1966:[2]

> It is estimated that by 1980, about half of the present farm jobs will have been eliminated by automation and mechanization. The accelerated trend toward mechanization by California farmers may advance this date considerably... Developments in mechanization and labor-saving advanced at a rapid rate during 1966, continuing the 1964-1965 trend resulting from vigorous efforts to overcome the threat of labor shortages occasioned by the end of the Bracero Program in 1964.

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[1] In this same year, officials estimated that the total hired labor force in the state's agricultural sector was 216,600 individuals (California Employment Development Department, 1981).

[2] California Farm Labor Service. (1966) Agricultural Mechanization Survey. (June).

Table 3.1

Factors Reducing Employment on California Farms

Crop	Period of Reduction in Labor Demand	% Change in Peak Harvest Demand per Acre	Technology Adopted
Cotton Harvest	1949-66	-86.8	harvester
Carrots	1959-66	-80.8	topper-digger
Almonds	1961-66	-66.2	mechanical knock, catch, pick-up
Sugar Beets	1965-66	-38.0	thinners, weeders (1)
Walnuts	1958-67	-58.8	mechanical knock, catch, pick-up
Potatoes	1959-68	-76.0	harvester
Hops	1958-68	-50.8	viner
Snap Beans	1962-69	-90.3	harvester
Tomatoes	1964-69	-55.4	harvester for process crop
Cotton Chop	1963-70	-52.0	herbicides, cultivators
Apricots	1966-72	-37.8	cutting machine
Figs	1958-75	-50.5	pick-up machine

Source: Reprinted from Barnett, et. al. (1978)
(1) from California Farm Labor Service. (1966) Agricultural Mechanization Survey. (June).

Although the impetus for mechanization was allegedly the fear of labor shortages, officials openly acknowledged that mechanization also helped to shift labor use toward qualitatively different kinds of labor:

> ... Mechanization not only reduces the numbers but may also change the types of workers needed. The tomato picking machine sharply reduced the need for men, but created a new demand for women—to sort the machine picked tomatoes.[3]

What the report does not say is that those women tended to be low cost, nonunion labor. Indeed, when sorters began to organize in the mid-1970s, this segment of production was also mechanized (Thompson and Scheuring, 1978).

Because temporary harvest labor traditionally represented such a large portion of total labor use, the lowering of harvest labor demand has tended to make the composition of employment more regular. In most crops, this swamped any counter-tendency created by the hiring of temporary or part-time labor in other operations, although both types of activity were going on simultaneously.

While reducing harvest labor provided the biggest possibility for minimizing vulnerability to a militant labor force, growers' approaches to technological change went beyond mechanization. As noted in Chapter 2, technological advance must be considered as a complex of changes, not a single innovation. Increasingly, growers also chose irrigation systems that could help them minimize labor input required for weeding and water management. Likewise, there was a major shift in chemical use

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[3] ibid.

toward expanded use of herbicides, which reduced labor requirements for thinning and weeding.[4]

Restructuring Capacity

As California growers increasingly pursued new forms of labor relations and technological change, it helped propel the industry down a developmental path that also had profound implications for the organization of capacity within the state. This restructuring of capacity had three primary elements: a significant increase in scale of operation; a marked shift toward export markets; and, an increase in productive mobility. In each case, these shifts represented a fundamental departure from the old way of doing business and served to further differentiate California agriculture from farming elsewhere in the U.S. Likewise, each of these structural shifts had profound implications for revenue stability.

The first and most observable pattern was a marked increase in scale. Part of this was a shift to very large farms, and part was an across-the-board increase in scale. That is, within any given crop sector, large farms grew most rapidly, but nearly all farms grew in size. Somewhat surprisingly, the logic behind scale growth is not fully

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[4] Changing census categories make a precise comparison difficult over time. However, it is clear that in the late 1960s and early 1970s, herbicide (and fungicide) use increased much faster than other categories of agricultural chemical use. Between 1964 and 1974, total non-pasture acreage treated with herbicides increased from 1.5 to 5.2 million acres (260%). Over the same period, insecticide use was next, increasing from 3.5 to 4.8 million acres (+34%). Fertilizer use, already well established, followed with increases from 5.9 to 6.6 million acres (+10%). Census of Agriculture, California: 1964, Table 20; 1974, Table 30.

understood even today. Certainly, technological shifts encourage scale increases by raising the fixed costs of firms.[5] Still, an increasing number of researchers have begun to argue that large segments of California agriculture operate at a scale well above that justifiable by costs alone. Several of these authors have pointed to the possible role of managerial scale economies and increased market power (Raup, 1969; Hall and LeVeen, 1978). Although subtle, these issues are vital. In the newly emerging sector of organic produce, for instance, producers have often found it extremely difficult to gain access to supermarket chains, because they produce at such a small scale that they cannot guarantee reliability of supply (Johnson, 1990).

Others have pointed out that scale increases represent an important strategy for coping with risk. The argument is that, because large farms have a greater revenue base and assets, they are more able to weather times of low profit rates (Wessel, 1983; Vogeler, 1981). In any case, it is clear that while deregulation of acreage was a necessary condition to expanding scale, it was not sufficient, in and of itself, to force growers to expand.

What <u>is</u> known about scale increases is that they contributed to a massive increase in aggregate capacity. In 1969, the average size of a

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[5] According to the USDA, fixed costs as a share of total annual expenses in the state rose from 17% to 24% in the decade of the 1960s (USDA/ERS Farm Income Situation Supplement #218, August, 1971). In reality, this probably understates the shift. USDA defines fixed costs to include mortgage interest, depreciation, and taxes. However, these categories are changing over time. As an example, the category of non-real estate debt is counted in the USDA definitions as part of miscellaneous variable costs. Yet, as other forms of lending became less accessible in the late 1970s, non-real estate debt soared, becoming a primary vehicle for financing longer term capital improvements (USDA/ERS 1971).

harvested farm in the state was 135 acres. By 1978, acreage on farms in this size category had increased just 1.8%. Had all farms in the state grown at the same rate as the average size farm and had the size structure of farms remained constant, the growth in aggregate capacity would have been some 1.2 million acres less than it actually was. Of this huge difference, 88% occurred on farms over 1,000 acres in size.[6]

The effect of scale increases on acreage has been particularly well-studied in the process tomato sector. There, mechanization in response to a growing union movement occurred over a very short period, allowing researchers to isolate the impacts of mechanization from other variables.[7] Chern (1976) has estimated that by increasing the operating scale of existing farms, the shift to mechanical harvesting added some 51,000 acres to tomato supply by 1971. This was over half of the total increase in acreage over that period. In a similar vein, Brandt and French (1983) have argued that 11% of the total acreage in processing tomatoes was due to the structural shift toward mechanized harvesting by 1977, and that share was increasing over time due to the spread of mechanization to other aspects of production (mainly sorting).

To be sure, part of the destabilization of the 1970s was related to exports. However, what was critical was how shifts in foreign markets and domestic restructuring interacted with one another. In the context of massive capacity increases, it is not difficult to see why

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[6] U.S. Bureau of the Census, Census of Agriculture California Area Tables, 1964 (Table 20) and 1978 (Table 33).

[7] Between 1964 and 1967, the share of process tomatoes harvested by machine jumped from under 4% to over 80%, (Freidland and Barton, 1975; Just and Chern, 1980)

international markets increased in importance. Rapid market extension was an absolute necessity if a collapse of prices was to be avoided. The critical requirements for new markets were that they be able to absorb relatively predictable, but large, surges of highly standardized output. Foreign mass markets filled this role well. To some extent, marketing in all crops tended to become more focused on exports in the 1970s. However, the overwhelming majority of this export buildup was dominated by mass produced crops—especially field crops like cotton, wheat, and rice. Non-field crops that also rapidly expanded their exports tended to be crops where mass production was firmly established. These included almonds, oranges, and lemons, all of which had strong process markets as well as being sold as fresh output.

Exporting was not the only means of extending markets. There were mass production crops that managed to expand markets domestically through well-practiced strategies. In process tomatoes, for instance, market extension proceeded based on a more or less traditional integration with large canners (Collins and Mueller, 1959). Likewise, in wine grapes, growers displayed an uncanny ability to create markets for inexpensive wine products, epitomized best by the "wine cooler" craze of the 1980s. Nonetheless, it is clear that the move into foreign markets has become a defining feature of California agriculture after 1970 (Table 3.2).

While exporting helped to support mass production, the opposite was also true. Growers and processors in California (especially cooperatives) worked diligently to develop overseas marketing networks

Table 3.2

Changing Export Behavior

	Export Share 1965	Peak Exports Share	Peak Exports Year
Wheat	1%	81%	1979
Rice	16%	80%	1980
Cotton	28%	88%	1980
Almonds	34%	83%	1979
Prunes	29%	60%	1986
Dry Beans	3%	41%	1980
Figs	12%	36%	1978
Raisins	15%	33%	1978
Walnuts	8%	32%	1986
Onions	8%	32%	1980
Fresh Grapes	31%	32%	1980
Alfalfa Seed	15%	29%	1986
Apricots	18%	27%	1986

Based on export figures through 1986. Export share refers to percentage of total revenue from exports, measured at the farm gate.

Other crops that show similar trends, where changing data definitions make it impossible to make precise comparisons include: oranges, lemons, cotton seed, ladino clover, cling peaches, and dates.

Sources: Annual Reports of the County Agricultural Commissioners. Also, California Dept. of Agriculture, Exports of Agricultural Commodities Produced in California (various years).

well before the dollar was devalued. Much of their success in this came precisely from the fact that they were mass producers, capable of offering large buyers a product of known quality with reliability. As a result, California growers experienced far greater success in exporting in the 1970s than growers elsewhere in the U.S., increasing their share of U.S. exports in nearly all those crops where they were significantly represented (Tables 3.3 and 3.4). In cases where they lost market share, it was usually because those crops were declining in importance within the state's farm economy (e.g. especially alfalfa, prunes, and table grapes).

Table 3.3

Changing Export Shares
Selected Crops

	California as a Share of U.S. Exports	
	1965	1976
Cotton	15%	46%
Lemons	9%	93%
Rice	13%	42%
Wheat	0%	4%
Almonds	67%	100%
Raisins	100%	100%
Walnuts	98%	99%
Process Tomatoes	70%	85%
Fresh Oranges	81%	81%
Fresh Tomatoes	31%	26%
Alfalfa	82%	55%
Prunes	99%	95%
Fresh Grapes	99%	95%

Export shares are value based.

Table 3.4

Real Value of Exports 1965-1976
California and the U.S. Compared
(1984 dollars)

	California			Rest of United States		
	1965	1976	change	1965	1976	change
Cotton	74,110,000	404,467,000	446%	420,610,000	475,908,000	13%
Wheat	156,000	221,471,000	(1)	1,063,475,000	4,761,338,000	348%
Lemons	17,100,000	73,904,000	332%	166,691,000	5,826,000	-97%
Rice	32,500,000	81,545,000	151%	211,971,000	113,833,000	-46%
Almonds	14,791,000	95,908,000	(1)	7,235,000	0	-100%
Raisins	20,702,000	52,927,000	155%	NA	NA	
Walnuts	2,896,000	38,662,000	(1)	56,000	391,000	(1)
Process Tom	7,598,000	26,330,000	247%	3,294,000	4,647,000	41%
Fresh Oranges	35,200,000	90,447,000	157%	8,260,000	21,216,000	157%
Fresh Tom.	3,000,000	7,934,000	166%	6,671,000	22,751,000	241%
Alfalfa	12,900,000	20,020,000	55%	2,837,000	16,346,000	476%
Prunes	22,790,000	54,481,000	139%	116,000	2,928,000	(1)
Fresh Grapes	22,540,000	50,472,000	124%	172,000	2,656,000	(1)

(1) Increase greater than 500%.

Clearly, by concentrating revenues so heavily in exports, growers have made themselves much more vulnerable to exogenous market shifts than in the past. However, increased volatility related to overseas markets has not been simply an issue of exposure to exogenous demand shifts. Domestic restructuring has actually contributed to the destabilization of foreign markets. Prior to the late 1960s, the large government surpluses held by the U.S. acted as buffer stocks to stabilize prices of key commodities. When the U.S. lowered its domestic price supports to world levels in the late 1960s, the U.S. government eagerly dumped its surpluses on international markets to clear out its own inventories. As a result, world buffer stocks declined relative to the overall level of output marketed, removing a key stabilizer on international prices.[8]

More recently, the extreme dependence of producers on exporting has forced the U.S. government into pursuing trade and domestic policies that are highly destabilizing. Increasingly under the Reagan and Bush administrations, domestic price supports have been purposely kept low. Because the U.S. represents a large share of total world production in key commodities, these domestic pricing policies can be used to drive down international prices.[9] These policies have allowed U.S. producers to seize a greater share of the market, but threaten to start a trade war that few countries would benefit from.

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[8] As recently as the 1968/1969 crop year, world wheat stocks were roughly twice as great as the total level of exports. By 1973, world exports actually were greater than total stocks. Over this same period, the U.S. share of total world stocks declined sharply from 36% to just 13% (USDA/ESCS Wheat Situation, May 1976, May 1978).

[9] As an example, in 1975, the U.S. represented 17% of world wheat production and 15% of world cotton production. Although it represented only 2% of world rice production, the U.S. accounted for 28% of all exports (USDA/ERS, Agricultural Statistics, 1978).

Governments throughout Europe have a strong commitment to protect their farmers, because agricultural policy is closely linked to land use and open space policies. In developing countries, protection of domestic farmers is seen as a way of reducing imports, a precondition to improving their balance of payments and solving severe debt problems.[10] By lowering world prices, the U.S. has raised the cost to these governments of keeping their farmers in business. In addition, the U.S government has used its enormous political and economic power in an effort to force the Europeans and Latin Americans to lower their barriers to U.S. imports (Ritchie, 1987; Ritchie and Ristau, 1987).[11] In late 1990, the inability to reach any negotiated settlement on agricultural trade led to the collapse of the Uruguay round of the General Agreement on Trades and Tariffs (GATT) talks. As a result, not only did the farm trade problem get shelved, but progress on other important areas such as trade in services was also prevented.

Increasing Flexibility:

Clearly, changes in international markets and their effects on revenues have not been independent of restructuring within the domestic industry. Still, restructuring does not consist of a discrete set of events. Producers continually redefine the competitive environment in which they operate, constantly seeking advantage over their rivals. In

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[10] To the extent that these debts are owed to U.S. banks, it is not at all clear that free trade policy is even in the U.S. interest.

[11] This brow-beating of other countries by the U.S. has been so severe as to draw criticisms from even the most ardent supporters of free trade (See The Economist, December, 1990:11).

agriculture, like other industries, one way that producers have sought to improve their competitiveness in recent years is to increase flexibility in production.

By itself, mobility in capacity is nothing new to California agriculture. Growers in the state have a history of surprising adaptability dating back at least a century. In the latter half of the 1800s, for instance, California agriculture was strongly dominated by wheat production for European markets. When these export markets collapsed in the 1890s, California growers revolutionized the industry by shifting their production to domestic fruit and vegetables.

What is different about acreage movements that have occurred after 1970 is their scale and frequency. In addition, there has been a significant increase in the range of crops that individual growers can move into. Regulation theory suggests that this sort of mobility ought to arise from a rejection of mass production techniques by growers, often accompanied by vertical disintegration, declining scale, and new types of alliances between producers. Yet, in the California case, mass production and improved flexibility have been mutually supportive. Most important of course, the same deregulation of acreage that was necessary before growers could increase scale also made it easier to shift acreage between crops. Equally noteworthy, ongoing technological change based on irrigation, mechanization, and chemical use allows physical features that were formerly associated with specific regions to be created through investment. The result is that land is much more homogenous than in the past, allowing a wider choice of crops to be grown in many areas. These changes in production methods have also tended to shorten the growing period for many crops, and helped to lengthen the harvest season.[12]

Increasing productive mobility has been manifested in at least two ways. First, it has become more common to see large acreage amounts of acreage converted from one crop to another over the medium-term. This is especially true in slower maturing fruits, nuts, and vine crops. As a result, growers remain identified with specific crop types, but that primary crop is more likely to change than in the past, as farmers experiment with new alternatives.

Much of this experimentation has resulted as an offshoot from existing business lines. In some cases, this has meant discovering new markets for older crops that have been grown for years, such as avocados, nectarines, garlic, and cauliflower. In other instances, new crops have emerged as extensions of existing markets, as in the case of organic produce, which increased its acreage from 2,000 acres to 60,000 acres in just five years in the late 1980s (Johnson, 1990).

In many instances, crops of great importance have risen rapidly from a very small acreage base. The example of pistachios is particularly spectacular, having expanded from just 139 acres in 1970 to over 25,000 acres 1980 (Annual Reports of the County Agricultural Commissioners, 1970, 1980). Even after years of proven success, many of these newer crops still do not get included in many of the standard statistical series for the state (a good example being Kiwi fruit). Although data are often scarce, the range of such experimentation should not be

[12] This ability to make a crop available over a longer period has often been identified as a key to convincing mass marketers to carry a given type of produce (Johnson, 1990).

underestimated. Recently, for example, Fresno County actually began keeping records on "chinese vegetables" (bok choy, etc) that are distinct from other miscellaneous vegetables.

These medium-term shifts are especially visible at the geographic scale of localized production regions. A good example of this was what occurred in the Salinas Valley (Monterey County), long known as the nation's "salad bowl" for its production of lettuce and fresh vegetables. As recently as 1971, there were only 1,500 acres of wine grapes grown in the Valley. As growers sought to take advantage of emerging mass markets for cheap wine, this total soared to some 30,000 acres by 1980. In less than ten years, wine grapes had become a primary output from one of the nation's elite agricultural counties.

Lest we forget the other side of the picture, these dramatic gains have also been matched by equally tremendous declines—often by former giants of California agriculture (many of these being relatively low value crops). Barley, for instance lost half a million acres in the 1970s; grain sorghum lost almost 300,000 acres; while safflower, alfalfa, and grain hay lost more than 100,000 acres each.

The second new trend we see is an increase in the short-term volatility of acreage. This California experience is at odds with traditional theories of agricultural instability in important ways. Traditional theory views capacity in agriculture as relatively immobile in the short-run. Most important, acreage declines are believed to be difficult to achieve, and likely to result only when there is a longer-term withdrawal of land from production. California growers not only shift acreage rapidly and frequently, but they have demonstrated a highly developed ability to temporarily withdraw acreage from production, even though base acreage is increasing over the longer-term.

Increasing short-run volatility is most obvious in those field crops that drove new capacity growth after 1970. Wheat (Figure 3.1), rice

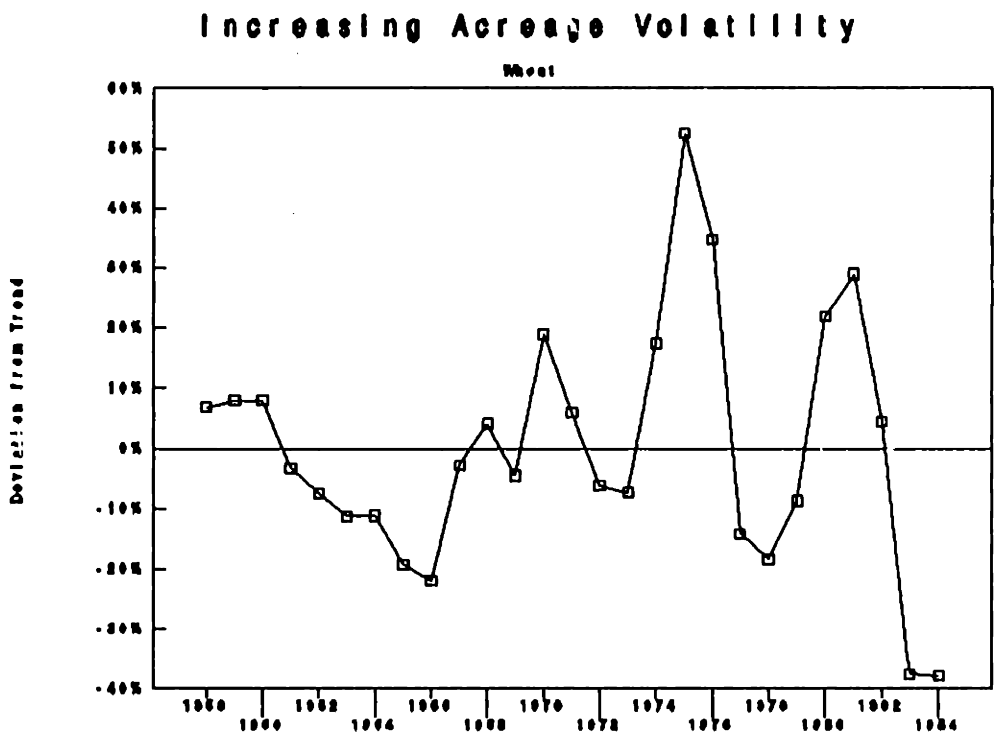

Figure 3.1

(Figure 3.2), and cotton (Figure 3.3) have all seen significant increases in acreage volatility, even after we account for underlying trend increase in capacity (the underlying regressions used in creating these graphs are provided in Appendix 3.1). Moreover, this increased volatility is not easily explained merely as a response to price instability. Adding a price variable to the regression equation, lagged so as to maximize variance explained, does not change our basic

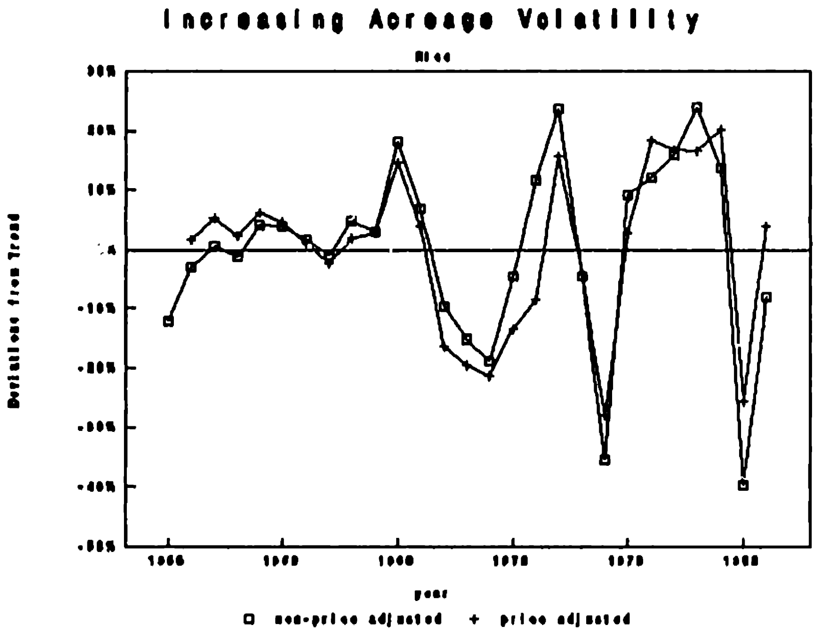

Figure 3.2

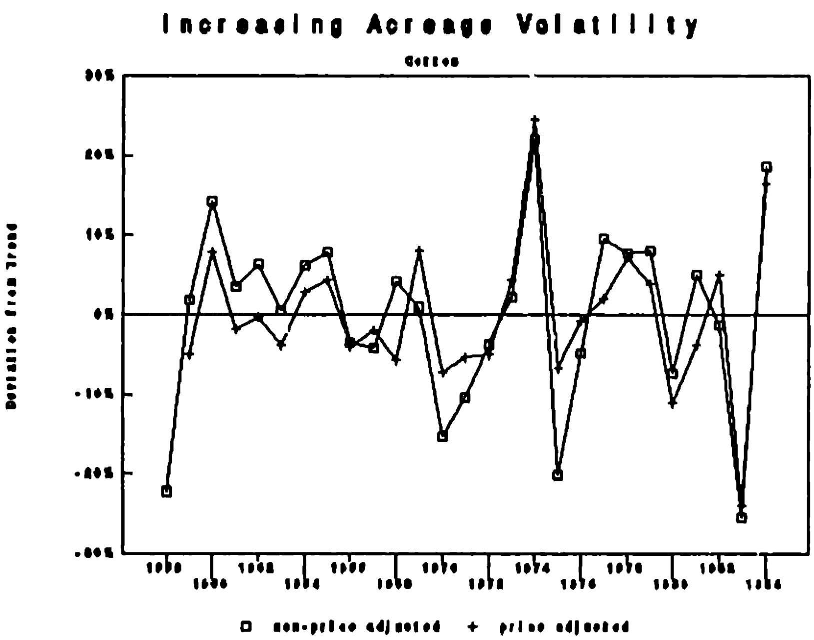

Figure 3.3

conclusion that acreage volatility has increased dramatically (Figures 3.2, and 3.3). (The price variable was insignificant for wheat; consequently, its price-adjusted trend is not included for Figure 3.1.)[13]

Mobility and Revenue Instability

In most cases, economists have welcomed increasing mobility in production. Unfortunately, proponents of greater mobility have failed to recognize sufficiently that mobility itself may be a source of instability. When production is assumed to be relatively immobile, revenue movements tend to be driven by prices rather than by quantity. In this instance, the main effects of acreage occur only in the very long-run. However, once we remove the assumption of low resource mobility, there is no a priori reason to expect that acreage is any less important to determining revenue shifts than are exogenous price movements.

The relative effects of price and acreage movements on short-term revenue instability can be shown by regressing detrended annual revenue deviations on acreage and price deviations. There is a methodological difficulty with this approach, in that we expect acreage and price to be correlated. One way around this dilemma is to run a series of regressions which yield an upper and lower bound on reasonable estimates of how much revenue variation is explained by acreage. The upper bound

[13] If anything, this method is conservative and overcounts the role of prices, since it assumes acreage has no role in determining prices. A more complete discussion of interaction between price and acreage is included in the case study of Chapter 5.

is found by regressing revenues on acreage alone. A lower bound can then be determined by calculating the contribution that acreage adds to variance explained, after price has already been accounted for. To make this calculation, two separate equations are estimated: the first is revenue on price; the second is revenue on price and acreage. The difference in variance explained between these regressions represents the additional contribution of acreage. The high and low estimates for the contribution of acreage to revenue deviations are shown in Table 3.5 (the underlying equations may be found in Appendix 3.2). The crops included represent ten of the largest mass production crops in the state. Because each of these crops suffered revenue destabilization at different times, the year in which destabilization began is also included. Only crops which faced significant destabilization of revenues are included (this excluded lettuce, which had roughly one-third of its revenues determined by acreage movements).

The most striking result of this analysis is the differing effect that acreage has on the revenues of perrenials and annuals. among annuals, only wheat revenues show a small impact by acreage movements (wheat is minimally affected by price shifts as well, with the overwhelming amount of revenue shifts being explained by yield changes; Appendix 3.2). Increasing acreage volatility is certainly not a major contributor to revenue instability in all crops. However, it is a major factor in several key crops, including rice and cotton—two of the crops that formed the base for the acreage surge of the 1970s.

Table 3.5

Share of Total Variance in Annual Detrended Revenues
Explained by Acreage Movements

Selected Mass Production Crops

	Low Estimate	High Estimate	Destabilization Beginning in
Cotton	.69	.71	1970
Rice	.69	.70	1968
Process Tomatoes	.49	.70	1967
Alfalfa	.50	.51	1973
Wheat	.02	.02	1970
Almonds	.01	.01	1968
Wine Grape	.01	.01	1971
Raisins	(1)	(1)	1968
Table Grapes	(1)	(1)	1970
Oranges	(1)	(1)	1970

(1) Acreage effects are statistically insignificant using a 95% confidence interval.

Another interesting result is that, for all the crops shown except process tomatoes, the difference between high and low estimates of acreage impacts is quite small. This suggests that interaction between short-term price and acreage movements is small. Because the values are detrended, we cannot say with certainty that overcapacity is absent. For instance, it may be that an upward trend in acreage is related to a downward trend in price. This is especially true in perrenials, where short-term acreage movements are small relative to trend growth. Nonetheless, if overcapacity were severe in annual crops, we would expect to see significant correlation between short-term acreage and price movements.

Of course, the fact that acreage movements are a significant factor in revenue instability might not be a problem. After all, the idea underlying much of the modern discussion on flexibility is that producers can switch between output types so as to maintain overall capacity utilization. If this is the case, we might see great instability at the level of any specific crop, while aggregate acreage remains relatively stable. However, if we examine aggregate acreage for the state as a whole, this is not the case (Figure 3.4).[14] At the state level, there are two striking changes in the time trend of acreage after 1972. First and most obvious, there is the tremendous surge in

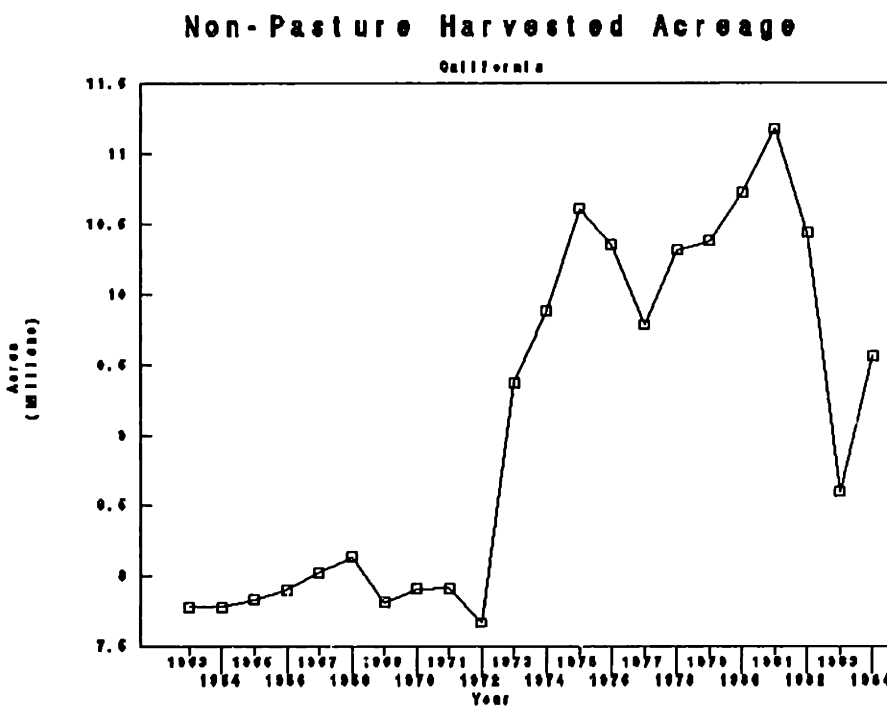

Figure 3.4

capacity associated with increasing scale and the move into export-bound

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[14] Unfortunately, when working at this highly aggregated level, we cannot use the same sort of analysis just conducted, because changes in crop mix make it impossible to define a price variable that has any consistent meaning over time.

field crops. Second, short-term volatility in acreage increases noticeably. Clearly, the tremendous volatility we observe at the level of individual crops has not been strictly a matter of switching between crops. At best, this process of crop switching is an incomplete one.

The Collapse of the Early 1980s:

We have seen that acreage adjustments play an important role in explaining short-term (i.e., annual) revenue movements. However, the importance of that role is restricted to a relative few key crop types. In this very short-run perspective, the importance of acreage movements on aggregate industry revenues arises in large part because of the structural shift toward concentration of capacity in those key crops.

If we lengthen our perspective even slightly (to say 2-3 years), the role of acreage is seen to affect a much larger spectrum of crop types. The potential for uncontrolled acreage movements to contribute to disaster became most evident in the early 1980s. In the short period between 1980 and 1983, real revenues in the state plummeted by nearly 15% (much more in specific crops). Almost without exception, experts have attributed this to the overvalued dollar and the domestic recession of 1981-1983. Again, both of these are argued to operate on the demand side and ought to affect revenues mainly through price shifts.

Certainly, the high value of the dollar hurt our exports. However, in most crops, excessive capacity increases led to price declines that began well before the overvaluation of the dollar. During these years prior to 1980, while prices for key crops were falling, the value of the dollar actually declined relative to our major trading partners. Of the major crops, only cotton had major price declines beginning after 1979 (Table 3.6). When the exogenous price shocks associated with the high dollar and the domestic recession hit, they served mainly to tip an

Table 3.6

The Bust of the 1980s
Selected Crops

Crop	1980-84 Price declines	Year that price declines actually started	Years of Peak Acreage Decline	Acreage Reduction Acres	Acreage Reduction %
Rice	-48%	1973	1981-83	- 275,691	-44%
Cotton	-28%	1980	1979-83	- 654,955	-40%
Wheat	-22%	1975	1981-83	- 522,849	-41%
Process Tomatoes	- 2%	1977	1975-80	- 89,036	-30%
Almonds	-50%	1979	na		
Walnuts	-30%	1978	1980-84	- 3,357	- 2%
Wine Grapes	-15%	1972	1978-82	- 10,995	- 4%
All Crops			1981-83	-1,752,791	-19%

Source: Annual Reports of the California Agricultural Commissioners.

already precarious industry into crisis. The price collapse was very real, devastating export-bound perrenials such as raisins, walnuts, lemons, and almonds, and prompting an outcry from growers that foreign governments were unfairly restricting their markets.

Just the same, prices were only part of the story. In more mobile crops, especially those field crops that had increased acreage so fast in the 1970s, growers responded with truly spectacular acreage cuts. Between 1980 and 1983, the state as a whole lost 20% of its harvested, non-pasture cropland.[15] The effects of these acreage reductions on

[15] Based on the annual reports of the County Agricultural Commissioners, non-pasture, harvested acreage declined from 10,720,159 to 8,594,027.

revenues were every bit as important as price effects. In any year, revenue for a specific crop can be expressed as the product of three terms: acreage, yield, and price.

$$\text{Revenue} = \text{Acreage} \cdot \text{Price} \cdot \text{Yield} \tag{3.1}$$

Knowing this, we can disaggregate the total change in statewide revenue for a given period into a series of additive components plus an interaction term, by taking the total discrete differential of equation 3.1.[16]

$$\begin{matrix}\text{Change} \\ \text{in} \\ \text{Revenue}\end{matrix} = \begin{matrix}\text{Change} \\ \text{due to} \\ \text{Acreage}\end{matrix} + \begin{matrix}\text{Change} \\ \text{due to} \\ \text{Price}\end{matrix} + \begin{matrix}\text{Change} \\ \text{due to} \\ \text{Yield}\end{matrix} + \begin{matrix}\text{Change} \\ \text{due to} \\ \text{Interaction}\end{matrix} \tag{3.2}$$

Table 3.7 shows this analysis for major crops during the growth period of the 1970s. Crops in the table are grouped by the factors which are most responsible for revenue shifts. In the majority of cases, it was acreage, not price or yield contributions that dominated revenue shifts.

Still, as pointed out in Chapter 1, this was no shakeout, not in the standard sense of restoring equilibrium. As soon as prices showed the slightest sign of recovery, mass production field crops again began building up capacity by 1983. This overwhelmed any concern for exchange rates. Indeed, heavily export-dependent crops like cotton, wheat, rice, and almonds, were actually increasing export acreage at precisely the time the dollar was reaching its highest value (Table 3.4).

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16 See Harrison (1982) and Appendix 3.3 for a more thorough discussion.

Table 3.7

Decomposition of Revenue Changes
1980-83

Crop	Percentage Change in Revenue	Percent due to changes in Acreage	Price	Yield	Inter-Action
Acreage Dominant:					
Strawberries	+ 42.0%	+ 17.1%	+ 16.6%	+ 3.9%	+ 4.3%
Process Tomatoes	+ 16.8%	+ 11.8%	+ 7.8%	- 3.1%	+ (-)
Cantaloupes	+ 15.5%	+ 15.6%	(-)	(-)	(-)
Table Grapes	+ 11.9%	+ 14.4%	+ 5.0%	- 6.8%	(-)
Alfalfa	- 11.2%	- 10.6%	- 1.1%	(-)	(-)
Field Corn	- 19.2%	- 11.2%	- 4.7%	- 4.6%	+ 1.2%
Dry Beans	- 29.2%	- 23.1%	+ 1.1%	- 9.0%	+ 1.7%
Barley	- 31.8%	- 29.4%	- 2.4%	- 1.0%	+ 1.0%
Cotton	- 41.6%	- 35.5%	- 11.0%	+ 2.6%	+ 3.0%
Wheat	- 45.6%	- 31.9%	- 9.5%	- 11.6%	+ 7.4%
Sugar Beets	- 49.3%	- 28.8%	- 21.9%	- 8.7%	+ 10.1%
Rice	- 55.1%	- 38.0%	- 35.9%	+ 12.9%	+ 11.7%
Price Dominant:					
Lettuce	+ 33.7%	- 9.4%	+ 39.0%	+ 6.2%	- 2.1%
Celery	+ 32.0%	- 4.8%	+ 41.6%	- 2.0%	- 2.7%
Prunes	- 16.9%	- 2.0%	- 8.8%	- 7.1%	(-)
Lemons	- 25.9%	- 3.8%	- 26.7%	+ 5.1%	(-)
Fresh Tomatoes	- 32.5%	+ 3.7%	- 19.8%	- 18.9%	+ 2.4%
Walnuts	- 33.5%	- 1.9%	- 34.4%	- 3.3%	(-)
Raisins	- 44.7%	+ 11.9%	- 35.4%	- 23.5%	+ 2.2%
Yield Dominant:					
Peaches	+ 16.0%	+ 5.2%	(-)	+ 10.7%	(-)
Wine Grapes	- 8.1%	+ 2.5%	- 4.8%	- 5.8%	(-)
Plums	- 10.8%	+ 16.6%	- 1.7%	- 21.9%	- 3.4%
Almonds	- 45.5%	+ 6.8%	- 25.3%	- 31.6%	+ 4.6%
Crops with Revenue Changes Less than 5%:					
Potatoes	+ 4.6%	+ 19.6%	- 14.7%	+ 2.4%	(-)
Oranges	- 1.5%	+ 1.0%	+ 3.5%	- 5.5%	- 1.6%

(-) less than 1%.
Totals may not add due to rounding
Data from Annual Reports of the County Agricultural Commissioners.

Summary

In this chapter, I have described some of the ways in which restructuring has contributed to instability in agricultural revenues for the California industry. These include an overconcentration of the revenue base in foreign markets, aggressive trade policy and stock reductions by government, and excessively rapid capacity movements as growers sought to increase flexibility. The lesson to be learned is <u>not</u> that instability is primarily determined by endogenous events. This would simply be repeating the mistake made with respect to exogenous factors like exchange rates. Rather, what is important is how these sets of forces interact with one another to affect economic development in the industry.

Restructuring represents an ongoing effort by growers to change the nature of competition in their industry. This effort is undertaken at virtually every level of production. Changes in labor relations, technological trajectories, and the organization of capacity all affect one another in fundamental ways. As an example, we saw in Chapter 2 that technological change influenced labor relations by helping to bring down the Bracero Program. On the other hand, the fall of the Bracero Program also helped reinforce and accelerate trends toward adoption of specific technologies.

Often restructuring also creates contrary forces within the industry. For instance, we have seen that growers responding to the collapse of stable labor relations often adopted strategies that were the exact opposite of other growers in the same region. In the industrial restructuring literature, this danger of oversimplification has been most present in discussions of the role of flexibility. In the agricultural case, enhanced productive mobility (especially in labor supplies) had existed for a long time—it did not arise suddenly as a response to crisis in mass production. Rather, mass production and high factor mobility developed simultaneously, often reinforcing one another.

Overall, restructuring within California's mass production agriculture has been central to its incredible success. California's export-oriented, large scale, and highly mobile, mass production system is different from farming elsewhere in the U.S. However, that success has not been costless. We do not currently know whether or when stability will be reestablished. What we do know is that the growth process played out since 1970 has been highly volatile.

Because the analysis in this chapter has been at such a high level of aggregation, it can only begin to describe the restructuring process. The description of restructuring it provides does not describe the real experience of any single sector well. It also fails to explain why some features of restructuring get adopted in specific sectors and not other. Nor does this broad analysis tell us anything about how the benefits of growth and costs of instability have been distributed among different growers within the industry.

With these questions in mind, I now turn to a case history of a single crop—cotton. In the 1950s and 1960, instability in the cotton industry was considered an exemplary case of overproduction. In the 1980s, cotton was held up as a prime example of a crop devastated by declining competitiveness due to the overvalued dollar. In fact, cotton's greatest successes and greatest instability have been intricately related to changes in the nature of mass production as it has been pursued in California.

CHAPTER 4

COTTON AND MASS PRODUCTION

By most measures, cotton has been California's most important crop since at least 1960, accounting for an average 12% of the state's annual harvested acreage and 10% of annual crop revenues.[1] Since 1970, the sector has experienced rapid growth based on a tremendous expansion of capacity. This growth is noteworthy for several reasons above and beyond its rapid pace. Most important, it was achieved while other cotton regions in the U.S. were declining in absolute terms. Moreover, in contrast to the view that cotton is characterized by massive overproduction, this growth occurred without significantly depressing output prices over the longer-term. It was accomplished during a declining federal presence and despite increasing international competition in cotton.

For all these successes, revenue growth has become highly unstable in the years after 1970 (Figure 4.1). In this chapter, I will describe the early development of mass production in the state's cotton industry. Although very much a mass production industry, the sector has never relied strictly on price-based competition. Rather, standardization and differentiation of output have gone together. Likewise, the industry has never experienced significant vertical integration or oligopoly. Instead, output, entry, and the extension of foreign markets tended to be controlled by government.

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[1] Acreage, yield, and income statistics from the Annual Reports of the state's County Agricultural Commissioners between 1960 and 1987.

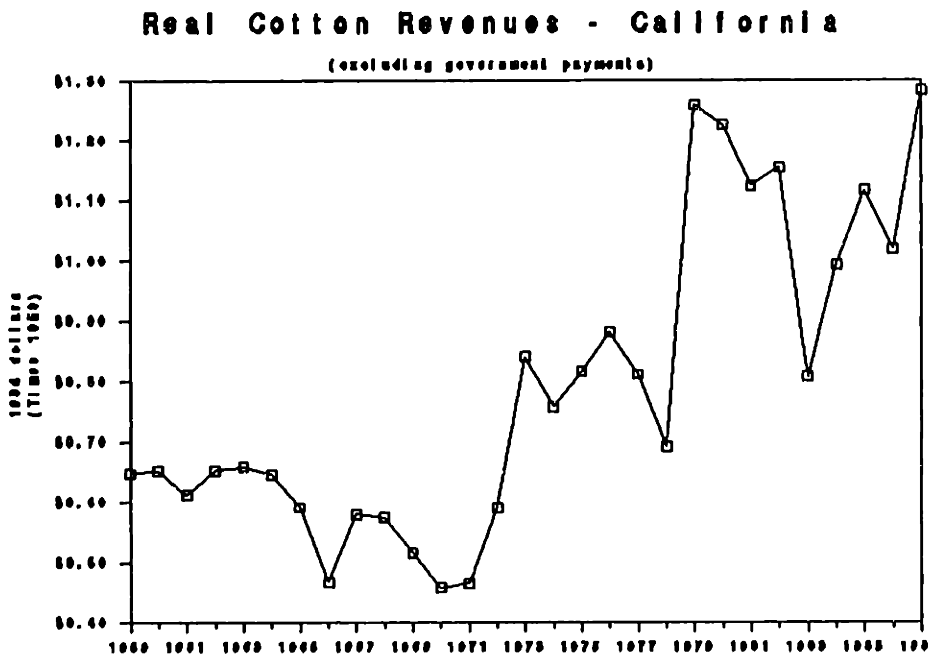

Figure 4.1

Increasingly, however, strict governmental control of the sector became an obstacle to further development of mass production. In the late 1960s and early 1970s, the role of the state was drastically altered, giving growers much more freedom to allocate capacity and design their own marketing plans than in the past. In Chapter 5, I will describe how these changes contributed to destabilization of revenues. First, however, let us examine the development of early mass production in California cotton more carefully.

Sectoral Development Prior to 1970

By the 1960s, cotton production in California already resembled mass production in manufacturing industries in many ways. Farm size was large, and production used highly capital-intensive methods. Specifically, irrigation and chemical use were far-reaching, and the harvest was entirely mechanized. Perhaps most important, California cotton already had a long history of extreme standardization. This early decision to standardize output not only affected marketing, but also had a profound influence on technological change and on the relationship between producers and the state.

Table 4.1

California Cotton as Mass Production
Miscellaneous Statistics

	U.S.	California
Average Size of Harvested, Commercial Farm (acres)(1964)	126	373
% of Acres on Farms > 1,000 Acres (1964)	51%	67%
Average Size of farms under 1,000 Acres (1974)	88	118
Average Yield (bales per acre)(1969)	.98	1.92
Share of Harvested Cotton Acres:		
with Mechanized Harvest (1960)	51%	87%
Treated with Pesticides (1964)	59%	97%
Treated with Fertilizers (1964)	76%	98%
Irrigated (1969)	25%	99%

Source: U.S. Bureau of the Census, Census of Agriculture.
Years vary due to inconsistent data collection and census definitions.

Product Standardization:

The standardization of output necessary for mass production cotton farming in the state began in the 1920s. From the beginning, standardization and product differentiation in the state's cotton sector have been inextricably linked. Given scarce labor supplies in the region and the long distances cotton had to be transported for marketing, production costs in California tended to be greater than for other regions. After World War I, this encouraged growers to adopt high quality Pima (Egyptian) cotton that could draw premium prices.

When the market for Pima cotton collapsed in the early 1920s, a search began in earnest for alternative varieties. This led to the discovery of Acala cotton. Native to Mexico, Acala was well adapted to California growing conditions and was an Upland variety of very high quality (only slightly lower in quality than Pima cotton). Acting on the advice of USDA agronomist Joseph Camp, California growers promoted legislation making Acala the only cotton legally grown in the San Joaquin Valley.[2] In 1925, the so-called "One-Variety Law," created a district within which only Acala cotton could be grown. This allowed it to be protected from cross-pollination by lesser strains and strategically placed California cotton at the high value end of mass production markets. Today, California growers typically receive a price premium on the order of 10-15% above other U.S varieties (Hall, 1989). This marketing decision to grow a highly standardized and differentiated product pre-dated many of the technological changes in the Valley that are the most visible features of mass production today. In fact, the adoption of the One-Variety Law helped determine the form technological change would take in the Valley in later years.

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2 The San Joaquin Valley has consistently produced 85% or more of the state's cotton during the study period of 1958-91, with that share tending to increase over time. Some non-Acala varieties may be grown experimentally within the Valley, but these are very small amounts.

Figure 4.2

California Cotton Producing Counties

First, and most obviously, standardization assured greater uniformity in cotton delivered to local gins, allowing ginners to standardize their equipment (Musoke and Olmstead, 1982; Hall, 1989). Second, and at least as important, the One-Variety Law provided the foundation for close cooperation between growers and the state that was central to ongoing technological dynamism in the sector. To prevent the monopolization of seed supply by private firms and guarantee its purity, the responsibility for seed development and distribution was given to the USDA, with their activities being overseen by a committee of growers.[3] This provided a centralized and coordinated institutional framework whereby research and development efforts could quickly be moved into the field. In some instances this made it possible to replace the entire productive capacity of the district with a new seed type in a single season (Turner, 1981).

On repeated occasions, the One-Variety Law nearly collapsed as individual counties and growers sought to introduce new varieties that either had greater market potential or were better suited to local growing conditions in specific parts of the Valley. This discord encouraged USDA to aggressively pursue the development of new and improved seed types, in order to maintain support for the one-variety concept.

Labor Relations:

A second major feature of mass production farming in California is its heavy reliance on hired labor. In marked contrast to traditional

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[3] Today, this group is known as the Acala Cotton Board.

cotton regions in the Deep South, there was no significant legacy of share cropping or other forms of labor relations that tied labor to land in the West. Partly because of this, there was always a stronger division of labor between field workers and management in the West than found elsewhere. Managers tended to be property owners or their family members while field workers were usually migrants with little hope of ever entering management or ownership roles (Galarza, 1964). This strong separation between field work and management has encouraged militancy on the part of field workers from an early date. In the 1930s, California cotton growers openly set wages by announcing a "prevailing wage" at the start of each season. In response, California's cotton workers attempted to organize the fields, leading to a series of violent and disruptive confrontations.[4]

Capital Intensity of Production:

The fear of labor's ability to disrupt production worried growers deeply, and provided a major incentive to mechanize the harvest (Turner, 1981; Musoke and Olmstead, 1982). At the same time, the absence of labor relations that tied workers to the land through share cropping or other similar relations made it easier for California growers to mechanize than growers in other areas (Whatley, 1987). In addition, California's dry climate allowed machinery to be used in the fields more

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[4] In 1934, control was reinstated only after the state intervened by arresting union leaders. According to London and Anderson (1970), they were held without bail for a long period and ultimately convicted under laws that were later ruled unconstitutional.

fully than in rainy regions, helping California's cotton harvest to be mechanized a full decade before regions elsewhere in the U.S.

In the years before mechanization was fully implemented, labor organization was effectively thwarted by use of vulnerable Bracero workers. This combination of early mechanization and the inability of labor to organize was critical. Unlike other sectors where the end of the Bracero Program caused near panic, cotton growers were relatively unaffected.

Another notable difference between production in California and elsewhere in the U.S. was its heavy use of irrigation. Throughout most of the century, California cotton was restricted to areas with natural water supplies, especially groundwater. When publicly-subsidized water projects began coming on line after the war, the crop became wholly irrigated and its production area expanded. This access to cheap irrigation was central to the adoption of sophisticated chemical use and allowed breeding programs to be much more focused on improving output quality (Turner, 1981). Although production costs per ton remained higher in California than in other areas, the state's growers routinely achieved yields double those in other regions (Table 4.1)(Whitaker, 1967).

Scale of Production:

Investment in irrigation facilities, mechanized harvesting equipment, and a deepening division of labor all helped create significant scale economies in farming. In what has been the most widely quoted study of scale economies of cotton production in the San

Joaquin Valley, Moore (1965) calculated that average costs declined until farms reached anywhere from 600 to 1,400 acres in size, depending on the production area.[5] Since that time, the technology of cotton production Moore assumed in his study has changed considerably. However, his basic finding of significant scale economies in cotton production has been widely confirmed (Madden, 1967; Keith, 1980; Paxton and Lavergne, 1986).[6]

Because of this, California cotton farms tend to be large, with an average size twice that in other regions. Most of the acreage in the state is on the very largest farms. Accordingly, in 1974, 67% of all harvested cotton acreage could be found on farms over 1,000 acres in size, compared to 51% nationally. Nonetheless, these scale figures are not simply a matter of there being a few very large farms. If, for instance, we examine farms under 1,000 acres, we still find that California's average size of 118 acres is well above the national average of 88 acres (Table 4.1).

Vertical Integration:

One of the main ways that California cotton differed from many models of mass production was that it was not characterized by extensive vertical integration. At times, analysts of modern agribusiness have

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[5] In lighter soils characteristic of the eastern side of the Valley, costs declined until farms reached an average size of 600-800 acres. In the heavier soils of the West Side (where most of today's cotton production is centered) costs declined until farms were 1,200-1,400 acres in size.

[6] Unfortunately, the Census of Agriculture does not publish detailed expenditure data by farm size for specific crop types.

tended to treat large scale farming and extensive vertical integration as inextricably linked (Vogeler, 1981; Wessel, 1983).

Growers sell their output through two primary types of outlet, each of which accounts for roughly half the total market. The first option is to write forward contracts with "line companies" (private gins)(see California-Arizona Cotton, April 1972, pg. 22). Virtually all of the cotton ginning in California is done between September and January. As a result, capacity utilization for gins is very low and only the largest farms have attempted to bring ginning in-house.[7] More often, private gins are owned by merchandisers and oilseed companies, which use contracting as a means of guaranteeing a stable supply for their other operations.[8] From the perspective of growers, forward contracting represents a means of lowering risk, since they are given a guaranteed price at the start of the season in return for accepting a lower average price. Typically, private gins also provide working capital to growers, an especially important resource under modern production methods requiring steady purchases of water and chemicals (ibid, pg 20; Roy, 1972).

The second main marketing option for growers is to sell to cooperatives. These generally focus on a single stage of production. As a result, cooperative growers typically belong to both a ginning

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[7] J.G. Boswell is the largest grower-ginner, owning three large gins.

[8] The relationships between these players have been highly fluid over time. As an example, in 1973, Anderson-Clayton, a large integrated ginner-merchandiser, divested itself from merchandising. In the 1980s, two of the largest ginning operations (Producers Oil and the Anderson-Clayton subsidiary of Western Cotton Services) were purchased by cotton merchandisers (W.B. Dunavant and Julian Hohenberg, respectively).

cooperative and a marketing cooperative. Ginning cooperatives tend to be small and localized, so as to minimize transport costs. Marketing cooperatives tend to be much larger and more spatially centralized, marketing output from many gins.

The largest marketing cooperative in the state is Calcot, which handles the vast majority of the state's cooperatively marketed cotton. Calcot does not guarantee a forward price to its farmers and it does not provide working capital. Instead, it makes progressive payments through the season as a means of getting cash to growers. Its biggest benefit to growers is that it enables independent producers to achieve significant economies of scale and scope by marketing their output as a common pool. This has usually allowed Calcot members to receive prices significantly above the state average. As an example, in the years between 1971 and 1976, Calcot member-growers received prices 9% above the state average.(Calcot News, Summer, 1977:6).

In the part of the sector dominated by private contracting, integration rarely proceeds more than one stage upstream or downstream. Likewise, because contracts are written for a single year, it is very easy for growers to move in and out of contract arrangements and longer-term acreage growth is not easily coordinated with marketing plans. For their part, the internal rules of cooperatives obligate them to market any output from their member-growers, as long as it is signed up in advance. The absence of strong vertical integration and oligopolistic market relations in California's cotton industry has meant that there are no private sector mechanisms for regulating supply other than prices.[9]

The Regulatory Framework:

In place of internal coordination of acreage growth, cotton markets were under the strict control of federal commodity programs prior to 1970. In the 1950s and 1960s, the U.S. cotton industry was perceived as a prime example of Schultzian overcapacity based on slow demand growth facing rapid yield increases. Nationally, yields increased as new agricultural chemicals were introduced to farming and as a larger share of the total crop base was brought under irrigation. On the demand side, two forces combined to create slow market growth, both of which were argued to be beyond the control of farmers. First, synthetic fibers such as rayon and polyester were seizing a larger share of the total fiber market. Second, the U.S. textile industry as a whole faced slow growth due to increasing competition from overseas-based, low-wage producers (Starbird, et. al., 1984).

Throughout most of the 1950s and 1960s, federal policy toward cotton consisted of an effort to reduce capacity based on the commodity programs described in Chapter 2. To review the highlights of these programs:

1. Cotton was under marketing quotas continuously between 1954 and 1970. These controlled the quantity of acreage from which growers could deliver cotton to market.

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[9] Although there are several very large growers (most notably Russel Giffen and J.G. Boswell), they do not routinely exercise their market power in a manner that dramatically affects total supply.

2. Acreage allotments were based on the prior production history of each grower, and the controls were enforced by fines. Consequently, short-term withdrawals of acreage resulted in later reductions in a grower's allotment.

3. Acreage allotments were not transferable between producers.

4. Beginning in 1964, the basic allotment system was augmented by diversion programs that offered growers higher payments to withdraw additional acreage voluntarily in some years.

In addition to the basic commodity programs, the U.S. government took a very active policy toward international cotton trading. The domestic market was essentially closed to imports by quotas on all but small quantities of extra long staple Pima (ELS) cotton. At the same time, the U.S. subsidized exports by offering loans to foreign buyers, by accepting various forms of barter from dollar-poor countries, and by selling cotton abroad at prices below domestic levels while compensating exporters for the difference (USDA/CCC, 1964).

The Collapse of Strict Supply Controls

By and large, mandatory acreage controls were successful at reducing U.S. cotton acreage. From its peak in 1952 of 28 million acres, U.S. planted cotton acreage was reduced to just 15 million acres in 1964. Yet, even with this considerable reduction in capacity, U.S. inventories of cotton soared to such an extent that stocks actually exceeded annual domestic consumption in 1964 and 1965. These inventories depressed prices in world markets, with real prices received by farmers falling by 3% per year throughout the decade of the 1960s. This, in turn, caused the cost of supporting farm incomes to skyrocket.

By 1966, support payments and nonrecourse loans under the upland cotton programs were estimated to be $730 million per year.[10]

What had gone wrong? One argument is that yield growth offset acreage cuts. To a certain extent this is true. Yield growth did roughly offset the acreage declines. As a result, output in 1968 was almost identical to that in 1952. However, output certainly did not increase. Rather, the problem lay on the demand side. A significant part of the problem came from efforts by foreign nations to adopt import substitution policies. While world cotton use increased by 12% between 1960 and 1965, the total level of world exports remained virtually unchanged and the total share of world demand met by trade declined sharply from 37% to 31% (Starbird, et. al., 1984:43).

Still, as we saw in Chapter 3, these changes in international markets did not occur in isolation from events within the U.S. market. U.S. domestic price supports (maintained by grower-approved marketing quotas) tended to raise world prices, allowing foreign producers into the market (Paarlberg, 1980). Between 1960 and 1965, U.S. exports as a share of the world's traded cotton declined from 40% to 18% (Starbird, et. al., 1984:10).

Moreover, even with changes in foreign markets, climbing inventories could have been controlled. Had domestic mill use of cotton grown by only 1% per year between 1955 and 1965, there would have been a steady decline in inventories (ibid:38). Instead, domestic mill use stopped dead in its tracks. Again, growers were not innocent victims.

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10 Nominal dollars. These huge inventories also had large storage costs. Although not available by crop, storage of all commodity crops was exceeding $1 million per day (USDA/CCC. 1964).

Consistently, growers voted in marketing quotas in order to obtain high price supports; consistently, they supported import quotas, even though these raised the costs of cotton to U.S. textile producers and made synthetics more competitive.

On the one hand, grower-supported domestic commodity policy simply failed to reflect the reality of world markets in the late 1960s. On the other hand, and of special importance to California growers, the regime of acreage controls was fundamentally at odds with industrialization based on mass production. Quite simply, acreage limitations prevented growers from expanding scale. In addition, the existing price support structure undervalued the Acala cotton grown in California. Deprived of their ability to expand scale and pursue broader foreign markets, and given little relief in government programs, California growers were forced out of the market disproportionate to growers in other regions. Between 1960 and 1969, capacity in California declined at an annual rate of 2.7%, compared to 2.3% nationally (Annual Crop and Livestock Reports of the County Agricultural Commissioners; Starbird, et. al., 1984:37).

Even when growers did not reduce capacity, they often delayed capital expenditures necessary for continued productivity growth. Most agricultural economists agree that long-run yield changes are primarily determined by investment patterns and technological change. However, it is generally assumed that technological change will cause yields to increase over time. This was not the case in California where, contrary to the national trend, yields actually *declined* by an annual average of 2.7% annually between 1959 and 1971.

As if these other problems were not enough, the big commodity programs also came under fire from legislators for various inequities in design. These were of decidedly secondary importance in bringing down the system, having existed for years before anyone actually contemplated revising the legislation. Nonetheless, they are worth mentioning:[11]

1. By basing total payments on the volume of output, the vast majority of benefits went to the very largest farmers (Cochrane and Ryan, 1976: 363-371)

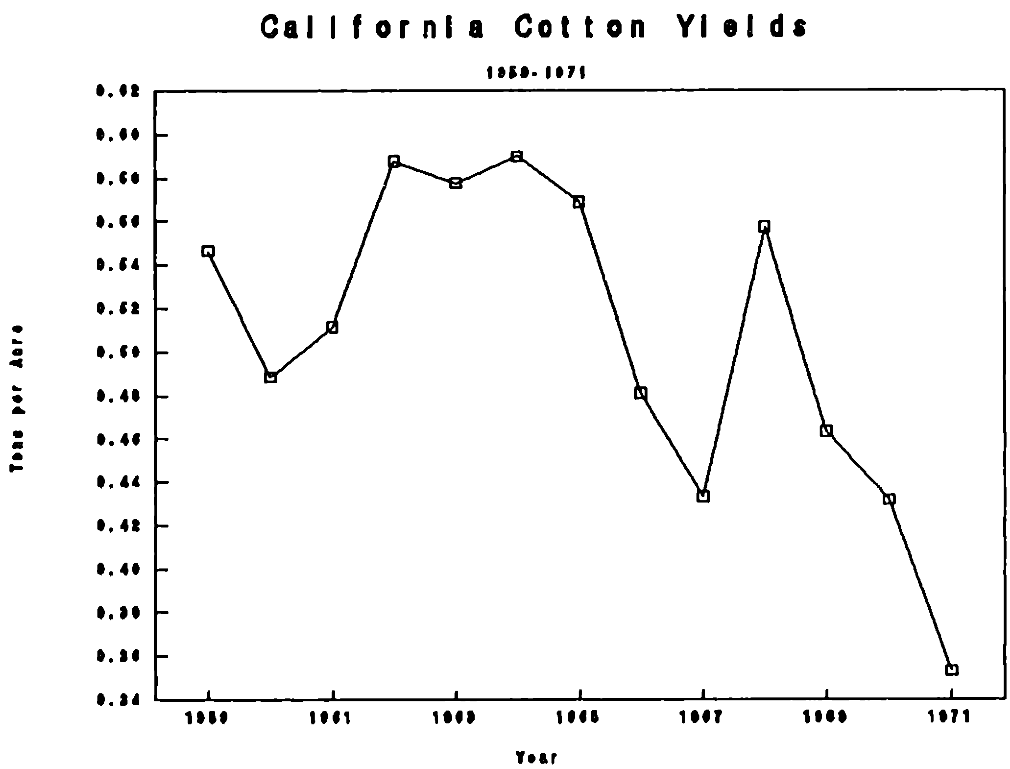

Figure 4.3

[11] Most citations listed are after Paarlberg (1980:34-42).

2. Price supports favored commodity farmers and ignored growers of non-commodity crops (Paarlberg, 1964: 23)

3. Price supports raised the price of cotton and basic foodstuffs to consumers. Because these necessities make up a larger portion of poor people's budgets, the policies were regressive (Tweeten, 1977:52).

4. Price support payments tended to be capitalized into land values, and thus constituted a form of economic rent (Hoover, 1975: 29)

Reshaping Regulatory Structures:

As grower support for strict supply management dwindled in the environment of increasing global competition and stagnant domestic markets, federal commodity policy took a major turn between 1965 and 1970. This redirection of policy had two main elements. First, there was a conscious effort to favor export markets by lowering domestic and world prices in order to force out foreign competitors. Second, the old system of strict acreage controls was dismantled in favor of a voluntary system.

In 1965, price supports were dropped to world prices. Lowering price supports did exactly what was intended. In the single year from 1965 to 1966, U.S. cotton exports increased by 60% (Starbird, et. al.; 1984:43). At least initially, the federal government manipulated policy so as to dispose of its own stocks. To prevent private sector cotton from flooding the market, export producers were given very limited allotments and were ineligible for price supports. Between 1965 and 1967, government inventories declined precipitously from 12.5 to 6.5

million bales, prompting protest by other countries that the U.S. was dumping cotton on the world market at below cost (Whitaker, 1967:138; United Stated Department of Agriculture, Cotton Situation. April, 1975).

For several years, marketing quotas were continued and growers were simultaneously offered very generous payments to divert extra acreage to conserving uses. U.S. production of cotton plummeted from 14.9 million bales in 1965 to 9.6 million bales in 1966 (Starbird, et. al.; 1984:43). However, the costs of the program were very high, surpassing $950 million per year in 1969 (excluding storage) (ibid:40).

In 1970, the federal government took the final step away from the old regime of commodity regulation by abolishing marketing quotas. In their place, farmers could enroll in a voluntary set-aside program. In addition, growers could plant whatever they chose on their remaining land. This complemented the 1965 legislation, which legalized the transfer of acreage allotments between growers. Together, these provision removed many of the rigidities of the old system. To address previous inequities of the old system, an upper limit of $55,000 was set on allowable payments to any single producer. By 1982, the USDA proudly boasted that 80% of cotton program benefits were going to farms under 500 acres in size (Starbird, et. al.; 1984:27).

Summary

Cotton is more dominated by mass production strategies than any other crop sector in California agriculture. Yet the sector never developed the degree of oligopoly or vertical integration observed in manufacturing sectors. As a result, cotton farmers relied on government to regulate output growth and the entry of new firms. Likewise, because labor never gained any bargaining power, Fordism never played a major role in the sector. Again, the government played a critical role in regulating demand, especially through its foreign market operations.

Unfortunately for California growers, in the 1960s, government policy consisted of mandated capacity reductions and divestment. This prevented growers from pursuing scale economies. Nor could they develop foreign markets for their carefully differentiated product. When the state's role in regulating agriculture declined in the late 1960s, it offered California growers both unequalled opportunity and far greater risk than they had seen in the past. Their response to regulatory reform was far from predetermined. Let us now consider those responses more carefully.

CHAPTER 5

EXPORTING, FLEXIBILITY, AND INSTABILITY IN THE COTTON SECTOR

Because the cotton sector mechanized at such an early date, its growers were much less vulnerable to labor shortages than producers of other crop types. This did not make them immune from union militancy, which remained a threat. However, it did mean that the decline of supply controls had a much more obvious and immediate affect on the industry than did deteriorating labor relations. In the years that followed regulatory reform, the national cotton industry, and California's in particular, experienced tremendous change. The industrial sector that emerged represented a fundamentally different way of doing business compared to the past. The lowering of price supports vastly improved the export potential of California cotton. At the same time, the collapse of supply controls allowed growers to move acreage much more easily than in the past. Growers used that mobility and their enhanced access to foreign markets to expand their mass production operations at an unprecedented rate, surging to the forefront of U.S. cotton production.

However, export-led growth was no easy path. Faced with increasing risk and market instability, growers also increased their flexibility in production, allowing them to maintain capacity utilization well above that of growers in other regions by rapidly switching between crops. As argued in Chapter 2, this shift toward strategic use of high factor mobility was not a rejection of mass production. Rather, mass production and flexibility supported one another.

Export-Led Growth

California growers were uniquely positioned to benefit from the lowering of price supports and the deregulation of acreage that occurred after 1965. Mass production textile firms demanded reliability and uniform quality from their suppliers. As mass producers themselves, California growers were ideally suited to meet this demand (Calcot News, Summer 1980:10; Rosson and Shafer, 1979). Playing to their strength, California cotton growers established themselves as the suppliers of choice to large textile producers throughout much of the world, especially in the "newly industrializing countries" (NICs) of the Pacific Rim (California-Arizona Cotton, February, 1973:16; Calcot News, Fall 1981:3). By 1982, the top six countries of Japan, South Korea, mainland China, Taiwan, Indonesia, and Hong Kong accounted for a combined value of 1 billion dollars worth of annual cotton exports from California ports.[1] Between 1965 and 1979, exports of California cotton more than tripled.[2] Cotton farmers in other regions of the U.S. tried to repeat this export-based success, but to little avail, as average U.S. exports from outside California increased by a mere 7% in the 1970s over their level in the early 1960s.[3]

Exporting provided the basis for a tremendous rush of new investment. Having led in divestment in the 1960s, California became

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[1] Based on 1 - 1-1/8 staple length cotton.

[2] Between 1965 and 1979, exports increased from 565,000 bales to 2.4 million bales (California Dept. of Agriculture, 1980).

[3] Based on the years 1962-65. These years are chosen due to the unavailability of data in other years.

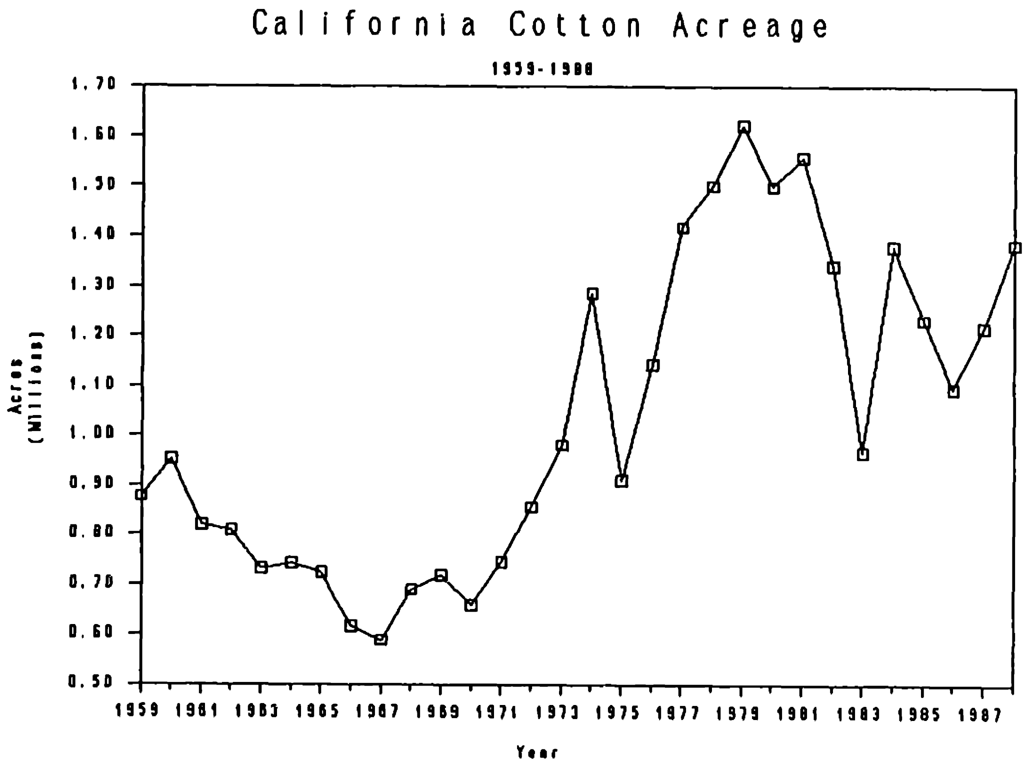

Figure 5.1

the national leader in acreage expansion during the 1970s. Throughout the new decade, capacity more than doubled, and virtually all the resulting output was exported (Figure 5.1).[4]

Likewise, this resurgence in investment turned around the productivity declines of the 1960s, making the state the leader in national yield increases (Figure 5.2). Between 1970 and 1979, yields in

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[4] Acreage increased from .7 million acres to 1.6 million acres between 1965 and 1979. Over the same period, output increased by 1.6 million bales and exports increased by 1.8 million bales (Agricultural Crop and Livestock Reports of the County Agricultural Commissioners; California Dept. of Agriculture, <u>Exports of Agricultural Commodities Produced in California</u> 1966,1980).

the state increased at an average annual rate of 4%, despite the fact that the state experienced the worst two-year drought on record in 1976 and 1977 (Figure 5.2).[5]

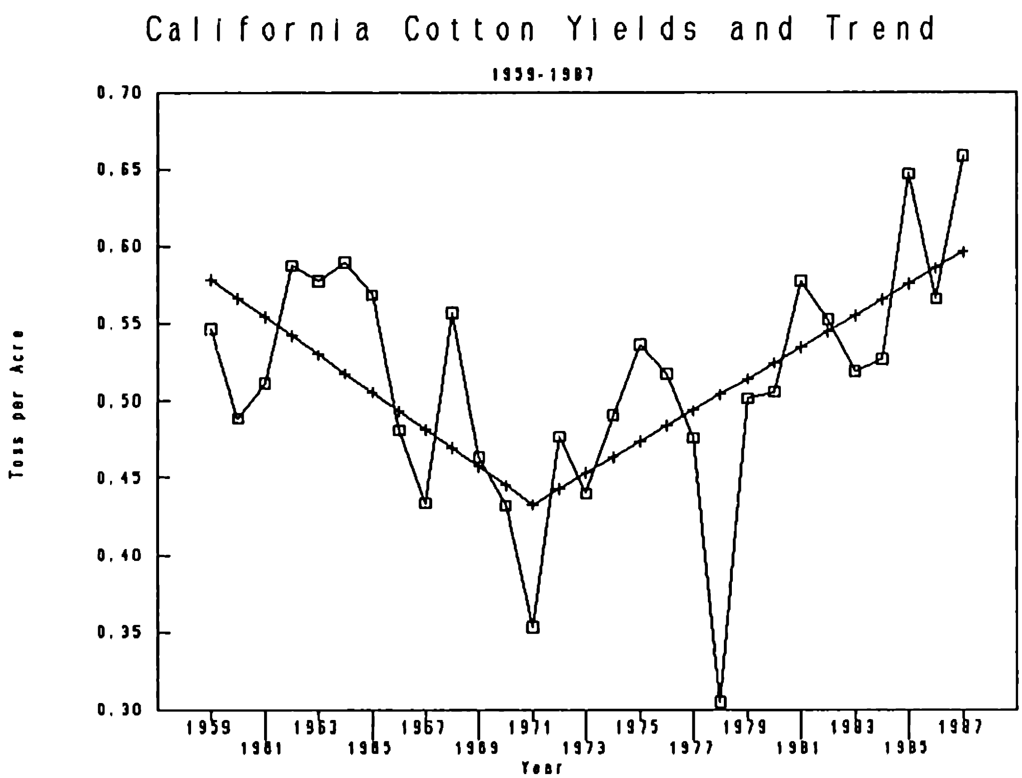

Figure 5.2

[5] U.S. yields increased by 3.2% per year over this same period. Trend line for Figure 5.2 is given as

$$\begin{array}{lllll} YIELD = .60 & - .01(T) & + .02(S71) & \bar{r}^2 = & .23 \\ \quad (9.00) & (-2.88) & (3.31) & d.f. = & 26 \end{array}$$

Together, these acreage and yield increases caused output to soar. In the short five-year period between 1969 and 1974, output increased from 1.3 to 2.2 million bales; by 1982 this total had climbed to 2.9 million bales. Yet, over the same period, there was virtually no longer-term decline in real prices. Indeed, earlier declines were reversed and real prices gained an average of 3.3% per year (Annual Crop and Livestock Reports of the California Agricultural Commissioners, 1973-1982).

This expansion of output, in the presence of strong markets, created phenomenal revenue growth. Between 1970 and 1987 real revenues in the sector rose at an average 11% per year. In short, while traditional theory suggests that resources should be transferred out of agriculture, the California cotton sector was growing at a rate far exceeding those manufacturing sectors that were supposed to absorb resources from farming.

Risk and Instability Associated with Export-Led Growth

As a regional competitive strategy, California's export-led mass production has been extremely successful. Still, the process has not been a smooth one. Without question, there has been a high degree of risk associated with exporting. Some of this risk comes from factors beyond the control of either California or U.S. growers. However, it is simply not true that the destabilization of international cotton markets has been independent of domestic restructuring.

The biggest exogenous threat to foreign marketing has been the aspiration of developing countries to become independent of the U.S. in commodity markets. By and large, this has <u>not</u> been a matter of foreign producers invading markets outside their own boundaries. As we saw in Chapter 4, commodity markets were becoming thinner throughout the 1960s, in the sense that world trade was smaller relative to total consumption. This trend continued into the mid-1970s, as developing countries sought to increase production to meet domestic needs. This has not been an easy task, as the U.S. has consistently tried to drive down world prices; but, they have done it anyway.

Since the mid-1970s, what has changed is that some of the players are operating on a massive scale, especially among centrally planned economies. The most dramatic case in point is the People's Republic of China (PRC). In the late 1970s and early 1980s, the PRC imported large amounts of U.S. cotton, making it second only to Japan among the world's importers. However, the Chinese were tenaciously dedicated to increasing domestic production. In 1980, Chinese imports of U.S. cotton peaked at 2 million bales. Just two years later, they were <u>net exporters</u> (USDA/ERS: <u>Agricultural Statistics</u>).

To be sure, these structural shifts in international markets have made California growers less able to dictate their own terms in the market. However, domestic restructuring has worsened the risk associated with international markets in several ways. First, as part of its policy of market deregulation, the U.S. government drastically reduced its inventories, which had historically acted to steady world prices. Between 1965 and 1975, world inventories of cotton declined by over 2 million bales, virtually all of which came from U.S. stocks. The result was a sharp decline in the level of stocks held relative to the level of world trade. In 1965, world stocks were nearly twice as great as the total level of trade. By 1971, inventories were actually less than the amount of cotton traded (Starbird, et. al.; 1984:43). The result was that any exogenous shift in demand was likely to cause a bigger price shock than in the past.

Second, the risk of international price destabilization was important specifically because growers had concentrated their revenues so heavily in exporting. In the California case, this vulnerability was worsened by the fact that, even within the export market, growers had concentrated their revenue base in a very few countries. By the early 1980s, more than 85% of California's cotton revenues came from overseas. Of those exports, 85% went to just four countries: Japan, South Korea, Hong Kong, and Indonesia.[6]

One particularly disturbing feature of this shift to exporting was that it entailed a more or less explicit abdication of domestic textile production. Quite simply, the attitude among most growers was that there was no future in domestic markets. California growers could have tried to maintain domestic demand by working with the domestic textile industry to make it more competitive. Anderson (1980), for instance, makes a compelling case that integration by cooperatives into textiles based in California would have been good business. Instead, it was not until 1989 that the first textile mill opened in the California—it was Japanese (California-Arizona Cotton. July, 1989:12). Instead of helping to rebuild domestic demand, growers actively supported public subsidization of our competition in textiles. Even today, California

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[6] Based on upland cotton with staple length between 1 and 1-1/8 inches (California Crop and Livestock Reporting Board. California Agricultural Exports - 1982).

producers continue to support U.S. government policies which promote exports by making and/or guaranteeing loans to those countries that provide the strongest competition to domestic textile producers (Calcot News. Fall, 1981:3).

Since the late 1960s, these changing conditions of international competition have contributed to a significant price destabilization (Figure 5.3). Yet, despite its importance, this destabilization of prices, by itself, was not enough to force growers toward greater

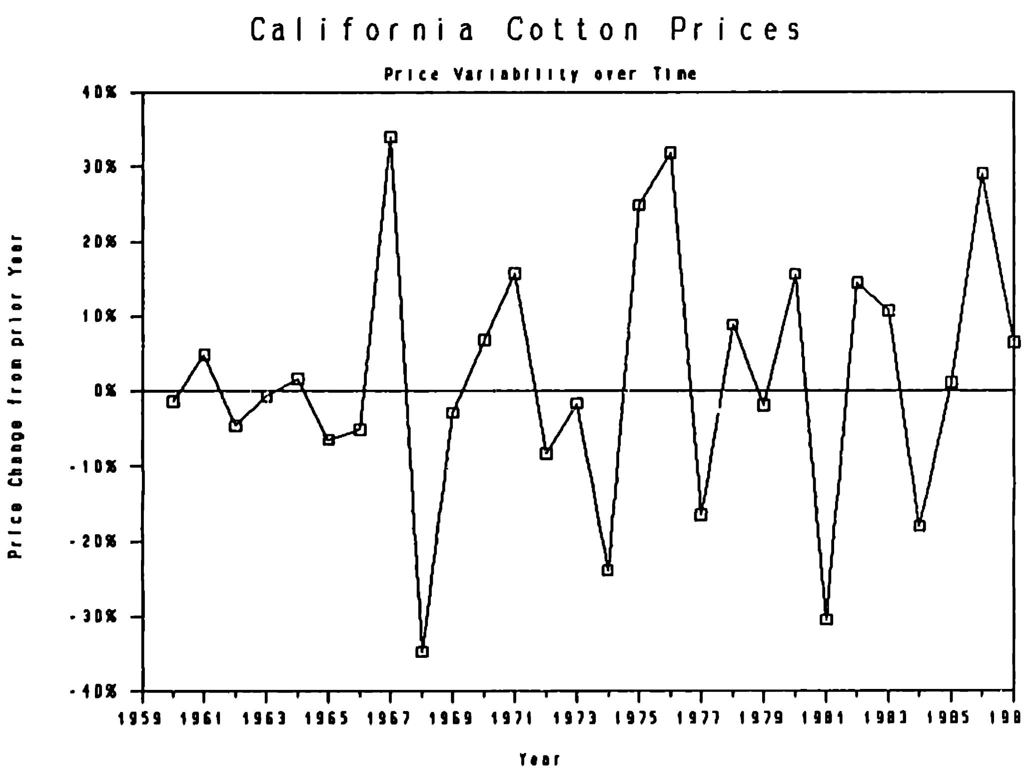

Figure 5.3

flexibility. At least in theory, the government programs were present to shield growers from demand side volatility. Thus, growers could either enroll in diversion programs and continue to have their acreage controlled in return for payments, or they could opt for the open market. In contrast to growers elsewhere, California growers chose not to enroll in government diversion programs. To return to acreage controls would have meant sacrificing the ability to fully pursue mass production. As long as foreign markets remained strong, diversion programs simply did not reflect an economically attractive option for most growers in a majority of years.

At the same time, the cap on total payments meant that only relatively small growers could protect a significant share of their income through diversion programs. As an example, in 1974, the cap on payments was set at $20,000. In that same year, 82% of California's cotton was sold on farms earning $200,000 or more. In short, even if these farms qualified for benefits and received the maximum allowed by the programs, they could only supplement their income by a maximum of 10%. Not surprisingly, supply in the San Joaquin Valley tends to be inelastic with respect to government price supports and California growers sell mainly on the open market (McArthur and Pawson, 1977).

Cotton and Flexible Mass Production

Given increasing risk in markets and limited access to the shelter afforded by government programs, California growers were placed in a difficult strategic bind. Instead of trying to moderate risk, they learned to cope with it. While pursuing mass production with greater intensity, growers were also developing the ability to shift production between a greater number of crops more rapidly than in the past. This process continues today. It goes beyond traditional product differentiation efforts, and is quite similar to patterns of flexible mass production identified among U.S. manufacturing firms:

> The approach which the American manufacturing firms are now taking goes considerably beyond cosmetic variations. It seeks to introduce into the productive system the capacity to produce several, basically distinct designs... This third alternative can be called flexible mass production. Formally, it is a productive system which consists of a closed set with a finite number of elements.
>
> Piore (1986:25)

What differentiates flexible mass production from pure mass production is that producers seek to produce a broader range of outputs in ways that go beyond traditional product differentiation. What differentiates it from flexible specialization is the fact that there are finite options for substitution (Piore, 1986; Sabel, 1990).

Part of this added flexibility introduced to California agriculture has been a matter of regulatory reform. No longer did growers have to fear their allotments would be cut if they reduced cotton acreage. Likewise, those enrolled in diversion programs were given considerable latitude in the crops they could substitute for cotton. Still, change has gone well beyond just regulatory reform. California growers have created an important series of mechanisms and practices for increasing flexibility in all areas of production. Broadly speaking, this effort has two parts. First, new crops have been developed and introduced that can be grown in new areas at new times. Second, factor mobility has been enhanced to make rapid switching between output types more feasible.

These strategies have had important successes. By making it possible for growers to remove acreage from production temporarily, enhanced mobility has helped growers to maintain strong real prices despite increases in base acreage, Likewise, the ability to move into the production of alternative crops has been crucial to maintaining capacity utilization during weak markets. On the other hand, increasing flexibility has costs as well. Because acreage movements are more responsive to price shifts than in the past, capacity and revenue have become much less stable.

Over the longer run, there are serious questions about whether the current patterns of flexible mass production can be maintained. To Piore, the limits on flexible mass production arise because there is an inherent tendency for producers to try and seek ever greater flexibility, which encourages them to reject former modes of mass production (Piore, 1986:29). In California cotton, however, increasing flexibility and mass production have been mutually supportive.
The limitation on flexible mass production is not as Piore argues, that mass production constrains further flexibility. Quite the contrary, at least part of the problem arises because scale economies exist in the technological base that makes greater flexibility possible. In the industrial literature, this technological base includes such general purpose machinery as numerically controlled machines. In agriculture, the key technological transformation is the homogenization of land made possible by the triad of irrigation, chemical use, and specialized

breeding, a technological base which is itself coming under increasing challenge from the public.

In the section that follows, I will consider the sources of increasing flexibility in some detail. Then, I will demonstrate concrete ways in which increasing flexibility has contributed to instability in revenues. Finally, I will outline several longer-term challenges to flexible mass production as it currently exists.

Mobility of Land and Capital:

Much of the recent discussion about restructuring of the industrial economy toward greater flexibility has focused on the problem of making capital more mobile. Typically, mass production systems are dominated by fixed capital and achieve their competitiveness by expanding and stabilizing output so as to utilize that capital fully. In modern irrigated agriculture it is impossible to dissect land and capital as factors of production. Investment in irrigation facilities and soil preparation are long-term investments which usually cannot be separated from the space they occupy.

To increase flexibility while maintaining capacity utilization, there are two broad strategies available to producers. First, they can substitute a greater share of their fixed capital with variable capital. California growers typically lease some 50-60% of their acreage. This minimizes the risk of overinvestment in land and shifts that risk to the landowner.

Second, producers can try to increase flexibility by using "general-purpose" equipment capable of producing different types of output. Despite the spatial fixity of land improvements, technological change based on intensive irrigation and chemical use has increased capital mobility in several senses. Perhaps most important, land has become more homogenous as a result of investment. In other words, the qualitative features of land formerly associated with a particular site can now be created through investment. As a result, a given plot of land can be used for crops that could not formerly be grown in that locale. These changes have made California farmland the equivalent of the general-purpose machine used in manufacturing. If we consider just those crops with a potential to substitute for cotton in the short-run (i.e., not tree or vine crops) some of the more important additions to the local crop base since 1960 include tomatoes, garlic, lettuce, cauliflower, and broccoli. In many instances, the introduction of these crops represented a significant geographic restructuring away from traditional production regions, especially coastal areas.

In addition, the production time of crops has gradually been shortened, and many crops can be grown at times of the year that were formerly infeasible. This gives growers greater flexibility in scheduling. It also broadens available marketing options by making it possible for growers to target markets outside the growing season for other production regions. This is especially important for lucrative early season markets.

One form of land improvement that deserves special attention is access to water. Historically, governmental water suppliers have tried to sell water via long-term contract to local water districts. In part, this reflected their own desire to cover fixed costs associated water development in a predictable manner. In the era of mass production, fixed contracts also aided growers by providing them the assurance they needed to make long-term investments in land improvements.

When new irrigation facilities were extended to the prime cotton counties in the late 1960s and early 1970s, virtually all cotton farms in the state had been updated to irrigation, making long-term contracts less of an asset than they once were. In fact, because many of the crops that substitute for cotton have very different water requirements, fixed contracts can be a liability. Increasingly, growers have substituted "surplus" urban water for contractual water.[7] This allows growers to buy this surplus water as needed, rather than being locked into fixed contracts.[8] Examining data for Kern County Water Agency, the largest local supplier in the region, Storper and Walker (1984) have shown that surplus water accounted for nearly 40% of all deliveries to growers between 1972 and 1979.

Labor Mobility:

To Schultz, fixity in the labor supply was a major obstacle to development in the sector, because it prevented the transfer of resources from agriculture into industry. Being dependent on family labor, U.S. producers could not easily release workers in periods of overcapacity. Likewise, the low skill levels of agricultural workers

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[7] This water is "surplus," in that large urban water agencies typically contract in advance for more water than they can use, slowly building up demand over time.

[8] This increased need for flexibility is also one key component behind a growing movement among academics and state officials to support open market trading of water in the state (Brown and DuMars, 1984).

made them difficult to hire in other sectors of the economy, even when jobs were available. To regulation theorists and other modern critics of mass production systems, labor immobility takes two additional forms. First, under mass production workers are trained to do very narrow tasks. Second, labor relations characterized by strict tenure rules and job descriptions make it difficult to reassign qualified workers to specific tasks (Piore, 1986).

In the California cotton sector, labor immobility has been circumvented mainly by eliminating labor from the production process through harvest mechanization. As a result, cotton growers are less dependent on contract labor than other types of growers, and tend to hire their own workers. The majority of workers are hired only temporarily, giving growers considerable flexibility. In contrast to manufacturing industries, and at least some other sectors of agriculture, the move toward mass production was not accompanied by a formalization of work.[9]

Likewise, there is a very minimal union presence in cotton farming compared to other sectors. This is not to imply that mechanization made the cotton sector immune from labor militancy or shortages after the fall of the Bracero Program, but it helped. In addition, growers often headed off union efforts before they could become established by offering improved conditions to a reduced work force. Alongside the broader pool of non-union, temporary labor, there is a much smaller core of key, year-round workers. These employees often receive benefit

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[9] Thomas (1985) and Wells (1981), for instance, describe how lettuce and strawberry production (respectively) often developed internal labor markets and greater formality of work.

packages including housing, paid vacations, and health plans. Because these workers stay on the farm permanently, they tend to gain a greater breadth of skills, and provide the continuity necessary to convert production from one crop to another, acting in some respects as middle management.

Managerial and Organizational Flexibility:

In the view of several prominent authors, managerial and organizational rigidities are the greatest constraint on increasing flexibility in the economy (Thurow, 1985; Peters, 1987). The main source of this inflexibility is the strict division of labor inherent in mass production. Just as workers on the shop floor are trained to do a narrow job and resist redeployment, divisions within large corporations have narrowly defined responsibilities. Because of the low level of vertical integration in California's cotton sector, this sort of structure never fully developed. Instead, different stages of production tend to be linked contractually. In the part of the industry in which growers sell to private gins, contracts typically are written for only a single production season. The conditions of these contracts also give growers considerable flexibility in production.[10]

This flexibility exists in the cooperative sector as well. Calcot growers may sell their output to either of two pools. Most output is delivered to a "seasonal pool," in which Calcot markets the crop as it sees fits so as to maximize revenues to its members. Alternatively,

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[10] This is in marked contrast to vegetable contracts, where specific production conditions are tightly controlled through the provisions of the contract (FitzSimmons, 1986; Roy, 1972)

growers may sell all or part of their crop through the "call pool." This allows growers to call their crop onto the market at any time. This is useful for growers who wish to trade on futures markets and allows Calcot greater flexibility in meeting unexpected demands of large customers (Calcot News; Summer 1977; pp 4-5.) In the early 1970s, the share of Calcot's cotton marketed through the call pool rose significantly from 14% to 25%.[11]

The Manifestations of Strategic Flexibility

The net result of these numerous incremental improvements in flexibility was to give California's cotton growers many more options than in the past. In the 1960s, rapid substitution into a broad range of crops was simply not possible. A reduction of cotton acreage could result in a grower's allotment being cut; commodity programs limited the selection of crops that could be grown on farms with cotton allotments; and, many crops could not be grown in the region without increased access to affordable irrigation. Among crops that could be grown, few were economically viable alternatives. The frustration with this situation felt by growers was well summarized by one top Calcot official:

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11 Based on San Joaquin Valley cotton for the 1971-2 season and 1975-6 season, respectively. For cotton from the southern production regions of Imperial and Riverside Counties, this increase was even more dramatic, going from 18% to 37% over the same period. Presumably this greater increases was due to the fact that the latter area grew higher value ELS cotton, subject to even greater price volatility than Acala.

> Current prices for cotton [are] very close to most growers' production costs. However, there are few alternative crops that present a breakeven situation when full costs are applied.
>
> Tom W. Smith, Calcot News. January, 1969. pg. 8.

As growers simultaneously pursued both mass production and greater flexibility after 1970, a subtle, but critical, change in the organization of capacity took place. On the one hand, the region was becoming more specialized in the production of highly standardized cotton.[12] At the same time however, growers were increasing diversity among the crops they substituted for cotton. This can be seen by looking at how cotton farmers planted their non-cotton acreage in various years (Table 5.1). There are two important trends visible. First is a general deconcentration of acreage in a few preferred substitutes. The other is a small, but significant movement of higher value fruits and vegetables onto cotton farms.

Table 5.1
Diversification Among Crops
Substituting for Cotton

Percentage of Non-Cotton Acreage on Cotton Farms			
1964		1982	
Barley	38%	Wheat	33%
Hay	25%	Hay	19%
Wheat	18%	Barley	18%
Grain Sorghum	6%	Vegetables	4%
Sugar Beets	5%	Orchard	4%
Alfalfa Seed	5%	Sugar Beets	3%
Top 3 Crops	81%		70%
Top 6 Crops	97%		81%

Source: U.S. Bureau of the Census, Census of Agriculture. 1964, 1982.

12 Between 1970 and 1980, the share of harvested acreage in the state dedicated to cotton doubled from 8.4% to 16.9%.

Relative to their competitors in other cotton regions, this gave California growers a tremendous advantage in volatile markets. We can best get a sense of this advantage by examining how growers in California and elsewhere adjusted capacity during a downturn. Fortunately (for statistical purposes), the census year of 1982 was just such serious collapse in the cotton market. A summary of the capacity movements is provided in Table 5.2.

Table 5.2

Distribution of Capacity
on Cotton Farms — 1982

	California			Rest of the United States	
	% of Acres	Crop Value ($/Acre)		% of Acres	Crop Value ($/Acre)
Crop (1):					
Cotton	60%	1,081	Cotton	66%	256
Wheat	13%	255	Soybeans	17%	160
Hay	8%	344	Wheat	8%	107
Barley	7%	186	Grain Sorghum	7%	110
Orchard	2%	1,384	Hay	2%	34
Vegetables	2%	1,996			
Corn (2)	2%	193		100%	
	94%				
Ratio of Acres in Diversion Programs to Harvested Acres (3)		.03		.08	
Capacity Utilization (4)		.93		.77	

Source: U.S. Bureau of the Census, Census of Agriculture; Volume 1; Parts 5 and 51.

Notes

(1) Includes only crops constituting more than 1 percent of harvested cropland.
(2) Data for California from County Agricultural Commissioners.
(3) This should not be interpreted as percent of harvested acres. While diverted acreage may be converted to other crops and harvested, it need not be. Required diversion was 20% in 1982.
(4) Total acres harvested as share of total cropland on cotton farms.

Comparing capacity use on California cotton farms to similar farms in other regions, several trends are observed:

1. California growers reduced their acreage of cotton further than other areas.

2. California growers were much less likely to enroll in federal acreage diversion programs, or to simply let the land go fallow.

3. California growers moved into a broader variety of crops.

4. The crops that California growers moved into were generally higher in value than the substitutes available to growers elsewhere.

Most important of all, California growers were able to maintain much higher capacity utilization based on their ability to move production between crops.

Instability under Flexible Mass Production

Short-Run Volatility:

As productive mobility increased and prices simultaneously became less stable, short-term acreage movements became significantly more sensitive to price fluctuations under flexible mass production, than they had been in the past. The traditional manner used by agricultural economists to examine growers' behavioral responses to prices is a "supply-response model," which estimates acreage movements as a function of lagged prices (Nerlove, 1958). Equations 5.1 and 5.2 describe a simplified version of such a model for California cotton.

Several other variables are also included to measure the effects of:

a. price of a major substitute in the prior period (BARLEY),

b. the attractiveness of acreage diversions under government programs (represented by the Commodity Credit Corporation (CCC) loan rate for cotton) (LOAN), and

c. acreage in the prior period (to adjust for serial correlation)(A).

Because acreage and price tend to be co-determined, a two stage least squares formulation is used which calculates the lagged price variable as a function of exogenous exchange rate (DOLLAR) and business cycle (GNP) movements. Because we are interested in changes, rather than the absolute levels of prices and acreage, all variables are converted to deviation form.

$$A_t' = ß_0 + ß_1(P^{*\prime}_{t-1}) - ß_2(BARLEY'_{t-1}) - ß_3(LOAN'_t) + ß_4(A'_{t-1}) \quad 5.1$$

where:

$$P^* = ß_5 - ß_6(DOLLAR'_t) + ß_7(GNP'_t) \quad 5.2$$

and:

A_t = Acreage in current period
P^*_{t-1} = Estimated price of cotton in prior period
$BARLEY_{t-1}$ = Price of Barley in prior period
$LOAN_t$ = CCC loan rate in current period
$DOLLAR_t$ = Real multilateral trade-weighted value of the dollar in current period (valued at 0 prior to the float in 1973)
GNP_t = GNP in current period

(′) denotes variable in deviation form.

As possible substitutes for cotton, we expect BARLEY and LOAN to have negative coefficients. The price of cotton is expected to have a positive sign, as is the lagged acreage variable. We should expect prices to be positively associated with business cycles and negatively with exchange rates. If we estimate the model for two different time periods (before and after our hypothesized regime change in 1970), we would expect the coefficient on cotton price to increase over time, as acreage becomes more responsive to the market after deregulation. Conversely, we would expect the LOAN coefficient to decline in importance as growers become more market-oriented. The changes in the remaining coefficients are more problematic. There is no a priori reason to believe that serial correlation will change. At the same time, an increase in the price of a substitute could go either way. If BARLEY was initially very important and newer, broader substitution patterns are adopted, then significance of BARLEY might be expected to decline. On the other hand, if BARLEY were not important to begin with, its significance might increase, somewhat irrespective of how broad the substitution options of growers becomes.

Table 5.3

Coefficients from Acreage Response Model

	$P^{*\prime}{}_{t-1}$	$BARLEY'_{t-1}$	$LOAN'_t$	A'_{t-1}	r^2
1959–1969 (with controls)	.32 (2.25)	.14 (.46)	−.96 −(3.03)	.62 (5.90)	.53 d.f.=60
1970–1987 (without controls)	.81 (5.98)	−.84 (−3.09)	−.10 (−.37)	.41 (5.26)	.39 d.f.=103

Estimating this model for each of the two periods, 1959 to 1969 and 1970 to 1987, these suspicions are confirmed (Table 5.3). Freed from acreage controls, the coefficient on the price of cotton more than doubles after 1970. At the same time, the role of government programs, as captured in the loan rate, goes from being highly significant to highly insignificant after deregulation. Finally, the price of barley becomes highly significant after exhibiting no statistically recognizable influence before the regime change. When we remove the overwhelming role of federal acreage controls, the explanatory power of this relatively simple model declines noticeably after 1970.[13]

Generally, we would expect the improved price response observed to be good for the industry, since it should allow growers to rapidly adjust to changes in market conditions. Unfortunately, flexibility in California cotton has occurred in a highly uncontrolled fashion, causing capacity movements to be extremely destabilizing. In Chapter 3 (Table 3.5), we noted that capacity movements have been the primary determinant of increasing revenue instability in cotton, explaining between 66% and 69% of total revenue variance in the years after 1970 (Table 3.5)[14].

Still, instability in cotton might be offset by crop switching. That is, by moving into other crops, growers might maintain aggregate revenues, even when cotton revenues decline. In fact, crop switching did allow aggregate capacity within the main cotton counties to be less erratic than the rapid and extreme shifts experienced in cotton. While the annual cotton swings have averaged 17% for cotton, aggregate acreage swings have averaged just 5% over the same 1961-1984 study period

[13] Complete model results are presented in Appendix 5.1.

[14] Somewhat surprisingly, the role of acreage in determining revenue actually declines slightly from 73% prior to 1970. The reason for this is the dramatic increase in price volatility. In other words, both price and acreage were becoming less stable over time, but price became even less stable than acreage. What is important to remember is that the role of price remained almost insignificant, explaining only 2-4% of all revenue shifts.

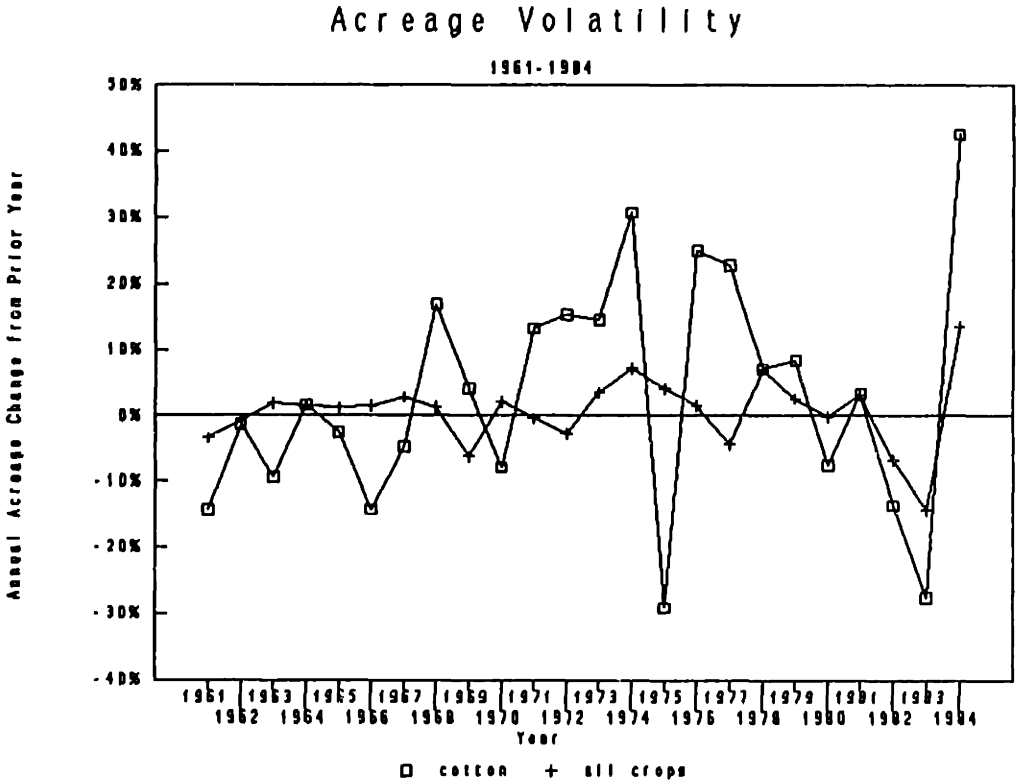

Figure 5.4

(Figure 5.4).[15] Yet, despite this buffering effect, aggregate acreage has also become less predictable after 1970. In fact, we see a major increase in the volatility of aggregate acreage that corresponds precisely to the jump in cotton volatility in the late 1960s, suggesting

15 The notable exception to this was in 1983, when the Reagan administration's Payment-in-Kind (PIK) exempted large growers from the $50,000 cap on total payments, making diversion an attractive alternative for California growers.

that destabilization of aggregate acreage has not been independent of what is happening in cotton.[16]

Longer-Term Instability:

Without question, restructuring of the California cotton sector has resulted in both renewed growth and heightened instability. Is instability the price that must be paid for continuing growth? Maybe what we are really seeing is an inevitable, but healthy case of Schumpeterian creative destruction. This sentiment is widely echoed in current discussions surrounding U.S. industry. To many modern writers, success requires brave souls and strong constitution to face an unpredictable world of increased international competition and government intervention. In the words of one author, we should learn to be "thriving on chaos" (Peters, 1987).

Unfortunately, this portrayal oversimplifies the problem in crucial ways. Even within conventional models, we know that prolonged instability may thwart new investment critical to longer-term growth. In the case of the California cotton industry, strategies based on flexible mass production have threatened the longer-term viability of the regime of accumulation in key ways.

Inequity and Instability:

Within much neoclassical analysis, issues of aggregate growth are treated as separate from the distribution of that growth between

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[16] Thus, the average acreage change rose from 2% before 1970 to 6% after the regime change.

producers. However, this view is highly inappropriate in California agriculture. In the cotton sector, the health of the entire industry has often relied on the ability of smaller growers to carry a disproportionate share of the burden of capacity reductions. As an example, between 1978 and 1982, acreage statewide was cut by 14%. Although both large and small farms reduced acreage, these cuts fell disproportionately on small growers. While farms over 2,000 acres in size cut acreage by just 6%, farms under 500 acres in size reduced capacity by 35%. As a result, these smaller farmers, which represented just 15% of all acreage in 1978 had to bear 39% of the burden of statewide capacity adjustments (Table 5.4).

Table 5.4
Cotton Capacity by Farm Size

	0-499 Acres	≥ 2,000 Acres	All Farms
1974 Acres	201,365	574,785	1,349,429
1978 Acres	232,300	818,867	1,519,257
1982 Acres	151,027	766,509	1,311,848
1974-1978	+15%	+42%	+13%
Share of State Total	8%	66%	100%
1978-1982	-35%	- 6%	-14%
Share of State Total	39%	25%	100%

Source: U.S. Census of Agriculture.

This, in and of itself, need not be a problem. According to models of industrial dualism, we might expect that small growers are better adapted to making such capacity reductions because they have fewer fixed resources. This would allow small growers to cut acreage more rapidly during economic downturns and increase acreage faster in upswings than their large farm counterparts (Berger and Piore, 1980). However, this has not happened. Although small farms do reduce acreage disproportionate to their share of the market in downturns, they also grow less rapidly than large farms in upswings. In the growth period between 1974 and 1978, cotton acreage statewide increased by 32%. While farms over 2,000 acres accounted for 66% of the total increase, farms under 500 acres accounted for just 8%, and large farms grew by 42% compared to just 15% for the small farms. In short, while large farms got the growth, small farms got the instability.

Over the longer term, as small farms are systematically excluded from growth, they become a smaller share of the market and the burden of capacity reductions must be shifted to larger firms if prices are to be preserved. This became frightfully clear in the San Joaquin Valley in the early 1980s, when the largest growers were forced to make serious acreage reductions for the first time since deregulation. The near collapse of one giant, Salyer-American, sent shock waves through the industry. In the early 1980s, the Salyers had been forced to buy out one of their relatives to keep their large acreage holdings intact. This placed just enough extra pressure on them that, as the market weakened, Salyer-American found itself more than $100 million in debt by 1983. The firm survived, not necessarily by being more efficient, but in large part due to its economic power. To retire the most of its debt, Salyer sold some 40,000 acres back to the Bank of America, and was then allowed to immediately lease back the majority of the acreage. Had this been a smaller operation, Bank of America may well have foreclosed. However, the bank itself was in difficult financial times during this period and already had large holdings of agricultural land. Dumping Salyer's land on the market would simply have further depressed prices at a time when the bank itself was reportedly trying to cut back its agricultural holdings (Hector, 1989; California Farmer, Sept. 1987).[17]

The Salyer-American experience was not an isolated case of mismanagement. Indeed, the Salyers are generally recognized as progressive growers, having diversified into vegetables years before most of their competitors. However, this revenue remains small relative to their huge cotton business; and, the survival of the firm remains dependent on cotton revenues. In the early 1980s, everyone in the industry was aware that large farms were fundamentally threatened. Faced with crisis, the Reagan administration responded by reversing the long-standing policy of capping payments to individual farmers in 1983 and allowed large farmers to enroll in its Payment-in-Kind (PIK) program. Under this program, growers could enroll in acreage diversion, but were paid out of government stocks of cotton rather than in cash. By encouraging the participation of large growers, the program was very influential in achieving a 28% reduction of acreage from the prior year

[17] Ironically, this "too big to fail" logic was eventually applied to the banks themselves, as government regulators protected the assets of depositors in large banks more fully than those in small banks during the late 1980s and into the 1990s.

and represents an important exception to the rule that California acreage was not strongly affected by government programs.

Instability in Related Markets:

Flexible mass production has also tended to destabilize markets outside of cotton. Relative to the immense scale of cotton markets, the markets for alternative crops are frequently very small. To date, shifting into crops such as vegetables has acted more as a safety valve for overcapacity than as a fundamental diversification of California's cotton farms. However, relative to the crops they are moving into, the acreage shifts on cotton farms can be substantial. Especially in the 1980s, production in primary cotton areas has come to represent a significant share of statewide acreage in many row crops (Table 5.5).[18]

Along with this geographical restructuring of production toward the San Joaquin Valley, there has also been a marked increase in acreage volatility. First, there has been a marked geographical restructuring of production in selected vegetable crops toward the San Joaquin Valley. Second, acreage movements in cotton-based counties account for a greater share of total capacity movements than in the past. Clearly, markets in other crops have not become less stable solely because of the actions of large cotton growers. Restructuring in California agriculture has not been confined to cotton. Just the same, there is an obvious potential for cotton growers to spread instability from their own crop to others.

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[18] As a further example, in the cotton areas of the Westlands Water District, between 1980 and 1988, growers more than doubled their acreage in broccoli, cauliflower, dry beans, onions, garlic, peppers, lettuce, and carrots (California-Arizona Cotton, July, 1989).

Table 5.5

Increased Acreage in
Selected Vegetable Crops

Primary Cotton Counties

Crop	1980 Statewide Acreage	Regional Increase 1980-88	Regional Increase Relative to State Base
Dry Beans	195,381	19,600	10%
Onions	29,657	5,677	19%
Garlic	13,910	5,343	38%
Broccoli	66,891	15,084	23%
Cauliflower	32,924	10,681	32%
Tomatoes			
Process	207,294	28,283	14%
Fresh	26,818	6,825	25%

Notes:
Source: Agricultural Commissioner's Database.
Primary cotton counties include Fresno, Imperial, Kern, Kings, Riverside, Tulare, Merced, and Madera.

This latter point is well illustrated by the case of broccoli. For years, the cotton counties of the San Joaquin Valley were only minor broccoli producers. In the 1980s, broccoli acreage in the Valley increased rapidly, but also erratically, swamping normal capacity adjustments. Figure 5.5 shows the scale of these annual acreage shifts. To give these a sense of proportion, the average annual change in statewide broccoli was about plus or minus 6,000 acres.[19]

The Threat to Current Resource Use Patterns:

A final long-term threat to the current strategy of flexible mass production is that its technological base (especially extensive chemical use and irrigation) is coming under fire from the public (California-

[19] In Westlands Water District, broccoli has been the most popular new crop, increasing its acreage by over 5,000 acres between 1980 and 1988 (California-Arizona Cotton. July, 1989:15).

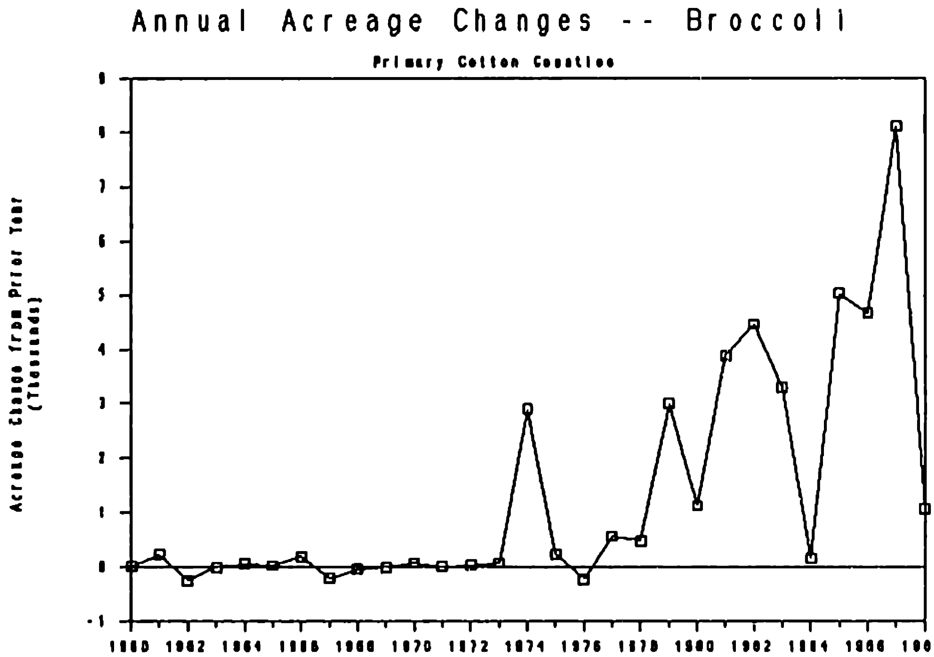

Figure 5.5

Arizona Cotton. February, 1973:20). Even before the Alar scare in 1989, Californian's passed Proposition 65, which imposed strict and costly new registration and disclosure requirements on growers. In 1990, growers helped to defeat the more restrictive Proposition 128 ("Big Green") that would have banned many agricultural chemicals (Richardson, 1990).

The threat posed by the loss of the current selection of agricultural chemicals is very real. Integrated pest management (IPM) strategies have existed for many years. However, actually placing these systems in the field is a long way off, due to an absence of in-field, practical demonstration. Thus, growers neither take IPM seriously for crops like cotton which are grown in huge standardized fields; nor is it clear how they would affect marketing and other strategies beyond the field. Although a large amount of new biotechnological pest management experimentation is being pursued and making rapid progress, this also remains primarily in the lab (Lehrmann, 1990; Prior, 1990).

After four years of drought, it is not particularly surprising to see heightened competition for water resources in the state. Battles over water are hardly new, and they always get worse during dry periods. However, the public opposition today is deeper than in the past. Well before the drought, growers faced a major defeat when California voters soundly rejected plans to build the Peripheral Canal. Today, the battle is as much over fiscal as environmental issues. In 1989, the issue came to a head with the near failure to renew contracts with farmers receiving water from Friant Dam (Hartshorn, 1989a, 1989b). In this instance, the fear of losing water rights altogether overrode any desire for flexibility, as growers sought to protect their current low-cost supplies, even at the risk of being tied into long-term contracts.

Again, the costs of the new public opposition are potentially high. Virtually all analysts looking at the problem agree that if prices for water were raised to their real cost, many growers would go out of business (Storper and Walker, 1984; Wyss, 1989).

Summary

Regulatory reform in the late 1960s and early 1970s offered California cotton growers both challenges and opportunities. Freed from strict supply controls, they were able to pursue mass production strategies to their fullest. With price floors lowered, growers were well-situated to enter foreign markets. However, they were also much more vulnerable to shifting markets than in the past and, more than farmers elsewhere, California growers lacked substantial security under government diversion programs.

The flexible mass production that emerged was unique, and relied heavily on local resources for its success. Most important, flexibility and mass production supported one another. On the one hand, flexibility was critical to maintaining capacity utilization by making it possible for growers to move into new markets quickly when cotton was weak. On the other hand, many of the features of California that made flexibility possible have large scale economies associated with them, including irrigation and chemical use.

Overall, flexible mass production has been undeniably successful. Capacity utilization remained much higher than in other regions, helping to support investment. Partly as a result, earlier productivity declines have been reversed, and the industry remains a leader in innovation. Flexible mass production has allowed continued capacity growth without any sign of longer-term real price declines. Finally, California growers have been much less dependent on government income programs than growers elsewhere.

Still, the trends are not all positive. Their extreme focus in overseas markets has made California cotton growers most vulnerable to exogenous demand shifts. Moreover, this overseas focus has often meant sacrificing markets at home. Likewise, increased flexibility has been a key factor in making both capacity and revenues more volatile in the short-run. Over the longer-term, this volatility threatens to undermine the success of flexibility of the industry, by forcing out those growers who have traditionally been relied upon to carry the greatest burden of capacity reductions during downturns. Equally disconcerting, this instability threatens to move into other crops as large growers rapidly shift into new markets at a scale above the sectoral norms (especially for specialty crops). Finally, flexible mass production remains based on technological trends that are rapidly losing public support, especially heavy chemical use and extensively subsidized irrigation.

In short, the growth process has been a tumultuous one, faltering, then lurching forward when a new advantage is found, often to bump up against its own limits later. Given this highly dynamic picture of the sectoral development, we should not expect growers to sit idly by while their future competitiveness is threatened—they have not. To what extent have very recent trends addressed the concerns raised in this research?

Two new trends have emerged with the potential to further restructure California agriculture—I believe both are positive. First, Calcot and other cooperatives have joined efforts with U.S. textile manufacturers to create a just-in-time delivery system. Such a system would arguably allow domestic textile manufacturers to enter specialty markets that large offshore firms cannot easily service quickly and efficiently. This is important, because it represents a commitment by cotton growers to invest in the rejuvenation of U.S. textiles. Most important, it attempts to do so by finding a real advantage based in production, rather than relying on protectionism.

A second trend that could be positive is a recent diversification within Acala cotton production. After years of dominance by one or two varieties of Acala, California cotton growers have been experimenting with as many as ten strains in the past few years. Some of these like the new Prema variety are extremely high quality, rivaling Pima cotton varieties.

Not surprisingly, this has created renewed tension within the one-variety district. At least up until now, growers have supported maintaining the one-variety strategy and their commitment to uniformity and quality. This, of course is what growers have done all along, seek ways to differentiate themselves as the top of the mass production market. Today, growers use the term "one-quality" district to refer to themselves, meaning that they see several varieties of high quality cotton being grown within an overall standard for quality that is very high. It will be interesting to see in future years is whether the one variety law can remain intact. We will also have to wait and see if diversification within cotton replaces diversification into other crops. If growers can successfully build differentiated markets within Acala, this may provide an alternative to growers' forays into other crop types. This, of course, would be welcome by growers of fruits and vegetables. Still, it may just be that increasing diversification within cotton will simply lead to even greater shifting of acreage.

CHAPTER 6

CONCLUSION

California agriculture has changed dramatically in the past twenty years. Consequently, the sources and nature of revenue instability in the industry have also changed. What has not changed are the theories used to understand that instability. As a result, conventional theories misinterpret the current problems facing agriculture in important ways. In this research, I have attempted to reinterpret agricultural instability using contemporary discussions from industrial sectors of the U.S. economy. According to this alternative interpretation, farmers are not simply victimized by exogenous events over which they have little control. Rather, growers have pursued very specific competitive strategies which, at the industry level, have simultaneously contributed to both rapid growth and the destabilization of revenues.

This alternative interpretation leads to a very different type of agricultural policy than conventional analysis. Stabilizing the macroeconomic environment is not sufficient to restore stable growth in California agriculture. Instead, we need to look more closely at how production is carried out, focusing policy action on those areas where current competitive strategies are destabilizing. Likewise, we need to identify those areas where current competitive strategies are most likely to be constrained and create policies either to remove those constraints or work around them. In this final chapter, based on my research, I will describe several specific areas where I believe special attention is warranted. Still, it would be a mistake to assume that the benefits of blending agricultural and industrial theories accrue only to agriculture. The agricultural experience also has important implications for current industrial theory.

Research Summary

Unstable revenue growth has been the single most defining characteristic of California agriculture for the past 20 years. Yet, the conventional explanations offered for this instability are unconvincing. The problem is not primarily overcapacity. Many key crops have grown at rates far surpassing industrial sectors of the economy for a prolonged period with virtually no sign of longer-term real price declines. Nor is the problem simply volatility in exchange rates or business cycles, since neither of these explain large amounts of variance in revenues. Finally, the problem is not mainly one of overly restrictive and inconsistent government policy. If anything, government policies toward agriculture are far less restrictive than they once were.

Each of these may have been a factor at various times. However, what is more important is how these forces interact with ongoing restructuring in the industry. In this critical sense, growers have had a larger hand in destabilization than is usually acknowledged. This research has focused on two aspects of restructuring, export-led growth and increasing strategic flexibility. While these strategies were not necessarily adopted together or in all crops, both were pervasive enough to affect the overall industry. The cotton sector has been presented as an example where both export-led growth and flexibility are used simultaneously.

Following the end of the Bracero period in 1964 and the end of strict supply controls in 1970, growers in most sectors deepened their commitment to mass production, increasing scale and capacity tremendously. If price collapses were to be avoided, growers absolutely had to find expanded outlets for this surge of output created under mass production. For some producers, this need was satisfied through vertical integration, especially in domestic markets. In other cases, growers took advantage of lowered price supports to concentrate their revenue base in international markets.

With the reformation of the major commodity programs, California growers were much less protected from shifts in the market than they had been before. In most cases, and especially for large farms, government diversion programs represented a relatively inaccessible and unprofitable alternative use of capacity. Instead, many farmers sought to make their operations more flexible, especially in field crops. Strategically, this enhanced mobility has been used within a broader strategy of mass production to move between a wider range of crops with greater speed than in the past. While growers' choices remain finite, they are much more diverse than in the past. This product-mix flexibility, in turn, has been supported by wide-ranging changes in production methods. Most important among these are the deepening use of irrigation, agricultural chemicals, and the adoption of complex breeding methods.

There were significant gains under these strategies of export-led mass production and product-mix flexibility. California farms experienced rapid revenue growth. Investment tended to be high and productivity increased dramatically. Likewise, Californians were much less dependent on federal income supports than growers in other regions. Further, by allowing temporary, but rapid acreage reductions, flexibility helped prevent longer-term overcapacity.

However, there have been costs associated with these strategies as well. The restructuring of domestic farm policies necessary to support mass production contributed to volatility in international prices by cutting world buffer stocks and lowering price supports. At exactly the same time, the industry as a whole was becoming more vulnerable to such shifts, because it had so heavily concentrated its revenue base overseas. Likewise, the large and frequent acreage movements associated with flexible production caused both capacity and revenues to become highly volatile.

Conventional Theory, Regulation Theory, and Public Policy

The regulationist interpretation leads us to strikingly different policy approaches than traditional theory. In conventional theory, growers have little control over their own fate, because instability is driven by exogenous events. The appropriate role of the state in this model is mainly to provide a favorable macroeconomic environment in which growers can operate. In the past twenty years, exchange rates have risen and fallen, restrictive acreage rules and price supports have been removed, and we have experienced several business cycles. Yet, instability continues with little sign of abating.

In regulation theory, macroeconomic and regulatory issues do matter. However, the most important opportunities for and limitations on stable growth come from producers themselves. If a sector performs poorly for a prolonged period, it is at least partly due to failures in the current set of competitive strategies in use by producers. Growers are constantly redefining competition in their industry as they try to gain an advantage. Moreover, the state is always a player in this process of restructuring. In this model, it is entirely appropriate for the state to identify weaknesses in the current competitive strategies of producers and work with industry and labor to correct them.

Based on my research, I believe there are three problem areas that deserve special concern for researchers, public officials and advocates trying to promote regional economic development. First, current competitive strategies in California agriculture have posed serious environmental and fiscal costs on the public. Increasingly, the public is responding by aggressively challenging current agricultural technologies that form the basis of flexibility in the industry. Second, the short-run instability associated with uncontrolled flexibility threatens both continued investment and the ongoing existence of small farms which play a critical role in the success of the system. Finally, the high degree of capital mobility embodied in flexible technologies may promote capital flight rather than local economic development.

Public Challenges to Current Agricultural Technology:

Technology based on irrigation, mechanization, and extensive chemical use is the hallmark of California agriculture. In recent years, however, growers and environmentalists have repeatedly been at odds on matters of key importance to the state. This is especially true in cases involving irrigation and chemical use:

1. Growers have consistently favored construction of large water projects such as the Peripheral Canal and reservoirs on North Coast rivers.

2. Environmentalists have opposed continuing subsidies to irrigation, claiming that they promote wasteful use of the resource.

3. Environmentalists have encouraged stricter regulations to be placed on the use of agricultural chemicals, including complex and costly registration procedures (Proposition 65), and the banning of several kinds of pesticides (Proposition 128, also known as "Big Green").

To be sure, current agricultural technologies have had important and deleterious environmental effect in terms of air and water pollution, excessive water use, and the widespread distribution of toxic substances. Growers have adopted the technological triad of mechanization, irrigation, and chemical use mainly to combat the growing cost and power of organized labor. Once propelled down that technological path, it has not been easy to redirect the industry toward more environmentally-sensitive technologies. Reducing water and chemical use requires a fundamentally new way of doing business. In this sense, there actually is a tradeoff between environmental quality and agricultural development. Yet, this tradeoff is a creation of very specific strategic choices and patterns of development. There are alternatives available that can improve environmental quality without leading to agricultural decline. In fact, the opportunities for cooperation between growers and environmental groups are abundant.

Water Resources: Current mass production strategies in the state are extremely dependent on a cheap and abundant water supply, and consequently very vulnerable to a cutoff in that supply.[1] At the same time, agriculture represents 80-85% of consumptive water use in the state. Consequently, even marginal reductions in water use by farmers have potentially huge payoffs in total water savings. There is widespread consensus among observers of California agriculture that the ability of farmers to obtain a stable, low cost, water supply is declining (Engelbert and Scheuring, 1984). In part, this is a consequence of increasing competition from other users; in part, growing fiscal and equity concerns threaten continued subsidization of irrigation. In either event, significant new supply projects are not being built and, as mentioned in Chapter 5, even the renegotiation of existing contracts has been challenged.

The most popular solution to the problem of uncertainty in supply is to create water markets. Currently, most governmentally-supplied irrigation water is sold to local water agencies under long-term contracts and then delivered to growers. In many cases, the exact allotments available to both growers and local districts are determined

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[1] In 1991, for instance, industry experts estimate that cotton acreage will be reduced by one-third as a result of the state's curtailing water deliveries during the current drought (California Farmer, 274:6:24).

by adjudication of water rights law based on the history of use and physical proximity of the user relative to the water supply. Under water markets, growers and water districts would be given authority to sell their allotments to other users.

While such institutional changes might make it easier to reallocate water between users in response to their ability and willingness to pay, they do not necessarily ensure resource allocation that is efficient by anyone's definition. As this dissertation is going to press in Boston, many growers in California are finding it more profitable to sell their subsidized water to drought-stricken urban users in newly created markets than to farm (especially in low value crops such as alfalfa) (Boston Globe, March 3, 1991. pg. 18). Water subsidies were designed to promote agriculture, not rent-seeking.

One solution would be to end existing subsidies to agricultural users. This would, without doubt, encourage a transition to more efficient irrigation technologies. However, given the current state of technology actually in the field, it would also result in the loss of a large number of farm operations and encourage a further consolidation of the industry among large mass producers (Storper and Walker, 1984). An alternative is to subsidize the conversion to water saving technologies. This would have obvious environmental benefits. According to Runsten and Chalfant (1987), an increase in irrigation efficiency from 65% to 90% in tree fruits and nuts alone could save an amount of water equal to

46% of the state's annual residential use.[2] The possible gains from converting a huge water user like cotton are several times this.

What is more, conserving water is good business for farmers. Researchers have known for years that reducing water application can prevent salinization and reduce subsidence of the land surface that requires costly investment in field levelling. In the case of cotton, field trials of subsurface drip irrigation using Acala cotton have produced yields of 4.6 bales per acre, compared to the current average of 3-3.5 bales per acre in the same growing region. The method also improved the efficiency with which fertilizer was applied (Street, 1988).

There are two main reasons growers have not adopted such systems. First, they represent a high fixed cost which many growers cannot afford, especially in an era of tight farm credit. Second, the potential for these systems to be profitable depends a great deal on grower expertise in actually incorporating new technologies into their everyday production practices. Accordingly, it takes many years of practical experience with these systems to make them cost-effective. Subsidization of new technologies could help overcome this problem by helping growers to gain the experience they need to make water conservation pay off.

<u>Agricultural Chemicals</u>: Many of the same points can be made with respect to chemical use. The economic danger of relying excessively on

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2 Based on 1976 water requirements. See Christensen, Harrison, and Kimball (1982).

complex chemical compounds has been made abundantly clear in recent years. Most notably, in 1989 consumers panicked over reports that the U.S. apple crop had excessive residues of the chemical Alar, a suspected carcinogen. There have been several other similar episodes, but of less dramatic proportion (Johnson, 1990). From a business perspective, there are two separate, but related, threats posed by the current chemical scare. The first is a general lack of consumer confidence in the quality of California produce. The second problem is the increased cost of operating under more restrictive regulations that are being imposed as a response to public outcry.

Once again there are creative alternatives available. In the late 1980s and into the 1990s, organic produce has established itself as one of the fastest growing new markets in California agriculture. This is not to imply that California agriculture is going to become dominated by organic farming in the foreseeable future. However, the introduction of any new economically viable crop type is always significant. In the case of organics, this significance is magnified by the fact that we are really referring to an set of alternative technologies with the potential to open new markets for many different specific crops.

The biggest constraints on the economic expansion of organics lie in marketing. First, there is the need to create a supply that is stable enough to attract the interest of supermarket chains and other large buyers. If some form of vertical integration starts to take hold, this may become less of an issue. Otherwise, because the total market is so small to begin with, experimentation in organics by larger growers is likely to be highly destabilizing.

Second, there is a problem of getting consistent, visible, and believable certification procedures that apply across different crops (California Farmer, 273:4:10). Without such certification or labelling, it is impossible to differentiate organic produce from other output. Currently, certification of organic produce is strictly voluntary. Although the state grants licenses to certifying organizations, the actual certification of organic produce is fragmented among half a dozen different groups and overseen by growers themselves, raising obvious questions of conflict of interest. As a result, growers have had only partial success at establishing credibility with consumers.

The state can play a major role here by unifying existing certification under a single state-run organization to create believable labelling. In fact, there is probably room for several different levels of certification. Many consumers do not ask for total abstinence from chemical use (for instance fertilizers); others are more strict in their purchases. The state could create a series of consistent, yet hierarchical categories that would apply across crops, while simultaneously creating broader options for product differentiation. As a service to growers, the system should be funded by growers themselves. However, we should recognize that some of the costs may be passed onto consumers themselves, since organic crops presumably have relatively higher demand-price elasticity.

Overall, the public reaction toward the use of both irrigation and chemical use in agriculture points out an area where regulation theory has been very weak up to this point. Quite simply, the environmental implications of these strategies have received very little attention.

What we see in the agricultural case is that the environmental problem is also an economic problem which threatens the viability of the competitive strategy. Moreover, although the problem is likely to be most serious and immediate in resource-based industries such as agriculture, it applies to other sectors as well. Saxenian (1983), for instance, has shown how environmental degradation poses a very real threat to the longer-term development of high technology sectors in California's Santa Clara Valley.

The Threat of Uncontrolled Flexibility:

Increasing mobility, by itself, cannot guarantee stability. Indeed, we have seen in this research how increasing, but uncontrolled flexibility has contributed to instability in acreage and revenues. In fact, capacity movements may be every bit as important as exogenously determined price shifts in causing volatile revenues.[3] Although the burden of instability is frequently shared unevenly, it is not just a problem for small farms. We saw in the Salyer-American case that even the largest firms are not immune. After the initial merger wave of the late 1960s, many of the largest corporations involved in California farming actually divested themselves of their agricultural-related operations as the farm environment became more risky (Cordtz, 1972).[4]

The danger of uncontrolled flexibility is made worse by the specific form that flexibility has taken in California agriculture.

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3 Schoenberger (1990:25-6) has made similar conclusions with respect to product development.

4 Among some more recent giants to leave California farming are Tenneco, Southern Pacific, and Anderson-Clayton.

Most important, those technologies that help to increase flexibility tend to be characterized by scale economies (especially irrigation and chemical use). This implies that flexibility will tend to be centered in the largest firms. This is a very different view than much of the industrial literature, which sees mobility centered mainly in small firms. To the extent that large, mobile, growers try to enter new markets as mass producers, they will be likely to move acreage in large blocks so as to enter new markets at a large scale. The exact extent of this destabilizing influence will depend in large part how big these blocks are relative to the average operational size of the market they are entering.

One possible solution would be to install some form of circuit breaker aimed at controlling extremely large and rapid acreage movements. The biggest obstacle to such a move in farming comes from growers themselves. To make it work, such a circuit breaker would require cooperation of growers across crop sectors. This cooperation would necessarily include advanced reporting of planting decisions, or at least some form of forecasting of the acreage for each crop. This is not likely to be popular and raises the risk of anti-trust violations. In cases where planning is coordinated through cooperatives, the anti-trust problem might not be that serious due to current exemptions from federal law. In other cases, it may be necessary to seek further exemptions to allow for coordinated planting.

Gaining cooperation of growers could be more difficult. Farm leaders from many regions have repeatedly tried with little success to organize growers of the state's different crops over issues far less contentious. Only recently, for instance, efforts to create a state agricultural commission with the goal of improving agriculture's public image have stalled because different segments of the industry were unable to cooperate (Schacht, 1990).

Still, there is precedent for this approach in other industries. Most notable among these are rules recently adopted on the stock exchanges that give market officials the authority to suspend trading under conditions of very high volume. Prior to the market crash of October, 1989, such restrictions were unthinkable. In Japan, anti-trust activities of government take a very different role, routinely allowing producers to cooperate so as to improve their collective competitiveness and stabilize performance (Florida and Kenney, 1990a; Best, 1990). In agriculture, rules limiting the worst swings in acreage could prevent even more serious regulation being applied later which might give growers a smaller voice in their implementation. Because most episodes of oversupply in recent decades have been associated with these very rapid buildups, limiting rapid shifts would unquestionably help to head off the need for longer-term acreage controls.

Policies to Protect Small Farms: Under mass production, small farms have consistently declined as a share of overall production. The realization that there are scale economies in many aspects of farming has too often led to the mistaken conclusion that small farms are not competitive. As an example, federal reclamation law was reformulated in 1982 explicitly to allow the government to subsidize water deliveries on farms above the old 160 acre size limit. The argument underlying this policy shift was that, because small farms are inefficient, the government was supporting a part of the industry where nobody could do business anyway (LeVeen and Goldman, 1978). Unfortunately, this may become a self-fulfilling prophecy when public policy writes-off the viability of small operations.

There is little doubt that scale economies are common in agricultural production. However, even the largest farms do not compete just on cost (Pope and Prescott, 1980; Gregor, 1979; Raup, 1969; Hall and LeVeen, 1978). Size alone is simply not an appropriate way to judge the competitiveness of farm operations. Indeed, there are good reasons to believe that large farms benefit from a continuing presence of small farms, since small farms have tended to carry a disproportionate share of capacity reductions during downturns—a pattern consistent with industrial theories of industrial dualism (Berger and Piore, 1980).

The challenge for big and small growers alike is to constantly seek new forms of competition. The presence of scale economies narrows the options available to small growers. However, it does not make these farms anachronistic. Clearly, small growers should not try to compete based primarily on cost against large mass producers. One of the contributions of regulation theory has been to identify alternative forms of competition such as flexible production whereby small producers can become more competitive. However, as we have already seen, it is a mistake to assume that small farms are inherently more flexible than large ones.

Fortunately, there are creative alternatives available for public policies to encourage experimentation with new competitive forms by small farmers. Current policies toward small farms operate mainly by supplementing income, while doing nothing to enhance their competitiveness. This could be remedied by gradually shifting a major portion of current price support payments toward targeted investment. For instance, the technology subsidies mentioned earlier could be explicitly targeted toward small farms. Small farms are most disadvantaged in marketing and connections to agricultural research and development (Raup, 1969; Hightower, 1973). The marketing disadvantage is often minimized by the progressive role of cooperatives. However, the problem of getting new technologies into the hands of small growers is very real. Providing technological assistance to small growers would help them gain the experience necessary to make these methods practical. It could be also an important way to support new technologies through their early development at an affordable scale. This would improve their visibility and demonstrate the viability of new innovations, helping them enter the mainstream faster.

Capital Mobility and Regional Economic Development:

The emerging consensus within industrial theory is that increasing factor mobility is a positive development. Yet, we have seen that enhanced factor mobility in the short-run has a dualistic nature. Rapid capacity movements between crops can help prevent longer-term price declines, and help to maintain capacity utilization. On the other hand, flexibility of this type can be a major destabilizing force. The same is true about longer-term capacity shifts. In both mainstream and regulation theories, enhanced factor mobility encourages producers to move into higher value markets over the longer-run. Yet, the contribution of enhanced factor mobility to local and regional economic development depends a great deal on the details of how that mobility is achieved. On the one hand, it can help local producers to exploit new markets. On the other hand, greater mobility can give industry greater power to create new competition for local industries. This creates a fundamental tension between the interests of the community and private industry. To industry, globalization of production is a logical next step in strategic use of increasing mobility (Cooke, 1988). This is likely to be especially true in vegetable sectors where mechanization and automation progress has been slow (Schoenberger, 1989:97). However, from the viewpoint of local communities, regional economic development is dependent on their ability to limit that mobility, or at least tie it to local resources.

California growers have never competed primarily on cost. Instead, they have either specialized in high value crops, or relatedly, tried to differentiate their product. This product differentiation has been prevalent even within low value field crops which are frequently (and mistakenly) presumed to be homogeneous (e.g. cotton). It is only within these narrower markets that California growers rely on price-based competition. Occasionally, new markets are created by gaining some price advantage. More often, however, markets are extended by improving the qualitative features of a crop, or by introducing new varieties (as we saw in Chapter 2).

These strategies have served the state's growers well. However, they are not as secure as they once were. With increasing regularity, producers from outside the state are offering goods of equal quality and competing in markets that were once the exclusive domain of Californians. Furthermore, this competition is not exclusively from low-cost producers in developing countries. In fact, much of it comes from other regions within the U.S. In recent years, for instance, Maine and New York have become major competitors in broccoli and cauliflower (Cook and Amon, 1987).

There are elements of truth in conventional views of changing markets. As we saw in Chapter 5, import substitution policies have genuinely hurt U.S. exporters by restricting the level of world demand met by trade. Likewise, as many industrial theorists have emphasized, local producers have on occasion neglected to upgrade quality (Dertouzos, Lester and Solow, 1989; Markusen and Carlson, 1989). In cotton, for instance, Calcot has recently had to fight to defend its traditional markets from the Soviets, because San Joaquin Valley Cotton uniformity is seen by buyers to be slipping, even though the strains of cotton grown are good ones (Calcot News. Fall, 1983:12).[5]

Just the same, a much greater problem for local growers is the increasing rapidity with which new technologies can be transferred between regions. In this respect, the problem is not that California product quality is slipping, but that the rest of the world is catching up. Moreover, in many cases this new competition is linked to California-based firms, as increasing factor mobility allows firms to

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[5] Plastic and other forms of field trash that are picked up by cotton harvesters have also become a major problem, interfering with the ability of local growers to obtain top prices (McMullin, 1991).

move their operations out-of-state.[6] This makes traditional solutions less applicable than in the past. Efforts to upscale the product, redefine it, or lower its cost through technological change are likely to be reproduced quickly by the competition. Further, to the extent that these firms are domestically-based, it is politically and practically difficult to impose barriers to their operation such as limits on technology exporting, quality grading, or tariffs (Cook, 1988).

These technology transfer and globalization problems are certainly not unique to agriculture. In the 1980s, state, local, and regional governments throughout former manufacturing regions of the U.S. have adopted at least two widespread strategies for combatting the downside of heightened capital mobility. The first of these uses public resources and tax expenditures to help local business form strategic alliances with foreign firms which might otherwise provide competition. The second approach has been for local and regional governments to encourage local businesses to become more flexible. Rather than erecting barriers to capital mobility, both of these approaches attempt to improve local firms' ability to operate in less stable environments.

The use of strategic alliances explicitly recognizes the "foreign threat" for what it is—the internationalization of capital—and has been used widely to fight job loss due to the decline of the auto

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[6] Some of these footloose firms with long histories of involvement in California agriculture include Del Monte, Heinz, Campbell's, Green Giant, and Birdseye.

industry.[7] In California agriculture, strategic alliance has generally been synonymous with offshore investment by California growers, especially in Mexico. In these partnerships, Mexican partners provide low cost labor and access to land, with California firms providing technical expertise, capital, and marketing outlets (California Farmer. April 21, 1990; Richardson, 1988). Agricultural Maquiladoras have also been established to process vegetables in Mexico (Cook, 1988).

By and large, the costs of these strategies have been borne by local workers as lost jobs. In the coastal community of Watsonville, for instance, workers have been hit by a double shock. First, there was a shift of strawberry production to Mexico. The was followed several years later by a shift of processing capacity when Smuckers (jams and jellies) closed down its local plant and moved it to Mexico as well.

As much industrial experience has shown, if strategic alliances are to encourage local development, governments must explicitly address the ability of global capital to relocate at will (see especially, Bluestone and Harrison, 1982). The options available to localities are either to regulate capital mobility or to develop regionally unique resources and markets. Regulating capital mobility of global firms cannot easily be done by local governments in the absence of federal support. Not surprisingly, repeated efforts to pass local content legislation have been largely unsuccessful. Instead, Governments in areas devastated by declining automobile production have been forced to try and tie foreign firms to their locality by offering some combination

[7] One of the more successful of these efforts is actually located in California. "New World Motors" is a joint venture between General Motors and Toyota in GM's former Fremont plant.

of a low wage (or nonunion) workforce and improved access to domestic markets.

The closest parallel in California agriculture to date is the opening of the Nisshinbo textile mill in Fresno, which allowed Japanese producers to sell to Los Angeles and San Francisco garment manufacturers free of restrictions imposed under the Multi-Fiber Agreement (California-Arizona Cotton, July, 1989: 12). Most cotton experts see this as a positive development, since the mill buys large quantities of local cotton and its demand is driven mainly by domestic factors.

Still, it is disturbing to know that while California producers have been moving offshore and eliminating domestic jobs, the only investors creating new jobs domestically have been foreign. Why wasn't this plant built by domestic capital? Currently, state, local, and regional governments have played little role in promoting strategic investments. Could an activist state industrial policy have put together a domestic operation to fill the same market? Does the Japanese firm have resources that make it better able to make such an investment succeed than local industry? How long-term is this investment likely to be? Is there room for additional mills of this type in the state? Answers to these questions can only be speculative without further research. However, these are precisely the type of questions that local growers, industry, and government ought to be asking (See Anderson, 1980).

Similar observations about the dualistic nature of increased capital mobility can be made with reference to efforts to increase the flexibility of local firms. If the cotton experience is representative of other crops, it is likely that improving product-mix flexibility will be a significant part of any new efforts to move beyond traditional competitive strategies in agriculture. That is, not only will competition be based on a mix of product differentiation and mass production, but increasingly, firms will be capable of rapidly shifting between output types. They key to making this product-mix flexibility work to the benefit of local communities is that mobility must result from local resources that cannot easily be reproduced elsewhere. Under these conditions, a firm must sacrifice its flexibility to relocate.

This effort by local and regional governments to tie flexibility to the community is the basic concept behind recent efforts to create industrial districts. In several states, including Michigan, Pennsylvania, and Massachusetts, effort has been focused on encouraging the development of specialized local resources (Sabel, 1990b:21). Representative examples of these would be efforts to create specialized research facilities and employment development policies to help organize networks of specialized subcontractors.

Given the level of effort that has gone into these efforts, it is ironic that some of the best examples of industrial districts in the U.S. already exist in agricultural settings like the San Joaquin, Salinas, and Napa Valleys. California's farming regions possess resources that organizers of many industrial development efforts can only dream of having. As we have seen, they have a remarkable history of cooperation between producers and the state; tremendous capital resources; a skilled labor pool specializing in technologies needed for farming; and, a highly sophisticated local market to test new ideas in.

These districts are not remnants of some historical craft production region that are only recently being rediscovered. They are industrial communities like any other, using the very latest technologies and management practices to produce mass production goods. In the sections that follow, I will consider how policies for managing new technologies and labor might be improved to strengthen these specialized resources further.

Technology Policy: California has a large and highly sophisticated agricultural research capability with growers and the state having enjoyed a long history of close cooperation around the development of new technologies. Nonetheless, improvements can be made. For most of the post-war era, state technology policy has tended to favor areas where there is perceived to be an immediate market. One result of this has been to reinforce existing technologies rather than promoting new ones. Most notably, research has been dominated by the effort to replace harvest labor through mechanization and chemical use, even after California had an undisputed competitive advantage in mass production of many crops.

Many industrial analysts have argued that this is essentially the right approach, that firms should focus their research and development efforts on extending areas where they already have expertise (Piore, 1986; Dertouzos, Lester, and Solow, 1989). While playing to one's strength may be sound policy, this logic must not be pursued to the point that we turn away from developing new technologies that could eventually provide the basis for alternative competitive strategies. Technological trajectories can become very entrenched and difficult to change (Storper and Walker, 1989). Nor should this logic necessarily be applied to public sector research. By promoting already proven technologies, we are much more likely spend public resources developing technologies that the private sector would pursue even without subsidization.

A second major weakness in existing technology policy is that agricultural research has often focused on developing new machines and seeds at the expense of broader process, organizational, and institutional reforms needed to support those innovations (a criticism also often made in the industrial literature). Owning a new machine does nothing unless we understand how to fit it into existing competitive strategies. This means integrating new innovations into broader plans for crop production, finance, and marketing. This integration effort is especially important under flexible strategies, because the ability to adapt rapidly is determined in large part by how quickly new technologies can be taken from the design stage to full implementation. One reason why the approach of subsidizing technological experimentation by small farmers is so attractive is because it provides a realistic way of getting the technology into the fields, encouraging learning-by-doing.

Labor Policy: Within the industrial literature, there is a very strong opinion expressed that the changes necessary to revitalize U.S. industry can only be made with substantial revisions in the way labor is used. First, labor relations must be made more flexible by eliminating the present system of narrow job classifications and shifting the subject of negotiation from procedural to substantive issues. At the same time, rather than training workers to do extremely narrow and specialized tasks, we ought to be teaching them skills of problem solving (Piore and Sabel, 1984; Kochan, Katz, and McKersie, 1986). Thus, for instance, researchers have recommended that U.S. firms copy Japanese practices of rotating employees through a wide range of different tasks (Florida and Kenney, 1990). Overall, many researchers believe that the past history of antagonistic labor relations has been a major stumbling block to pursuing new competitive strategies, and needs to be replaced with more cooperative approaches in which both labor and management recognize that they have mutual interests (Dertouzos, Lester, and Solow, 1989).

By and large, overspecialization of labor has not been a constraint on flexibility. Indeed, flexibility in the labor force has always been a characteristic of mass production in California agriculture. What exists instead is a shortage of managers trained in the breadth of tasks required to run a farm operation. This is a familiar problem, as family members of farmers continue to seek employment outside agriculture (Luckett, 1988). Another possible constraint on flexibility exists in the current lack of organization among specialized subcontractors of agricultural services. As it is today, there is no organization through which specialized service providers and growers can get together. Instead, the system is an informal one, based mainly on personal acquaintance. If growers seek to divest themselves of fixed costs associated with specialized equipment by relying more on subcontractors, this system is likely to be prove increasingly inadequate.

In both these instances, organized labor could make a contribution to improving flexibility in the industry. Field workers represent a logical pool from which draw future managers. Likewise, many specialized contractors are former field hands, with strong links to the union (FitzSimmons, 1986). It would be relatively easy for the union to play a role in setting up a hiring hall-like institution for such specialized service providers.[8] There are other innovative ways the union could benefit new competitive forms in agriculture as well. Workers, for instance, could play a significant role in monitoring organic produce certification programs. After all, who could add more credibility to grower claims of low pesticide residues than the workers applying those chemicals?

There is no shortage of creative solutions available whereby organized labor could contribute to restructuring of the industry. Yet, calls for cooperation of the sort coming from industrial researchers seem shallow in an industry where a weak union presence and strong anti-union bias by the state has usually made it unnecessary for growers to bargain with labor. Instead, the costs of flexibility are borne primarily by labor, and deep barriers to mobility between field work and management remain.[9] When Salyer-American nearly defaulted on its loans in the mid-1980s, its actions and the responses to those actions by

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[8] This recommendation has frequently been made by Michael Piore with respect to other industries.

[9] Wells (1981) has shown how even relatively cooperative forms of labor relations, such as share cropping may increase worker exploitation (in this case self-exploitation).

public officials and industry leaders demonstrated the nature of the problem:

> Salyer's wage and benefit cuts, part of the cost-cutting program the bank had requested caused an upheaval in Corcoran, however. The only way the Salyers felt they could reduce wages and benefits was by hiring more labor contractors, which gave them labor at roughly the old cost, but without expensive benefits. Predictably, this brought the United Farm Workers into Corcoran to fight the cuts and to organize. Just as predictably, Salyer's move upset local farmers and city officials.
>
> "It showed a lack of judgement," says one former Boswell executive. "No one could believe anyone would be foolish enough to bring the union in."
>
> "We were deeply concerned," recalls Corcoran Mayor Bob Hansen. "We're working to redevelop the town, and one of the incentives we offer to industry is a large pool of nonunion labor."
>
> Wyss (1987:13)

Lessons for Industrial Theory

The application of regulation theory to agriculture has helped to illuminate how development may proceed in many directions—a prerequisite to creating new development strategies. Does it work the other way as well? Can agricultural experience teach us anything about industrial restructuring? We have seen that California agriculture is a mass production industry using many of the same strategies adopted in other industries. Just the same, the industry is characterized by at least a few features which make it distinctly different from manufacturing and other "heavy" industries. First, as a primary sector, agriculture's backwards linkages with the rest of the economy are quantifiably smaller and qualitatively less complex than other sectors. Consequently, the farm experience can tell us relatively little about the sort of sophisticated supplier relationships that have been stressed heavily in industrial discussions (Holmes, 1986). In addition, agricultural producers have much less control over timing of the production process than industrialists in other sectors. Thus, agricultural experience is of minimal help in understanding how producers may accelerate the circulation of capital (Schoenberger, 1990).

Similarly, resource-based industries like agriculture are usually argued to be fundamentally different because of the extreme fixity of their resource base. Indeed, land is often used as an example of a resource with virtually no mobility. On the contrary, this research has demonstrated how mobility in agricultural production has been consistently underestimated. Indeed, the defining physical features of land have been transformed as investment has allowed land to be homogenized to the point that it plays a role remarkably similar to the multipurpose machinery often alluded to in industrial theory.

Finally, we have seen that agriculture was never dominated by Fordism to the extent that other sectors were (at least not the tying of wage and productivity increases). However, this itself may provide a lesson, in that it demonstrates how a mass production industry may experience significant dislocation even in the absence of collapsing Fordist relations. Quite simply, industrial producers have not been at the mercy of the collapse of Fordism any more than they have been victimized by shifting exchange rates and macroeconomic conditions (Storper and Walker, 1989; Hudson, 1988).

In short, I believe the agricultural experience can provide important lessons for industrial theory, providing the analogies are drawn carefully. In the following section, I discuss the implications of agricultural development for several recurring themes within the modern industrial literature on flexibility: the geography of production, the role of small firms in flexible production, the implications of flexible strategies for labor, and the role of the state in promoting and regulating flexibility.

The Geography of Production:

Some of the most debated questions in recent industrial literature revolve around the spatial implications of flexible production strategies. To some researchers, increasing factor mobility provides the basis for a "new international division of labor" in which multinational capital goods producers have considerable freedom to relocate production outside the developed countries to take advantage of low cost, nonunion labor (Lipietz, 1986; Frobel, Heinrichs, and Kreye, 1980, Bluestone and Harrison, 1982). To other authors, emerging flexible strategies are dependent on a fluid and recurring sharing of ideas and personnel that encourage greater spatial concentration of economic activity (Scott, 1988; Storper and Scott, 1988; Storper and Christopherson, 1987; Sabel, 1989).

The experience of California demonstrates that concentration and dispersal of economic activity are likely to coexist. Within California agriculture, for instance, there has tended to be geographical concentration of production into increasingly powerful agricultural centers such as the San Joaquin, Imperial, and Salinas Valleys, while many traditional production areas along the coast and in the Sacramento Valley have declined in importance. Simultaneously, parts of the production process have been moved offshore to Mexico and other regions (see also, Schoenberger 1989, 1990).

The California experience also suggests that even today's successful industrial districts cannot escape the threat of heightened capital mobility. In recent years, it has become clear that the state's most unique resources contributing to flexibility cannot be relied upon to limit the movements of global capital. In fact, these specialized resources may actually encourage the development of competition from other regions. Agricultural economists Kirby Moulton and David Runsten, for instance, have described how the state's agricultural research facilities have become a training ground for farm experts from throughout the world, many of whom will return to their own regions to compete with California growers (Moulton, et. al., 1987:100). Similar patterns have been observed in high technology sectors, where U.S. firms have arguably become "think tanks for global networks" of producers (Cooke, 1988:294).

To Florida and Kenney (1990a, 1990b), the solution is to improve the integration of innovation, production, and marketing, so that new ideas are transformed into marketable products domestically rather than overseas. Yet, this view oversimplifies the role of global capital, tending to see competition as existing between regions rather than among global firms. The transfer of agricultural technology to regions that compete with California growers has been promoted by precisely these global firms, some of which originated in California. Likewise, research cannot be restricted to issues of local importance, partly because the firms which sponsor that research have a very real interest in applying the results internationally.

Clearly, there is an inherent tension between the efforts of local communities to promote economic development and the desires of global capital to seek out new, more profitable methods and centers of production. Creation of unique local resources such as networks of specialized subcontractors does not change this. That does not mean that efforts to strengthen local resources are misguided. However, global firms will continue to seek ways to move capital in response to competitive needs rather than to benefit local communities. It may be, for instance, that we will see global firms encouraging competition between spatially distinct industrial districts, much as traditional mass production firms have encouraged interregional competition for growth in the past. Within such an environment, public policy will still have to place some sort of limits on capital mobility. Moreover, this cannot be effectively accomplished without federal support.

The observed coexistence of centralizing and decentralizing tendencies also indicates that we must move beyond the current recentralization/diffusion debate. Rather, future research should focus on identifying those circumstances under which we might reasonably expect centralizing forces to gain an upper hand over dispersion tendencies. Walker and Storper (1989), for instance, argue that "windows of locational opportunity" may exist in the early stages of adoption of new technologies, when forces favoring concentration are at their weakest. There has also been relatively little concern how demand enters the picture. As we saw with the Nisshinbo textile mill, at least in the near-term, it appears that access to markets will continue to be one of the strongest weapons local governments have at their disposal to limit capital flight.

The Roles of Small and Large Firms under Flexible Strategies:

Regulation theory has made a significant contribution in reassessing the role of small firms in regional development. Indeed, much of the regulation literature sees small firms as playing a leading role in emerging flexible strategies (Best, 1990; Piore, 1989; Schmitz, 1989). There are several reasons for this. First, the need for rapid responses to changing markets under flexible production arguably encourages vertical disintegration to dismantle bureaucratic obstacles to communication and decision making. Second, it is widely believed that newer technologies forming the basis of flexible production are characterized by lower scale economies. Third, niche markets that tend to be targeted under flexible strategies are too small to allow scale economies to be achieved. These markets are also highly differentiated, minimizing the importance of cost-based competition that favors large scale (Piore and Sabel, 1984).

The experience of California agriculture indicates that the advantages attributed to small firms under flexible strategies may be overstated. First of all, as we saw in the cotton sector, vertical disintegration need not be synonymous with small firm size. Second, even the mass markets that favor large production scale can be pursued in a manner that increases flexibility. Thus, while growers are moving more rapidly between a wider range of crops, many of the crops being targeted remain characterized by relatively large production runs and extreme standardization. Finally, the technologies that have been used to increase flexibility in agriculture are definitely not characterized by declining scale economies (this is most obvious with irrigation and chemical use). Piore (1986:25) has observed similar patterns in manufacturing sectors using numerically controlled machinery (CNCs), where scale economies shift from the investment in machinery to the programming of those machines.

Consequently, the continuing presence of large producers is not simply explained by an incomplete evolution of the sector towards more idealized forms of flexible production (Piore, 1986). This has several important implications. First, increasing flexibility may not be enough to improve small producers' competitiveness. Second, if large flexible firms tend to move in and out of markets at large scale, this will presumably raise the risk of destabilization. The role played by large firms in increasing or decreasing sectoral volatility is far from predetermined. According to Florida and Kenney (1990), large firms in Japan's high technology sectors actually help to stabilize the industry by coordinating the activities of otherwise atomistic, smaller firms. Especially in agriculture, we need much better information than we currently have about how growers choose their production patterns before we can adequately assess the role of these large, flexible firms. What, for instance, determines the scale at which a grower enters a new crop? Is it some perceived level of efficient scale of production for that crop? Alternatively, is it determined by how much a grower is willing to risk in a market where she has less expertise?

Unfortunately, both the methodology and data sources used in this research have inherent limitations for answering such questions. The method employed has been to make inferences from county level acreage data about farm-level behavior. This is appropriate for trying to depict broad trends. However, it tells us little about how individual growers make their acreage decisions from year-to-year. Aggregate data can show us, for instance, that annual variations in broccoli production in the 1980s are becoming more strongly influenced by production in cotton regions. However, we cannot link annual changes in broccoli acreage to what is actually occurring on cotton farms. Today, the sort of longitudinal microdata that would be most helpful in answering such questions accurately are extremely rare, pointing to the need to expand the types of data series that are collected by the state and federal governments.

Flexibility and the Role of the State:

To date, most of the industrial research on changing competitive strategies has tended to focus on how firms are restructuring themselves to become more flexible. Within this research, there has been relatively little investigation into the role of the state in that process. It is true that researchers have examined the collapse of traditional state roles under Fordism. However, it is much less clear what the state's role is and will be under emerging strategic forms.

In part, this neglect of the state's role in restructuring is understandable, given the decimation of the public sector in recent years (Harrison and Bluestone, 1989). However, it also reflects the fact that the current academic consensus surrounding the importance of increasing flexibility is a fragile one, made up of many divergent viewpoints. To a significant number of researchers, the crucial (and desirable) element of increasing flexibility is declining state intervention in the economy as manifested in modern movements toward deregulation and privatization, accompanied by a significant decline in the power of organized labor (Kochan, Katz, and McKersie, 1986; Weitzman, 1984).

Still, one of the lessons from California agriculture is that, even in an era of deregulation, the public sector has had a very strong hand in shaping restructuring. Current efforts of firms to become more flexible are highly dependent on state subsidization of very specific types of technological change. Likewise, while income maintenance programs are less important in California than elsewhere, they remain a significant issue, especially when flexibility leads to great instability. As we saw in the cotton sector during 1982 and 1983, even large firms may require income maintenance when flexibility is allowed to proceed in its most uncontrolled fashion.

There are several different areas of research that need to be pursued. First, there are very obvious and basic questions about how flexible strategies affect infrastructure development and the provision of public services. In California, for instance, we might ask how rapid and frequent changes in crop mix influence water demand. Has it become more variable over time? If so, this will likely encourage design and real time operational changes in large water systems (James and Lee, 1971).

Flexible strategies are likely to encourage institutional changes in the provision of public services as well. Again using water resources as an example, at least some of the increased popularity of water market proposals (and the declining popularity of long-term contracting) has to do with perceptions that existing institutions are insufficiently flexible to meet modern service demands.

More broadly, we would like to know what the shift from mass production to flexible production implies for stabilization policy. Certainly the answer depends on just how widely flexible strategies are adopted and how different they are from traditional mass production. My research, like that of many regulation theorists, suggests that traditional Keynesian stabilization policy is insufficient. Does that actually mean that there is an increasing need to conduct stabilization policy at the level of specific industries? If so, what would such stabilization policies look like? I have tried to give some suggestions for agriculture in the policy section of this chapter. However, it should be remembered that agriculture is one of the very few industries in the United States (the others being regulated monopolies) with any history of explicit stabilization policy. Thus, similar industrial policy in other sectors may be more difficult to achieve.

Flexibility and Labor:

Perhaps more than any other issue, industrial researchers have vigorously debated the likely implications of restructuring for the quality, type, and number of jobs available. Like agriculture, the costs of flexibility in manufacturing have frequently been borne by workers as wage cuts and reduced employment (Harrison and Bluestone, 1989; Hudson, 1988). To proponents of flexible competitive strategies, these costs can be offset by the potential for skill improvement and improved conditions in the workplace offered under flexible production strategies. Yet, in California agriculture these promises have not been fulfilled. Overall, the industry remains characterized by poor working conditions, low wages, and little hope of upward mobility for the lowest skill workers.

Why is it that producers have failed to reinvest in labor and build more cooperative labor relations? Much of the industrial literature implies that the problem is simply misguided behavior based on a history of adversarial labor relations. According to this view, what is necessary is to convince producers and labor alike that it is in their mutual interest to build more cooperative relationships (Dertouzos, Lester, and Solow, 1989). Certainly, the animosities between growers and field workers are rooted in a long history of mistrust and poor relations. However, the problem is more fundamental than simply misguided behavior and, as Stephen Wood points out, mutual dependence is not the same as common interests (Wood, 1989:18).

Once again, the details of how flexibility is achieved matter. In California under the Bracero Program, growers never had to capitulate to labor during the formative years of labor relations for mass production agriculture. Moreover, state cooperation was central to encouraging the adoption of labor saving technologies that seriously undermined the strength of organized labor when the Bracero Program finally collapsed. As a result, flexibility in labor resources has been achieved, not by reforming labor relations and upskilling the workforce, but by eliminating jobs and undermining job security wherever possible. This does not mean that labor can be eliminated entirely. However, it does suggest that a very real conflict between labor and management remains, and that the conditions of that conflict are heavily mediated by the state. Without stronger union representation or state intervention to "level the playing field," management will continue to view labor as its first and foremost source of flexibility.

While the Bracero Program is unique to California agriculture, similar statements would seem applicable to other industries as well. In widely cited examples of Japanese labor relations, for instance, skill upgrading has only occurred because of lifetime employment policies which make it possible for firms to justify longer term investment in human capital (Dore, 1986). Similarly, this stable employment has encouraged workers to develop long-term commitment to firms.[10] What is critical to realize is that these lifetime employment policies have not resulted from the wisdom of far-sighted Japanese

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[10] This is not to imply that lifetime employment policies practiced in Japan are any panacea. As practiced, they can be very undemocratic, and they cover only a fraction of the total labor force (Best, 1990:146-7). However, the general point about how such institutions mediate labor-management conflicts remains valid.

managers as much as from a prolonged struggle by organized labor (Florida and Kenney, 1990).

Summary

As it exists today, agricultural policy in the U.S. is at a tragic standstill. Based on the belief that instability comes from exogenous sources, policies have failed to realize ways in which current competitive structures can be reshaped to build a better industry. Consequently, instead of trying to improve the ways farmers do business, policy has become hopelessly bogged down in issues like trade regulation and administered pricing. Existing theory has tended to treat current development patterns as the only alternatives available. As a result, this analysis tends to create a series of false policy tradeoffs wherein small farms, environmental quality, stable growth, and rewarding forms of agricultural labor all must be sacrificed in the name of continuing development of mass production methods.

At the same time, much recent industrial theory has placed too much faith in the ability of emerging flexible production strategies to promote stable growth, without considering how the details of those strategies influence their results. Flexible production strategies, like mass production, can have very different outcomes for development, work, and environmental quality. In my research, I have tried to demonstrate that the details of how growers compete really do make a difference to ongoing development in the industry. California agriculture is an example of a sector which has achieved improved flexibility and has used that flexibility to its strategic advantage. Yet, flexibility has had unintended consequences.

Nonetheless, there is room for creative solutions to current problems that can propel policy in positive directions. Small farms need not be sacrificed in the name of development. Nor must we accept any necessary tradeoff between agricultural development and environmental quality. Finally, instability is not a necessary by-product of growth. However, to achieve these outcomes requires more than macroeconomic stabilization, a dismantling of old bureaucracies, and an effort to increase flexibility. It also requires a renewed commitment by the state to promoting agricultural development in which growers, workers, and consumers share both the benefits and costs. Finally, it demands a fundamental change in how we think about agricultural development and instability. Agriculture and industry are not that different; analysts in each branch of economics should be learning from the other.

APPENDICES

APPENDIX 1.1

Measuring Revenue Instability

In this research, revenue volatility is measured as deviations from a trend growth in revenue. Revenues are first converted to real 1984 dollars using the USDA Index of Prices Received by Farmers for All Crops. The index is not disaggregated regionally, but represents a nationwide estimate.

Trend regressions are run in log form. Accordingly, residuals represent percentage deviations from trend growth. In many cases, the trend itself has made a change during the 1958-87 study period. Accordingly, trends are allowed to change by introducing a spline variable that takes on values of zero before a hypothesized change in trend, and incremental values (1,2,3...,n) thereafter. By allowing the trend to change, we adjust better for multi-year shifts in revenues. Thus the residuals better reflect only very short-term (annual) patterns.

Admittedly, first, difference data could have been used and this might have even been more conventional. However, such estimates do not totally adjust for the trend, and are very weak at picking up changes in the trend. That is why first differenced data are not used.

APPENDIX 1.2

Revenue Time Trends—Top 25 Counties

	Equation LN(Y) =	$\bar{r}^2$	d.f.*
Counties with Simple Growth Trends			
Monterey	19.26 + .05(t) (16.01)	.92	23
Kern	19.88 + .04(t) (11.24)	.85	22
Santa Barbara	18.20 + .04(t) (11.87)	.86	23
Siskiyou	16.90 + .06(t) (20.52)	.95	23
Tulare	20.01 + .03(t) (10.99)	.84	23
Counties with Single Change in Trend			
Orange	17.84 – .04(t) + .13(S70) (–6.52) (14.92)	.97	21
San Luis Obispo	16.59 + .06(t) + .05(S71) (7.52) (3.62)	.97	22
Riverside	19.14 + .02(t) + .06(S80) (13.46) (4.95)	.96	21
Sacramento	18.03 + (STEP68) (7.09)	.69	23
Solano	17.88 + .06(t) – .05(S68) (7.00) (–4.40)	.84	22
Stanislaus	18.76 + .04(t) – .04(S69) (4.58) (–2.35)	.73	22
Ventura	19.01 + .05(t) – .05(S70) (6.82) (–3.77)	.82	22

Notes:

See Appendix 1.6 for variable definitions.
*d.f. = degrees of freedom.

Appendix 1.2 (continued)

	Equation LN(Y) =	$\bar{r}^2$	d.f.*
Yolo	18.92 + .02(t) - .04(S75)	.44	22
	(4.18) (-3.50)		
Butte	18.17 + .04(t) - .14(S80)	.81	22
	(9.76) (-4.69)		
Colusa	18.08 + .05(t) - .19(S80)	.81	22
	(9.69) (-5.75)		
Imperial	19.43 + .03(t) - .07(S80)	.86	22
	(10.81) (-3.19)		
San Joaquin	19.43 + .03(t) - .10(S80)	.80	22
	(9.14) (-4.25)		
Glenn	17.66 + .04(t) - .02(S81)	.84	22
	(10.35) (-3.71)		
Sutter	18.57 + .04(t) - .18(S81)	.90	22
	(14.24) (-6.89)		
San Diego	18.48 + .03(t) - .13(S82)	.77	22
	(8.41) (-2.18)		

Counties with
<u>Multiple Changes in Trend</u>

	Equation LN(Y) =	$\bar{r}^2$	d.f.*
Santa Cruz	16.72 + .15(S70) - .09(S76)	.92	22
	(9.02) (-2.76)		
Yuba	16.24 - .06(t) + .07(S71) - .24(S80)	.96	21
	(6.03) (3.78) (-5.83)		
Kings	19.06 + .08(S71) - .15(S80)	.89	22
	(12.00) (-4.85)		
Fresno	20.40 + .02(t) + .07(S74) - .12(S81)	.96	21
	(5.69) (7.34) (-6.21)		
Madera	18.41 + .03(t) + .10(S75) - .22(S80)	.94	21
	(6.80) (5.73) (-6.47)		

APPENDIX 1.3
Revenue Time Trends—Top 25 Crops

	Equation LN(Y) =	$\bar{r}^2$	d.f.*
Crops with No Trend Growth			
Sugar Beets			
Prunes			
Crops with Simple Growth Trends			
Alfalfa	19.97 + .01(t) (4.61)	.45	24
Oranges	19.69 + .06(S76) (6.41)	.62	24
Table Grapes	18.95 + .03(t) (12.85)	.88	22
Almonds	18.05 + .08(t) (10.67)	.82	24
Walnuts	18.17 + .04(t) (6.38)	.61	24
Dry Beans	18.30 + .18(t) (3.18)	.27	24
Crops with Single Change in Trend			
Cotton	20.69 − .07(t) + .13(S70) (−4.28) (6.07)	.67	23
Lettuce	18.87 + .08(t) − .04(S70) (+7.53) (−2.85)	.89	23
Process Tomatoes	18.18 + .10(t) − .13(S76) (12.75) (−6.18)	.89	23
Wine Grapes	18.59 − .12(t) + .17(S68) (−2.97) (6.37)	.86	23

*d.f. = degrees of freedom

Appendix 1.3 (continued)

	Equation LN(Y) =	r^2	d.f.
Rice	18.72 + .07(t) − .06(S70) (4.15) (−2.51)	.56	23
Barley	19.35 − .03(t) − .12(S81) (−8.68) (−4.88)	.92	22
Peaches	19.00 + .02(t) − .05(S71) 3.26 (−3.77)	.34	23
Lemons	18.64 + .04(t) − .05(S71) (4.85) (−4.00)	.48	23
Straw-berries	18.33 + .05(t) − .22(S73) (.123) (7.73) (−2.29)	.84	23
Potatoes	19.02 − .06(t) + .18(S80) (−4.59) (4.15)	.44	23
Wheat	17.48 + .20(t) − .17(S76) (13.35) (−5.25)	.93	23
Fresh Tomatoes	18.37 + .12(S67) − .14(S74) (7.88) (−5.60)	.76	23
Celery	18.21 + .07 − .52(S73) (6.74) (−4.05)	.71	23
Field Corn	17.63 + .13(t) − .11(S72) (14.86) (−8.02)	.96	23
Canta-loupes	18.20 + .27(t) + .03(S76) (3.94) (3.24)	.61	22
Plums	17.80 + .11(t) − .08 (5.50) (−3.36)	.81	22

Crops with
<u>Multiple Changes in Trend</u>

Raisins	19.59 + .02(t) + .09(S76) − .28(S81) (3.42) (4.11) (−6.23)	.83	20

APPENDIX 1.4

The Effect of GNP and Dollar Movements on Crop Income

Crops for which both GNP and DOLLAR are significant:

Crop	Coefficient on GNP'	Coefficient on DOLLAR'	$\bar{r}^2$
Cotton	-6.97 (-6.58)	-2.56 (-4.91)	.65
Rice	2.19 (2.27)	-1.18 (-2.40)	.54
Wheat	-4.23 (-3.02)	-2.83 (-3.95)	.40
Barley	1.60 (2.40)	-0.89 (-2.54)	.44

Crops for which only GNP is significant:

Crop	Coefficient on GNP'	$\bar{r}^2$
Field Corn	2.35 (2.65)	.19
Strawberries	-1.66 (-3.14)	.26
Process Tomatoes	4.73 (4.18)	.40

Crops for which only DOLLAR is significant:

Crop	Coefficient on DOLLAR'	$\bar{r}^2$
Wine Grapes	-1.57 (-2.30)	.12
Potatoes (1)	1.51 (2.87)	.20
Walnuts	-1.48 (-2.57)	.18
Peaches	-0.75 (-3.44)	.31

APPENDIX 1.4

The Effect of GNP and Dollar
Movements on Crop Income (continued)

Crops for which neither GNP nor DOLLAR is significant:

Crop	Coefficient on GNP'	Coefficient on DOLLAR'	$\bar{r}^2$
Prunes (1)	−0.82 (−0.92)	−0.60 (−1.33)	.00
Alfalfa	0.45 (0.68)	0.11 (−0.35)	.00
Sugar Beets (1)	2.55 (1.63)	−0.39 (−0.51)	.09
Celery	−4.89 (−1.42)	−0.04 (−0.13)	.00
Fresh Tomatoes	0.42 (0.29)	−1.02 (−1.68)	.09
Cantaloupes	0.10 (0.11)	0.36 (0.60)	.00
Lettuce	0.06 (0.09)	−0.08 (−0.21)	.00
Plums	−0.53 (−0.57)	−0.38 (−0.87)	.00
Oranges	−0.39 (−0.47)	−0.06 (−0.15)	.00
Lemons	0.03 (0.05)	−0.53 (−1.64)	.05
Dry Beans	0.23 (0.29)	−0.51 (−1.29)	.02
Almonds	2.91 (0.76)	−.48 (−.26)	.00
Table Grapes	−0.40 (−0.89)	0.14 (0.66)	.01
Raisins (2)	1.42 (2.31)	0.35 (1.23)	.13

Notes to Appendix 1.4:

All intercepts insignificant at the 95% confidence level.
GNP equals real Gross National Product.
DOLLAR equals real, trade weighted value of the dollar between 1973 and 1984. The variable is set to zero before 1973.
(') denotes variable in deviation form.
All independent variables modelled using 2 year moving average (t, t-1), except potatoes, for which variance was maximized with no lags.
(1) No time trend evident. Data normalized as percentage deviations from the mean value.
(2) GNP becomes insignificant when DOLLAR variable is removed.

APPENDIX 1.5

Explanation of Data Sources

Unless otherwise noted, the primary data source for all acreage, revenue, yield, and price data is a data tape compiled by Charles Goodman, of the University of California, Berkeley, Dept. of Agricultural Economics. The tape is a compilation of the Annual Reports of California's Agricultural Commissioners, between 1958 and 1984. These data are compiled and reported at the county level. The data presented exclude pasture land (which does not constitute a crop in the traditional sense). In some crops, the early year data are unreliable and have frequently been omitted in this research. Data after 1984 have been compiled for cotton by hand from hard copies of the reports.

All dollar figures are deflated by the USDA Index of Prices Received by Farmers for All Crops. Except where noted in the text, prices are indexed to 1984. Likewise, revenue figures exclude government payments, except where noted.

APPENDIX 1.6

List of Variables

A =	Acreage, expressed as percentage devation from trend
Y =	Real crop income in 1984 dollars
P =	Real crop price in 1984 dollars per unit
t =	Index of time (t = 1, 2, ..., n)
Sxx =	Splined index of time: (0 in years prior to 19xx) (1, 2, ..., n in subsequent years)
GNP =	Real gross national product in constant 1988 dollars (1)
DOLLAR =	Real multi-lateral, trade-weighted value of the dollar (1984)
FLOAT =	Categorical variable representing the floating of the dollar relative to other currencies: (0 prior to 1973) (1 thereafter)
LOAN =	Real current CCC support price (1984 dollars)
BARLEY =	Real price of barley
T =	Yield in tons per acre
d.f. =	Degrees of freedom

(') Indicates variable presented in deviation form

APPENDIX 3.1

Acreage Time Trends for Wheat, Rice, and Cotton

<u>Figure 3.1 (wheat)</u>

$$\begin{array}{llll} LN(A) = 12.65 + & .07(S65) & & \bar{r}^2 = .83 \\ \quad (60.52) & (11.32) & & df = 25 \end{array}$$

$$\begin{array}{llll} LN(A) = 9.86 + & .07(S65) + & .06(LN(P_{t-1})) & \bar{r}^2 = .85 \\ \quad (47.36) & (11.25 & (1.44) & df = 23 \end{array}$$

Price not included in figure since it is not statistically significant.

<u>Figure 3.2 (rice)</u>

$$\begin{array}{llll} LN(A) = 12.49 + & .03(t) & & \bar{r}^2 = .62 \\ \quad (79.55) & (6.61) & & df = 25 \end{array}$$

$$\begin{array}{llll} LN(A) = 10.02 + & .03(t) + & .45(LN(P_{t-1})) & \bar{r}^2 = .65 \\ \quad (69.94) & (6.98) & (2.48) & df = 23 \end{array}$$

<u>Figure 3.3 (cotton)</u>

$$\begin{array}{llllll} LN(A) = 13.75 - & .04(t) + & .12(S68) - & .16(S81) & & \bar{r}^2 = .85 \\ \quad (112.04) & (-3.93) & (7.41) & (-4.80) & & df = 23 \end{array}$$

$$\begin{array}{llllll} LN(A) = 10.80 - & .05(t) + & .12(S68) - & .17(S81) + & .41(P_{t-1}) & \bar{r}^2 = .90 \\ \quad (107.96) & (-4.41) & (8.55) & (-6.18) & (2.53) & df = 21 \end{array}$$

APPENDIX 3.2

Estimates of Acreage Contribution to Revenue Instability

Rice	Acreage only	Y' = .01 + .93(A')	$\bar{r}^2$ = .69
df = 234		(.06) (22.94)	
	Acreage + Price	Y' = .15 + .94(A') + .89(P')	$\bar{r}^2$ = .82
		(.17) (22.97) (12.67)	
	Price only	Y' = .03 + .85(P')	$\bar{r}^2$ = .12
		(.08) (.5.52)	
	A = .69 -> .70	P = .12 -> .13	
Cotton	Acreage only	Y' = .04 + .86(A')	$\bar{r}^2$ = .69
df = 118		(−.13) (16.16)	
	Acreage + Price	Y' = −.03 + .87(A') +.79(P')	$\bar{r}^2$ = .73
		(−.11) (17.78) (4.73)	
	Price only	Y' = −.16 + .64(P')	$\bar{r}^2$ = .02
		(1.31) (1.98)	
	A = .69 -> .71	P = .02 -> .04	
Almonds	Acreage only	Y' = .01 + .32(A')	$\bar{r}^2$ = .69
df = 314		(.03) (2.09)	
	Acreage + Price	Y' = .07 + .35(A') + .64(P')	$\bar{r}^2$ = .17
		(.15) (2.50) (7.83)	
	Price only	Y' = .07 + .64(P')	$\bar{r}^2$ = .16
		(.15) (7.70)	
	A = .01 -> .01	P = .16 -> .16	
Process tomatoes	Acreage only	Y' = .00 + 1.02(A')	$\bar{r}^2$ = .70
df = 252		(.01) (24.35)	
	Acreage + Price	Y' = .00 + .91(A') + .61(P')	$\bar{r}^2$ = .76
		(22.67) (7.82)	
	Price only	Y' = .02 + 1.24(P')	$\bar{r}^2$ = .27
		(9.64)	
	A = .49 -> .70	P = .06 -> .27	
Alfalfa	Acreage only	Y' = .00 + .96(A')	$\bar{r}^2$ = .50
df = 441		(.01) (21.08)	
	Acreage + Price	Y' = .01 + .96(A') + .95(P')	$\bar{r}^2$ = .69
		(.08) (26.58) (16.06)	
	Price only	Y' = .02 + .94(P')	$\bar{r}^2$ = .18
		(.06) (9.91)	
	A = .50 -> .51	P = .18 -> .19	

Raisins df = 116	Acreage only	$Y' = .00 - .20(A')$ $(.00)\ (-.76)$	$\bar{r}^2 = .00$
	Acreage + Price	$Y' = .02 - .00(A') + .57(P')$ $(.11)\ (-.01)\quad (6.70)$	$\bar{r}^2 = .28$
	Price only	$Y' = .02 + .57(P')$	$\bar{r}^2 = -.28$
Table grapes	Acreage only	$Y' = .00 + .77(A')$ $(.02)\ (1.42)$	$\bar{r}^2 = .01$
	Acreage + Price	$Y' = .02 + .77(A') + .44(P')$ $(.08)\ (1.61)\quad (4.82)$	$\bar{r}^2 = .23$
	Price only	$Y' = .01 + .44(P')$ $(.06)\ (4.77)$	$\bar{r}^2 = .21$
	A = .01 -> .02	P = .21 -> .22	
Wine grapes	Acreage only	$Y' = .06 + .41(A')$ $(-.09)\ (2.10)$	$\bar{r}^2 = .01$
	Acreage + Price	$Y' = .01 + .49(A') + .62(P')$ $(-.02)\ (2.64)\quad (7.22)$	$\bar{r}^2 = .13$
	Price only	$Y' = .01 + .61(P')$ $(-.02)\ (7.02)$	$\bar{r}^2 = .12$
	A = .01 -> .01	P = .12 -> .12	
Oranges	Acreage only	$Y' = .68 - 1.69(A')$ $(.28)\ (-.69)$	$\bar{r}^2 = .00$
	Acreage + Price	$Y' = .74 - 1.59(A') + .22(P')$ $(.30)\ (-.65)\quad (1.06)$	$\bar{r}^2 = .01$
	Price only	$Y' = .73 + .23(P')$ $(.30)\ (1.06)$	$\bar{r}^2 = .01$
Lettuce	Acreage only	$Y' = .02 + .94(A')$ $(-.07)\ (9.35)$	$\bar{r}^2 = .32$
	Acreage + Price	$Y' = .05 + .94(A') + .84(P')$ $(.30)\ (16.95)\quad (20.58)$	$\bar{r}^2 = .79$
	Price only	$Y' = .05 + .84(P')$ $(.18)\ (12.87)$	$\bar{r}^2 = .47$
	A = .32 -> .32	P = .47 -> .47	

APPENDIX 3.3

Decomposing Revenue Shifts Using the Total Discrete Differential

In any year, revenue (Y) is equal to the product of yield (T), price (P), and acreage (A):

$$Y = T \cdot P \cdot A$$

Changes in this product from year to year can accordingly be decomposed into several components, by taking the total discrete differential.

$$dY = \left[d\frac{T}{A} \cdot \frac{P}{T} \cdot A\right] + \left[d\frac{P}{T} \cdot \frac{T}{A} \cdot A\right] + \left[dA \cdot \frac{T}{A} \cdot \frac{P}{T}\right]$$

$$+ \left[\frac{T}{A} \cdot d\frac{P}{T} \cdot dA\right] + \left[\frac{P}{T} \cdot d\frac{T}{A} \cdot dA\right] + \left[d\frac{T}{A} \cdot d\frac{P}{T} \cdot A\right]$$

$$+ \left[d\frac{T}{A} \cdot d\frac{P}{T} \cdot dA\right]$$

or,

Change in Total Revenue = Change due to Yield Shift + Change due to Price Shift + Change due to Acreage Shift

+ Price/Acreage interaction + Yield/Acreage interaction + Price/Yield interaction

+ Price/Acreage/Yield Interaction

APPENDIX 5.1

Modelling Acreage Responses

The simplified supply-response model used here is estimated as a two-stage least squares model in which price is first purged of exogenous demand components. For a broader discussion of such models, see Nerlove (1958) or Askari and Cummings (1976). Data used are deviation form, using pooled, cross-sectional, county data. Separate models are estimated for the 1959-1969 and 1970-1987 periods.

$$A_t' = \beta_0 + \beta_1(P^{*\prime}{}_{t-1}) - \beta_2(BARLEY'{}_{t-1}) - \beta_3(LOAN'{}_t) + \beta_4(A'{}_{t-1})$$

where:

$$P^* = \beta_5 - \beta_6(DOLLAR'{}_t) + \beta_7(GNP'{}_t)$$

and:

A'_t	= Acreage in current period
P^*_{t-1}	= Estimated price of cotton in prior period
$BARLEY'_{t-1}$	= Price of Barley in prior period
$LOAN'_t$	= CCC loan rate in current period
$DOLLAR'_t$	= Real multilateral trade-weighted value of the dollar in current period (valued at 0 prior to the float in 1973)
GNP'_t	= GNP in current period

(') denotes variable in deviation form.

The adjusted price equations are estimated individually for each county over the entire study period, with all values in deviation form. Riverside and Imperial counties have been excluded, because they grow significant amounts of ELS cotton, which has different market characteristics from Acala. The adjusted price equations are presented below:

County	Adjusted Price (P^*) =	
Fresno	0.00 − .40(DOLLAR) − .42(GNP)	$\bar{r}^2$ = .04
	(.02) (−1.76) (−.50)	d.f. = 27
Kern	−0.00 − .22(DOLLAR) + .30(GNP)	$\bar{r}^2$ = .00
	(−.01) (−.81) (.29)	d.f. = 27
Kings	0.00 − .34(DOLLAR) − .43(GNP)	$\bar{r}^2$ = .00
	(.02) (−1.38) (−.47)	d.f. = 27
Madera	0.00 − .59(DOLLAR) − .64(GNP)	$\bar{r}^2$ = .14
	(.03) (−2.56) (−.74)	d.f. = 27
Merced	0.00 − .54(DOLLAR) − 1.14(GNP)	$\bar{r}^2$ = .10
	(.04) (−2.23) (−1.25)	d.f. = 27
Tulare	0.01 − .17(DOLLAR) − .46(GNP)	$\bar{r}^2$ = .00
	(.05) (−.65) (−.46)	d.f. = 27

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