SOME ASPECTS OF AGRICULTURAL PRICE INSTABILITY

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ABSTRACT

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PRICE INSTABILITY

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In the past, agricultural price instability has been intertwined with and complicated by issues of price and income support from which have arisen the current price support policies of the U.S. This study attempts to separate price instability from price support, and examine the issue of price instability on its own. In particular, an attempt is made to examine the interrelationships between "causes" and "effects" of price instability, and the inherent conflicts which occur between causal relationships and policy issues in allocating resources in agriculture efficiently.

Four major difficulties appear to arise from the literature with respect to price instability. These are (1) a definition of instability, (2) analytical techniques, (3) performance criteria, and (4) the existence of differentials between acquisition cost and salvage values of fixed inputs. This study deals only with the first three difficulties, while only briefly examining the fourth.

In order to deal with the breadth of issues involved, a broader framework is presented which provides the essential links between structure, conduct and performance and analysis, design and management. While the complexity of the issues involved do not provide easy quantitative analysis, a simple nonlinear systems simulation model is developed in order to examine the time path of various pricing policies under both

certainty and uncertainty. In addition, a modification to the neoclassical approach to price instability is presented.

The essence of the systems simulation approach stems from the conceptualization of price instability in terms of the transient response of a system, providing the possibility of redirecting performance criteria away from the unmeasurable and problematic areas of utility and welfare implications, towards some tangible tradeoffs. Unfortunately, the concept of transient response is not, as yet, a viably operational tool in agricultural economics, but the possibility of its use in the future is promising. The extent to which this study deals with the possibilities of its use, however, is hopefully useful input to ongoing research in price instability.

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CHAPTER 1

INTRODUCTION

Introduction

For much of the past three decades, low farm prices and incomes, chronic surpluses and problems of adjustment on farms and in rural communities have been major concerns of farm policy in the U.S. In 1973 these problems of "abundance" were replaced by food policy issues, including high food prices, market instability, changing input costs, and an expanded role of U.S. agriculture in world markets and world food crises. The mix of policy concerns in the food system has evolved from changing economic, political and technical conditions surrounding agriculture and from changing structural conditions within agriculture and the food industries.

This study deals with only one aspect of the complex of current food policy issues, namely, price instability. In particular, an attempt is made to examine the causes of price instability and the inherent conflicts which occur between causal relationships and policy issues in allocating resources efficiently. To deal effectively with such a topic therefore, would require analysis of each issue separately and interdependently; such a task is not intended here. An attempt will be made to draw out the broad nature of the issue in this first chapter, touching only briefly on some of the major concerns, but with the objective of highlighting the underlying rationale which makes the issue of price instability worthy of consideration both as a separate entity and as a part of the overall integrated matrix of policy objectives and formats. In order to do this without losing perspective, the following will be considered:

(a) the current structure and evolution of the food system which has lead to the changing nature of our analytical framework;

(b) the goals of agricultural policy; and

(c) the issue of price instability in relation to the analytical framework and to the goals.

Evolution and Change in the Food System

There are two types of evolution which occur in the disciplines which substantially affect the nature of inquiry, and which emphasize the need for dynamics:

(a) the changing nature of the problems within the system;

(b) the changing philosophical underpinning of the discipline.

In the past decade, U.S. agriculture has undergone three basic changes which affect the nature of policy issues and concerns, and which therefore affect the analytical framework of agricultural policy analysis.

(a) the internationalization of agricultural issues;

(b) the increased political participation in the agricultural system;

(c) structural change both within agriculture and in the economy as a whole.

It is clearly impossible to do justice to any one of these broad topics in a short discourse, let alone all three of them. A short discussion of the major issues, however, is sufficient to provide a background to the ensuing discussion.

The most important changes have occurred in the international and political areas. Since the mid 1960s the U.S. has moved from a relative position of a closed economy to a much more open one with respect to agriculture--which has resulted in a vast increase in the importance of exporting industries, the largest being grain. With this expansion in agricultural trade has come the need for the U.S. to carefully coordinate their domestic and international policies in order to retain some aspect of consistency with respect to consumers, producers and the agricultural industries both domestically and abroad. In addition, as a result of increased concern for international trade and the need to coordinate domestic and international policy, there has been increasing political participation in the process of U.S. agricultural policy. An increasing awareness of consumers in food prices, food safety standards and marketing, together with widening concern over the rapid expansion of the food manufacturing industries, and with it the augmentation of its political lobby, has created an expanding political platform on which food and food policy has become a major political issue. At one time considered to be a separate entity, agriculture has now blossomed out to become an integral part of the ever increasingly large and complex machinery of the U.S. economy.

Structural changes have also occurred within agriculture--partly as a result of the increasing international and political aspects of food policy, and partly as a result of its own changing nature. In the past decade, there has been a substantial decrease in migration of labor from farm to city, a decrease in the amount of total technology which exudes into agriculture, but a large increase in specialization of farming practices, and tremendous increases in the costs of production due to inflation and resource constraints. These changes have been responsible for a change in the behavioral attitudes of producers. The increased specialization has lead to increased susceptibility of farmers to unstable price and quantity fluctuations. These tremendous shifts in the terms of trade which farmers operate under has resulted in increased investment in land and capital in an attempt to reduce the riskiness of the operation of the farm unit and leading to situations of overinvestment (Johnson and Quance, 1972).

There is little doubt that some substantial changes have also taken place in Agricultural Economics as a discipline, and will continue to take place in the future. These changes are characterized by two aspects:

(a) changes in the basic philosophy underlying Agricultural Economics; and

(b) changes in the analytical techniques.

These two facets of change are not entirely independent of one another. Clearly, changes in the basic philosophy of any discipline will lead to new and innovative analytical techniques, although causal changes in the opposite direction are rare.

The nature of the changes which have taken place in Agricultural Economics is therefore a complex interaction between the changing nature of its philosophical base and the accompanying change in analytical techniques (see Johnson, 1977) and changes which have occurred in the economy. As a result of these changes, many of the goals of agricultural policy have changed.

Goals of Agricultural Policy

In his paper on the new macro economics of agriculture, Schuh (1976, p. 810) concludes:

> We are now faced with new challenges. The domestic structure of agriculture is changing, especially in the way that agriculture is linked to the nonfarm sector and in the contribution that agriculture makes to the larger economy. At the same time, the U.S. is increasingly linked to a large and rapidly changing world economy. Events in the rest of the world are now as important to the strength and vitality of the food and agriculture sector as are developments in the domestic economy.

These remarks serve to emphasize not only the increasing complexity of agricultural policy, but also the need for a much broader reference base upon which agricultural policy can be aligned with the goals of the larger economy so that conflicting goals do not occur. The changes which have taken place in the goals of agricultural policy, in response to the increased international participation of agriculture, the increased political participation and the structural changes which have occurred, is most dramatically demonstrated by a comparison of published goals between 1945 and the present.

In his book on forward prices in agriculture, Johnson (1947) lists six agricultural policy goals.

1. Maximum total return from a body of resources.
2. Provision for economic growth and progress.
3. A minimum level of living, based on social welfare criteria, for all.
4. Cross inequalities of income should be mitigated.

5. Any particular economic group should receive a per capita income which is on a par with other comparable groups in society.
6. The distribution of income should in time be reasonably stable or changing at a constant rate.

It is clear that Johnson's goals are based on an overt need to "put the domestic house in order." In contrast, literature in the last decade states a very different set of goals for agricultural policy. A summary list of common concerns provided by Cochrane (1974), Brandow (1976), Paarlberg (1972), Thor (1972), and Raup (1975) includes:

1. A clear unpolluted environment.
2. More efficient energy usage.
3. Food availability for the world.
4. Concern over the causes and effects of price inflation.
5. Education of rural communities.
6. Stability of prices and incomes.
7. The need for increased anti-trust action and protection of both producer and consumer from the influences of large corporate institutions.

The list could go on and on, each one emphasizing the increased importance of a holistic view of agriculture, its role in the larger food system, and increasing concern over welfare equality. Efficiency in resource use has become a much more specific issue related to energy and environmental protection. Economic growth is no longer an issue but is replaced with a concern over minimum living standards has expanded to include world wide equality. The result has been a peculiar polarization of individual and community aims. Farm production has become much more specialized while government policy has become broader and more holistic. The need for compatibility of aims and objectives is the major problem facing agricultural policy makers today.

The Issue of Price Instability

Price instability has been an issue in agriculture since the inception of economics as a discipline. More recently, the issue has been specifically singled out as a problem as a result of the depression of the 1920s. In general, U.S. agricultual policy since the 1930s has reflected an attempt to increase and stabilize returns to resources in agriculture. Most programs have been attempts by government to manipulate demand or control supply with the dual objective of increasing and stabilizing incomes. Policy instruments are used to improve efficient resource allocation by providing forward planning prices, and in doing so, improve social welfare. By stabilizing prices, one element of instability in producer income is removed.

It should be recognized that instability per se is concerned with price, income, production, and consumption instability. The categories cannot be separated if instability is to be dealt with effectively. On the other hand, to deal with such a large topic would be a formidable task. This study arbitrarily examines price instability on the basis that price is an outcome of the economic process and is a variable which significantly effects income, production and consumption.

Apart from the need to single out price instability while recognizing that income, production and consumption instability are just as important, price instability itself is a large and complex problem.

With the significant changes which have occurred in agriculture and the resulting polarization of individual and community goals, price instability has become a renewed and even greater problem. The recent demonstrations by farm producers in Washington, D.C. in 1978 and 1979 are testimony to this increased concern. With this concern over price level and instability of price and income comes the disconcerting thought that agricultural economists have not been overly successful in approaching the problem.

Many of the issues are of course emotive ones, but the concern of what lies behind the emotive issues forms the basis of much of the political action to date. Government programs directed toward instability in agriculture include a broad slate of policies roughly divided into demand oriented and supply oriented programs. Demand oriented programs include (a) changing the aggregate product demand curve facing producers using storage and disposal programs; (b) market differentiation using quotas, tariffs, and commodity agreements; (c) programs to increase consumption of farm products such as food stamps, subsidized consumption and export subsidies. Supply oriented programs include: (a) acreage allotments and price support programs; (b) land retirement; (c) marketing quotas; and (d) information supplying programs.

Most of the research on instability can generally be divided into three major areas.

1. The Need for Stabilization.

While some empirical work has been carried out in this area, most of the research has been theoretical in nature, stemming from two sources. The first, and possibly the more important source of work, has been carried out by agricultural economists such as Benedict (1953, 1955), Benedict and Stine (1956), Hathaway (1963), Clawson (1968), and more recently Johnson and Quance (1971). The second source of literature is in the quantitative/welfare area coming from the work of Waugh (1944), Oi (1961), Massell (1969), Turnovsky (1974, 1976), Subotnick and Houck (1976) and Just (1974, 1976, 1977, 1978). The questions asked, and the solutions posed are varied and complex, but the end result is generally that there is a felt need for stabilization. Some, however, feel that stabilization, and in particular price stabilization, is not necessary, and may be more detrimental than beneficial (see, for instance, Campbell, 1977 and Robinson, 1975).

2. International Trade.

With the liberalization of international trade has come a concern for the sources of instability not only in agriculture, but in the entire economy. The conflict between protection of domestic interests and free trade becomes a major issue (see Johnson, 1973). The effects on agriculture appear to be even more devastating (see Johnson, 1973; Turnovsky, 1977; Anderson and Riley, 1976; Heuth and Schmitz, 1972).

3. The Feed-Grain Livestock Relationship.

With the increasingly important linkages between the feed-grain and livestock industries and the increase in specialization in both industries, concern over price instability in the grain industries which would have detrimental effects for the livestock industry is a major issue. The issue revolves around whether livestock interests have an equal voice in policymaking or whether their interests have been ostracized (Breimeyer and Rhodes, 1975). Whether or not livestock industries should also have stabilization programs is also an issue

(Robinson, 1975; Parton, 1978; Freebairn and Gruen, 1977). While these three general areas of research provide most of the large literature on price instability in agriculture, two other areas are worthy of mention. The first is the disaster payments programs and insurance. This area specifically enters the realm of risk and uncertainty and its effects on price, income production and consumption. (See, for instance, Knight, 1921; Johnson, 1947; Benedict and Stine, 1956; and more recently Miller and Allen, 1977; Anderson, Hazell and Scandizzo, 1977; and Just, 1978.) The second area is that of government induced instability. According to Sharples and Slaughter (1976) "If government intervention is highly unpredictable, producer and consumer uncertainty is increased, and conversely; if that intervention is predictable, uncertainty caused by intervention is minimized."

Each of the above mentioned areas of research is, in itself, a large area of research, although they are all interrelated. Having already limited the extent of this study to price instability, it is necessary to further refine the topic to a specific area of research, namely the first mentioned--the need for stabilization. Just as it is recognized that price instability cannot be separated effectively from income, consumption and production instability, so, too, it is recognized that research on the need for stabilization cannot be divorced from the other areas of international trade, the livestock feed-grain relationship, insurance and government induced instability. From time to time, these topics will be broached in this study because of their interrelatedness and a need to clarify issues.

Finally, in order to reduce the study to manageable proportions, one further refinement is necessary. Most of the current literature on the need for price stabilization has concentrated on showing that the need for price stability is in its effects. That is, research has concentrated on showing that economic welfare will be enhanced if prices are stabilized. Ensuing discussion revolves around the effects of price instability and how it can be combatted. This approach has lead to the popular conviction that since it is price instability that creates problems for society, then direct intervention at the price-level is the most effective way of solving the problem. This has been the basic philosophy behind the price support schemes and their development as we know them today. Little, if any, research has been carried out on the "causes" of price instability. The problem is complicated by the confusion which exists as to whether price instability is a "cause" or "effect." Depending on the individual perspective, price instability is the "cause" of many other problems, and is a specific problem itself. When price instability itself is a problem its "causes" are often confused with its "effects." This study concentrates on the causes of price instability although at times it is never certain whether a difference between "cause" and "effect" actually exists since the "effects" of instability are partially responsible for its "causes."

The justification for studying the "causes" of instability may be attributed to the old adage that "it is better to treat the cause rather than the symptom." That price instability is the "cause" of many problems is undisputed. That price instability is indeed a symptom is a subject for debate. That price instability has "causes" which might enlighten the approach towards a solution is the topic of this study.

Summary and Plan of Study

The evolution of and resultant changes in the food system has created the need for a more holistic and dynamic approach to policy issues in agriculture. The issue of instability in agriculture has been an important one with respect to the goals of society in general, and of agriculture in particular from 1921 to 1960. Since 1960, increased trade liberalization and production specialization has lead to increased interest in price instability. While instability is a large and complex issue, this study is limited to an examination of price instability, while recognizing the other interrelated variables of income, consumption and production instability. In further refining the problem to be examined, the need for stabilization is singled out as being important, but recognizing that the related areas of international trade, the livestock feed-grain relationship, insurance and government induced instability are of paramount importance to the topic as a whole. Finally, in order to reduce the study to a manageable size, it is intended that this study concentrate on the "causes" of instability rather than the "effects" since: (a) most research has concentrated on the latter and little on the former; and (b) that it is better to treat the "causes" rather than the "symptoms."

Chapter 2 will deal with a review and appraisal of past work on price instability and attempt to draw out some of the problems involved with definition, performance criteria and analytical technique. In order to deal with these problems, a broader framework is introduced in Chapter 3 which lends itself both to theoretical and empirical analysis.

Chapter 4 begins with an analysis of instability by operationalizing the principles of the approach described in Chapter 3 and examining a potential definition and some performance criteria which can be useful in an empirical mode.

Chapter 5 presents a systems model of analysis, and examines some theoretical and empirical aspects of the "causes" of instability. Chapter 6 deals with possible methods of control, design and management of unstable systems. Chapter 7 presents some possibilities for a modified neoclassical approach to the issue of price instability, and Chapter 8 summarizes the study and draws some conclusions.

CHAPTER 2

HISTORICAL ANALYSIS OF PRICE INSTABILITY

In order to gain some perspective of the subject matter of price instability it is necessary to review the relevant literature in order to evaluate its contributions to an explanation of the causes of instability. As previously mentioned, the field is an extremely broad and complex one, making it difficult to summarize all of the ideas in a compact way. Basically there are three broad fields of literature which need to be examined. First, a most important area of work has been carried out by agricultural economists in attempts to explain disequilibrium prices (and income) in agriculture and the failure to achieve efficient resource allocation, particularly in the short-run during periods of declining farm product prices. The second area of research has been the purely theoretical one of attempting to quantify and measure welfare. The third area, and one which attempts to put the first two areas together is the attempt to measure the welfare impacts of stabilizing prices. It is in this third area that the development of theoretically quantitative models has occurred, and which will form, for the most part, the review of analysis of price instability.

Disequilibrium Prices and Resource Allocation

According to Hathaway (1963), until the 1950s it was generally believed that the disequilibrium problems in agriculture were the result of short run instability, and most of the price and income policies have been directed toward a reduction of this instability. Since the late 1940s, however, it appears that disequilibrium problems are found to be concentrated in the factor markets for inputs and in the uncertainty regarding future production techniques. With respect to the disequilibrium created by input markets, work initiated by Schultz (1939) and D. Gale Johnson (1947) and continued by G. Johnson and Hardin (1955), G. Johnson (1959), and Edwards (1959) has done much to explain the persistent disequilibrium in agriculture most evident in the low returns to labor and capital. G. Johnson's (1972) Overproduction Trap in U.S. Agriculture spells out the result of the differences between acquisition and salvage values culminating in an investment/disinvestment or fixed asset theory. In short, the persistent disequilibrium in agriculture is a result of resources being trapped in the agricultural sector.

The importance of uncertainty in agricultural economic theory dates back to Knight (1921) with subsequent recognition from Schultz (1945) and D. Gale Johnson (1947). More will be written about this later.

A major consequence of these explanations of the persistent disequilibrium in agriculture has been the price support programs for various commodities throughout the decades from 1920 to the present. The relevance of these programs to price instability is large, but the major rationale for price support (as opposed to price stabilization) is a result of the realized low returns to labor and capital in agriculture. That is, the problem of price (and income) instability is mixed up with the matters of maintaining farm incomes at some desired level. (For a summary of these programs, the rationale and effects, see, for instance, Benedict, 1953, 1955; Benedict and Stine, 1956; Hathaway, 1963; and

Clawson, 1968.) The question of price instability has therefore become entwined with the broader issues of price (and income) support.

Of importance, also, are studies relating to the impact of price support programs on agriculture, which examine the effects of reducing uncertainty due to a variety of sources. Such studies have been carried out, for example, for the tobacco industry (Johnson, 1952), the potato industry (Gray, Sorenson and Cochrane, 1954), and dry beans (Hathaway, 1955).

It is important to note that the issues involved in price stabilization are somewhat different to those of price supports. However, it is also important to recognize the intertwining nature of the two issues. From time to time throughout this study, reference will be made to some of the issues involved in the question of price supports. It is impossible to completely divorce the two. In particular, while the question of price instability (as opposed to price support) has been recognized as a specific problem in agriculture since the 1920s, it has often been used to justify price support programs. Whether or not this is justified is a complex question, involving the issue of the magnitudes of returns to productive resources in agriculture.

Development and Description of the Neoclassical Model

The development of theory relating to instability appears to have been taken in two stages. The first stage might be called the market equilibrium approach. Neoclassical theory holds that there is no guarantee that an equilibrium price will be established if the market is not in equilibrium when contracting begins. Movement of the supply and demand curves create disturbances, and in general, a disturbance denotes a situation in which the actual price is different from the equilibrium price. An equilibrium is stable if a disturbance results in a return to equilibrium--and is unstable if it does not. Much more rigorous definitions of market stability are given by Samuelson (1948) and Baumol (1959), but the above is essentially the basis of a simple definition. Stochastic fluctuations in demand and supply can therefore be analyzed by means of expectations models which establish the conditions for stability.

The second stage of theoretical development might be called the economic surplus approach. This stage is directly related to the first by virtue of the popularly held conviction that any movement (stochastic or deterministic) in the demand-and-supply curves will have welfare implications for participants in the market. Use is therefore made of the concepts of economic surplus as measures of welfare in order to determine the effects of movements in the demand-and-supply schedules as a result of their stochastic (or deterministic) properties.

This two-stage approach was first used by Waugh (1944) who showed that each individual consumer is <u>better</u> off with prices that vary than he would be if prices were stabilized at or above their unweighted arithmetic means. Howell (1945) and Lovasy (1945) demonstrated, however, that each individual consumer is <u>worse</u> off with prices that vary than he would be if prices were stabilized at or below their <u>weighted</u> mean. At a somewhat later stage Oi (1961), in what appeared at the time to be an unrelated note, examined the behavior of a competitive firm facing uncertain demand and concluded "given a fixed expected value of price, $\overline{P}$, the greater the variability of price about that expected value, the greater will be expected profit."

It appeared, at least theoretically, that neither consumers nor producers would gain if prices were stabilized. However, to consider whether or not consumers would benefit when it was their behavior which created uncertainty, requires the simultaneous treatment of both groups in the same model. This was recognized by Massell (1969) who then integrated the Waugh (1944) and Oi (1961) models into a single framework and derived a number of results:

1. Producers gain from price stabilization if the source of price instability is in their own production
2. Consumers gain from price stabilization if the source of price instability is in their own consumption behavior
3. Simultaneous random shifts in supply and demand leaves indeterminate the welfare implications for producers and consumers
4. The total welfare gains from price stabilization are always positive

In theory, a market should be able to be described and the conditions under which it is stable be derived. The simplest type of single market can be described with linear supply and demand curves.

$$D_t = \alpha_t - a\,P_t + \mu_t$$

$$S_t = \beta_t + b\,P_t + \nu_t$$

where D_t, S_t, and P_t represent demand, supply, and price, respectively, in time (t). μ_t and ν_t are additive stochastic disturbances which result in parallel movements of the supply and demand curves. α_t and β_t are trend elements or shift parameters.

Since in equilibrium demand equals supply, equilibrium quantities and prices are found as follows:

$$D_t = S_t = \frac{\beta_t\, a + \alpha_t\, b}{a + b} \qquad \frac{a\, \nu_t + b\, \mu_t}{a + b}$$

and

$$P_t = \frac{\alpha_t - \beta_t + \mu_t - \nu_t}{a + b}$$

If a buffer stock is established which will buy or sell stock at a stabilized price (P_s), this buffer stock is established so that the market balances on average (over time) such that expected demand is equal to expected supply:

$$E\,(P_t) = P_s = \frac{\alpha_t - \beta_t}{a + b}$$

and the stabilized demand and supply is

$$D_s = \frac{\beta_t\, a + \alpha_t\, b}{a + b} + \mu_t$$

$$S_s = \frac{\beta_t\, a + \alpha_t\, b}{a + b} + \nu_t$$

These then are the conditions for a simple price stabilization scheme. Notice that by comparing P_s with P_t, such a scheme implies that price is stabilized at its arithmetic mean.

The first stage (the market equilibrium approach) has identified the stability conditions for market equilibrium, given that some random disturbances occur which shift the supply-and-demand curves. The second stage (the economic surplus approach) necessitates stating a policy goal. Specific policy goals are, of course, extremely difficult to define, especially when faced with two groups (producers and consumers), both of which have somewhat conflicting utility maximizing goals, and either of which may or may not gain or lose from price stabilization. One could therefore reason that a suitable policy goal might be one which overall allowed welfare gains to society (as a whole). The performance criterion then is that welfare gains to society are positive. In order to derive these gains (or losses) to society it is necessary to estimate the economic surplus which might result from stabilizing prices. The method used by Waugh (1944), Oi (1961), Massell (1969), Turnovsky (1977), and Just (1977) is to examine the change in producers' and/or consumers' surplus. The nature of this process is demonstrated in Figure 2.1. In Figure 2.1 demand does not fluctuate, whereas supply does. Now, if demand (D) and supply (S) are <u>not</u> subject to random fluctuations, the equilibrium price will be P_0 and consumer surplus is given by (a + b + c). If S_1 and S_2 are the positions assumed by the supply function as a result of stochastic shifts, then consumer surplus will be a if S_1 results and (a + b + c + d + e + f) if S_2 results. Thus, the gain in consumer surplus is [(a + b + c) - a = b + c] if S_1 results. If the nonstabilized supply function was S_2, then a loss in consumer surplus results [(a + b + c) - (a + b + c + d + e + f) = - (d + e + f)]. Provided the parallel movements in supply are equal and the slopes of the demand and supply curves are negative and positive, respectively, then (d + e + f) > (b + c), and consumer surplus will decline as a result of the introduction of a stabilization scheme, i.e., Waugh (1944) results. Similar constructions allowing both demand and supply to fluctuate give results for both producer and consumer surplus. Supposedly, summation of both producer and consumer surplus gives the net welfare gains to society.

Going back to the original simple linear model, the change in producer surplus is given by the area above the supply curve and between the (new) stabilized price, P_s, and the original equilibrium price, P_t.

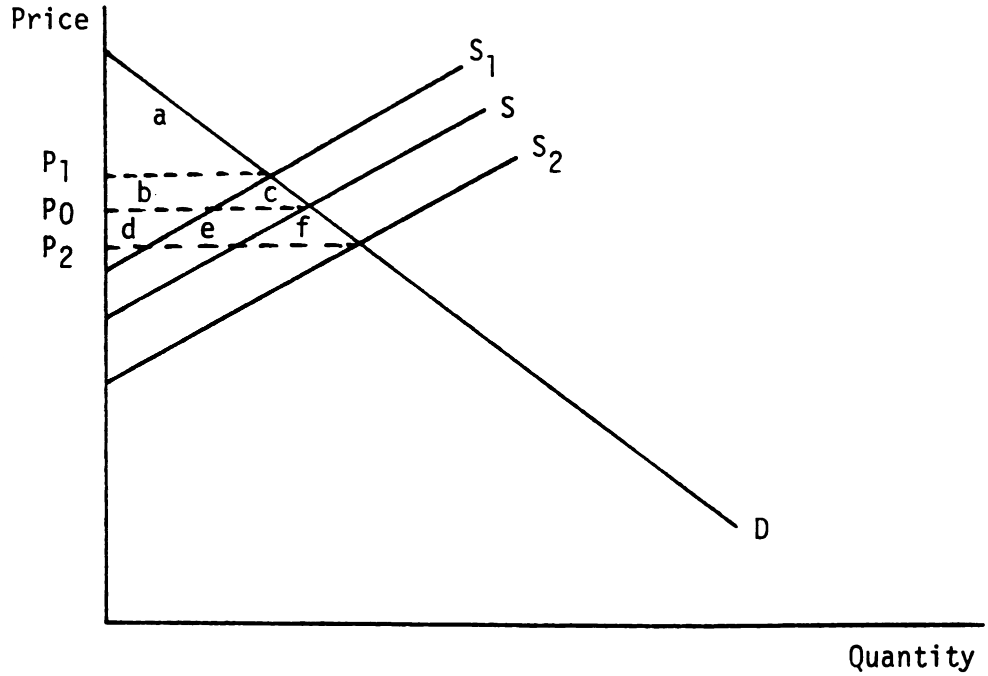

Figure 2.1

Consumers' Surplus under Fluctuating Supply

$$G_p = \int_{P_t}^{P_s} S(P)\, dP$$

$$= \frac{1}{2} [P_s - P_t] \; [S(P_t) + S(P_s)]$$

Similarly, the change in consumer surplus is given by the area below the demand curve and between P_s and P_t.

$$G_c = \int_{P_s}^{P_t} D(P)\, dP$$

$$= \frac{1}{2} [P_s - P_t] \; [D(P_t) + D(P_s)]$$

Taking expectations of both expressions yields:

$$E(G_p) = G_{11}\, \sigma_u^2 + G_{12}\, \sigma_v^2$$

$$E(G_c) = G_{21}\, \sigma_u^2 + G_{22}\, \sigma_v^2$$

where

$$G_{11} = \frac{-b}{2(a+b)^2} < 0$$

$$G_{12} = \frac{2a + b}{2(a+b)^2} > 0$$

$$G_{21} = \frac{2b + a}{2(a+b)^2} > 0$$

$$G_{22} = \frac{-a}{2(a+b)^2} < 0$$

Total expected welfare gains is the summation:

$$E(G) = E(G_p) + E(G_c)$$

$$= G_1\, \sigma_u^2 + G_2\, \sigma_v^2$$

where

$$G_1 = G_2 = \frac{1}{2(a+b)} > 0$$

From these results, Massell's (1944) conclusions as previously reported, follow.

Some Problems with the Neoclassical Model

As with any economic analysis, there is always a fine line between what may be considered a "problem with analysis" and what is considered as "an acceptable assumption." Advancement in economics has generally proceeded in steps which show that certain assumptions may be unacceptable, and then replace the unacceptable assumptions with "more acceptable" ones. The development of theory relating to instability has been no exception to this general rule. In order to demonstrate some of the potential problems with the simple linear model developed in the previous section, it is necessary to review the assumptions underlying it.

There appear to be four broad problems associated with the use of the conventional economic model referred to above and these will constitute most of the rest of this study. They are as follows:

1. A definition of instability
2. Appropriate analytical technique(s)
3. Appropriate distinct and coherent performance criteria
4. The existence of asset fixity due to the existence of a differential between acquisition costs and salvage value

These problems are not independent of one another, and it is indeed a major aim of this study to show how these problems are interrelated. The remainder of this chapter will address these problems as separate entities. However, since the fourth problem, that of asset fixity, has been dealt with adequately elsewhere, it will not be specifically dealt with here. Ensuing chapters will examine the interrelatedness of the first three problems.

Asset Fixity

As previously mentioned, G. Johnson's (1962) major contribution to neoclassical theory has done much to explain the persistent disequilibrium in agriculture. Of further importance is that the fixed asset theory points out explicitly why conventional modern welfare theory cannot be used to evaluate economic adjustments. The theory itself is laid out in Johnson's (1972) Overproduction Trap in U.S. Agriculture and summaries are outlined in Hathaway (1963) and more recently Buse and Bromley. The theoretical implications are outlined briefly as follows. Within conventional neoclassical economic theory, two assumptions are made explicitly, which, when accounted for, substantially increases its explanatory power of disequilibrium in agriculture. That is, when it is assumed that (1) there exist differentials between acquisition costs and salvage values, and (2) there exists imperfect knowledge; some reasons for the existence of a persistent disequilibrium in agriculture become clear. The recognition of these assumptions reveals that under various conditions under- or over-production can occur which may or may not be completely corrected. In some cases, errors of overproduction may be partially corrected by expanding production while in other cases, a reduction in production would be the least loss action. In still other cases there are no solutions in which overproduction can be corrected (see Johnson, 1972). Further analysis reveals that the supply function differs for increases in price from that when prices are decreasing (i.e., reversible supply functions only occur when acquisition cost is equal to salvage value and there is perfect knowledge). In addition to these theoretical findings, imperfect knowledge of technological, human and other changes creates errors of organization of the farm-firm production schedule, resulting in non-pareto better situations.

A major consequence of this theory is that conventional neoclassical economics theory cannot be used to evaluate economic adjustments using aggregative measures such as producers and consumers surplus. Further expansion of these ideas will be dealt with later. While some references will be made to fixed asset theory throughout the text, consideration of it as a specific area is not included in this study. It is important, however, to understand that this addition to neoclassical theory presents consequences which call for a much more serious look at evaluation of economic adjustments from the point of view of welfare.

Definition of Instability

Apart from considerations of the combination of issues which face agriculture in general, of which instability is one, instability has had the strange distinction of remaining a rather obscure and somewhat indefinable concept. That is not to say that economists do not know what the problem is. It is perfectly clear that when economists talk about instability they imply that unexpected fluctuations in the system create a situation whereby the system deviates from a desired or expected outcome. What has gone undefined in economic terms is the clear distinction between a deviation or fluctuation which is considered to be stable, and one which is unstable.

Instability is most commonly used to describe fluctuations which occur in any system, but this is quite inaccurate. A system may fluctuate, but may be quite stable or may have dampening fluctuations. Instability in this case usually refers to explosive fluctuation.

Instability is often used emotively. Prices which fluctuate in the open market, for instance, are often described as unstable depending upon the speed at which they rise or fall, the length of time between ups and downs, or simply the number of times they deviate from some norm.

Typically, in economics, instability has been measured in terms of statistical measures such as

1. Absolute deviation from mean or trend
2. Standard deviation from mean or trend
3. Coefficient of variation--a so-called dimensionless statistic

Clearly, such fluctuation measures require some comparative norm before they can be used to declare that something is stable or unstable. Who shall choose the norm and on what basis should it be chosen?

Graphing is another common method of exhibiting instability. Here again value judgements are made on the basis of the observed number of turning points, the trend of the fluctuations, and the rapidity of fluctuations which occur. It is never clear, for instance, whether a large number of small fluctuations constitute a lesser or greater degree of stability than a few large fluctuations.

Within the conventional approach to instability, there exists some doubt as to the clarity of the definition of instability. On the one hand, the explicit definition is one of describing the fluctuating nature of prices as a result of movement in the supply-and-demand curves. On the other hand, there is an implicit definition of mathematical instability in arriving at the mathematical conditions for stability. This is both confusing and somewhat inconsistent, and might be explained by several aspects of the conventional approach.

It is generally accepted that stability is defined by a situation in which variables, after some initial disturbance, approach their equilibrium over a period of time. When the situation does not return to equilibrium then the system is considered to be unstable (Samuelson, 1947). By strict definition then, an equilibrium market would not exist if it were unstable, since it would never reach an equilibrium. Therefore, testing for mathematical stability would not seem to make much sense.

What is perhaps more interesting is to find the mathematical stability conditions for a mathematical model of the market. Mathematical models can be split into two components--the known or deterministic component and the unknown random variation or stochastic component. Similarly, a distinction is made between deterministic and stochastic stability. Deterministic stability refers to those conditions which must exist in order for a system to be stable in the absence of stochastic error. Hence, the common approach in assessing stability of demand-and-supply functions is to take their expected values and examine the stability of the remainder. This is the same as ignoring the stochastic nature of the relationships and concentrating on their deterministic aspects.

Stochastic stability, in contrast, refers to those conditions which must exist in order that stochastic disturbances do not destabilize the system upon which it is imposed. This is generally analyzed with the use of a Liapunov distance function.

Deterministic stability does not imply stochastic stability in general. (The converse is also true.) It is therefore necessary to establish within the conventional approach that a system is mathematically stable only when conditions exist for both deterministic and stochastic stability. Thus, a major part of the literature on price stability deals with the effects of the interaction between deterministic and stochastic stability (see, for instance, Turnovsky, 1968, 1973).

How does all of this relate to the confusing and inconsistent definition of instability? The mathematical stability conditions only refer to the mathematical model of the market. These conditions are interesting only when the actual conditions of the market approach these bounds. That is, once it is established that actual market conditions are mathematically stable, other criteria must be used to justify a further reduction in fluctuations which occur. Since, by definition, a market can only exist if it is stable--then all existing markets must fall within the bounds of the mathematical stability conditions. Inside the bounds of the mathematical stability conditions the market is free to fluctuate--and yet still remain mathematically stable. Hence, there are no mathematical conditions which can describe an optimal degree of stability. The optimal degree of stability is either perfectly stable (no fluctuation at all) or may refer to anything which lies inside the bounds of mathematical stability. There is no known objective mathematical condition in between. Of course, if there was a consensus of agreement that a certain level of fluctuation--measured, say, by the coefficient of variation--was undesirable, then other optimal degrees of stability become applicable. As stated previously, who shall choose the norm and on what basis should it be chosen?

Analytical Techniques

While there is a great deal of literature about instability in agricultural economics, most of the consideration has been given to the question of price supports as opposed to price stability. The intertwining nature of the two questions is demonstrated in Johnson's (1972) Overproduction Trap. In this study, specific interest is centered around the theoretical quantitative model, which, although inadequate, is the only attempt to deal with the welfare effects of price instability (as opposed to price supports). Consequently, it is necessary to review a much narrower field of literature concerning the problems of the neoclassical model. The most extensive survey of this narrower field is provided by Turnovsky (1977). While he has ignored the asset fixity theory completely, other problems also arise in the model which are now discussed.

Linearity and Additive Stochasticity

The basic model described in the previous section was formed with two key underlying assumptions. The first is that the demand-and-supply schedules are linear including the random disturbances. Additive stochastic disturbances imply that the demand-and-supply curves move in a parallel fashion. This assumption is responsible for the conclusions arrived at in the basic model. More importantly, however, are the empirical findings of many economists that nonlinear relationships may be superior and therefore more applicable to market studies. Furthermore, as Hazell and Scandizzo (1975) point out, stochastic movements in the supply-and-demand schedules may well change their slopes as well as their positions. This suggests that multiplicative disturbances may be more appropriate. Turnovsky (1977) therefore reformulates the basic model so that it is multiplicative in nature, and in particular, so that the stochastic disturbance terms become multiplicative. This results in substantial modifications to the conclusions which Massell (1969) reached. With multiplicative errors and nonlinear supply-and-demand curves the "desirability of stabilization" (determined by Turnovsky to be positive net welfare gains) is determined independently of the origin of stochastic disturbances, or any specific parameters characterizing their probability distributions such as their variances. In the case of the multiplicative analogue of the original linear model, it is the price elasticity of demand which determines whether or not there are gains from price stabilization. Specifically, Turnovsky shows that if the price elasticity of demand is greater than unity, then producers gain from stabilization, while consumers always gain from price stabilization irrespective of the magnitude of the demand elasticity. (Supply elasticities do not affect the results at all.) Turnovsky also concludes that, overall, net welfare gains will always be positive unless either demand or supply become infinitely elastic, in which case they may become zero.

Certainty and Price Expectations

The second key assumption under which the basic model is derived assumes that all decisions are made under conditions of complete certainty. Turnovsky (1977) argues that this is perfectly natural for the demand side, but for the production side this assumption is much less plausible. Production decisions must be made before the actual market price is known, therefore producers must base their decisions on expected price. This is particularly so in agricultural industries in which a great deal of time might elapse between the decision to produce and the time to sell, and in which producers are increasingly restricted in their abilities to modify production after the decision is made to produce.

Turnovsky's solution to this problem is to outline a model in which supply decisions are based on expected prices. He uses two widely recognized mathematical mechanisms. The first is the Nerlovian (1958) lagged expectations model and the second is the Muthian (1961) rational expectations model. Both of these models have unfortunately only been developed for the linear model, thus, consideration is only given to the basic linear model. Again, the conclusions of the Massell (1969) model are substantially modified by the introduction of either of these models. Under the adaptive expectations model, analysis of expected gains becomes extremely complicated. While the conclusions about demand remain essentially unchanged from the original analysis, the analysis of expected gains for producers results in some parameter signs becoming indeterminate, and dependent upon the assumptions of how the stochastic disturbance terms are correlated. That is, indeterminacy of sign becomes a major problem because stochasticity in supply induces stochastic movements in the demand schedule as well. Turnovsky is able to conclude, however, that net welfare benefits from stabilization appear to be positive, even though one group may lose.

Using the rational expectations model, Turnovsky is able to come to much more definite conclusions:

1. Producers lose from price stabilization if the source of price instability is random shifts in demand, provided that these random disturbances are autocorrelated (either positively or negatively). They gain from having supply fluctuations stabilized, irrespective of their autoregressive properties
2. Consumers lose (gain) from price stabilization if the source of price instability is random shifts in supply (demand)
3. The total gains from stabilization are always positive

While Turnovsky has managed to show that net welfare gains from stabilization are positive irrespective of the two price expectations models used, the major conclusion demonstrated is that whether or not producers lose from price stabilization depends crucially upon how expectations are generated as well as the autoregressive properties of the stochastic disturbances. The real point is, which price expectations model should be used for analytical purposes? Empirical results do not show that one model is superior to the other. Furthermore, econometric studies are now using more complex types of lag structures such as polynomially distributed lags and rational lag models, of which adaptive expectations and rational expectations models are special cases.

Subotnik and Houck (1976) use a rational expectations model within the basic linear model relying on some restrictive assumptions about the autoregressive properties of the stochastic disturbance to compare alternative schemes which stabilize both consumption and production at their means. They show that under certain conditions (when the slope of demand curve is more than or equal to twice the slope of the supply curve), the gains from supply stabilization are more than or equal to price stabilization which in turn are more than stabilization of demand. They also demonstrate the effects of variances of changes in government stocks and conclude that the larger the variance, the greater the stocks must be to achieve stabilization, and therefore the higher the costs of the scheme. Furthermore, since the variance of change in government stocks is proportional to the expected social gains, then the storage costs can be ranked in the same order as expected gains from various stabilization schemes, i.e., the more beneficial the scheme, the higher the costs.

These conclusions would obviously change under some other assumptions about the model and its stochastic components.

Finally, it is possible to question the validity of the method of Turnovsky and others which relax the assumption of certainty by introducing price expectation models. If supply-and-demand schedules are derived from underlying utility functions under conditions of certainty, how valid is it to use the derived conditions under certainty to introduce aspects of uncertainty? It would seem more plausible to analyze demand-and-supply schedules which have been derived under conditions of uncertainty.

Introduction of Risk and Uncertainty

While there is a good deal of literature on instability and its analysis, there appears to be a dearth of literature which considers specifically the interrelationship of price instability with risk and uncertainty. D. Gale Johnson (1947), following Knight (1921) and Schultz (1939) recognized this important interrelationship when he argued that allocation of resources in agriculture can be improved only when three fundamental characteristics of price behavior have been addressed:

1. The degree of instability in prices must be reduced
2. The lengthy time span when the marginal rate of return is equal to zero must be eliminated
3. Significant elements of uncertainty in production arising from unpredictable movements in prices should be reduced

Johnson mentions in his text that it is in this last area (reduction of uncertainty) that he hoped to make a contribution. The result, of course, is his well-known doctrine of forward prices. However, Johnson never really focused on the specific interaction of price uncertainty and instability. He appears to keep the two concepts separate, while at the same time recognizing an interaction.

Just (1978) also recognizes an interrelationship between producer risk and instability. His symposium paper specifically focuses on the use of welfare economics to discuss the role of risk in agriculture, identify policies and institutions which reduce the adverse effects of risk, and evaluating their ability to improve the well-being of agricultural producers and others affected by agricultural markets. Just discusses some approaches of reducing the adverse effects of risk in which he includes price stabilization. As already mentioned, Turnovsky (1977) also recognizes this same interrelationship by examining situations in which price expectations mechanisms enter into the distribution of welfare gains from price stabilization. Despite, however, his recognition of the interrelationships between instability and risk and uncertainty, he does not discuss their interaction extensively.

In order to clarify the issue of the interrelationship between instability and risk, the following two questions need to be addressed:

1. Does instability create uncertainty, or is the causal relationship that uncertainty creates instability?
2. Would a reduction in instability reduce risk, or would it be better to attempt to reduce uncertainty in order to reduce instability?

The literature which deals with instability and risk separately is extensive, but it is beyond the scope of this study to deal with both as separate concepts and as interacting entities. In a recent paper, Quiggin and Anderson (1979) make a distinction between risk and instability and examine the implications of various schemes designed to reduce either or both in the context of Australian agricultural exports. They conclude that "schemes which are designed to reduce risk rather than instability hold the promise of achieving many of the benefits potentially available from stabilization" (p. 17).

In order to discuss these interesting conclusions it is necessary to delve into the distinctions between risk and instability. A distinction will be drawn between the causes and effects of uncertainty and instability separately, and their interaction effects on each other.

Self-Liquidating Stocks and Partial Adjustments

One of the basic assumptions used in the above models is the concept of "perfect" stabilization. That is, the analysis assumes that the price will be perfectly stabilized and that the buffer stock authority will buy and sell to exactly offset any random disturbances in supply and/or demand. In reality, this is practically impossible for any authority to achieve if only for the reason that perfect information is not attainable. As Subotnik and Houck (1976) point out, the more beneficial a scheme, the more costly it becomes. There will clearly be a trade-off between costs and level or degree of stabilization. An optimum strategy would obviously be one in which the benefits were more than or equal to the costs of the stabilization scheme. Under these circumstances, it would be expected that a form of partial adjustment would be more appropriate than perfect stabilization.

Turnovsky (1977) analyzes three types of partial adjustment schemes. The first is a price-band policy under which intervention by the buffer stock authority would only take place when the fluctuating price moved outside the established upper and lower price-band levels. While it is possible to analyze such a situation, explicit probability distributions are required to estimate the probability that the price will exceed the limits set. Given the probability distribution of the movement of price over time, this methodology clearly lends itself to estimation of the tolerable limits of price fluctuations when expected benefits are equal to costs of the scheme.

The second type of partial adjustment examined by Turnovsky is a linear adjustment policy. A simple scheme might be one in which intervention by the authority is determined by some function of the difference between actual price and a forecast long-run equilibrium trend price. The authority will buy stock when prices are low and sell when prices are high. Turnovsky raises several issues to be addressed. Some concern must be given to whether or not the linear rule will succeed in reducing the variability of prices. It is shown that certain circumstances lead to a reduction in the variance of prices--but that it is also possible that such a stabilization rule may <u>increase</u> the variability of prices! In general, Turnovsky concludes that the Massell's (1969) results continue to hold, but the possibility exists that they may be reversed. In examining an optimal degree of intervention, Turnovsky concludes that it is possible--but optimality is perfect stabilization in the absence of cost constraints.

The third type of partial adjustment policy examined by Turnovsky is an extension of the linear adjustment rule. Here Turnovsky examines the possibilities of stabilization through publicly announced forecasts--much in the spirit of D. Gale Johnson's (1947) forward price mechanism. Smyth (1974) showed that the publication of rational forecasts formed by government (or a similar authority) will reduce the variance of prices. Turnovsky extends this work to examine the allocation of benefits from provision of this information. He concludes that:

1. Provision of rational price forecasts by public authorities do indeed lead to an increase in price stability
2. Whether or not producers use this forward price information, they will gain from such announcements
3. More gains will accrue to those producers who utilize the information than to those who do not
4. Consumers lose from this forward price information
5. Overall net welfare benefits are positive

Partial Equilibrium

In most of the existing literature, analytical models which examine instability are based on partial equilibrium type models. That is, the usual analysis considers only a single market and consequently abstracts from any repercussions that market may have on other markets, or the rest of the economy. According to Hanoch (1974) treatment of cases in which prices are considered exogenous are also partial equilibrium in nature. Turnovsky (1977) attempts to analyze this assumption by formally maximizing the utility of consumers. He demonstrates that the desirability of price stability for consumers decreases with the magnitude of price and income elasticities, but increases with the convexity of their utility function. It is hard to understand why Turnovsky did not carry out a similar analysis for producers. Nevertheless, his concern for extending the partial equilibrium assumption is well taken. Samuelson (1972) has considered the welfare benefits from price stabilization in a simple general equilibrium model. Using the Pareto optimality of perfect competition, Samuelson shows that stabilization at the perfectly competitive equilibrium is beneficial. Others who have examined the general equilbrium model (but not expressly for the stabilization issues) include Ruffin (1974), Turnovsky (1974), Batra and Russell (1974), and Anderson and Riley (1976). In another paper Fleming, Turnovsky, and Kemp (1977) argue that for problems involving uncertain relative prices the geometric mean, rather than the arithmetic mean, is the most appropriate measure to use.

Performance Criteria

The third and final problem to be discussed is a much more difficult one. In the conventional approach discussed at the beginning of this chapter, the performance criteria used is the concept of economic surplus--producer and consumer surplus--to assess the net benefits and the distribution of benefits from price stabilization. It is difficult to argue that these performance criteria are "wrong." What is questionable is the validity of the definition and analytical technique and its compatibility with the performance criteria. These can be conveniently grouped for discussion into the categories of welfare problem criteria and compatibility.

Welfare

As previously mentioned, most of the existing literature uses the concept of economic surplus to assess the welfare benefits from stabilization. According to Turnovsky (1977), while some controversy involving the use of these measures does exist as well as some well-known limitations, the use of these concepts is justified if applied with care. The potential problem with the welfare criteria can be broken down into several interesting and complex parts. While it is recognized that some criterion like economic surplus is required to assess welfare benefits from stabilization, its ability to deal with the introduction of uncertainty is questionable. As with the problem of certainty dealt with previously, the concepts of economic surplus assume underlying utility functions formulated under certainty. Attempts to apply these same concepts in the case of risk are of dubious validity since the extent to which changes represent improvements depends both on income distribution and the relative importance or weighting attached to individuals. Economists have never been very comfortable making interpersonal comparisons which this approach requires, and, to which it is not suited.

As Turnovsky demonstrates, it is possible to divide distributional effects into two groups--producers and consumers. The value judgement that changes represent improvements as long as the total welfare effect is positive assumes that, if consumers as a group lose from stabilization, producers are able to, and do, compensate consumers from their gains. Apart from the problem as to whether or not compensation actually takes place, the fact that individuals have different preferences is overlooked. That is, consumers or producers as a group are treated as individuals. It is conceivable that stabilization, while having advantages for producers as a group, may involve some producers who will lose and others who will gain. The fact that the total welfare criterion itself is dubious is therefore only part of the problem. The effects of distribution between consumers and producers shares the same problem. The problem is one of interpersonally valid common denominators. It is a problem which has confounded economists since Marshall and is a problem which will continue to confound us. Under such situations, Pareto optimality rapidly loses any meaning that it may have had. While most economists understand and appreciate the problem, they continue to remove themselves from reality by applying these measures to justify policies which are more political than economic in nature. This is largely because economists do not as yet have available operationally adequate measurement tools.

Compatibility

There are three distinct questions which arise when considering applying performance criteria to the problem of instability.

1. Whether or not price instability (as defined by the fluctuation of prices due to movement of supply-and-demand curves) is detrimental to the welfare of the participants in the system
2. Whether or not currently recognized price stabilization schemes actually stabilize prices
3. Whether or not price stabilization (however defined) will negatively or positively affect the welfare of the individuals involved

Regarding these questions in the light of the conventional model described previously, there is little doubt that fluctuating prices do in fact affect the welfare of individual participants. That price stabilization is actually achieved by some currently recognized stabilization schemes, there is also little doubt. What the conventional model apparently fails to do is to distinguish between these two questions. Rather, it answers the third question while implying that the first two questions are taken for granted. Put in another way, it is assumed that if a market is found to be "unstable," then it is also assumed that the effects of instability are detrimental to society and that stabilizing that market will put a stop to the detrimental effect.

Kaspura (1975) shows that the stability of prices is not necessarily compatible with the stability of quantity sold. That is, it is possible that a price stabilization scheme may actually lead to destabilization of quantity sold. Similarly, he indicates that it is possible that the introduction of a price stabilization scheme may actually lead to a destabilization of incomes. Little, if anything, has been carried out (or reported in the literature) with respect to the costs and benefits of stabilization. While some theoretical and practical problems certainly would be involved in carrying out such a study, it is surprising that more thought has not been given to this field.

In short, the conventional economic model requires too many assumptions of a sensitive nature to adequately cope with the problem of instability. That is not to say that a large econometric model would not be adequate. The major criticism comes from the inadequacy of current neoclassical theory of market equilibrium and welfare to deal with the distributional problems of policy.

Summary

The problem of instability is a large, complex and challenging area of research. Past research of the problem has demonstrated the need for a different approach to its analysis. Criticism levelled at the neoclassical approach is not criticism of the neoclassical model itself, but is rather a questioning of whether or not that model is adequate to handle the complex interrelationships involved. A brief summary is provided here to emphasize the major points.

The lack of a clear definition of instability has resulted in some inconsistencies between the analysis of the problem and the performance goals. Of importance has been the relatively inadequate handling of the potential causes of price instability, and of establishing the importance of time and uncertainty which play large roles in the analysis of instability.

In reviewing some of the theoretical work that has been carried out, four broad problem areas are presented. Three of these problems form the basis of this study, while the fourth, that of asset fixity, is not dealt with, but is recognized as a major development in the theory. These developments should be borne in mind throughout the study. This study will attempt to deal with these areas by attempting to conceptualize a different slant to the definition of instability, the performance criteria and a somewhat different analytical technique. The basis of this expansion of the analytical model is presented in Chapter 3. Ensuing chapters will then attempt to apply the broader framework.

CHAPTER 3

A METHODOLOGICAL PARADIGM[1]

Problem Specification

According to Johnson (1977) research can be classified into three types of effort; disciplinary, subject matter and problem solving. Since a single set of problems pertaining to specific prescriptions has been distinguished, the research which follows is typically subject matter research. In response to the implicit philosophical or methodological foundations associated with research the following epistemological precepts are assumed to hold throughout:

(1) Solutions to problems (or prescriptions) are dependent on both normative and non-normative information.[2]

(2) A prescription is only pertaining to the truth when it is objective.[3]

(3) If a prescription is "right," then it must pertain to the truth.[4]

(4) Objectivity of truth is intimately related to the way in which knowledge is generated. To this extent a great deal of importance is placed on the Hegelian or dialectic system of inquiry.[5] It matters not, therefore, what philosophical position one holds,[6] the matter of great importance is the strength of the tests of objectivity in the quest for truth.

In specifying the problem there is no universally acceptable method of determining the bounds of either positive knowledge or of knowledge values. Various problems may be considered in a variety of spatial and temporal dimensions depending on the discipline, the nature of the problem and the level at which the problem is relevant. In economics, several recognizable systems have been established for helping in problem specification and solution. These include the neoclassical framework, the institutional (structure-conduct-performance) model and the Marxian paradigm. It is not intended to imply that these systems are distinctly different to each other; yet they do have differing philosophical origins. In particular, it should be emphasized that there is no dichotomy between the institutional model and the neoclassical model. It is convenient here, however, to choose the larger framework of the institutional (structure-conduct-performance) model, (hereafter referred to as the SCP model), slightly modified and adapted to the systems approach. The systems approach simply offers an opportunity to enrich the SCP model by affording an extra dimension.

The SCP Framework

Institutional economics is not new to agricultural economics. More recently much has been written in the literature on the structure-conduct-performance paradigm which seems to have formed from the principles of institutional and neoclassical economics. It should be made clear from the outset that the choice of this paradigm over the neoclassical framework does not preclude neoclassical economics from consideration. Indeed, as will become clear in ensuing chapters, the neoclassical model forms a large basis for much of the analysis of instability. The choice of the SCP paradigm at this stage is convenient for two important reasons:

(1) It forms a convenient platform on which the problems of instability can be articulated;

(2) It includes (rather than excludes) neoclassical economics in its broad aspects, and places neoclassical economics into the perspective of an overall political economy.

To explain the SCP framework with its multifaceted spatial dimensions would take several volumes; clearly not a desirable intention here. Yet there is the problem of explaining not only how the framework relates to the real world, but to the various levels of conceptualization of a problem. The SCP framework ranges from the highly abstract (the idea that it provides a skeletal structure upon which general theories can be classified) to the very practical [such as those ideas which relate to market concentration, product differentiation, barriers to entry, etc., and their measurement; see, for example Bain, 1959; Clarke, 1961; Scherer, 1970]. One simple way is to start into the framework as Caves (1964) does by simply stating that "market structure is important because the structure determines the behavior of firms in the industry, and that behavior in turn determines the quality of the industries' performance." Though rather simplistic, this is the essence of the SCP paradigm. A more explicit statement about institutionalism is made by Knight (1921, p. xii):

> . . . all "economic" theory in the proper sense of the word, is purely abstract and formed, without content. . . . any question as to what resources, technology, etc. are met with at a given time and place, must be answered in terms of institutional history. . .

Shaffer and Schmid view the political economy as a complex game defining the essential elements of the SCP model as follows.

Structure

Refers to all of the predetermined characteristics of the game and the players, which constrain the players' choices. The structure establishes the opportunity set for each player.

a. Jurisdictional Boundaries - these define who and what are included within a community's (economy's) span of control.
b. Property Rights - these prescribe the means of access and control of the assets of each individual and of the community's (economy's). To have a property right is to have access to a flow of benefits, and to deny access to others (except with your permission).
c. Rules of Representation - these involve the rules for making and interpreting other rules. Who gets to vote on what? Whose preferences count and how are they taken into account in the political process? Who controls the agenda?

Conduct

Refers to all of the choices, decisions, or strategies that the players adopt within the opportunity set established by the structure.

Performance

Refers to all of the consequences of the players' choices which are payoffs to the participants of the game. Performance is the matrix of benefits and costs resulting from playing the game. Performance is the result of the behavior or conduct of the players which result from the structural characteristics of the system.

In contrasting institutionalism with Keynesian economics, Wallace C. Petersen (1977) offers the following rather neat summary.

> Institutionalism does not offer the world a compact and unified set of theoretical ideas as does the neoclassical paradigm, but it does more than reject the latter. It sees the economy as part of an evolutionary, historical process, moving from a known past to an unknown--and perhaps unknowable--future, a process split between two diverse forms of human behavior. Institutions and technology shape behavior, much of which may be irrational. The simple calculus of pleasure versus pain found in conventional economics will not do. In place of self-interest constrained by competition, institutionalism sees coercion and the thrust for power as a well spring for most economic activity. This view of the world leads to a healthy skepticism with respect to the efficacy (and justice) of the automatic organization of society through markets. It provides a more realistic understanding of the power of the state and its use for good or ill, as well as a more sophisticated understanding of why the distribution of income and wealth--much neglected in orthodoxy--is at the heart of what Robinson (1972) calls the "second crisis" of economic theory.

This passage expresses a whole host of ideas, concepts and theories which, while complex in the context in which it is presented, will become much clearer as the approach is developed.[7]

The Systems Approach

Manetsch and Park (1977) define the systems approach as

> a problem solving methodology which begins with a tentatively identified set of needs and has as its result an operating system for efficiently satisfying a perhaps redefined set of needs which are acceptable or "good" in light of trade-offs among needs and the resource limitations that are accepted as constraints in the given setting.

There appear to be two prominent attributes of this approach:

a. it overtly seeks to include all factors which are important in arriving at a "right" solution to the given problem;

b. it makes use of quantitative models (and often computes simulation of those models) to assist in making rational decisions, at many levels where it is appropriate to use such tools (but is not limited to quantitative models).

There are several things which are immediately striking about the systems approach, the most important of which is its similarity in its overall aims to the institutional SCP paradigm. Indeed, such sources as Forrester (1961) and Churchman (1968) make it clear that the aims and objectives of the systems approach have been derived from the same philosophical thinking and background as those of institutional economics. It is this compatibility between the two "approaches" (institutional and systems) which are used to extend and enrich both paradigms and which may aid in arriving at real solutions to real life problems.

Figure 3.1 presents a diagrammatic representation of the way in which the systems approach view problems. Some of the basic concepts involved are defined as follows:

A <u>system</u> is a set of interconnected elements organized toward a goal or set of goals. The system is made up of <u>system inputs</u> which are factors which cause or stimulate a change in system behavior. These inputs may come from within the system or may be <u>exogenous</u> (or environmental) <u>inputs</u>. Inputs may also be classified as <u>controllable</u> or <u>uncontrollable</u>.[8] The <u>system structure</u> is a set of interacting elements and related variables that intervene in the causal chain that links outputs to inputs, and are influenced by <u>exogenous</u> or <u>environmental effects</u> and by <u>system design parameters</u>. A system design parameter is fixed at the time a system is designed. Its value often expresses an important decision variable that affects the performance of the system. <u>Outputs</u> from the system may be classified as <u>desired output</u> which is a

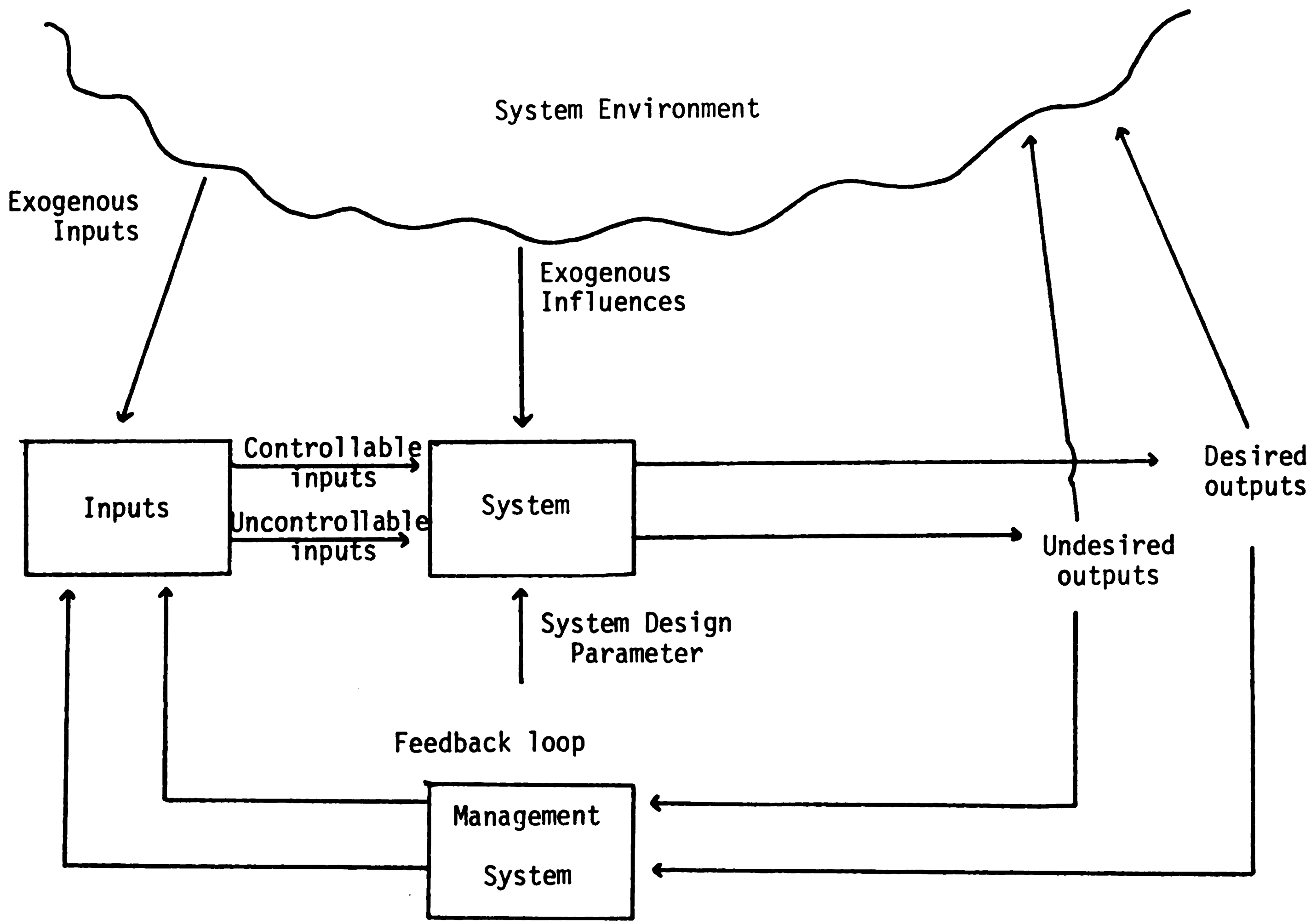

Figure 3.1

A Closed System

means of satisfying a goal for the system, and undesired outputs which may or may not conflict with the achievement of goals. It is recognized in the systems approach that outputs (both desired and undesired) may have effects on the environment which may in turn affect the exogenous inputs and influences upon the system. The system also has feedback loops where system variables are coupled in a way such that a change in one variable causes a subsequent change in that same variable in a future time period. A feedback system can be designed in a manner such that a desired time path of a variable is compared with the actual one and the difference is used to correct the errors, thus decreasing the error between "what is" and "what ought to be." This is the cybernetic "management" function of the system. Management is thus defined as manipulating inputs in order to decrease the magnitude of the error between actual and desired output.

The systems approach, like any other, has limitations that should be made clear. Manetsch and Park (1977) conclude that the systems approach works well when the following conditions are met:

a. when the aims or goals of the system are well-defined and recognizable, if not quantifiable;

b. when the decision making process in the real system is centralized or fairly authoritarian;

c. when a long-range planning horizon is possible.

These limitations to the systems approach (in a practical sense) provide important inputs into the specification and analysis of the problem. While it is assumed initially that all three conditions hold, an important part of the ensuing study will involve relating these conditions.

The systems approach as viewed above performs three fundamentally important functions as an abstract model, and will be referred to as the ADM Concept (Analysis, Design, and Management).

a. Analysis: defined as the determination of model outputs given inputs and system structure;

b. Design or "Planning:" defined as the determination of a system structure given system inputs and desired system outputs;

c. Management or "Control:" defined as determination of system inputs given a system structure and desired outputs.

These three important functions can be summarized in the matrix form of Figure 3.2.

	Inputs	System Structure	Outputs
Management	determine	given	given
Design	given	determine	given
Analysis	given	given	determine

Figure 3.2

Abstract Functions of the Systems Approach

Modification of the SCP Framework

The similarities between the SCP framework and the systems approach go much further than simply sharing a common basic philosophical origin. In particular, it can be seen that the three major subparts of the SCP model (structure-conduct-performance) roughly coincide with the three basic subparts of the systems approach (inputs-system structure-outputs). Furthermore, by superimposing the SCP framework onto the matrix format of Figure 3.2, it becomes clear that the components of both frameworks become interchangeable as in Figure 3.3.

	Structure	Conduct	Performance
Management	determine	given	given
Design	given	determine	given
Analysis	given	given	determine

Figure 3.3

Summary Matrix of the SCP/ADM Framework

The analogy between the SCP framework and the systems approach can be viewed much more in the processes involved than in the interchangeability of the subparts. For instance, the systems definition of inputs does not coincide exactly with the institutional structure, if exact definitions are examined. The institutional (SCP) model provides much broader definitions than the systems approach. However, it is not intended that the two concepts be exactly interchangeable. Of importance is the distinction between analysis, design and management and the iterative process implied by the structure-conduct-performance framework.

Policy Analysis Under the SCP/ADM Concept

Analysis is defined in the previous section as the determination of performance (system outputs) given the structure (system inputs) and conduct (system structure). That is, by examining the structure and conduct (inputs and system structure), it should be possible to determine an expected performance. If actual or expected performance differs from some desired performance level, then design and/or management can be used to make recommendations about changes necessary for achieving the desired performances.

By tracing out the jurisdictional boundaries of a system in institutional economics, distinct boundaries for the problem are made; and this is parallel to accounting for the exogenous influences of the systems approach. That is, differences between that which is exogenous and that which is endogenous are clearly identified. In economic problems this can be both a blessing and a curse. On the one hand, it mandates understanding of the important endogenous and exogenous influences of the system. On the other hand, it can be a curse because even the simplest economic problems can become so broad as to be unmanageable.

Property rights might be viewed as the uncontrollable inputs of the system. As society has developed, the tendency has been to endow individuals and institutions with property rights--that is, the right to use or control resources. Calling property rights uncontrollable inputs does not of course mean that they cannot change. They are controllable in the sense that property rights may be taken away from individuals or institutions. They are uncontrollable in the sense that these rights and obligations have been endowed by society through "law, custom and covenant." If a change is deemed to occur, then it must be changed in the light of what the system has determined are the jurisdictional boundaries. Clearly, a right may be endowed within a narrow set of boundaries, but may not apply generally to a wider set of boundaries. Changes in property rights therefore must be made with due account to the external influences of the system.

Rules of representation may be interpreted as the controllable inputs in the system. They are also rules which can be used to manage the system and to alter the design of a system.

Conduct which is the second dimension of the SCP model, is simply another word for behavior. It is the "choices, decisions or strategies adopted by the participants in the political-economy, given the opportunity set established by the structure." Conduct is the important linkage between structure (inputs) and performance (outputs) of the system. It fills the place of the system structure in the systems approach, determining the actual outcome of any particular set of structural inputs. Within the political-economic model, conduct will involve an understanding of the actions of individuals and institutions.

Conduct or behavior as such, however, is not a definable element of the system--but is rather the result of the underlying structure of the system. It is a dynamic aspect of the system which is reinforcing and at the same time is reinforced by itself.[9] To quote Shaffer (1977):

> the personality of each individual in a society is constantly being developed--reinforced or modified--under the influence of economic activities of himself and other members of society. At the same time, the economic activities are largely controlled through the personalities of the members of society. Thus, there is a continuous interacting process in which the members of society are in a real sense a product of their own economic activities of the past, and of the effects of their economic activities of the present and future.

Determination of performance which is the third dimension of the SCP model is the aim of policy analysis. Within the SCP/ADM framework it is necessary to identify both desired and undesired performance (outputs) for, in considering both, allowance is made for the widest possible implications of observed performance.[10] However, determination of desired performance has been the bane of the economist's life. Two problems are involved. First, the determination of desired performance involves determining, at the aggregate level, what is "best" for society. The second problem involves what criteria should (or can) be used to determine whether desired performance has or has not been achieved.

While policy goals are nothing more than a description of a more desirable state of affairs, there has been a long-standing debate within the economics profession as to whether economists should or can determine policy goals. The view of many economists is that it is not the job of the economist to select goals, but rather to present alternatives. D. Gale Johnson (1947), on the other hand, feels strongly that economists should be involved in determining policy. Johnson maintains that (a) short-run and long-run differences exist which must be made consistent; (b) economists should aid in clarification of policy goals; (c) since policy goals are never ending in themselves, but rather a means for the individual to achieve his/her ends, then the economist must indicate the policy appropriate to reach these ends; (d) policies must be consistent and concise, and in being carried out, need direction which economists can give them; (e) policies often conflict with one another, thus requiring the economist's technical knowledge to put them in perspective.

Despite Johnson's rather strong feelings, some qualifications must be made. Policy analysts cannot divorce themselves from participation in the system. Thus, the policy analyst must be aware of his/her own patterns of behavior, biases and values. There is also the question of aggregation of values. Since each individual has different values, then policy conflicts may occur for just this reason. These qualifications provide serious threats to the analyst's objectivity if they are not accounted for. Where policy goals do not have clear-cut boundaries, interaction between the analyst and the bearer of the responsibility (i.e., legislators, state officials, etc.) is a desirable course of action, and is an essential source of knowledge. Suggestions for this type of approach to determination of policy goals have been made by Keeney and Raiffa (1976) and Schmid (1975). A recent study in Korea by a multidisciplinary team of analysts utilized this process as an iterative interactive input into their simulation studies.[11]

The second problem of criteria for the selection of policy goals has also posed problems for analysts. The major thing to realize about policy goals is that the more there are of them, the more difficult their simultaneous attainment becomes. Economic theory indicates that there should be a policy instrument for each policy goal. It therefore becomes readily apparent that if the number of policy goals exceeds the number of instruments, then some conflict of interests in achieving the goals should be anticipated. D. Gale Johnson (1947) suggests four basic criteria for selecting policy goals.

1) If the policy has more than one objective, the objectives should be consistent and possible of achievement at the same time.

2) The specific policy objectives should be consistent with a body of generally accepted social goals and purposes.

3) The specific policy objectives should be those which can be attained more effectively by that policy than by other policies.

4) It should be possible to state the objectives in terms which make them useful to an administrative agency in its operations, and to provide citizens and the legislature in checking the effectiveness of the policy and/or its administration.

Analysis as a Dynamic (Iterative) Problem: System Size Criteria

In considering the aims of analysis--to determine both desirable and undesirable performance--insights may be gained by the analyst as to the nature of the problem. In the original conception of the "system" it should be noted that in addition to identifying desirable and undesirable outputs (performance) we should also identify those outputs which have an effect on the environment (externalities). If strong influences are identified in the external environment by the resulting outputs of the system, it may be indicative of the size of the system that needs to be considered. This may involve a reconsideration of the jurisdictional boundaries dimension. That is, it may be necessary to extend the boundaries of the system so that externalities caused by outputs of the system are "internalized," for, by definition, outputs which affect the external environment are not controllable via the management cybernetic feedback loop.

There are, of course, trade-offs to be considered in such action. The larger the system, the more unmanageable the system becomes and therefore the problem. Within the systems approach, value judgement must be used to make the system as large as is necessary so that externalities which occur will be "weak" or negligible. This added dimension of dynamics is often overlooked in the "solution" to problems. While the possibility of external effects resulting from the system are often enumerated, their effect on the structure (inputs) of the system are often neglected. In summary, the dynamic and iterative effects of the system move in <u>two</u> directions in terms of the elements of Figure 3.3; structure → conduct → performance → structure/conduct and analysis → design → management → analysis/design.

Policy Design Under the SCP/ADM Framework

The concept of design is not a difficult one in this paradigm, but may pose some confusion unless defined. Design is the determination of the conduct or behavior (system structure) of the system, given desired outputs and inputs. It should be clear that a behavior system is not literally "designed"--but rather that the behavior which is necessary to produce the desired performance (outputs) is determined. The information generated by such a process is therefore used as information to identify those structural input variables which affect or create behavioral responses. Design then involves the determination of the necessary behavior or conduct of individuals or institutions in order to achieve a desired output. Design is not the physical changing of the structure (inputs) in order to create a desired behavioral response--this is management.

Since exogenous influences will affect the conduct (system structure) then the principle of system size criteria will also affect the behavioral responses of the system. Again, it is desirable that the system be large enough in order that exogenous effects have a zero or negligible effect on conduct. It is at this point also that one aspect of uncertainty in the system can be identified. Clearly, the system size will influence the magnitude of behavioral uncertainty, and will therefore be an important aspect in the design process. It should be noted that this uncertainty is only one of three types of uncertainty which can enter the system. Uncertainty will also exist as exogenous influences on the structure (inputs) as well as in the managerial process in the identification of controllable inputs to be manipulated in order to decrease the magnitude of the error between actual and desired outputs. The type of uncertainty to be examined in the design process is specifically behavioral in nature.

Finally, in order to clarify what is meant by the mechanisms of conduct or behavior (system structure), the following example is examined. Supply and demand schedules are considered to be part of the behavioral aspects of our paradigm. Supply and demand curves are indeed the functional forms of the conduct process. That is, a deterministic demand process provides information about the behavior of individuals within the system. A price elasticity is the behavioral response of individuals when price is changed. Two important points might be noted here. First, if uncertainty is introduced into a demand or supply response function as a stochastic process, then only one aspect of uncertainty is being identified; specifically, the behavioral uncertainty of individuals in the system. Uncertainty which affects the structure (inputs) of the system or the managerial process must necessarily remain as residuals. Second, demand and supply curves assume a known and predictable underlying functional form in utility functions. Being specific about utility functions and its parameters which form the structural inputs of the system is the same as specifying the structure of the system.

Policy Management Under the SCP/ADM Framework

Management is the determination of structure (inputs) given previously determined conduct (system structure) and performance (outputs). Management is all about control. It is the important function of the SCP/ADM paradigm which determines whether a policy will be successful. An important function then of management is the identification of controllable and uncontrollable inputs. According to Manetsch and Park (1977) "a system is completely (state) controllable if, for any initial time, there exists an unconstrained control (vector) which will transfer any initial state to any final state in finite time."

It is important to (again) distinguish between management and design. Management or control problems ask "how can operation of an existing set of interacting processes be improved without changing the processes themselves?" Design is the function of changing the processes--management is simply improving their operation in order to produce a "better" performance, where better performance is defined in terms of analytical performance specifications on the system variables.

In addition to the importance of identifying both controllable and uncontrollable inputs, two other important functions of management may be emphasized. The first is the feedback loop which acts as a sort of thermostat or sensor in the system. It measures the difference between actual and desired performance (output). The information which is fed back to the structure provides the criteria, of which management is the very function, for manipulating the inputs to "improve" conduct of the system. The second function of the management problem is the identification of uncertainty within the system. Uncertainty can emanate from two sources. Environmental influences provide exogenous inputs into the system. As previously elaborated upon, system size will depend on the extent to which exogenous influences provide fluctuations in the system and affect control of the process. In agriculture, for example, these exogenous effects are weather, pests, disease, etc. The second source of uncertainty in the system is the uncontrollable inputs. In many cases, the uncontrollable inputs will be the same as the exogenous ones, such as weather. The extent to which an exogenous influence will become an uncontrollable input depends upon whether or not it is controllable. For example, while disease is often an exogenous influence on the structure (inputs), there may be some methods of control available. The management function may or may not exercise control on these inputs, thus increasing or decreasing control over uncertainty in the system.

Summary and Recurrent Themes of the SCP/ADM Paradigm

Throughout the discussion of the SCP/ADM paradigm there have been some recurrent themes which provide the essence of policy analysis, design and management. In summarizing the paradigm an attempt to place these recurrent themes into perspective will be made.

1. Power: Power is the ability to control and influence. It is derived from an ability to produce and/or control information which is used to reduce uncertainty. Such information is obviously valuable, and its price is the opportunity to influence or coerce decision making processes.

2. Participants: A vital link in the SCP/ADM paradigm involves human values. It is therefore necessary to identify the participants in the system, and identify the factors which motivate them to behave the way they do. Who has power? Whose preferences count? What degree of sovereignty does the system afford them?

3. Uncertainty: Uncertainty is defined as the lack of knowledge or information about a process, with respect to time, place and form. Uncertainty affects the participants of the system in many different ways. Three types of uncertainty in the system have been identified:

(a) uncertainty emanating from exogenous influences on the structure (inputs) of the system;

(b) uncertainty involving the uncontrollability of inputs;

(c) uncertainty emanating from exogenous influences on the behavioral responses (conduct or system structure) of the system. Information which leads to a reduction in uncertainty is a major factor in the exertion of power in the system.

4. Information: Information is knowledge of an entity or process which reduces uncertainty about that entity or process. Information has a cost and a value. When the marginal cost of collecting information is equal to the benefits derived from that information, then increasing accuracy has a cost which exceeds the benefits (see Figure 3.4). The amount of accuracy required determines the amount of information to collect--but is determined by the probability of an error.

5. Performance Criteria: Performance criteria is the method by which the "goodness" or "badness" of performance (output) is evaluated. It is important to identify desired performance as well as criteria to measure the achievement of those goals and to realize that information used to reduce uncertainty with respect to the outcome or performance of the system has, implicitly, a desirable performance built into it. Performance criteria should therefore include careful examination of information used to measure performance.

6. Control: Control is defined as the ability to be able to manipulate the structural inputs of the system in response to information generated by observation of the differences between actual and desired performance (output). Power and uncertainty tend to reduce control of a system when they reduce availability of information to those who bear responsibility for public policy decisions.

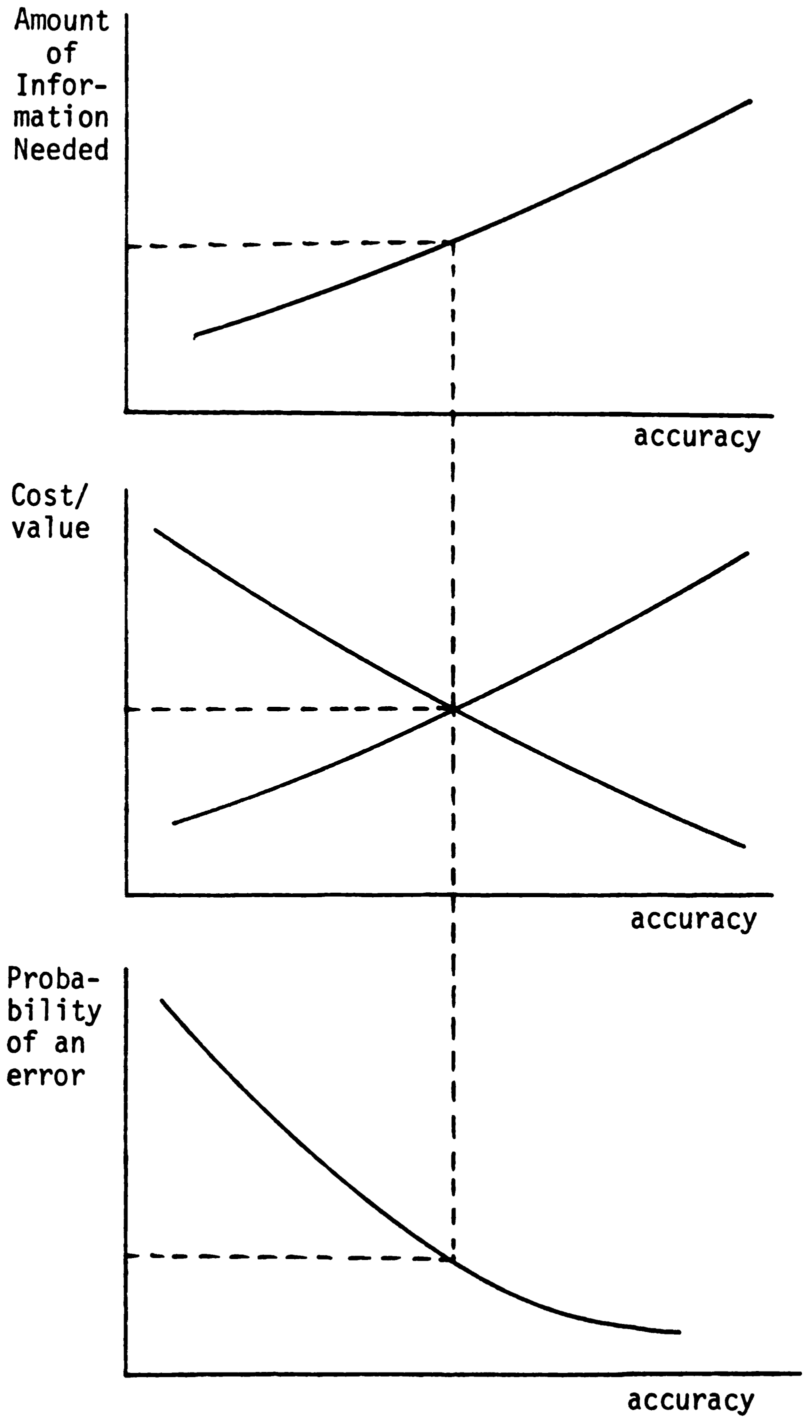

Figure 3.4

Cost and Value of Information

7. Time and Evolution: Time is the factor against which the dynamic aspects of the system are measured and is the ever pervading force of the system which determines its evolution and development. It is an uncontrollable factor against which change is measured. Time cannot be differentiated or integrated, but rather is the factor which is used to differentiate and integrate.

8. Conflict: Conventional economics presents us with a harmonious view of the world in which markets work silently and efficiently, pushing society toward an optimum with respect to allocation of resources and distribution of income. Institutionalism, on the other hand, stresses conflict as a dominant condition of economic and social order. "Harmony is replaced by coercion, aggression and a struggle for power," (Peterson, 1977). According to Samuels (1972), coercion obviously implies power; and without power there can be no coercion.

9. Implementation: One of the most important aspects of policy analysis, design and management occurs when a change is recommended. The mechanics of that change must be accounted for, and must be able to be achieved within the realms of the system. A policy is not operational until its implementation is achieved. Implementation of a policy requires and is influenced by control and power, information feedback and performance criteria.

10. Planning and Institutional Change: Perhaps the ultimate aim of policy analysis, design and management--and its implementation--is involved with planning. It seems that we, as humans, are genetically programmed to plan--to look into the future in an attempt to control our own destinies. In many ways, our destiny is controlled by our "two-self image" (Shaffer, 1977). On the one hand, we influence the

environment which ultimately controls our destiny, and on the other hand, we are controlled by our environment. Skinners (1974) Radical Behaviorism presents us with a view that "man can now control his own destiny because he knows what must be done and how to do it." Humans discriminate--they solve problems by assembling, classifying, arranging and rearranging. They analyze contingencies of reinforcement in their world, and extract plans and rules to enable response without direct exposure to the contingencies. They discover and use rules for deriving new rules from old--a behavioral conditioning which leads to learning, social traps and evolutionary change.

Footnotes: Chapter 3

[1]There does not appear to be any satisfactory agreement upon the definition of the world "paradigm." Thomas Kuhn (1970) in The Structure of Scientific Revolutions uses the term "paradigm" to refer to "universally recognized scientific achievements that for a time provide model problems and solutions to a community of practitioners." However, as is well known, there is no precise, unified body of theoretical ideas which can be readily and clearly identified as institutionalism. Institutionalism has many facets, but it is not necessarily without boundaries. In the text, "approach" or "framework" may be substituted for "paradigm."

[2]A "right" action is such that no alternative possible under the circumstances is better. But "good" is not necessarily "right" because something better could be done. Similarly, it might be "right" to do something "bad" because less "bad" is not possible. Thus, following Lewis (1955) "right and wrong" are prescriptive terms and "good and bad" are undefinable primitive terms which are personal and subjective. "Right" and truth are not determined by what is "good or bad" alone, for "right" can be either "good" or "bad" and it is subjective. In order to do that which is "right" we require other information which may be non-normative.

[3]The four tests of objectivity are: coherence, correspondence, clarity and workability (see Johnson, 1970, 1971, 1973, 1977).

[4]This follows naturally from Footnote 1 [see Moore, 1956, Lewis, 1955).

[5]The dialectic is distinguished as a discussion, and the reasoning of knowledge by dialogue. It is a systematic reasoning that juxtaposes opposing or contradictory ideas and then seeks to resolve their conflict. What makes it distinctive is that opposing arguments are kept apart from data (analytically) so that the crucial aspects of the ideas or expressions are clearly displayed. Thus, in solving the problem, the solutions found, which are subjected to the tests of objectivity, are deemed to be the results of a resolution of a conflict rather than of sedentary agreement.

[6]The distinction between the types of knowledge used as information can be also classified in terms of logical or analytical knowledge and descriptive or synthetic knowledge. Analytical knowledge is completely free of factual content or information. It is the abstract knowledge we use in linking logical ideas. In contrast, descriptive or synthetic knowledge is factual knowledge (that which pertains to reality). The dichotomy of these uses of knowledge has created the well-known rift between normativists (who believe that value judgements such as "good and bad" are synthetic and that prescriptive knowledge is possible without the use of non-normative knowledge) and positivists (who deny that objective normative knowledge is possible; therefore, that values are unreal and that they belong to analytical knowledge and are hence unobservable and scientifically unattainable). From a research point of view it is extremely difficult to maintain one philosophy or the other if one believes that objective prescriptive knowledge is dependent upon both normative and non-normative knowledge. Adherence to one philosophy precludes access to the other by definition. Compromise of these positions can lead to conditional normativism (assumes normative knowledge and proceeds positively), conditional positivism (assumes positive knowledge and proceeds normatively), pragmatism (observes or forms opinions about normative knowledge and uses this information as if it were non-normative) and eclecticism (using the strengths of all philosophies without strict adherence to any one).

[7]While at the outset it would appear that Peterson is advocating and/or condoning the rejection of the Keynesian model, his purpose is actually to point out that institutionalism has many similarities with the Keynesian model, and indeed employs the neoclassical model within its overall framework. Many of the criticisms of the neoclassical model are problems which are recognized and acknowledged by non-institutional economists (see, for instance, Shaffer, 1969; Hymer-Roosevelt, Sweezy, Lindbeck, 1972; Heilbronner, 1970). As Peterson so aptly points out, "problems cannot so readily be put into neat categories labelled 'economic,' 'political,' or 'sociological.' This is unfortunate, but realistic. For economists it suggests that in the realm of policy it will not do simply to assert that a proposal may be 'correct' economically, but that it will not work politically."

[8]Strictly speaking, inputs are always considered to be exogenous. As will become clear, changes within the system which feed back to influence the output of the system are also termed, in this case, inputs. Note also that controllable inputs do not necessarily imply that they are endogenous to the system, nor do uncontrollable inputs necessarily imply that they are exogenous to the system.

[9]The concept of "reinforcement" is based on B.F. Skinner's (1974) belief that all responsive behavior is produced by the environment in the form of positive and negative reinforcement or contingencies of reinforcement. Differential reinforcement is the occurrence of a reward that is related to how an act is performed; and rewards are contingent upon a response to the environment (see Carpenter, Platt, 1972, 1973; Skinner, 1977).

[10]Consideration of both desired and undesired performance (output) puts emphasis on the importance of carrying out analysis before design or management. Policies which are aimed at a particular goal or set of goals often will determine the design and management and of the system.

[11]See Rossmiller (1978).

CHAPTER 4

INSTABILITY ANALYSIS AND PROBLEM IDENTIFICATION

In accordance with the SCP/ADM paradigm of Chapter 3, the aim of analysis is to identify performance (outputs) of the system. This aim may be achieved by:

1. Identification of desired and undesired performance
2. Examination of the structure (inputs) and conduct or behavior (system structure) of the system
3. Description of actual performance of the system
4. Identification of the difference between desired and actual performance

In this chapter a definition of instability will be described which will allow identification of the desired and undesired performance. A brief examination of the structural and behavioral aspects of the system will then be made, after which some indication as to the nature of the problem should be clear.

An Approach to Definition

In the previous discussion in Chapter 2, of the definitional problem of instability, one thing which became clear was the undefinable nature of what constitutes the difference between stability and instability. Some of the concepts of the system approach will be used here to clarify these differences, and to define instability in terms of what might constitute some criteria for performance.

One way of viewing instability, is to conceive of it as being of two types:

1. The inherently unstable system which explodes
2. The occurrence of fluctuations in an otherwise stable system

Inherently Unstable Systems

In terms of output reaction, little needs to be said about systems which are inherently unstable. This system is characterized by explosive and unbounded reaction due to any change, momentarily or otherwise, of an input or initial condition.[1]

In linear systems, instability is associated with positive exponential kernels:

$$\text{i.e.,} \quad \lim_{t \to \infty} e^{+/a/t} = \infty.$$

Alternatively, stability of linear systems is associated with negative exponential kernels:

$$\text{i.e.,} \quad \lim_{t \to \infty} e^{-/a/t} = 0.$$

For instance, it is easy to show that given a transfer function in s-space (s-space is the integral transformation of a variable in time t-space to its equivalent Laplace transform).

$$x(s) = \frac{3}{s^2 + 2s + 5} = \frac{3}{[(s + 1) + 2j]\,[(s + 1) - 2j]}$$

where:

$j = \sqrt{-1}$ is an imaginary number

is stable and oscillatory because its poles are in the negative quadrants. Its equivalent function in the time domain is given by:

$$x(t) = 1 - 5\,e^{-t} \sin 2\,t.$$

On the other hand:

$$x(s) = \frac{3}{s^2 - 2s + 5} = \frac{3}{[(s - 1) + 2j]\,[(s - 1) - 2j]}$$

is unstable, oscillatory and explosive because its poles are in the positive quadrant. Its equivalent time domain form is:

$$x(t) = 1 - 5\,e^{+t} \sin 2\,t.$$

Notice that instability is associated with positive exponential kernels, and stability with negative exponential kernels.

Fluctuations in Otherwise Stable Systems

Any system which is momentarily or otherwise disturbed is said to settle into its steady state when the effects of the disturbance no longer effect the system (provided the system is stable). Whether or not the steady state is actually achieved is of concern here. Stability is a necessary and sufficient condition before the consideration of steady state error which is defined as:

$$e_{ss} = \lim_{t \to \infty} e(t).$$

Clearly, the larger the response to changing inputs or initial conditions, the larger is the steady state error. While this is not instability in the true sense of the definitions we have used above, it does illustrate the semantic differences between the various "instabilities." That is, what is often observed as a fluctuation, deviation from some norm or desired output, or achievement of a so-called "disequilibrium" position and is often termed instability, is in reality often a large steady state error in an otherwise stable system.

Transient response is the short-term response to a disturbance which eventually dies out when the system returns to equilibrium or

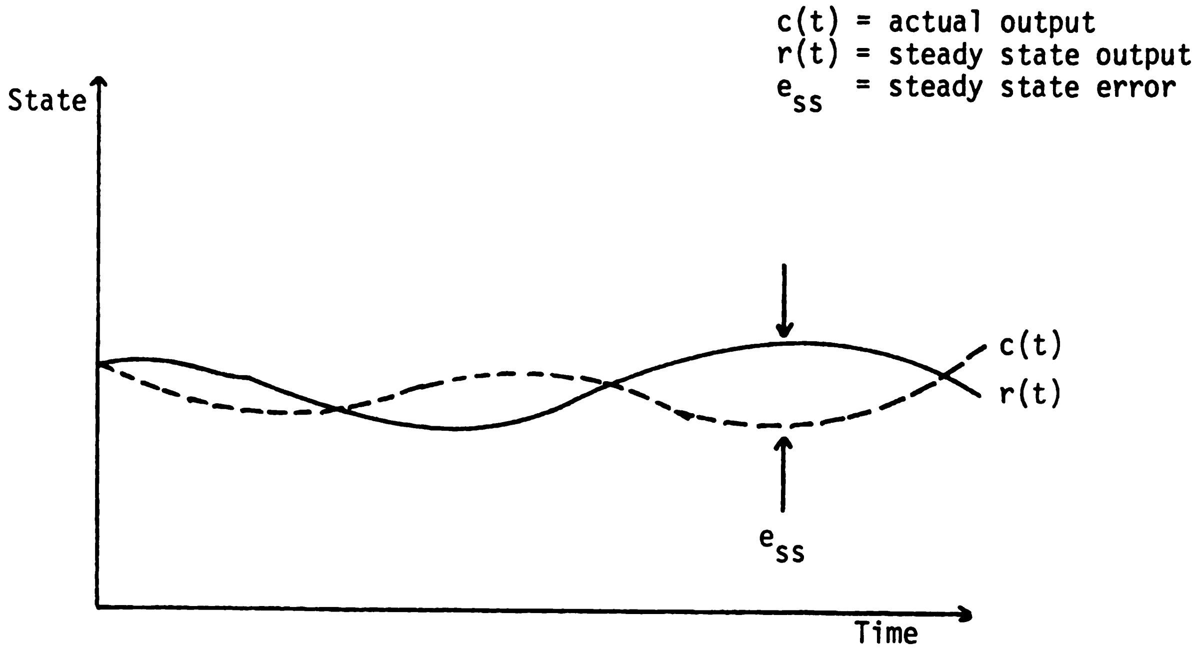

Figure 4.1

Steady State Error

steady state. Suppose that desired output is described by the step function R(t) in Figure 4.2. At the time desired output increases, the system must adjust to the desired requirements. The actual response of the system (called transient response) is described by the actual output c(t). As seen in the figure, three basic output responses are responsible for the eventual outcome of a change in desired output. That is the steady state error or difference between actual and desired output is affected by the systems:

1. rising time - T_r [measured from 10 percent to 90 percent of R(t)];
2. overshoot - M_T (measured as a percentage overshoot);
3. settling time - T_s [measured within 5 percent of R(t)].

It is clear that if the rising time is slow, then the system will tend to take longer to adjust. Similarly, if the overshoot is large, then the system will experience large fluctuations in output. Finally, if settling time is long, then the system will take longer to adjust and will experience fluctuations during the settling time. Transient response is also affected by the interaction of each of the basic output responses. For instance, if the rising time is increased (i.e., becomes faster), then overshoot may increase and settling time may become larger. It may be that to reduce overshoot a slower rise time may be desirable which may or may not increase settling time. If settling time is proportional to overshoot, then to reduce settling time a reduction in overshoot is necessary which may or may not require a slower rising time. Responses will be different for each different system and different control measures will be called for as systems vary. It is clear that deviations,

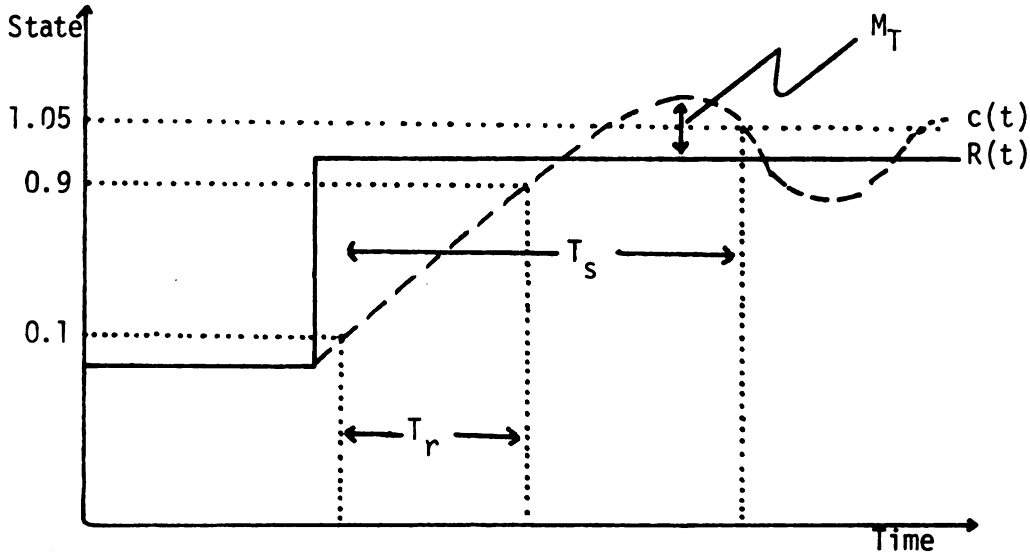

Figure 4.2

Transient Response

fluctuations or disequilibrating output responses may indeed be observed as instability and is, rather, the result of the transient response of an otherwise stable system.

The point of the above description of the system's view of stability has been to describe the differences between the strict mathematical definition of stability and the classification of fluctuations in the system which are often termed "instabilities." In the strictest sense, steady state error and transient response (which make up the fluctuations in an otherwise stable system) are not really "instabilities." They might be more accurately described as "less desirable stability."

There is, however, a second use for the description of stability in terms of transient response. It provides ideal criteria for desired and undesired performance. In order to minimize steady state error (the difference between actual and desired output) it is necessary to find the optimum tradeoff between maximizing rising time and minimizing overshoot and settling time. The methodology, of course, is a control problem and will be more properly discussed in Chapter 6 on design and management.

It is convenient here to begin to distinguish between stability in the mathematical sense and stability in the sense of transient response. Hereafter, stability or instability will refer to that as described by transient response except where there is a specific mention of mathematical stability. From time to time it may be referred to as economic stability/instability, again, to distinguish it from mathematical stability/instability.

An important aspect of the use of the concept of transient response is the introduction of the dynamic principles of price instability. In contrast to the static model introduced in Chapter 3, transient response emphasizes the importance of the elements of time. Two of the three descriptive parts of transient response specifically refer to the time element--rising time and settling time. This is perhaps the most important contribution of systems concepts. The importance of time cannot be overemphasized. It is perhaps one of the most important aspects of the problem of instability and is also perhaps one of the most neglected areas in the literature on instability.

In terms of a definition, it is clear that instability (as described by transient response) can be described in terms of the three separable parts of transient response; rising time, overshoot and settling time. Of course, the definition will be in terms of the differences between desired and actual output of the system. A tentative definition might be as follows: economic instability[2] may be defined as the characteristic effects on all outputs over time of the transient response of a system which is subjected to a one time or sustained disturbance.

In terms of performance, it is possible to identify three criteria which may be used to evaluate an improvement in economic stability. In order to improve transient response of a system:

1. rising time should be as fast as the system allows;
2. overshoot should be kept to an absolute minimum; and
3. settling time should be as short as possible.

Structure and Behavior in the System

A discussion of the structure (inputs) and behavior (system structure) of the system in this case can be reduced to three major subheadings:

1. participants in the system;
2. system mechanism; and
3. identification of random variation.

Participants

Within the conventional economic framework, two groups of participants are generally identified; consumers and producers. Under the SCP/ADM paradigm, a much broader identification of participants is used, which specifically recognizes some of the power in the system and the conflicts which occur. Hence, a more realistic system might follow Bartlett's (1973) rather broader definition. Bartlett's concern with expanding the system is to show how a market system operates--rather than how it should operate. He identifies four groups of participants shown in Figure 4.3. As shown, the four groups of participants in the system have conflicting maximization goals. Outcomes in the market are determined by the ability of each group to achieve their respective aims. In this respect, Bartlett makes three assumptions about the participants.

1. All agents are primarily motivated by their own self interest
2. All agents are rational in the pursuit of their self interests
3. All agents labor under the constraints of uncertainty, and are therefore subject to influence in the making of market and political choices through information subsidization

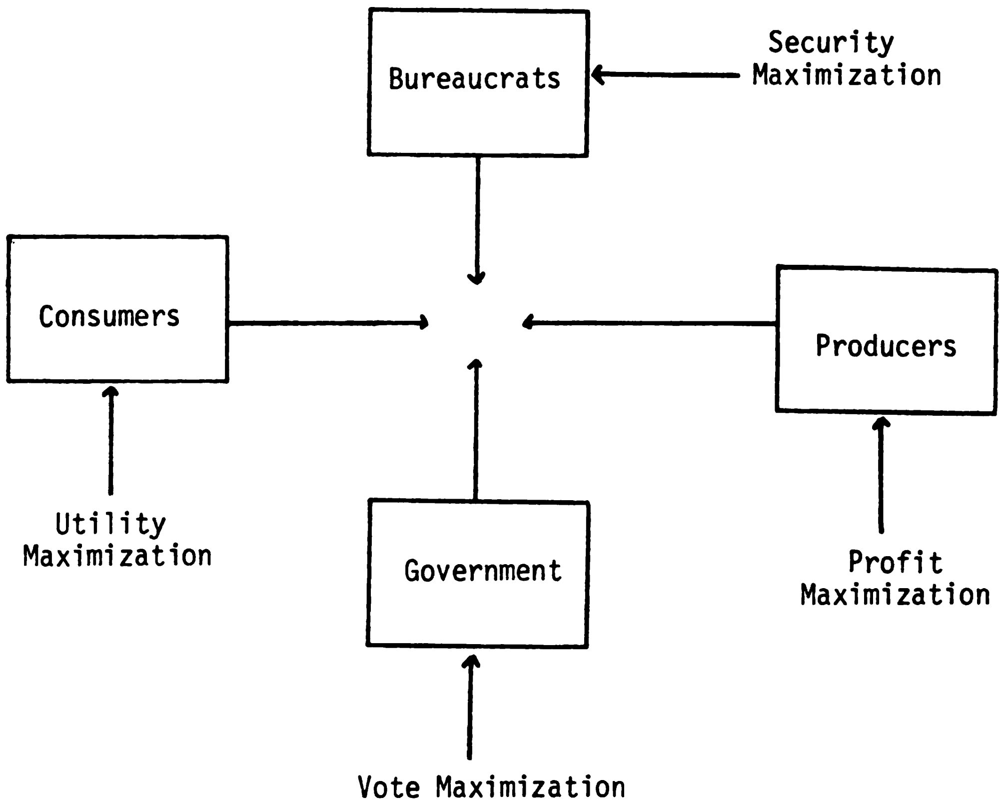

Figure 4.3

Participants in System (Bartlett, 1973)

Despite the realistic nature of this view of the market participants, it is extremely difficult to quantify all the relationships involved. How, for instance, does one quantify security and/or votes in the form of a function which is at least twice differential?[3] On the other hand, it may be valid to question the need for "maximization" of aims. "Satisficing" may well be a more realistic attitude, recognizing the flexibility of the market to withstand small amounts of noise, and the realities of the operation of the economic and political system. Inability to quantify all of the relationships in the system calls for a need to exclude them from the quantitative model, but to specifically recognize the importance of those excluded elements of Figure 4.3.

Of significance also, is the level at which the model is conceptualized. In dealing with groups of individuals, it is necessary to make some assumptions about the relationships between the aggregate model and the individual. It is necessary to recognize that individual aims and behavioral responses are necessarily simplified so that individual traits become the same as those of the group under consideration. Similarly, while each individual participant is ultimately involved with the "management" of the system, the case in point is involved with the necessity or otherwise of government intervention, where it is specifically recognized that "government" is the manager of the system. Nevertheless, the "macro economic" system is made up of many "micro economic" systems where individuals can be identified as "managers" of a micro system; i.e., farm managers, family unit decision makers, etc. Controllability is not the same at all levels, accounting for some controllability through the use of incentives. For example, quantity of land available and utilized for production is a controllable input at the farm level.

Recent government policy has created incentives for farm producers to partake in price stabilization schemes by mandating that participation is subject to a reduction in the use of productive lands. In this way, it is reasoned that large surpluses should not occur, thus providing a more stable quantity supplied, and reducing the possibility of high variance in prices. Hence, government, as "manager" of the macro system, may gain control of a previously uncontrollable input.

System Mechanism

The price mechanism is an extremely complex aspect of the economic system. The major work in this area was carried out by Walras (1874) where he expounds his generally accepted concept of "tâtonnement" (a French word meaning literally groping or tentative effort). Walras pictures a situation where producers and consumers come together and literally "discover" a price which satisfies both consumer and producer ability. Figure 4.4 shows a simple causal loop diagram of the price mechanism. A positive sign at the arrow head indicates that as the causal factor increases in magnitude, the effect increases in the same direction. A negative sign means the opposite. The net effect can be seen to be one of balance. An increase in price will cause a decrease in demand and an increase in production, and this is balanced out by the negative impact of supply and the positive impact of demand on their differences (DIFF). The difference between demand and supply is expressed as a differential equation, known as the Walrasian stability condition.

$$\frac{dP}{dt} = k\,[\text{DEM} - \text{SUP}] \quad ; \quad k > 0$$

If the market is cleared in each time period (i.e., DEM = SUP) then $\frac{dP}{dt} = 0$ and fluctuations in price do not occur.

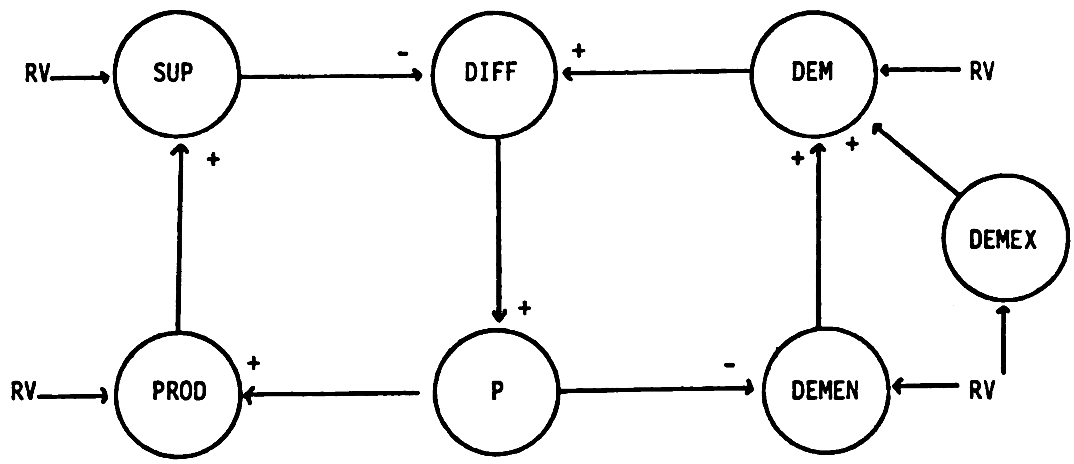

Figure 4.4

Causal Loop Diagram of Price Mechanism

Random Variation in the System

Figure 4.4 also specifies the random variation in the system--specifically, it can enter into all the elements of the price mechanism due to:

(a) exogenous inputs from outside the system;

(b) random variation occurring in the feedback mechanism; and

(c) exogenous influences on behavioral aspects of the system.

Exogenous Inputs

These types of random variation can be either controllable or uncontrollable. They include seasonal effects, disease, changes in other parts of the economy such as relative incomes, laws, taxes, inflation, information, etc. The controllability of these inputs is determined by the way in which they enter the system. Some inputs are controllable by the manager of the micro system (i.e., farm producer) and others are controllable by government. The most important inputs in the case of price instability are, however, those which are uncontrollable by both farm producer and government.

Random Variation in the Feedback Process

This type of random variation occurs in the system due to the effects of the outcome of the process (changes in price), differences in individual preferences and changes in management practice (at both the micro and macro level) i.e., formulation of price expectations. Random variation in the feedback loop should not be confused with the process of the feedback loop itself. When prices change, due to dP/dt being either positive or negative, the resulting price is fed back directly to the demand and supply determining factors. This is <u>not</u> random variation. Random variation is created by noise in the feedback system which may affect the direct signal of the outcome.

Exogenous Behavioral Influences

Many of the occurrences of random variation in the behavioral relationships of the system are similar to those which occur in the feedback mechanism. However, differences between these random variations will be distinguished here because their effects are different and their causes are, of course, resulting from very different sources. For instance, changes in individual preferences can be influenced by both the resulting outcomes of the system (r.v. in feedback) and from external influences (i.e., changes in laws not only change the structure of the system but the behavioral responses of individuals).

Problem Identification

The above brief description of the structure and behavior of the system has specifically identified three major areas around which the problem of instability can be related to research effort. That is, the three principal aspects of the structure and behavior of the system--participants, mechanism and random variation--provide the major identifiable sources of instability. There is, however, a single underlying principle which accounts for the reasons why these three aspects of the system are indeed the major sources of instability; that is the principle of uncertainty.

Instability, however, should not be equated exactly with uncertainty. Instability, as previously discussed, is an outcome. It is indeed the problem in terms of performance. Uncertainty, on the other hand, "is the complement of knowledge. It is the gap between what is known and what needs to be known to make correct decisions" (Mack, 1971, p. 1). The problem of instability, then, can be clearly stated as a problem which involves the presence of uncertainty in the system, and specifically that the interrelationship between uncertainty and the participants, the mechanism and the random variation in the system are responsible for what has been termed instability.

The presence of uncertainty, as an underlying cause of instability, presents some interesting questions with respect to the solution of the problem of instability. The complexity of the problem is accentuated by the following two questions:

1. Is it uncertainty which is responsible for creating instability, or is it instability which creates uncertainty?
2. Would a reduction in the amount of uncertainty reduce the degree of instability or is it that a reduction in instability would reduce uncertainty?

The answers to these questions is perhaps somewhat academic. On the other hand, as the following shows, there is a real need to understand what is cause and what is effect.

How is uncertainty linked so vitally to the three identifiable sources of instability? First, it is clear that random variation in the system is a major cause of uncertainty, by definition. Specifically, uncontrollable exogenous inputs, unpredictable behavioral responses and unexpected changes in the feedback mechanism are probably the major factors which determine the magnitude of uncertainty in the system.

Random variation may also be created by instability since instability will produce some undesirable performance which in turn feeds back into the exogenous environment and re-enters the system as exogenous inputs or influences on behavior. Secondly, the mechanism itself is both a source and a sufferer of uncertainty. Apart from the random variation entering the mechanism via almost every element of the system, the pricing mechanism itself is a major cause of uncertainty. As price is formulated (see Figure 4.4) it is fedback to both producers and consumers who utilize the observed information to formulate new conditions for supply and demand which in turn determines the next price. Since neither knows what the other will do, there exists some uncertainty as to the outcome of the individual decisions made. Theoretically, of course, the system is self-balancing and should tend toward a stable equilibrium. Random variation, however, will create differences in the system which are not necessarily self-balancing. Thus, the uncertainty feeds on itself. The ability of the system to adjust to this uncertainty will determine whether or not it is undesirable. Finally, the participants in the system, as explained by Bartlett (1973) are subject to uncertainty and are therefore also a prime cause of uncertainty. Again there is a feedback mechanism involved, and individuals subject to uncertainty will create uncertainty in the system.

Uncertainty, then, is an all pervading, underlying principle of instability. Furthermore, within the system, the feedback mechanism makes it indeterminate whether uncertainty creates instability or whether instability creates uncertainty. While the question of the causal relationship may not be important, the dynamic feedback relationship between uncertainty and instability is an important aspect of the understanding of the complexity of the problem for the following reasons.

1. A reduction in instability requires that fluctuations in the system converge to some desired level over time
2. A reduction in uncertainty requires some knowledge or information which will ensure an outcome before that event has occurred

Thus, in a system in which there is no intervention one is reduced when the other is assured. That is, a reduction in instability will occur when a reduction in uncertainty is assured. Similarly, a reduction in uncertainty will be achieved when instability is reduced. The problem is, which one should be reduced?

Superficially, it would appear that it does not matter whether instability or uncertainty is reduced. Since they are both intimately related, then reduction in one creates a reduction in the other. Quiggan and Anderson (1979) present an argument which shows that inconsistencies can arise between the need to reduce uncertainty and the need to stabilize price. If a scheme is to reduce risk then forward prices must be known as far in advance as possible. If a scheme is to stabilize price (rather than support prices) it is necessary to have the long run price converge to actual price in a particular time period. The point is, if, for reasons of reducing risk, a price is fixed in a time period before produce is to be marketed, then clearly that price cannot be changed once producers have made their decisions to produce. Hence, the fixed price may be the cause of misallocation of resources if there is a deviation between supply and demand. On the other hand, in order to stabilize the price, deviations between supply and demand must shift the price to its long run equilibrium price--which, for price stability, must be its actual price.

In terms of the conceptualization of instability as being explained by transient response, price stability requires the "settling" down of prices to its "desired" level. Risk reduction, on the other hand, requires that prices be fixed and remain fixed throughout the production and marketing period.

The nature of inquiry therefore makes it necessary to attempt to understand what current agricultural policies actually achieve. While the inconsistency between stabilizing prices and reducing risk (or uncertainty) remains a problem in theory, the nature of the inconsistency is an empirical question. More importantly, it is clear that there is an important interaction between the "causes" of instability and the "effects." That is, it is necessary to understand the connection between policies which stabilize prices to offset the "effects" of instability, and policies which stabilize prices to offset the "causes" of instability.

In order to reinforce the abstract themes of the theoretical nature of this study, it is necessary to evaluate a model which demonstrates the operation and mechanisms of the economic system. Unfortunately, such an empirical study will not be able to be generalized, since it is necessary to be specific about an industry, and about the levels at which that industry operates. Clearly, other industries, under different assumptions, and different policies will not react or have consequences of the nature or magnitude than the one that has to be investigated.

Other problems of empirical research also exist. Because of the complexity of any industry, the model will necessarily be simplified. Many of the theoretical problems considered previously are unable to be quantified, and, in order to make the model manageable, some aspects of the market interaction mechanism will have to be ignored.

Summary

Chapter 2 dealt with three basic difficulties in past and current research into price instability. These are definition, performance criteria and analytical technique. In this chapter an attempt has been made to clarify the concept of instability by redefining it in terms of the transient response of the system, which leads to a more basic concept of performance criteria. Having conceptualized a new set of performance criteria, the SCP/ADM framework of Chapter 3 is applied, in which three basic sources of instability are identified, all of which may be captured by the principle of uncertainty. The crucial link between the "causes" of price instability and its "effects" is encapsulated in the desire to reduce the detrimental effects of price instability by controlling the price. In doing so, however, the feedback mechanism of price discovery results in some basic inconsistencies in the system. Of importance is the conflict between a desire to stabilize prices to offset its detrimental effects, and a desire to reduce risk to offset some of the potential causes of instability. Of equal importance is the effect which price stabilization has on the system itself and the need to understand what it is that price stabilization achieves. These are empirical questions which will be considered in the following two chapters in the form of the following four questions.

1. Is it necessary to stabilize prices?
2. Is price stabilization better than nothing?
3. Is it necessary to improve existing price stabilization policies?
4. Is it possible to improve the existing system?

Specifically, an attempt will be made to show the interaction between the price mechanism and the potential causes of price instability. Of considerable interest will be Chapter 6 in which some attempt will be made to examine the controllability of the system, and survey the effects of some policies on the system as a whole, the aim being to discover if price stabilization policies achieve price stability or a reduction in risk.

Footnotes: Chapter 4

[1]More precise definitions of stability may be found in Manetsch and Park (1977, pp. 5-20 - 5-23) and other engineering literature on automatic control theory. Only linear systems concepts are being dealt with here. Similar, but more complex theory has been developed to deal with nonlinear systems.

[2]Economic instability is used to differentiate that instability which is created by fluctuations in an otherwise (mathematically) stable system, from mathematical definition of instability.

[3]Second order conditions are required for maximization.

CHAPTER 5

A MODEL FOR INSTABILITY ANALYSIS

Thus far, discussion has been theoretical and at a fairly high level of abstraction. As mentioned in the previous chapter, the distinction between theoretical and empirical work necessarily extends the work that must be carried out in order to get to the problems of price instability. The ensuing two chapters will deal with a practical systems model for the analysis of price instability. This chapter will develop the model and attempts to show the sources of instability. Chapter 6 will show some further results when some system controls are introduced.

A Simple Nonlinear Systems Simulation Model

The first task in constructing a systems simulation model is to identify the essential mechanisms involved. The most important, of course, is the price mechanism, which is explained in Chapter 4 (see Figure 4.4). It is convenient to begin with that causal loop diagram and develop from it an initial simple and general block diagram of an economic process. The model that is developed initially can be viewed as the economic mechanisms of a single competitive industry under certainty.

Figure 5.1 represents the block diagram of a general economic system. While the model is fairly self explanatory, a brief description is provided here.

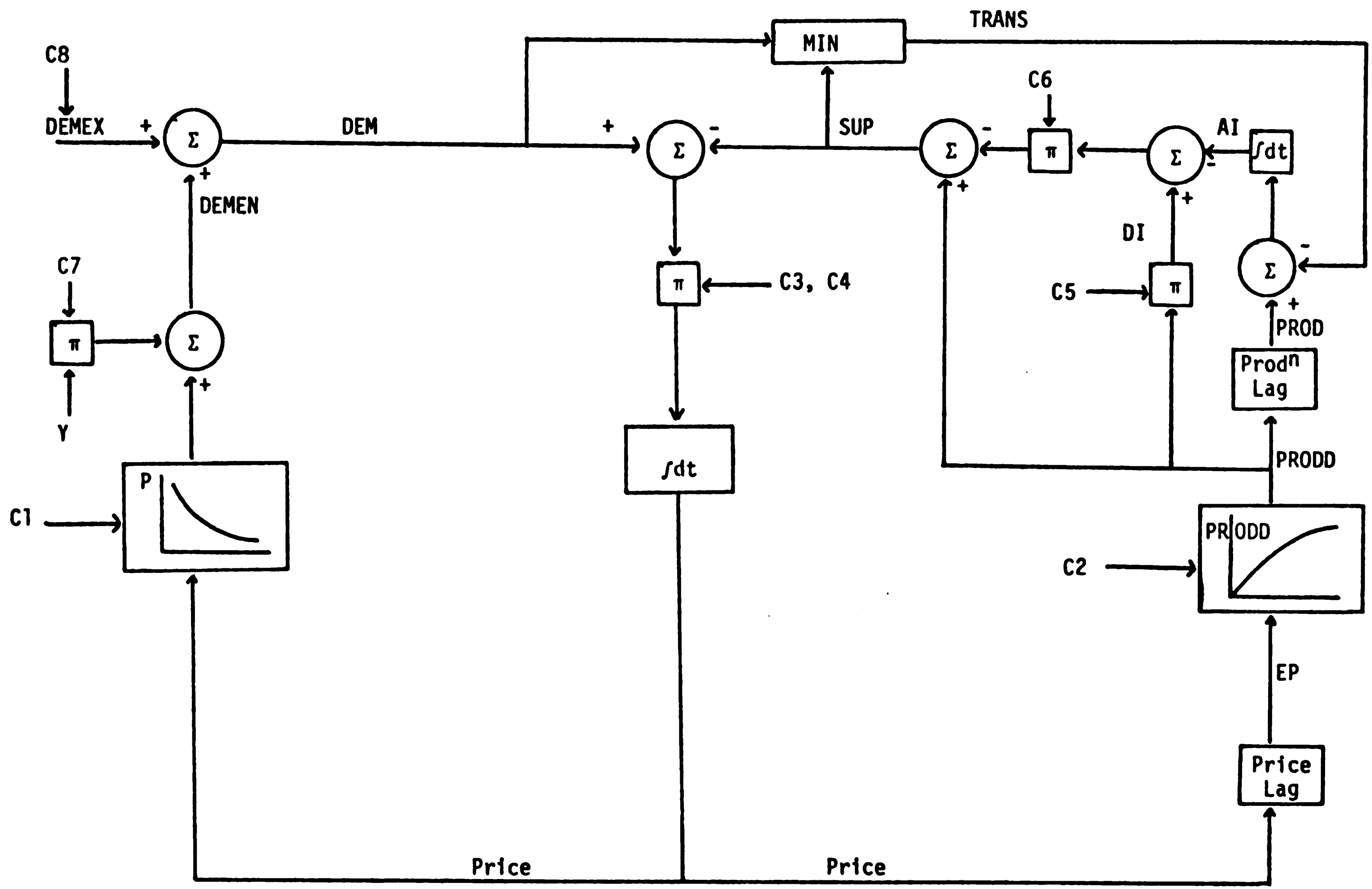

Figure 5.1

Block Diagram of General Economic System

The model can be divided into six parts.

1. Demand: There are two aspects of demand. One is endogenous demand (DEMEN) representing that aspect of constant demand influenced by price and income. The other aspect is exogenous demand (DEMEX), representing a type of random variation in the system provided by exports and other shocks to the system. Total demand (DEM) is the addition of both these sources of demand.

2. Production: Production is individualized by specifying a price lag relationship from which it is hypothesized that price expectations are formed (EP). These price expectations are fed into a simple production function representing the technical aspects of production and forming the basis of desired production (PRODD). Since agricultural production is not instantaneous, desired production is transformed into a delay mechanism, the output of which is actual production (PROD). Whilst in the production delay or lag mechanism, some loss or delay may occur.

3. Inventory: Clearly realized or actual production is added, each time period, to the total inventory of stocks. From time to time, the producer will draw stocks to sell. Thus inventory is a changing aspect of the system represented as

$$\frac{dAI}{dt} = (PROD - TRANS)$$

where

AI = actual inventory

PROD = actual production

TRANS = transactions

By integrating $\frac{dAI}{dt}$ (using Euler's Integration) then AI = AI + DT *(PROD - TRANS) where DT is the time change. It is conceivable that some constant amount of inventory will be kept to try to stabilize market conditions. That is, inventory is used to ensure that supply to the market is not dependent only upon discrete production.

4. Supply: Supply is given by the following equation

SUP = PRODD - C6 *(AI - DI)

where

SUP	= supply
PRODD	= desired production
C6	= constant
AI	= actual inventory
DI	= desired inventory

An illustration will help to explain this. Suppose current prices were higher than previous ones. Since PRODD = C2 * P, then PRODD will increase. Now suppose also that desired inventory had not been achieved previously--thus DI > AI. Therefore, the producer will sacrifice income now for the prospect of more income later. Thus, supply will be reduced until such time as desired inventory is more than or equal to actual inventory. When AI = DI then SUP = PRODD, and current prices will reflect the amount of supply to market.

If, on the other hand, prices increase but inventory is large such that AI > DI. Clearly, the excess will be loaded into the market until DI = AI again.

5. Transactions: The amount of stock transacted in the market (TRANS) is simply the minimum (MIN) of supply and demand. Under conditions

of excess demand, supply will be the limiting factor. The opposite is also true. Clearly, the number of transactions which occur will affect inventory.

6. Price: As in any competitive market, equilibrium price is determined by the clearing of the market; i.e., that which equates of supply and demand. The price mechanism is described by the Walrasian market condition $\frac{dp}{dt}$ = k(DEM - SUP), or DPDT = CONS * (DEM - SUP). Since price changes can occur differently under conditions of excess supply or excess demand, it is specified in the model as

```
IF (DEM - SUP) 30, 40, 40
30 DPDT = (DEM - SUP) * C3
40 DPDT = (DEM - SUP) * C4
```

That is, if there is excess supply then (DEM - SUP) < 0 and C3 will be the relevant constant. If there is excess demand, then (DEM - SUP) > 0 and C4 is the relevant constant. Clearly, if equilibrium is achieved then (DEM - SUP) = 0 and DPDT = 0. Hence, there is no price change.

Data Specification and Model Solution

In order to use the model, the first problem is to find the parameters C1, C2, C3, C4, C5, C6, C7, and C8, as identified in Figure 5.1. While it would be simpler to specify these hypothetically, some reality is given to the model if actual industry data are used. In this case, the U.S. beef industry was chosen for several reasons. A reasonably good data series exists for this industry; there does not exist any stabilization scheme; and previous work with this industry yields some knowledge of its mechanisms.

Since the model is dynamic and nonlinear, parameter estimation using the usual econometric techniques is extremely difficult. In this case, the algorithm COMPLEX is used, in order to find a "best fit" to the historical time series using a weighted least squares criterion. COMPLEX is essentially a search technique, which, given initial (feasible) starting points, will tend to collapse on the optimum solution using standard geometric techniques (see Kuester and Mize, 1973). The data used are from Crom (1970), and is specifically the U.S. fed beef sector. The data are quarterly and the time series is from 1956 to 1969. Both price lag and production lag are specified in the model. The production lag is three years and the price lag is a three year (12 quarter) polynomially distributed lag.

Applying COMPLEX to the model the following results are obtained.[1]

Parameter	Value
C1	211266.5
C2	91.197
C3	0.0832
C4	0.0321
C5	0.0502
C6	6.402
C7	0.0574
C8	709.323

In order to test the model, two methods are used. First, the above values are inserted into the model and ten years of data are generated. This is then compared to the actual data to see how closely the model tracks the historical model. The second test is a sensitivity analysis. Each of the parameters is adjusted up and down by five percent, and the differences are recorded. These are then compared with the generated data and with actual data. All parameters except for C3 and C4 were found to be relatively stable in the sense that large deviations were not observed. C3 and C4 were found to be quite sensitive to change, which would make sense since these parameters both determine the change in price which will occur. The results of the historical tracking test are presented in Figures 5.2 to 5.5. The results of the sensitivity analysis are excluded.

Introduction of Random Variation

The exact extent to which random variation enters the model is impossible to determine analytically. On the other hand, random variation does occur in three ways as described in Chapter 4. They are: (1) exogenous inputs from outside the system, (2) random variation occurring in the feedback mechanism, (3) exogenous influences on behavioral aspects of the system. In order to capture this variation, it is necessary to make the assumption that deviation of estimated from actual output is due to random variation entering the system. Of course, it is not possible to say exactly where or how it enters in an analytical way. In order to introduce random variation into the model the following arbitrary rules are used.

1. Random variation is assumed to enter into income (Y), endogenous demand (DEMEN), price (P), expected price (EP), production lag (reflected in PROD) and desired inventory (DI)
2. For each variable, the mean and variance of the actual minus estimated variable values are calculated
3. These means and variances are then used to estimate the random variation in each process. Each of the distributions are assumed to be exponential or exponentially autocorrelated

4. The historical tracking of the model is tested against actual observations. These results can be seen in Figures 5.2 - 5.5. While it is clear that these methods are crude, the essence of the model under uncertainty is captured. It should be remembered that the model results represent a controlled experiment rather than a true reflection of reality. The generated output of the model is realistic only in that it can track ten years of actual beef industry output reasonably well. The reality of the model is in its mechanisms, even though simplified

Instability in the System

In order to demonstrate instability in the system, it is necessary to reconsider the definition given in Chapter 4. Briefly, it is proposed that there are three aspects to instability as described by transient response. They are rising time, overshoot and settling time. Two aspects of this definition become immediately clear. First, in order to measure transient response, a desired output is needed to compare with actual output. In any economic system, desired output is normative. That is, it is subject to conjecture, since output is not centrally controlled, nor is it ever certain what desired output should be. Any attempt to describe desired output necessitates describing some criteria which are necessarily value judgements. Secondly, since transient response is described over time, the definition adopted here requires the observation of actual output, which is the result of a single increase (or decrease) in desired output. Apart from not being able to specify desired output, observation of the results of a single action in the market is not normally possible. This is because the market is a dynamic process in which changes occur constantly in both desired and actual output. The definition therefore is necessarily hypothetical and not subject to easy measurement.

A third problem also occurs when the definition of system output is considered. Which output is to be observed? Since major interest centers on price instability, should observed output be price? The answer to this question is both yes and no. Strictly speaking, every variable in the system can be considered system output. Furthermore, when system stability is considered, each and every variable becomes an important component of the observed output. In order to deal with these problems the following rules are considered.

1. There are five "final" outputs in the system. They are (a) price, (b) demand, (c) supply, (d) inventory, and (e) transactions. Since transactions are simply the minimum of supply and demand, it can be eliminated from the list, thus making the number of important component outputs four.
2. Since transient response cannot be satisfactorily operationalized in an economic system without further criteria being considered, analysis of instability involves observance of the results of different actions in the system by considering the four final outputs. This is achieved in summary form by (a) graphical comparison, and (b) mean, standard deviation and coefficient of variation.

While these methods are crude, it is felt that satisfactory analysis can be carried out using these methods. Other methods are possibly available but require varying degrees of inference to be satisfactorily interpreted.

In Chapter 6, some controlled experiments will be carried out to demonstrate several scenarios with respect to price stabilization. Since transient response cannot be measured directly, it is assumed that policies to stabilize price in terms of rising time, overshoot and settling time can be compared to the "base" model described here. Under each scenario, results are analyzed under both certainty (without random variation) and uncertainty (with random variation). At the risk of being somewhat repetitive, the "base" model is summarily described as follows.

Figures 5.2 - 5.5 demonstrate graphically the output of the control model of price demand, supply, and inventory under both certainty and uncertainty. While the observed results are quarterly observations over a ten year period, the time change (DT) in the actual model is 0.1. That is, the model produces ten output results every quarter. Observing only quarterly results is equivalent to collecting quarterly data for analysis and making corresponding inferences. Quarterly statistics assume that output is constant within a single quarter (or every 90 days). It should be noted that this model assumes change every nine days, which is more realistic than a quarterly econometric model but is not perhaps as realistic as daily change or even half daily. It is sufficient to say that economists must recognize that measured noise in a system is only as accurate as the observed time between changes.

In order to capture in part the unobserved noise in the system, Table 5.1 summarizes the base model in terms of the mean, standard deviation and coefficient of variation of the four final outputs.

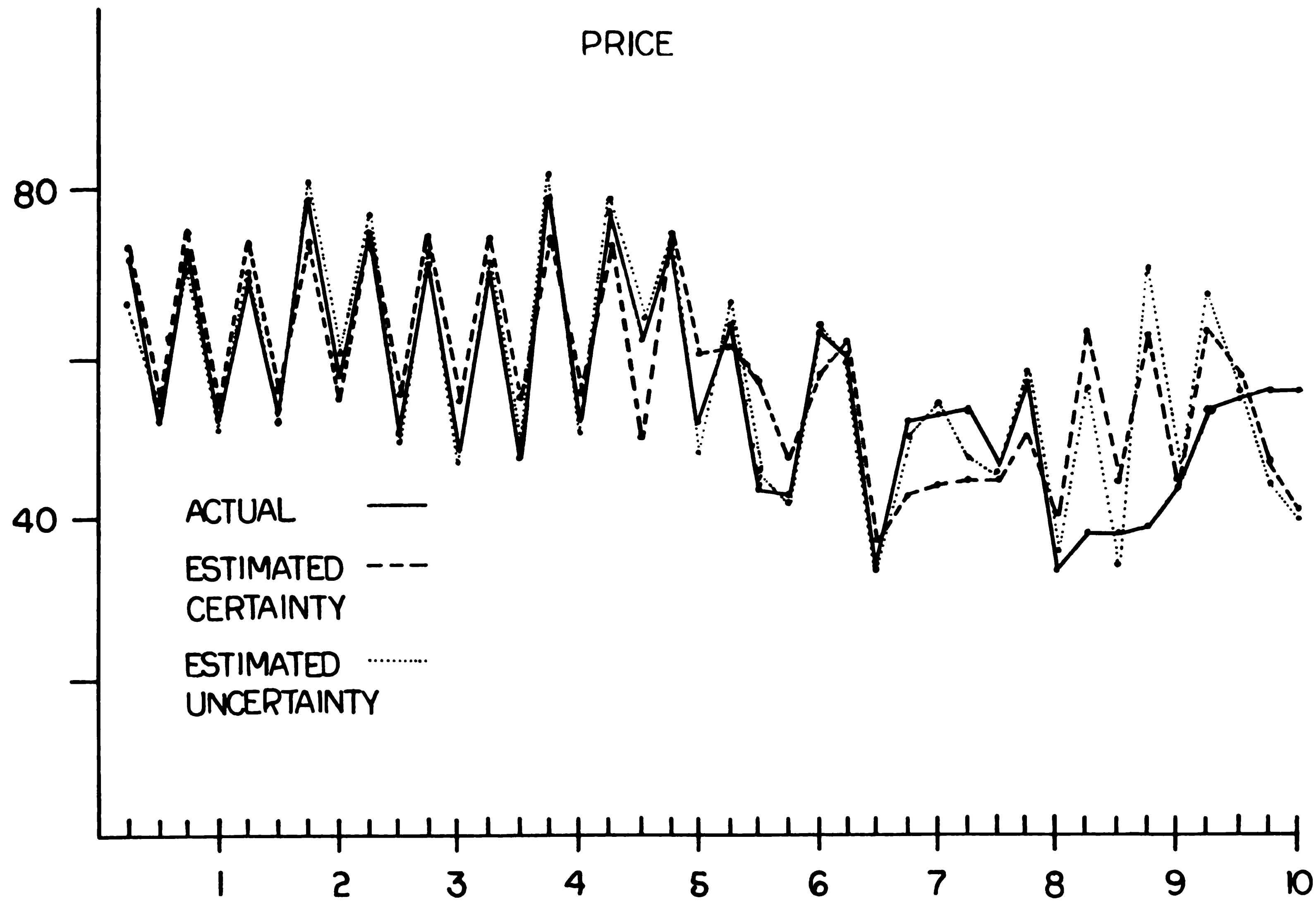

FIGURE 5-2
HISTORICAL TRACKING OF BASE MODEL UNDER CERTAINTY AND UNCERTAINTY

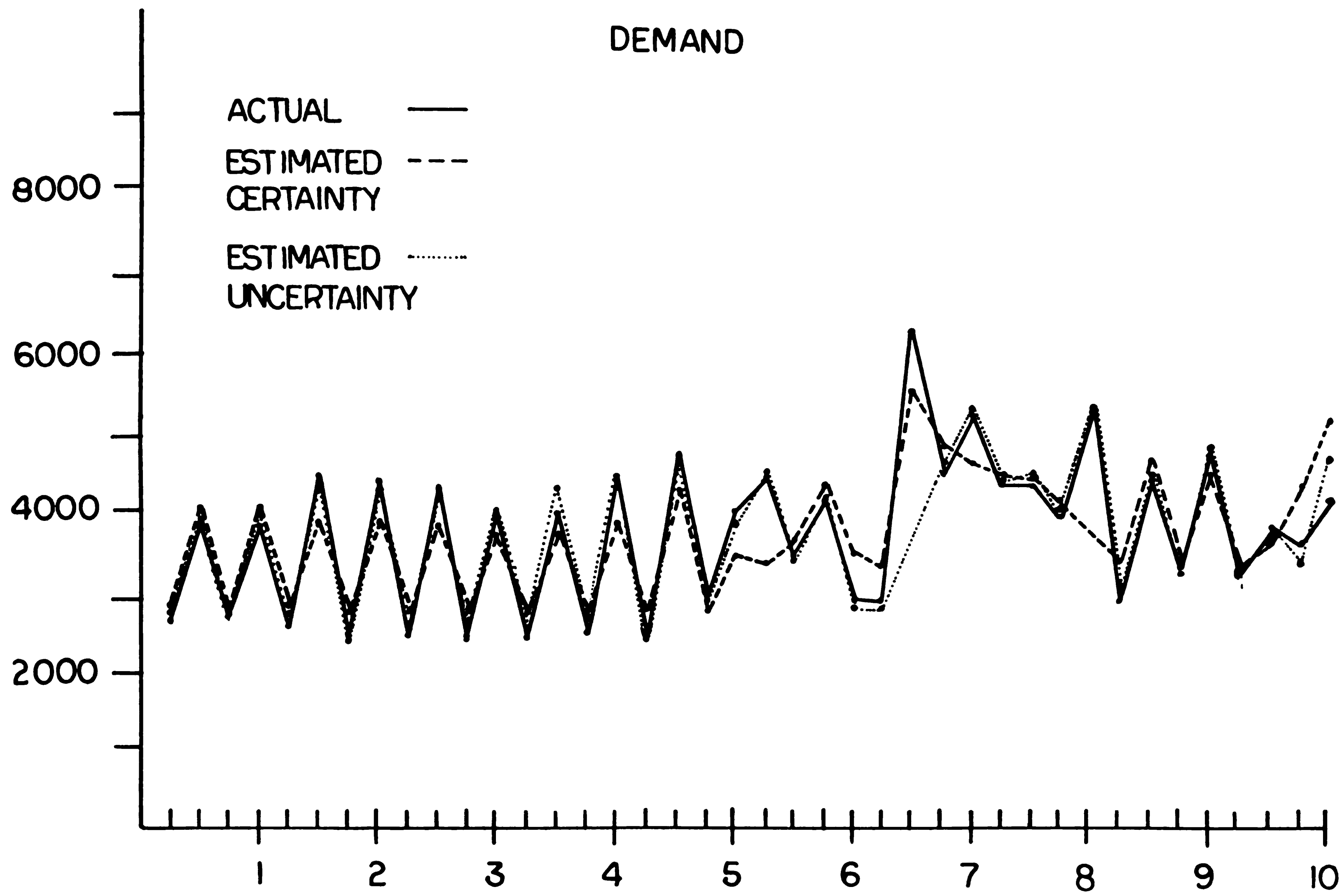

FIGURE 5-3
HISTORICAL TRACKING OF BASE MODEL UNDER CERTAINTY AND UNCERTAINTY

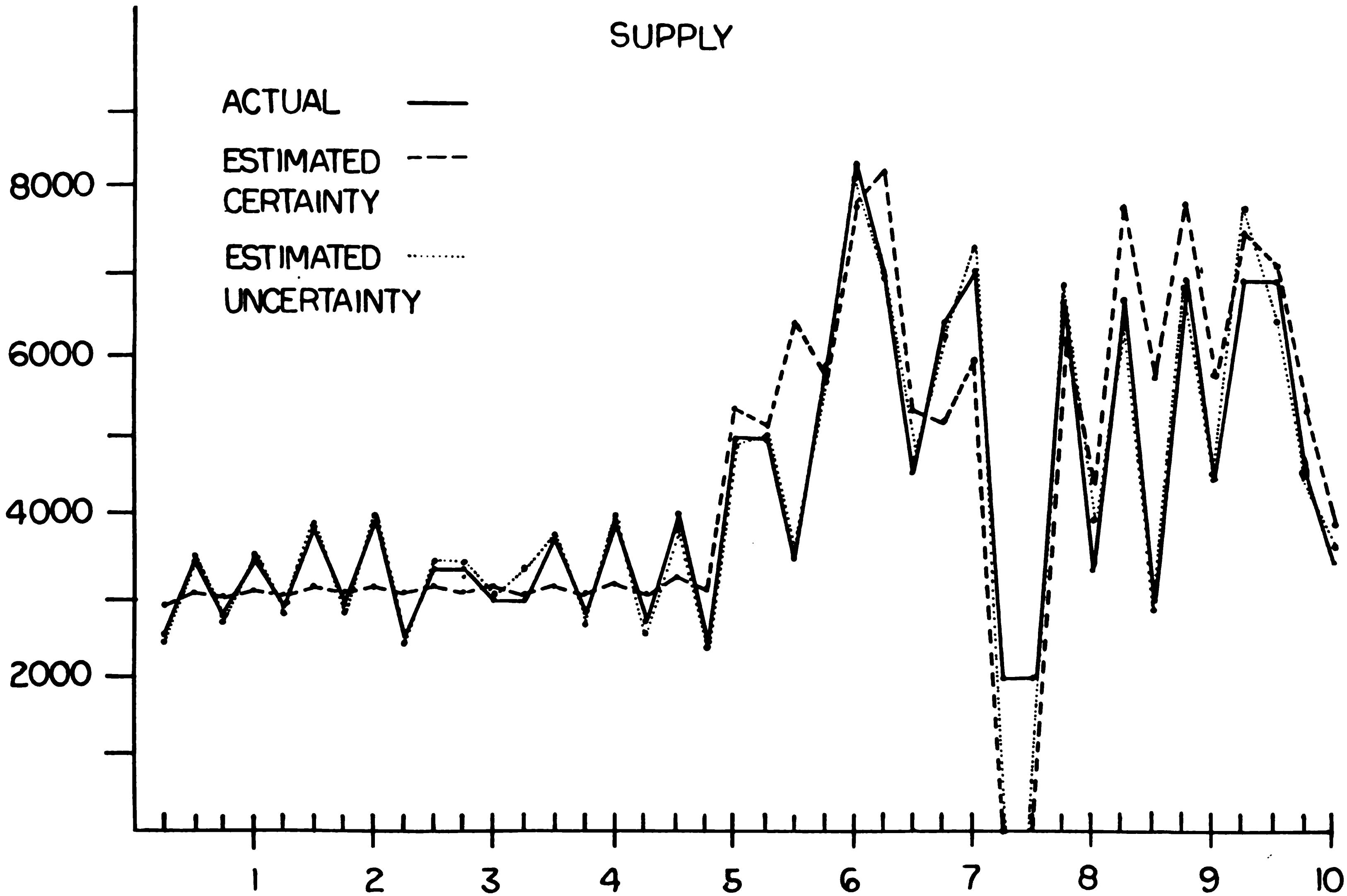

FIGURE 5-4
HISTORICAL TRACKING OF BASE MODEL UNDER CERTAINTY AND UNCERTAINTY

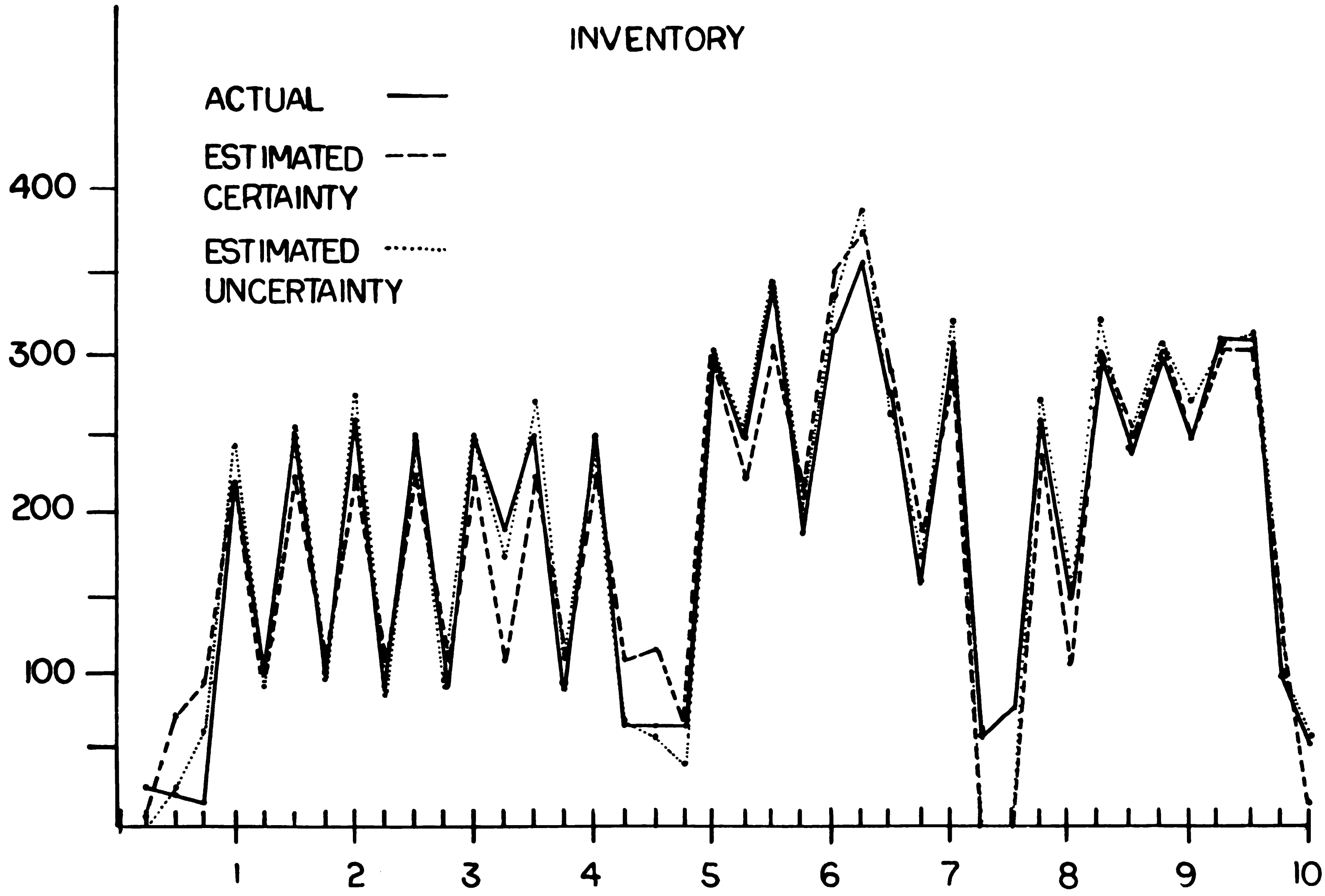

FIGURE 5-5
HISTORICAL TRACKING OF BASE MODEL UNDER CERTAINTY AND UNCERTAINTY

Table 5.1

Summary Statistics of Base Model

	Mean	Standard Deviation	Coefficient of Variation
Under Certainty			
Price	57.8	11.7	0.203
Supply	3959	1994	0.504
Demand	3959	844	0.213
Inventory	169	112	0.660
Under Uncertainty			
Price	44.3	17.4	0.392
Supply	5011	4630	0.924
Demand	2946	1078	0.366
Inventory	225	218	0.968

Finding the Transient Response

Although it has been previously mentioned that transient response cannot be directly measured it is possible to apply to the systems model a hypothetical one time change. The aim of such a controlled experiment is to observe the response of the system to a one time change in price, thus noting how rapidly the system responds (rising time), the extent of the fluctuation (overshoot) and the time taken to settle down into a relatively stable system (settling time). To experiment demonstrates the effect of a one time change in price.

In order to carry out such an experiment, the system must be observed to settle into an equilibrium. That is, the transient response is observed as the difference between how the system actually reacts compared to the situation of a one time or sustained increase in price. In order to enhance the "settling down" of the system, initial conditions are set up as close as possible to equilibrium conditions. Unfortunately, because of the lag structures and the continuous adjustment which occurs in the model, there is no observed continuously constant "settling down" of the system. However, when the model is "run" for 50 years (200 quarters) a cyclical pattern emerges where all outputs tend to "settle down" to very little change for a short period of time every 47 quarters.

In order to observe the transient response, prices are increased by 50 percent in the first observed "settling down" phase of the time path, and held constant for the entire quarter, after which the system is allowed to adjust as it normally would. By observing the two time paths it is possible to demonstrate how the system reacts to the one time change in prices, how long it takes to return to equilibrium, and the overall effects of the lag structures.

Figures 5.6 - 5.9 demonstrate graphically the results of this "experiment" while Table 5.2 shows the summary statistics for the two time paths. Since this is a relatively simplistic approach to transient response the experiment is only carried under conditions of certainty. The results begin in the 27th quarter and show the effects of the transient response through the 79th quarter. The 50 percent price increase occurs in the 30th quarter.

In Figures 5.6 - 5.9 it is clear that there is an initial impact of considerable change after the "price shock," which appears to settle down after five or six quarters. However, another impact can be observed between the 11th and 16th quarters after the "shock" due to the lags involved. Smaller impacts can be observed thereafter for the entire cycle but with decreasing effects. Although not shown in the figures, these increasingly smaller impacts continue throughout the 200 quarter simulation, but with negligible effects on the system. Table 5.2 shows that these "shocks" of transient response have negligible effects on the distribution of price and demand, but some impact on supply and inventory.

<u>Summary</u>

The purpose of this chapter has been to describe a simple nonlinear systems simulation model which may be used to examine the make-up of the price mechanism, and demonstrate how the "causes" and "effects" of price movements interact.

While the model is a much simplified version of reality, the intention of the model is to demonstrate the mechanisms involved in price discovery. While the model simulates a ten year period of the U.S. fed beef sector reasonably accurately, the methods used are crude and simple and its results should be interpreted and used with care.

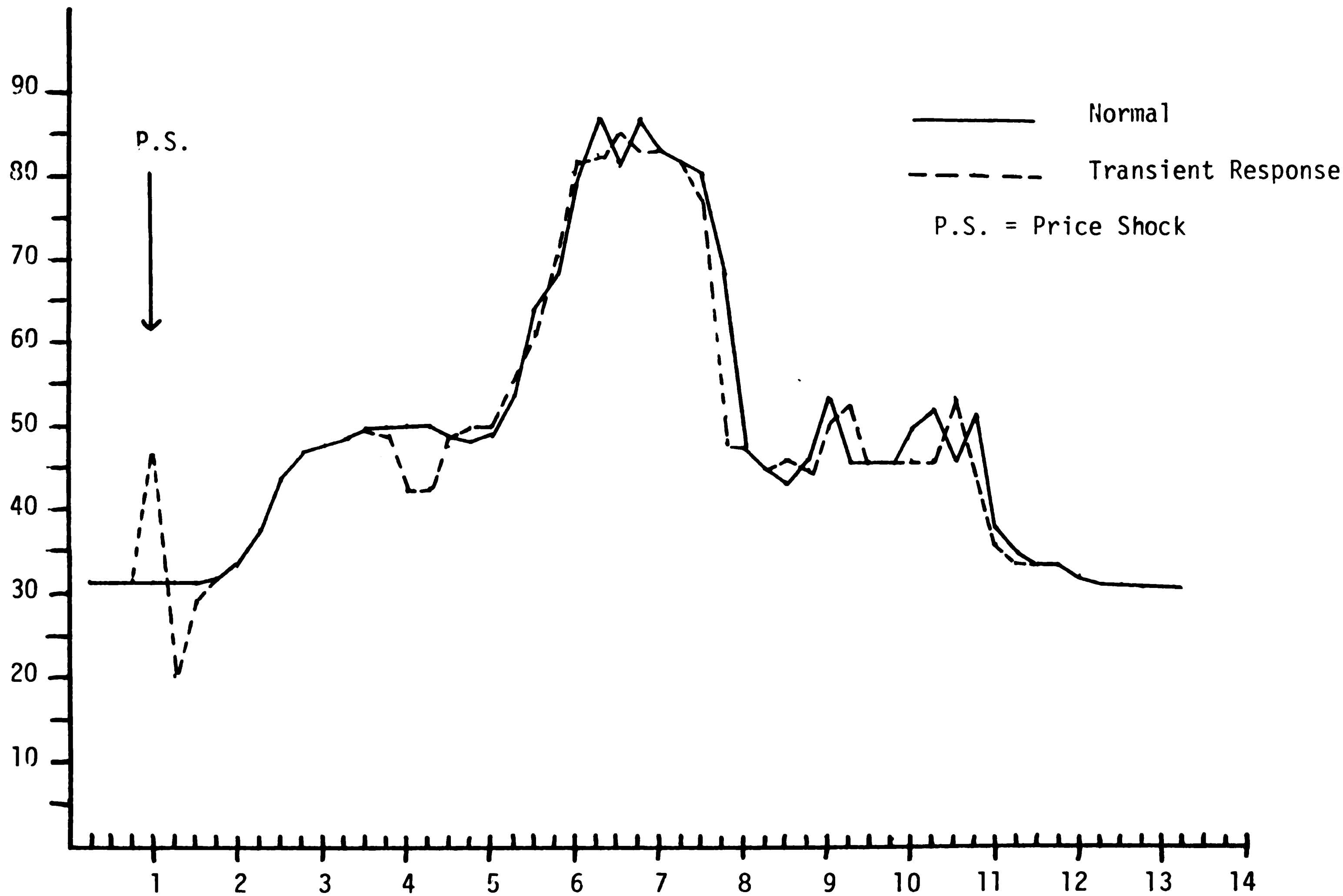

Figure 5.6

Price Response to Price Shock

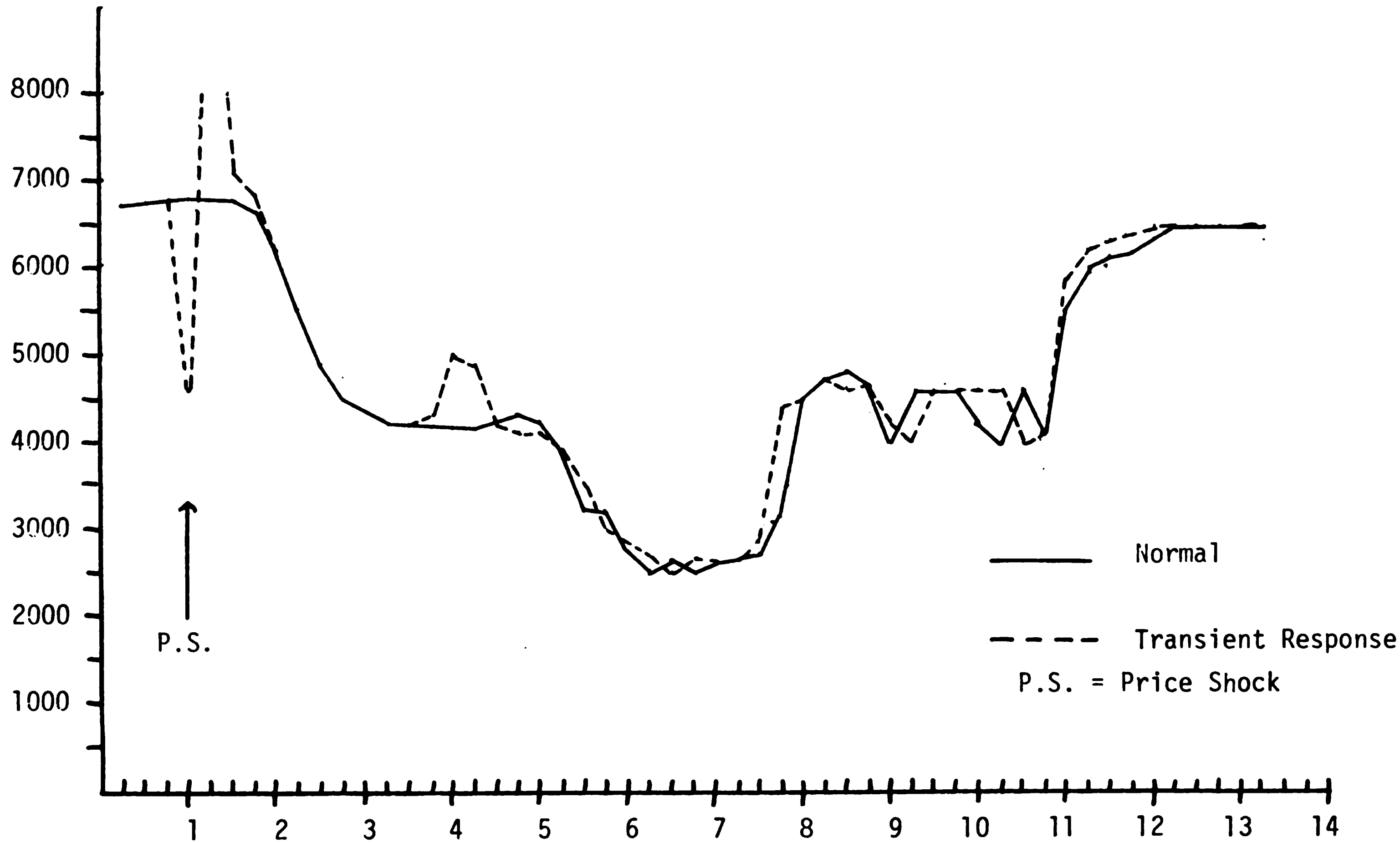

Figure 5.7

Demand Response to Price Shock

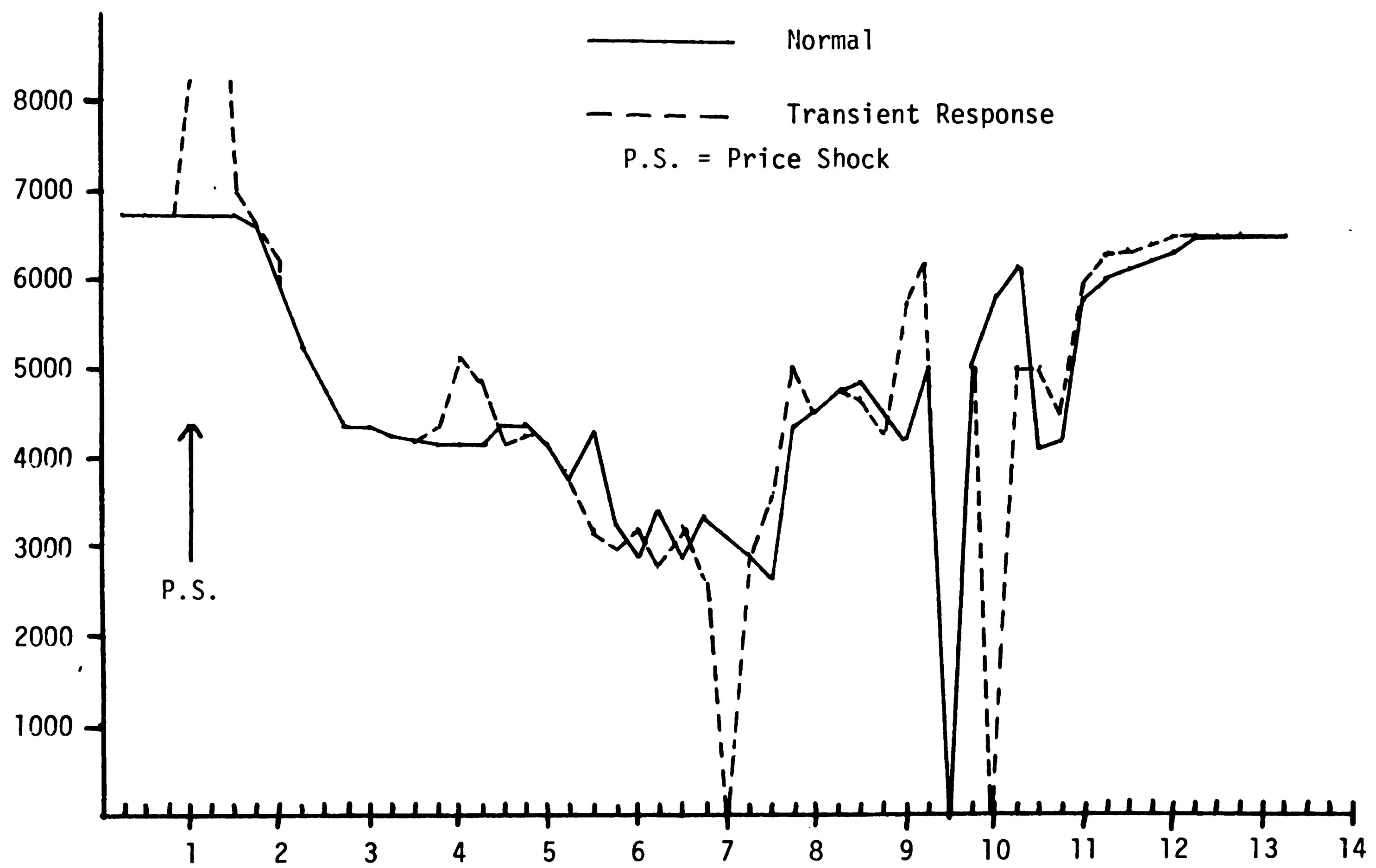

Figure 5.8

Supply Response to Price Shock

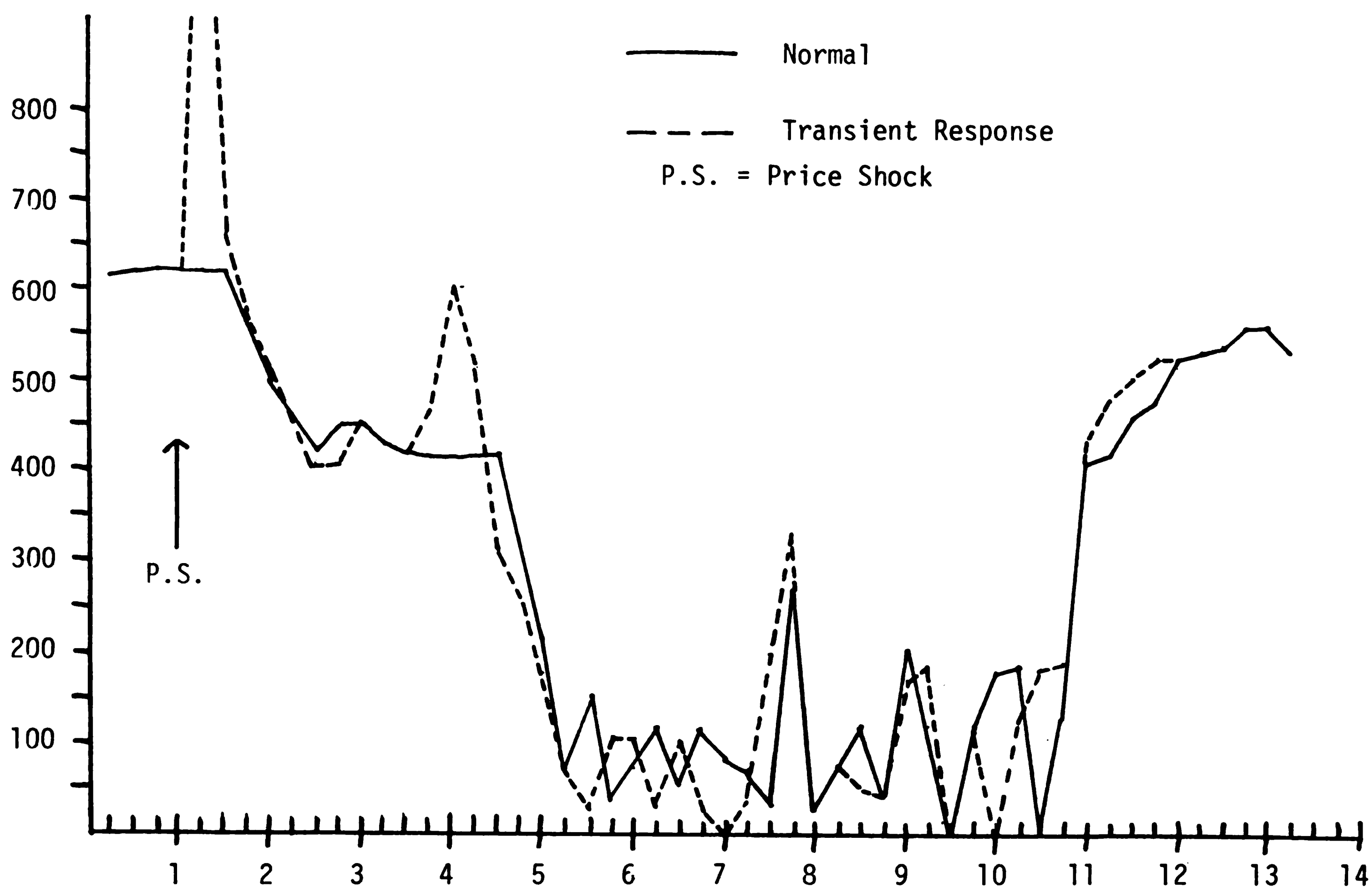

Figure 5.9

Inventory Response to Price Shock

Table 5.2

Summary Statistics for Transient Response Experiment

	Mean	Standard Deviation	Coefficient of Variation
Normal			
Price	51.1	15.6	0.305
Supply	4587	1514	0.330
Demand	4588	1212	0.264
Inventory	269	198	0.738
Shocked			
Price	51.1	15.5	0.304
Supply	4663	1784	0.383
Demand	4603	1240	0.269
Inventory	278	245	0.883

The model is also used to attempt to show the concept of transient response, but with somewhat disappointing results. Transient response is unfortunately more hypothetical than operational when used in this type of economic model. Hopefully, further research will uncover a way of operationalizing it in a more satisfactory way than it is used in this chapter.

The following chapter will use the model as it is developed here to demonstrate some scenarios of price stabilizing policy. The aim of these "experiments" is to attempt to discover how "causes" and "effects" interact in the system, and whether or not price stabilization policies achieve anything in the way of price stability over time or reduction in risk.

Footnotes: Chapter 5

[1]While these values do not have much interpretative meaning, the most significant values are C3 and C4 which indicate that prices are adjusted downward at a faster rate (0.0832) than they are upward (0.0321).

CHAPTER 6

SYSTEMS CONTROL AND PRICE INSTABILITY

Introduction

Many of the problems faced by economists are control or management problems--and indeed it would appear that price instability is such a problem. In accordance with the SCP/ADM paradigm of Chapter 3, control problems are separated from analysis. A good deal of confusion exists in economists' approach to problems when analysis and control problems are not separated. There appears to be a tendency to allow the methodology to dictate the problem, rather than to allow the problem to dictate a methodology. By separating out analysis from design and management it is easier to keep research goals in perspective.

The purpose of this chapter is to examine some of the control issues, and to demonstrate four scenarios of price stabilizing policy. Apart from the problems of controllability, interest will be centered around whether or not price controls and other policies actually stabilize prices over time, whether they reduce instability or uncertainty or both in the short run and in the long run, and the effects of price stabilization policies on the system as a whole.

There are two approaches to the control problem.

1. Some systems have inputs which are directly controllable by managers. For example, at the farm level, the control problem is solved by adjusting inputs so that desired output is attainable. This

is the management mode, where a particular structure is determined in order that the system be managed (or manageable).

2. Other systems do not have naturally or directly controllable inputs, so that design is required in order to gain control of the system. For example, the automobile must be designed so that control is attained by the driver. It is supposedly possible to control or "tune" the economy by adjusting taxes and/or interest rates. These policy inputs form part of the design of the economy by which government may exert some control over the system.

It should be remembered that the difference between design and management is that design is defined as the determination of a system structure or conduct given system inputs and desired output. Management is the determination of inputs given the system structure (conduct) and desired output. Design is <u>not</u> the physical changing of the structure (inputs)--this is management.

The first problem confronting the economist then, is to determine whether or not the system is controllable. If the system is controllable, then it may be possible to manage the system by adjusting the controllable inputs. If the system is not directly controllable, then it may be possible to design a system structure such that control is attained.

Controllability of the System

While there exists a mathematical theory of controllability, the system developed in Chapter 4 is not in a form which can be mathematically analyzed to determine whether or not it is controllable. According to Manetsch and Park (1977) the conditions necessary for dynamic control are:

1. The system can be modeled mathematically with reasonable accuracy.
2. The system is controllable in the sense that the policy inputs are "connected to" or change the state and/or output variables.
3. The system operates with random disturbances which affect the state.
4. Desired performance of the overall system can be stated mathematically as a set of consistent specifications.
5. There is a rational control design procedure.

Of the two approaches to control problems, the management mode requires control over inputs while to the management design mode requires some method of controlling the system structure. In a macro-economic model such as the one developed in Chapter 5, where "management" is considered to be the government, there is little in the way of control over inputs which affect the outcome of the system. Therefore, it is necessary to examine the second approach to control--namely the management design mode. Apart from taxation, interest rates and some other marketing policies, the only direct method of gaining control over the system structure is through the price feedback loop. It is in this fashion that past and current policies of stabilization have been formulated.

Examination of the possibilities of government control of prices gives rise to a series of other possible control measures. For example, if inventory, until now considered to be private, became a government controlled instrument, then some control can also be exerted over supply by using inventory to buffer the shocks to the system. While there is no such stabilization scheme in the U.S. for beef, most economists are familiar with the current price stabilization schemes in the grain industries. The aim of such policies is to reduce risk in the private sector by transferring it to the public sector. This can be achieved, under conditions of certainty, in several different ways. Current policy formed under the 1977 Food and Agriculture Bill provides for price control in the form of announced annual price setting arrangements together with a buffer stock scheme. Such control over prices and inventory also allows government to coerce the farm producer by allowing them to partake in the price stabilization scheme only if certain conditions of production are met.

What does this indicate in terms of the problem of price instability? As stated in the problem identification of Chapter 4 the major cause of price instability is uncertainty. This uncertainty has three major sources, namely, participants in the system, the mechanism and random variation. The entire problem has the added dimension of time, in addition to the problem of compatibility of aims (i.e., price stabilization may cause destabilization of other variables of the system). Government control of prices and inventory therefore has the possibility of reducing some uncertainty and of making some of the goals more compatible. Unfortunately, price stabilization in this form leaves some of the major sources of uncertainty unattended; namely, some participants and two of the three sources of random variation. It deals with some of the random variation in the feedback loop but does not deal specifically with random variation from exogenous sources and/or random variation in the behavioral aspects of the system. In short, current price stabilization policies can only purport to be partially stabilizing at best. It would be unfair to say that this is all that is attempted by government. In addition to direct price stabilization, government policy also provides for disaster insurance and forecasting of commodity market expectations. In addition to this, agricultural marketing agencies provide forward contracting for some commodities, futures markets and crop insurance--all of which aid in reducing uncertainty in various parts of the market and tend to stabilize the market.

Price Control in the System

While the system developed in Chapter 5 does not demonstrate all the sophistications of the real market situation, it is possible to examine some scenarios of price control and price stabilization. Four scenarios are presented here in order to gain some perspective of the problem in quantitative terms. It should be remembered that the purpose of examining these scenarios is to demonstrate the potential conflicts between a reduction in uncertainty and stabilizing the system over time. Interest is therefore centered not only on price, but on supply, demand and inventory as well.

Annual Price Control

The first scenario deals directly with the price mechanism. Instead of allowing the market to determine prices, government sets and announces prices which are fixed for each year of the system output. Since prices are announced before the production process begins, the price expectations model will be affected. It is expected therefore that the production process will be relatively more stable. Since demand is affected by price and income, then demand too will be relatively stabilized. The two outputs of the system of interest therefore will be inventory levels and price changes over time.

Figures 6.1 to 6.4 present the graphical details of such a policy under both certainty and uncertainty. Table 6.1 presents the summary statistics.

Interpretation of the results is rather difficult because of the inability to present the results in a neat and compact way. Thus interpretation requires some judgement to be made. Besides examining the results on their own, some comparison can be made with the results of the base run in Chapter 5. In addition, some care needs to be taken in the interpretation of the coefficient of variation as an indicator of stability or instability. Since the coefficient of variation is given by

$$CV = SD/M \qquad CV = SD/M$$

where

SD = standard deviation SD

M = mean

then it is clear that its use as a summary statistic is subject to how the mean and standard deviation react to policies. If the mean is increased while the standard deviation remains constant, then the CV will decrease. Where the CV decreases, it is important to identify it as a mean increasing or standard deviation decreasing type decrease. This is particularly important with respect to price, where increased mean will cause the CV to decrease, but, in general, reflects increased supply and decreased demand, with the result often indicating a substantial rise in the variance of the distribution. Hence, of greatest interest is a policy which is relatively mean-preserving while reducing the variance of the fluctuations.

Table 6.1

Summary Statistics for Annual Price Control

	Mean	Standard Deviation	Coefficient of Variation
Under Certainty			
Price	50.8	12.4	0.244
Supply	4302	2718	0.632
Demand	4686	1779	0.379
Inventory	279	386	1.38
Under Uncertainty			
Price	47.9	15.4	0.323
Supply	4412	3587	0.813
Demand	4763	2377	0.499
Inventory	302	504	1.67

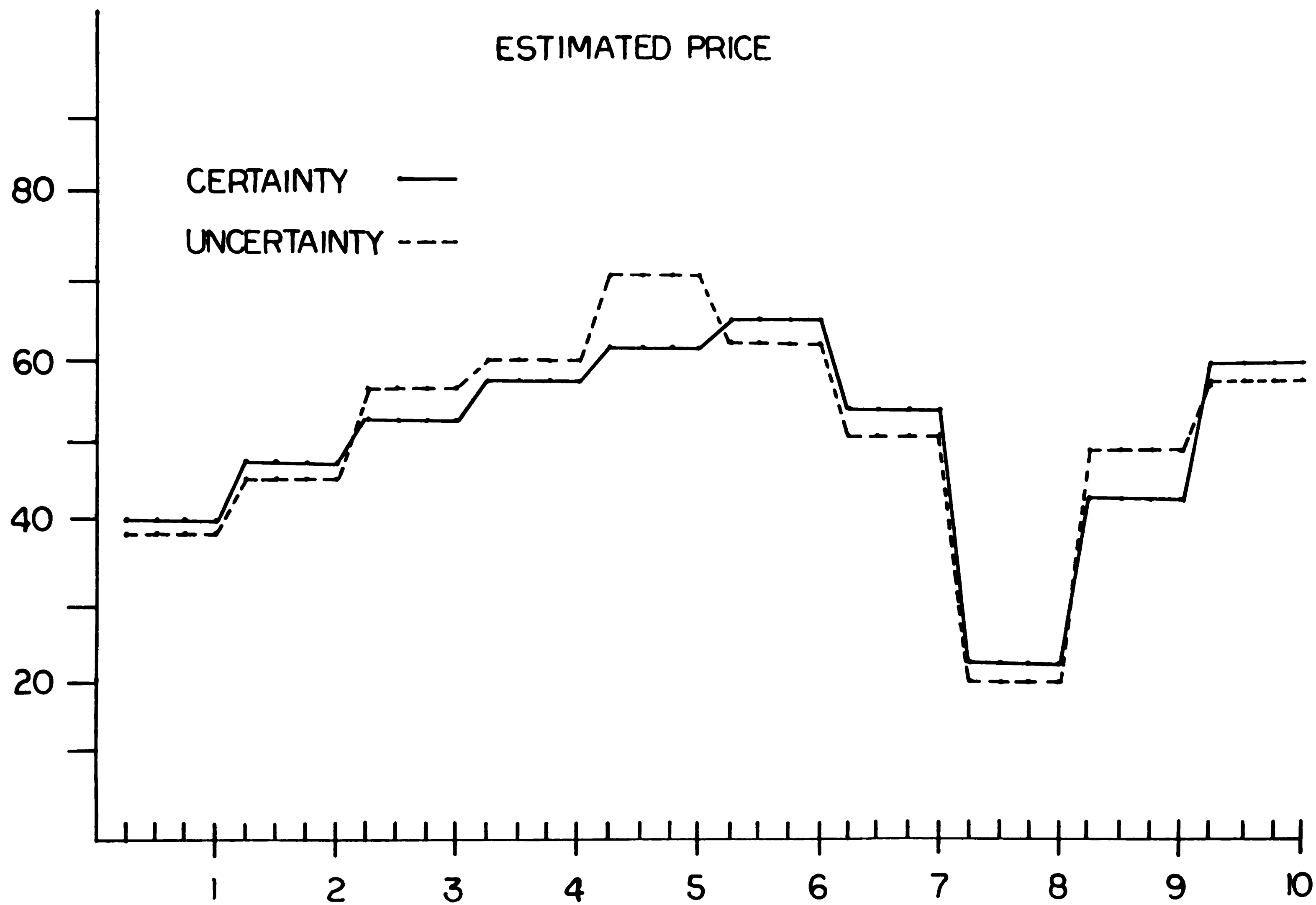

FIGURE 6-1
ANNUAL PRICE CONTROL

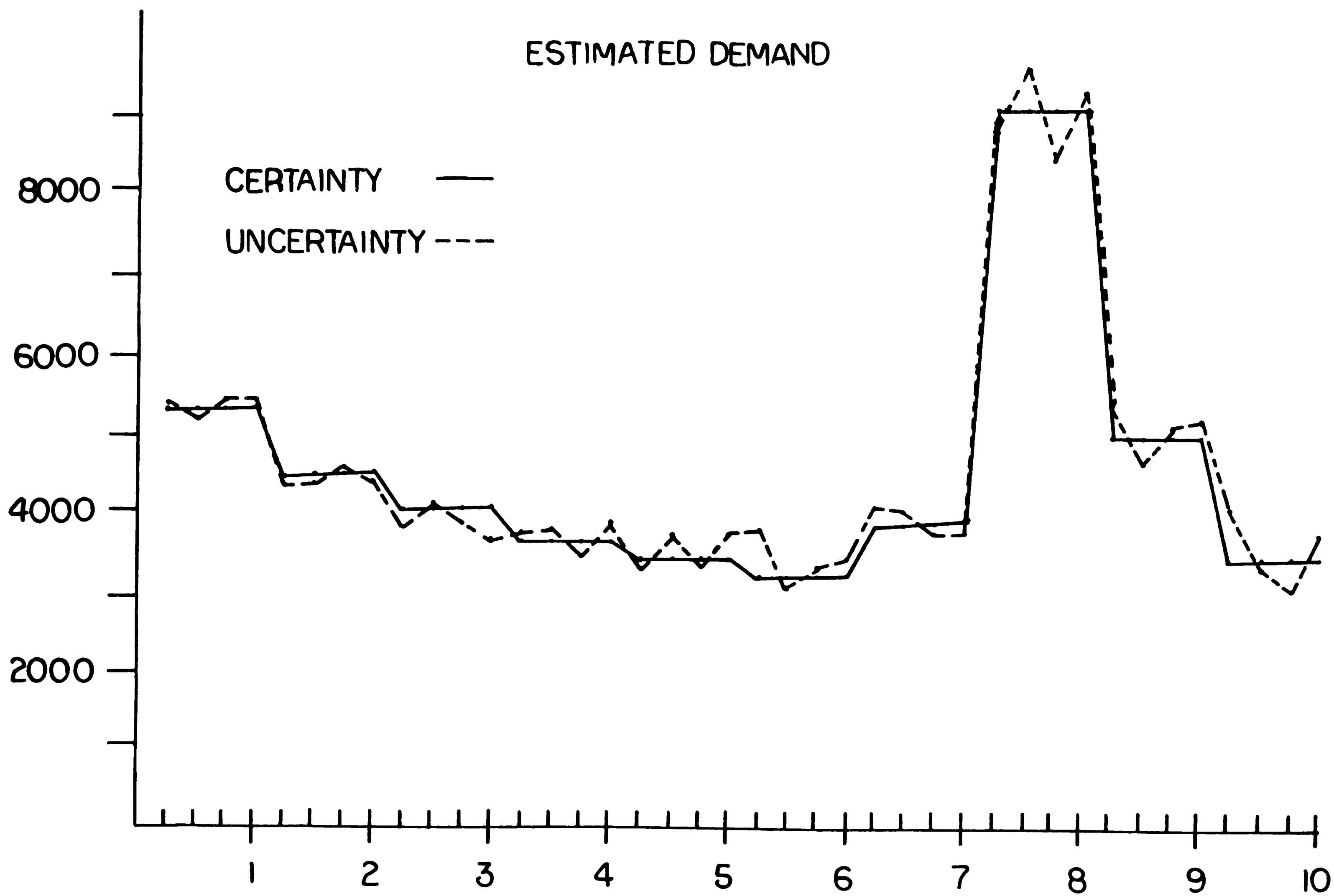

FIGURE 6-2
ANNUAL PRICE CONTROL

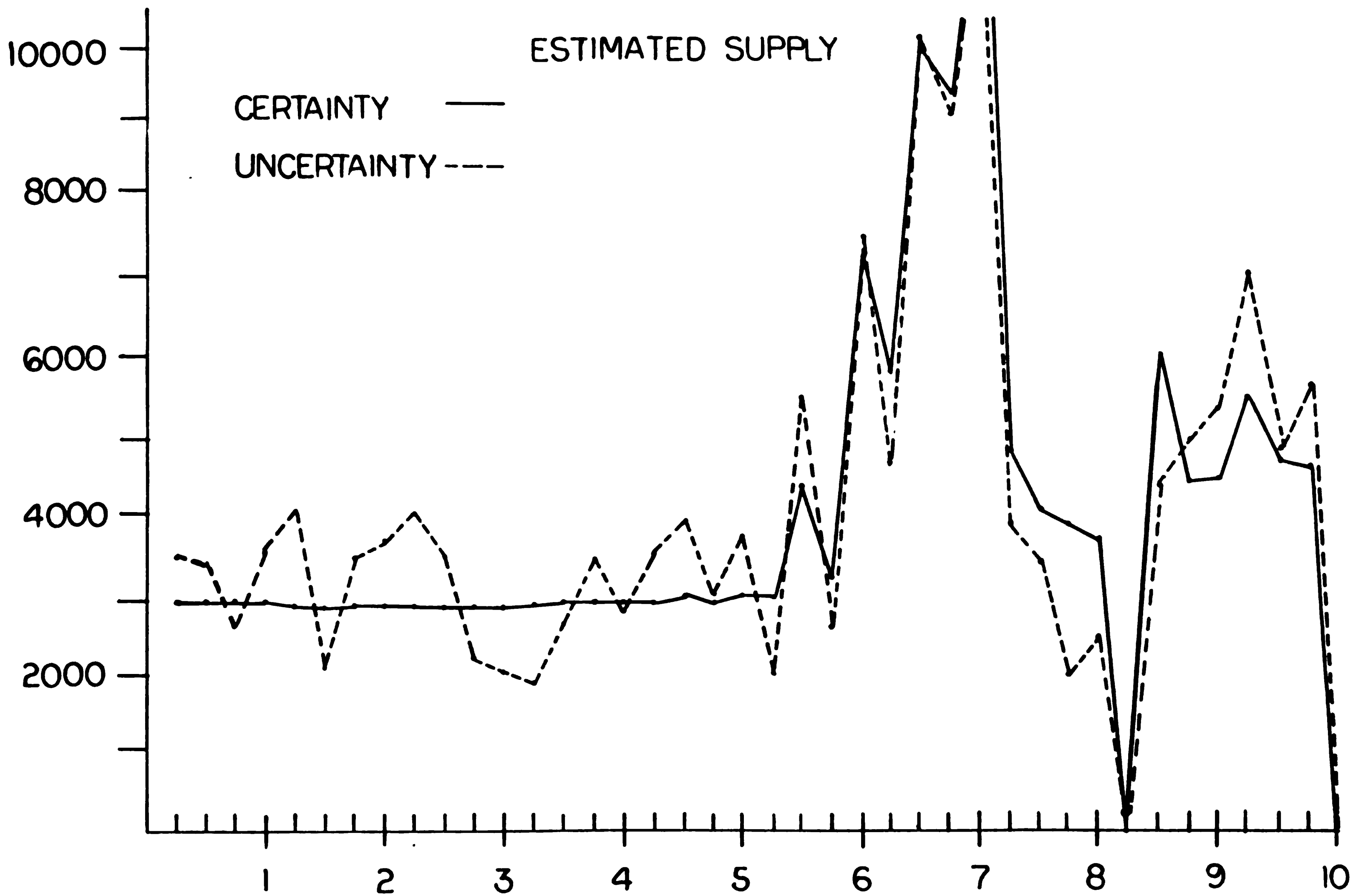

FIGURE 6–3
ANNUAL PRICE CONTROL

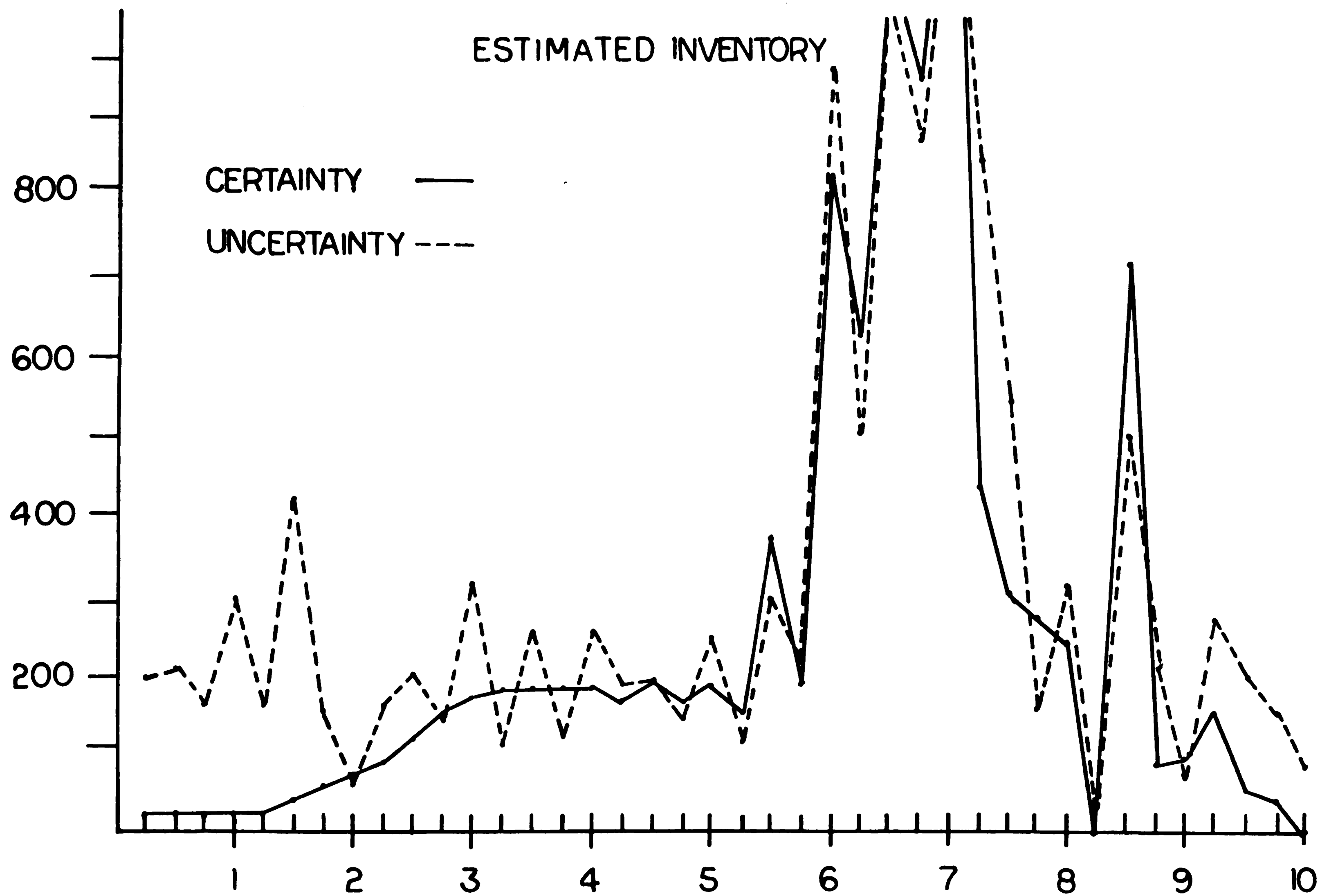

FIGURE 6-4
ANNUAL PRICE CONTROL

As mentioned previously, examination of transient response under these conditions is not possible without a considerable amount of judgement being exercised. Where possible, some comment on the transient response will be made, with much of the judgement being determined by the theoretical outcomes.

The annual price control policy examined here clearly provides for short run price stability, in the sense that it prevents fluctuations in price from year to year. However, depending on the direction of price movement from year to year, there is not necessarily any long run stability. The results indicate that the model remains relatively stable for the first seven years. However, because of the general build up in inventories, the price plunges in year seven in order to clear the market and restabilizes in year eight. Whether this is a more desirable state of affairs depends entirely on people's preferences.

With respect to a reduction in uncertainty, it is clear that price uncertainty to producers is substantially reduced in the short run. Nevertheless, it is clear that as prices rise, producers begin to overproduce and inventory accumulates culminating in the need to reduce prices substantially to clear the market. Again, it is not possible to say whether this is a more desirable state of affairs or not.

Inventory Limits

The relatively stabilizing effect of an annual price change is really only possible if, at time of low prices, inventory can be allowed to accumulate in anticipation of "better" prices. Since it is assumed that the government operates the buffer stock, there will obviously be an upper limit to the amount of produce that can be stocked. A complication occurs here, in that producers of course can also withhold stocks. It might be assumed that even with an upper limit to government inventories, producers could withhold stocks in times of depressed prices. Nevertheless, it will be assumed that total inventories cannot exceed 500 million pounds of beef. This is the same as setting an upper limit on desired inventory, but does not necessarily mean that actual inventory will not exceed the upper limit. Thus, it can be expected that prices will be forced to lower levels when inventories exceed the upper limit, and the effects will be fed back to supply and demand.

Table 6.2 shows the results of this upper limit on inventory with annual price changes, while Table 6.3 presents the results of the upper limit on inventory without any price controls. Figures 6.5 to 6.8 present the graphical results.

It is interesting to note that an annual price control together with the upper limit on inventory appears to be less stable overall than the same thing without price controls. This is an effect of the mean increasing, while the standard deviation decreases. Both of these effects of course cause the coefficient of variation to decrease.

Demand Oriented Markets

The third scenario is an attempt by government to control supplies to the extent that demand is always satisfied. In the original model developed in Chapter 5, transactions are determined by simply taking the minimum of supply and demand. It is hypothesized here that a destabilizing effect could occur when available supply falls short of demand. In this scenario, demand is always met, even at the expense of decreasing inventory below desired minimums, thus attempting to avoid sudden price increases which may destabilize the market. Of course, it

Table 6.2

Summary Statistics for Annual Price Change
And Upper Limit on Inventory

	Mean	Standard Deviation	Coefficient of Variation
Under Certainty			
Price	46.4	11.9	0.258
Supply	4244	2819	0.664
Demand	5149	1968	0.382
Inventory	293	418	1.428
Under Uncertainty			
Price	48.2	16.4	0.342
Supply	4563	4043	0.886
Demand	5352	2901	0.542
Inventory	323	557	.723

Table 6.3

Summary Statistics for Upper Limit on Inventory
With No Price Controls

	Mean	Standard Deviation	Coefficient of Variation
Under Certainty			
Price	56.1	12.8	0.229
Supply	4123	2392	0.580
Demand	4117	979	0.238
Inventory	177	112	0.63
Under Uncertainty			
Price	57.2	16.7	0.292
Supply	4246	2900	0.683
Demand	4224	1905	0.451
Inventory	348	343	0.985

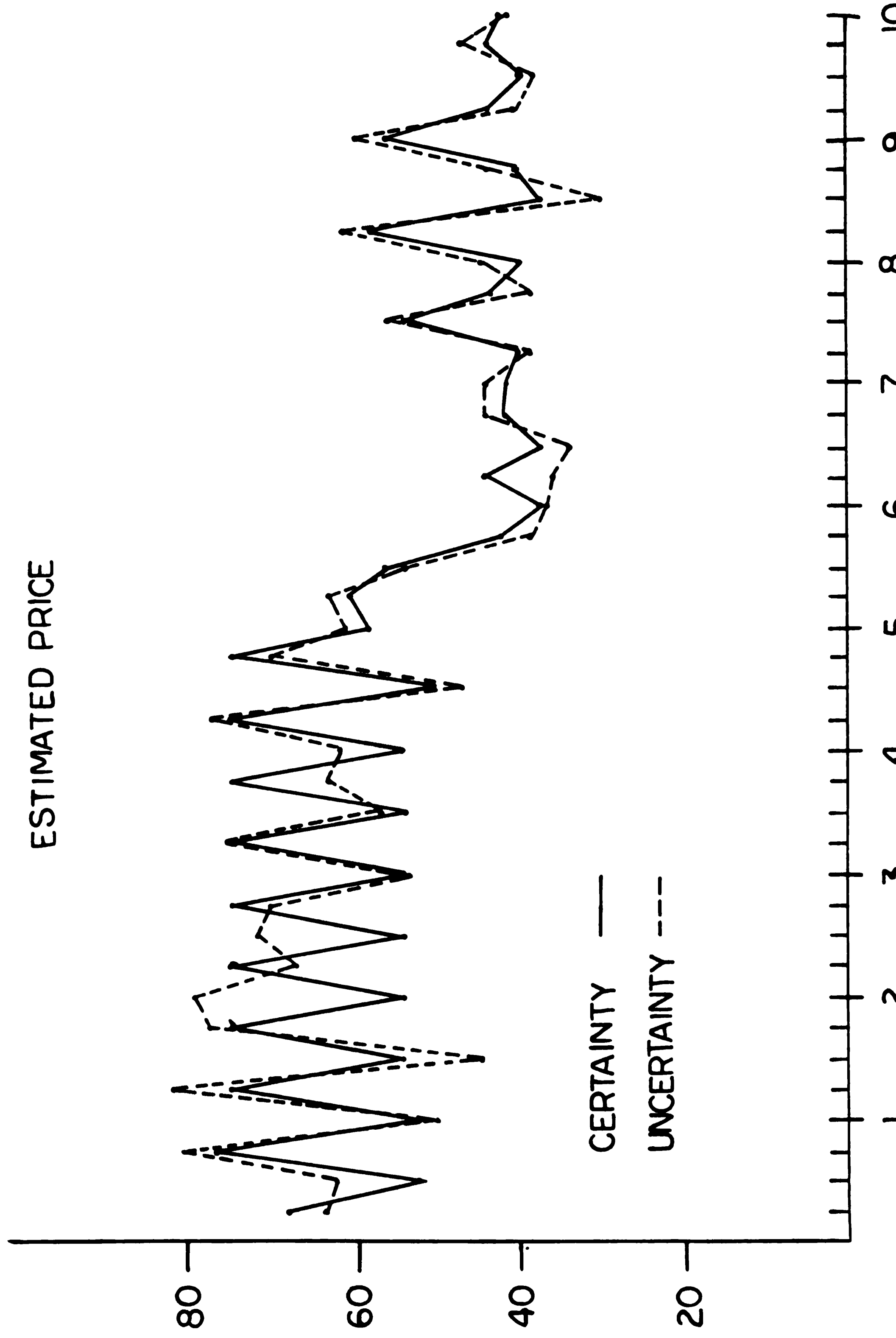

FIGURE 6-5
INVENTORY LIMITS

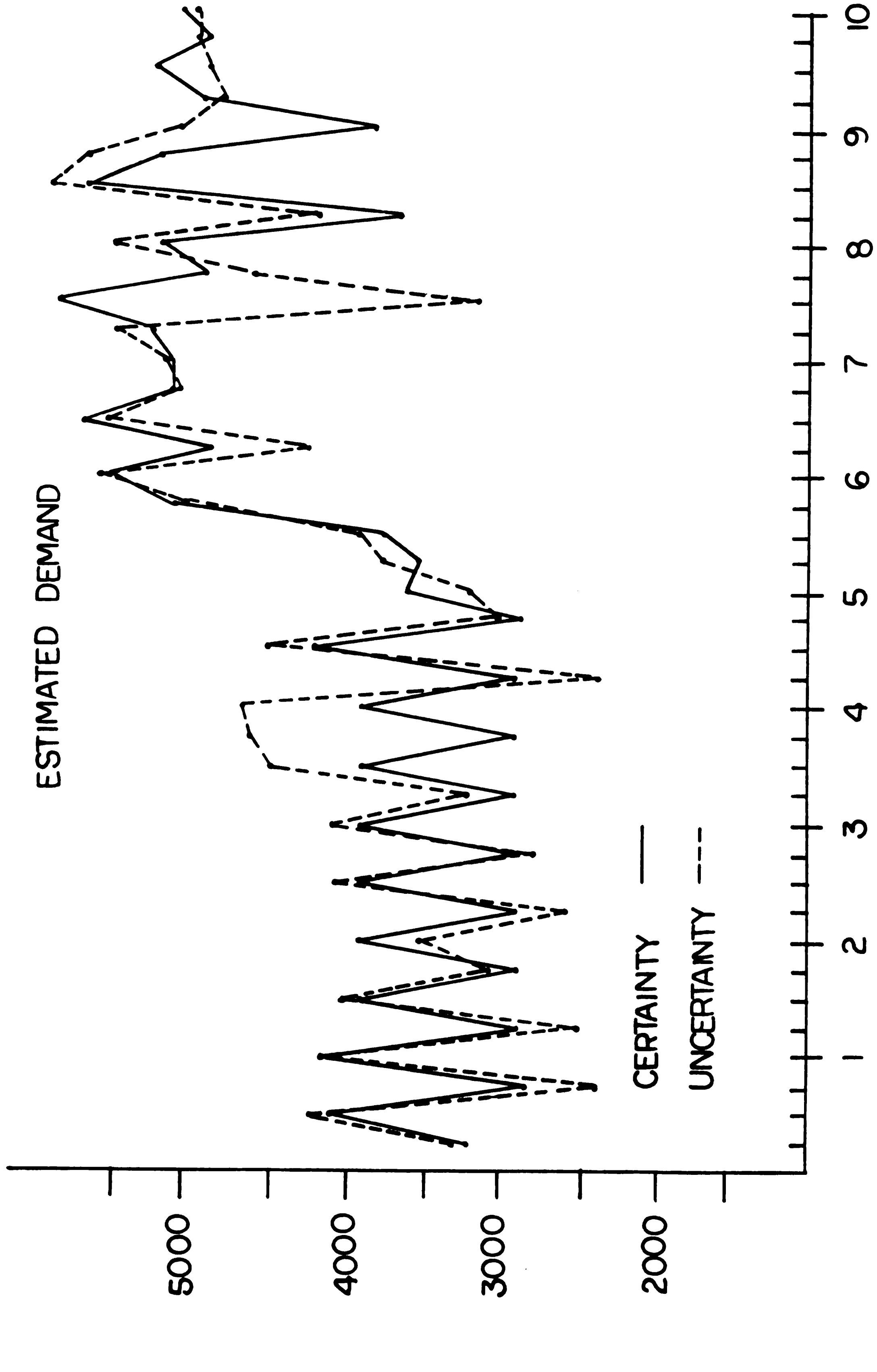

FIGURE 6-6
INVENTORY LIMITS

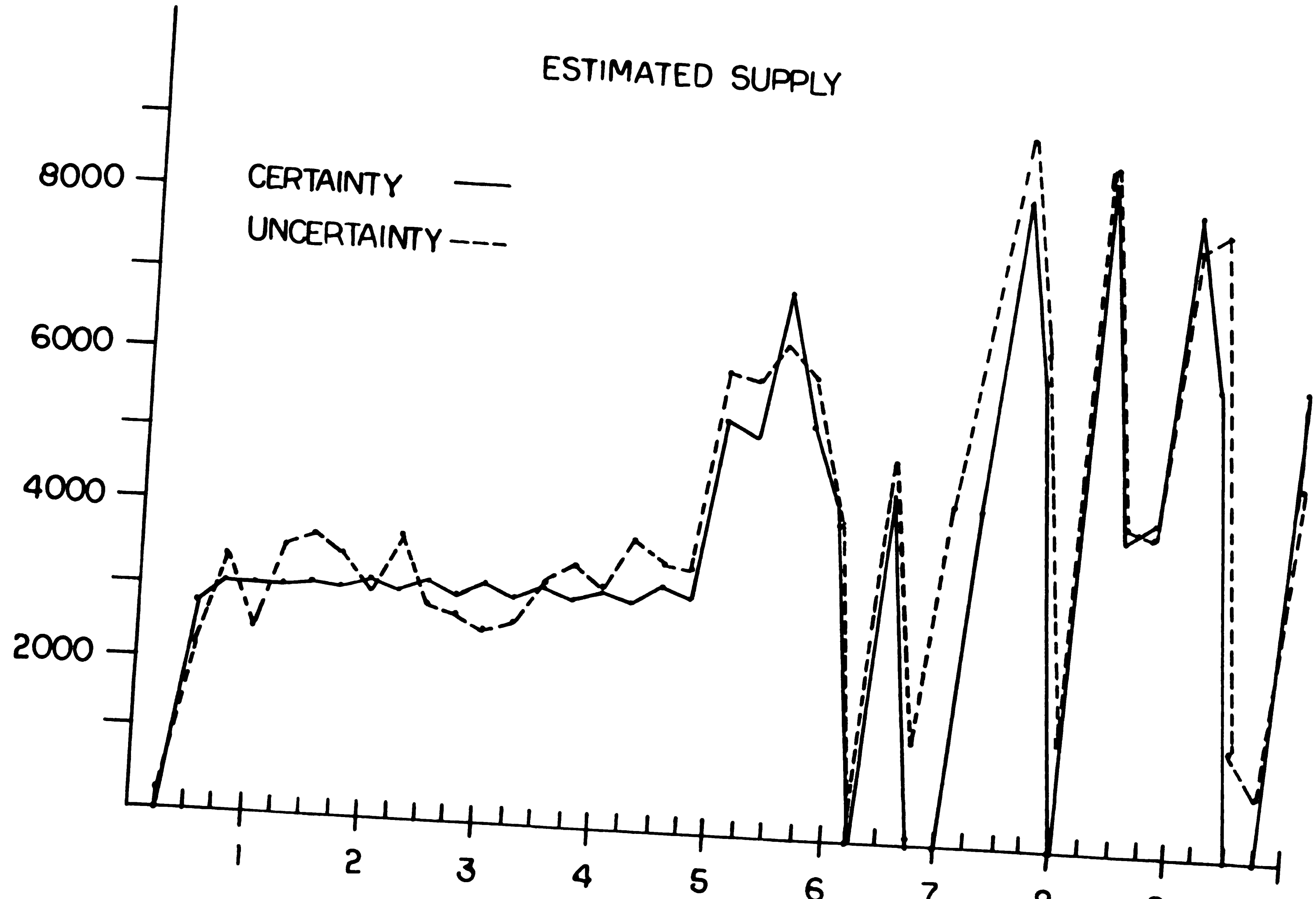

FIGURE 6—7
INVENTORY LIMITS

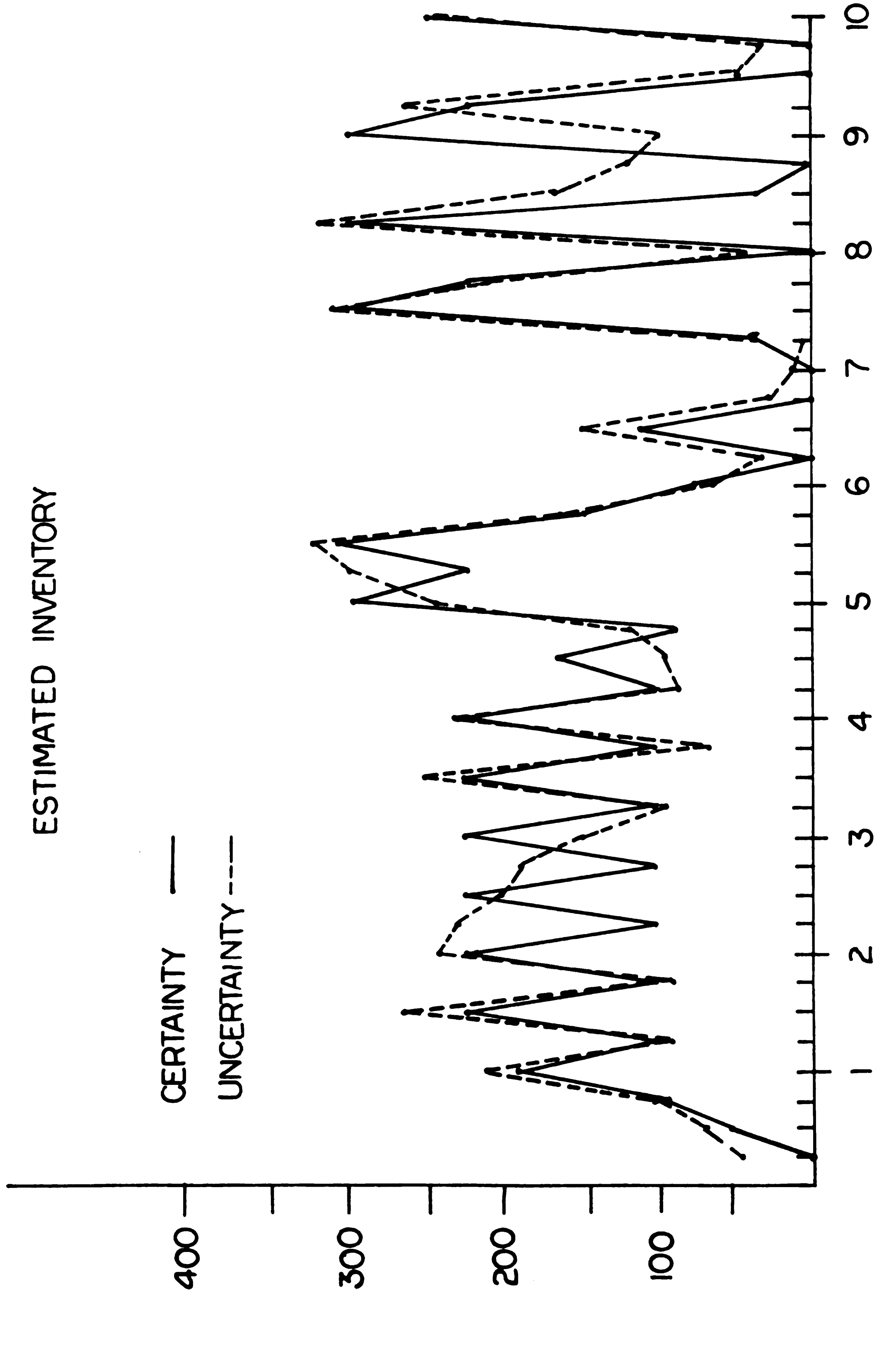

FIGURE 6-8
INVENTORY LIMITS

stocks in inventory are totally decreased then supply will fall to zero and a price increase is inevitable. This is most likely to occur in a "bad" year when production is decreased and demand is met predominantly out of inventory.

The following three results are presented under both certainty and uncertainty.

1. Demand is met under conditions of no other controls (Table 6.4).
2. Demand is met when annual price controls and inventory limits are imposed (Table 6.5 and Figures 6.9 to 6.12).
3. Demand is met when inventory limits are imposed but with no price control (Table 6.6).

Price Bands

The final scenario examined here is another type of price control--namely the specification of upper and lower price limits. The idea of price bands is an old one, constituting the conviction that prices should not be fixed, but rather allowed to move within a band. Obviously, prices will be stabilized and therefore, under certainty, demand will also be stabilized. Once again, the interesting variables will be supply and inventory. While there is no clear cut rule as to how prices should vary, or to the extent that they should be controlled, an arbitrary figure of ± 20 percent of previous price is used here.

The following four results are presented.

1. Price band policy (Table 6.7 and Figures 6.13 to 6.16).
2. Annual price band policy (Table 6.8 and Figures 6.17 to 6.20).
3. Price band policy with inventory control (Table 6.9).
4. Annual price band policy with inventory control (Table 6.10).

Table 6.4

Summary Statistics When Demand is Met

	Mean	Standard Deviation	Coefficient of Variation
Under Certainty			
Price	69.6	19.1	0.274
Supply	3274	2492	0.761
Demand	3423	771	0.225
Inventory	113	146	1.292
Under Uncertainty			
Price	68.3	28.6	0.420
Supply	3382	3152	0.932
Demand	3442	1243	0.361
Inventory	136	199	1.463

Table 6.5

Summary Statistics When Demand is Met With
Annual Price Controls and Inventory Limits

	Mean	Standard Deviation	Coefficient of Variation
Under Certainty			
Price	58.6	13.6	0.232
Supply	2902	3864	1.33
Demand	4009	1275	0.318
Inventory	193	329	1.659
Under Uncertainty			
Price	62.4	19.5	0.313
Supply	3421	4861	1.421
Demand	4216	1720	0.408
Inventory	226	367	1.623

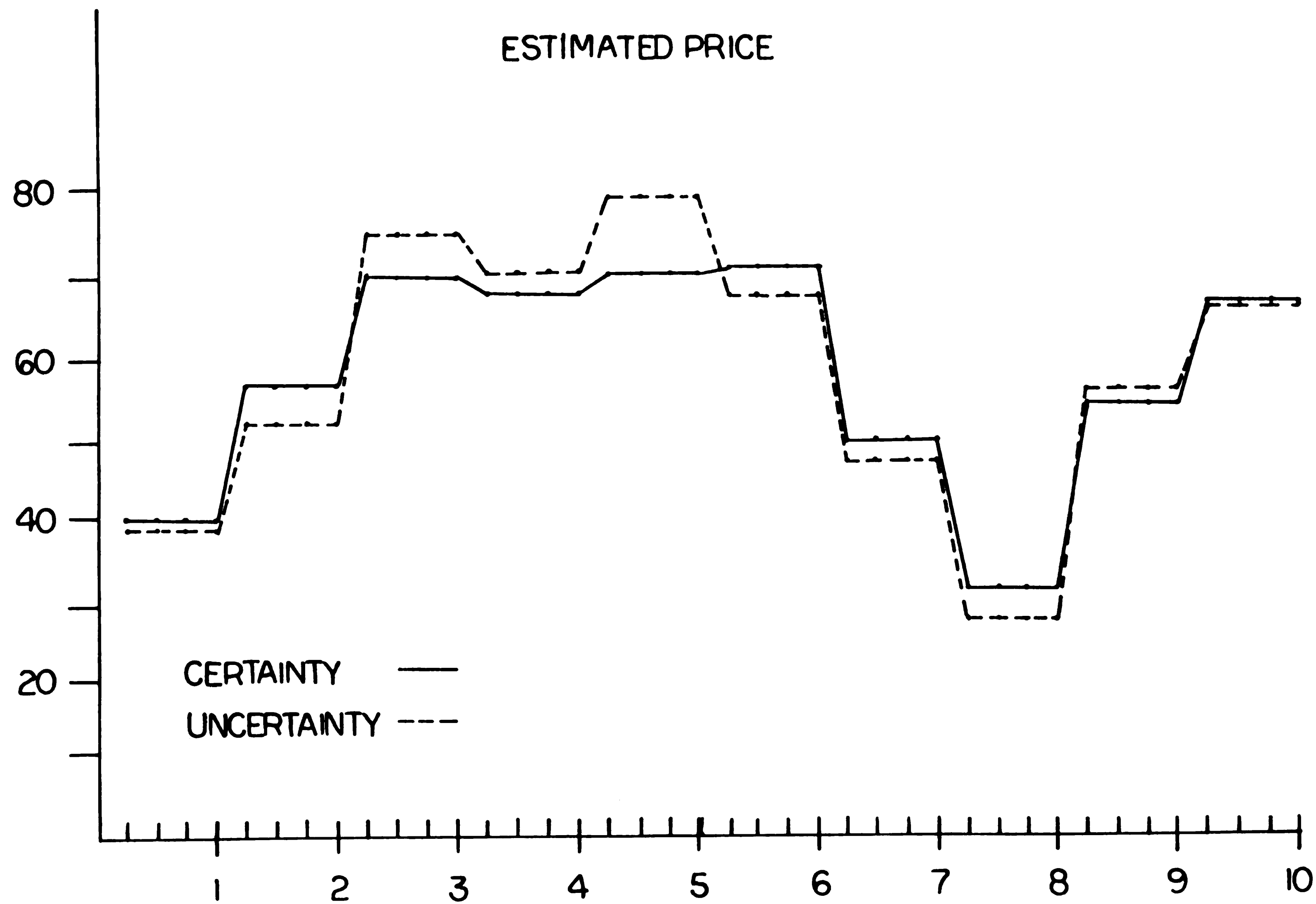

FIGURE 6-9
DEMAND IS MET, ANNUAL PRICE CONTROL AND INVENTORY LIMITS

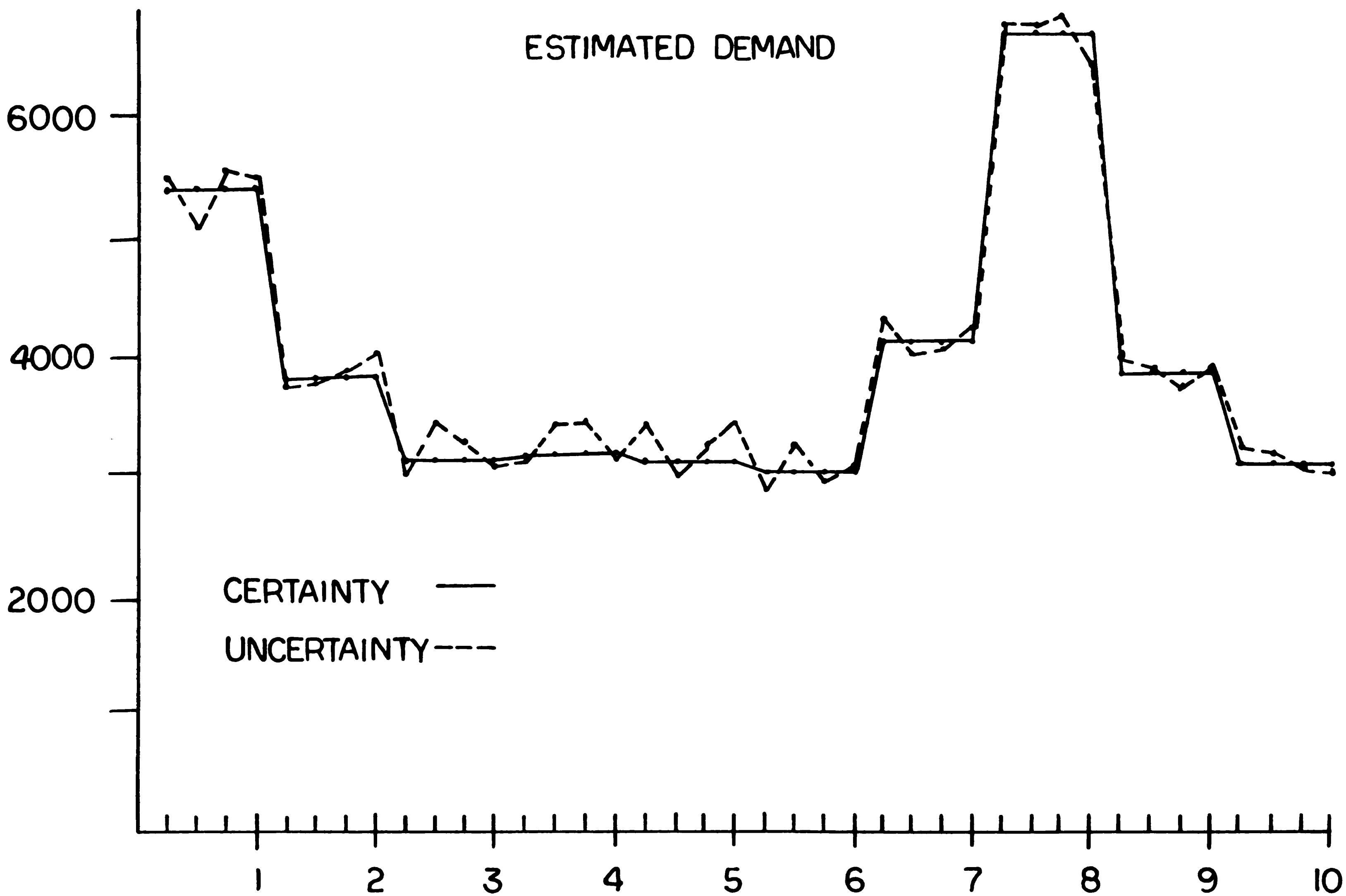

FIGURE 6-10
DEMAND IS MET, ANNUAL PRICE CONTROL AND INVENTORY LIMITS

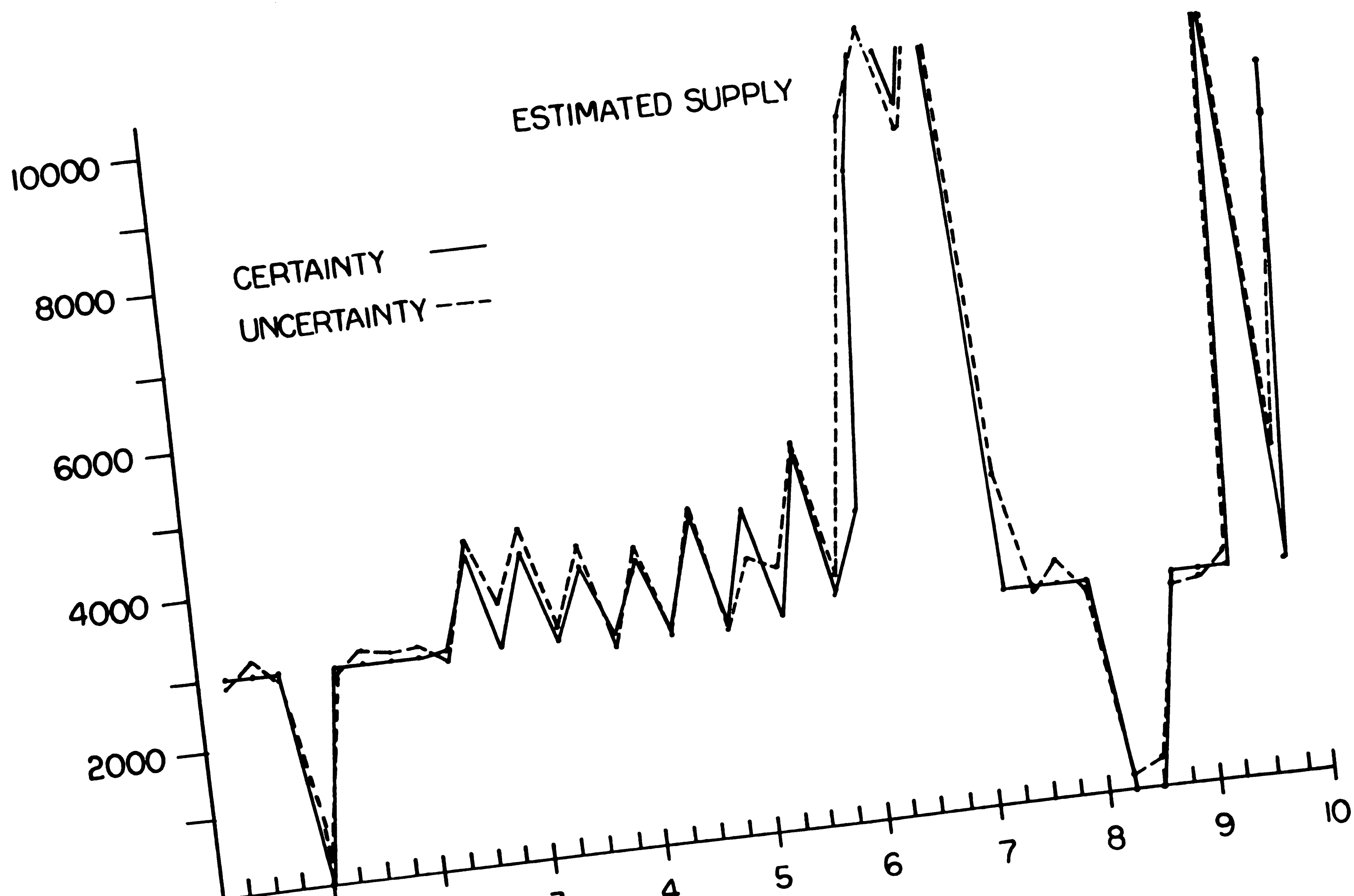

FIGURE 6-11
DEMAND IS MET, ANNUAL PRICE CONTROL AND INVENTORY LIMITS

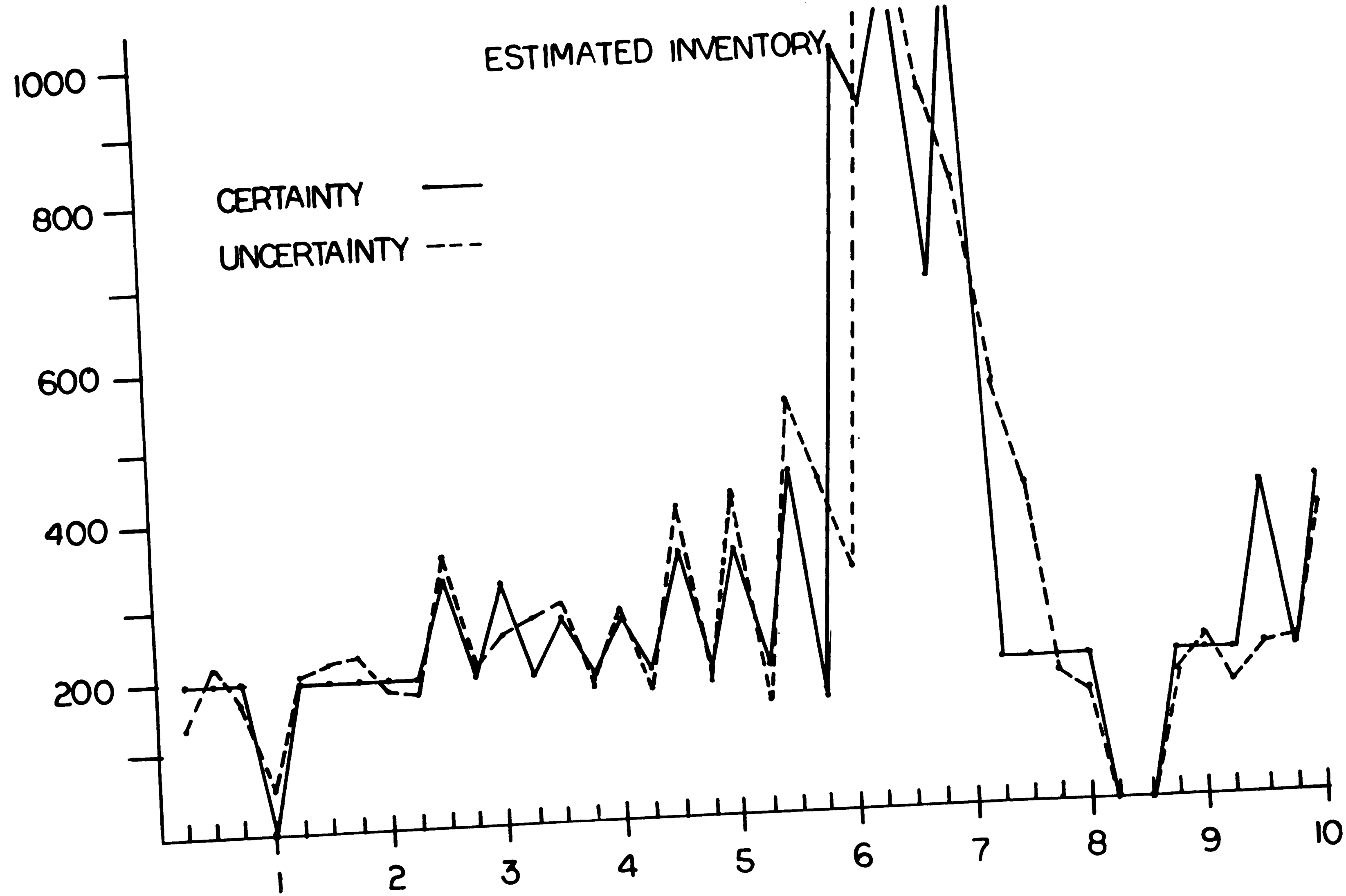

FIGURE 6–12
DEMAND IS MET, ANNUAL PRICE CONTROL AND INVENTORY LIMITS

Table 6.6

Summary Statistics When Demand is Met With
Inventory Limits but No Price Control

	Mean	Standard Deviation	Coefficient of Variation
Under Certainty			
Price	68.8	19.3	0.280
Supply	3352	2907	0.867
Demand	3473	831	0.239
Inventory	103	140	1.363
Under Uncertainty			
Price	65.1	19.6	0.301
Supply	3221	3150	0.978
Demand	3491	841	0.241
Inventory	120	171	1.420

Table 6.7

Summary Statistics for a Price Band Policy

	Mean	Standard Deviation	Coefficient of Variation
Under Certainty			
Price	57.7	11.7	0.203
Supply	3960	1994	0.504
Demand	3959	845	0.213
Inventory	169	112	0.659
Under Uncertainty			
Price	59.3	17.4	0.294
Supply	4214	3548	0.842
Demand	4169	1255	0.301
Inventory	204	175	0.856

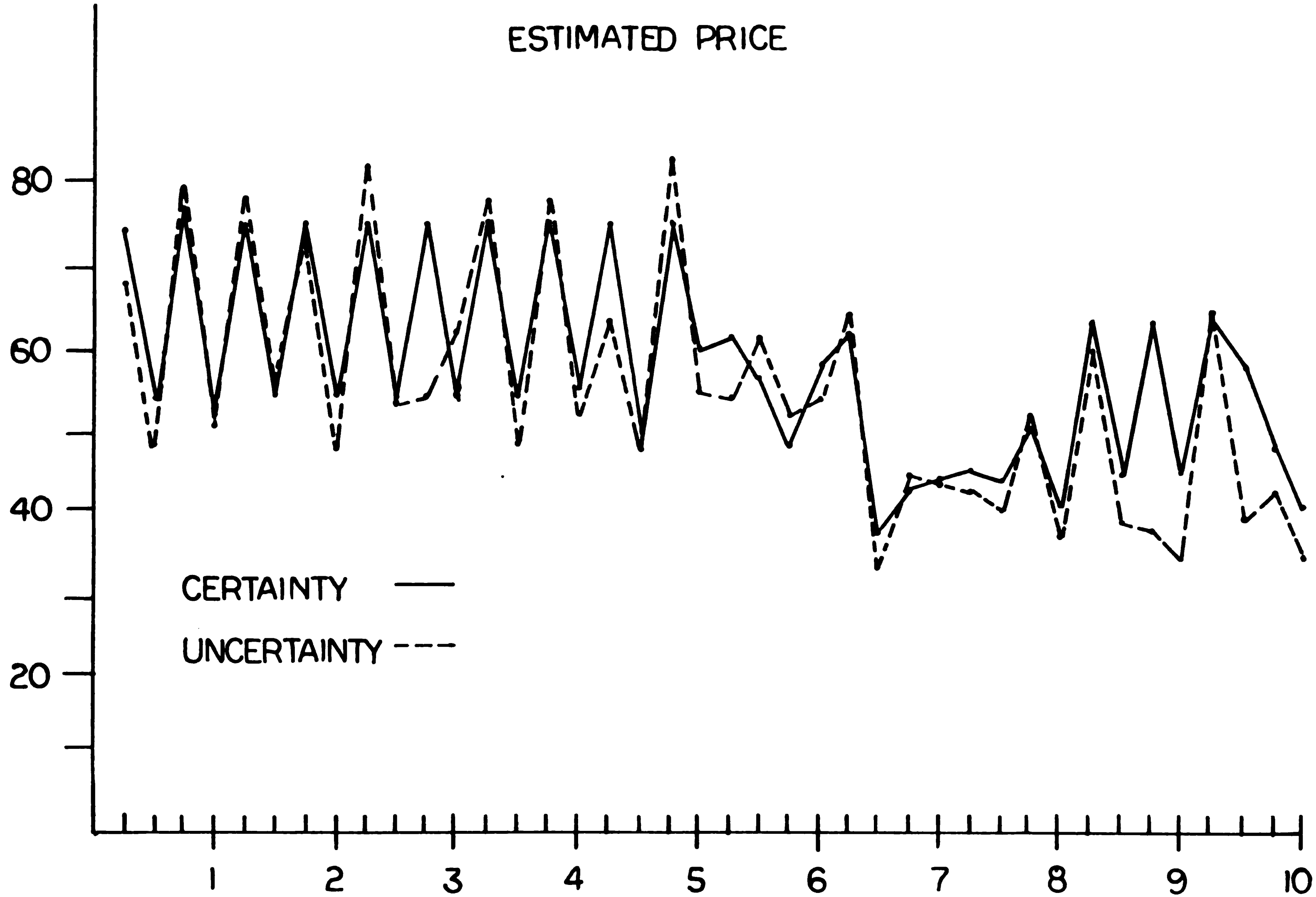

FIGURE 6-13
PRICE BAND POLICY

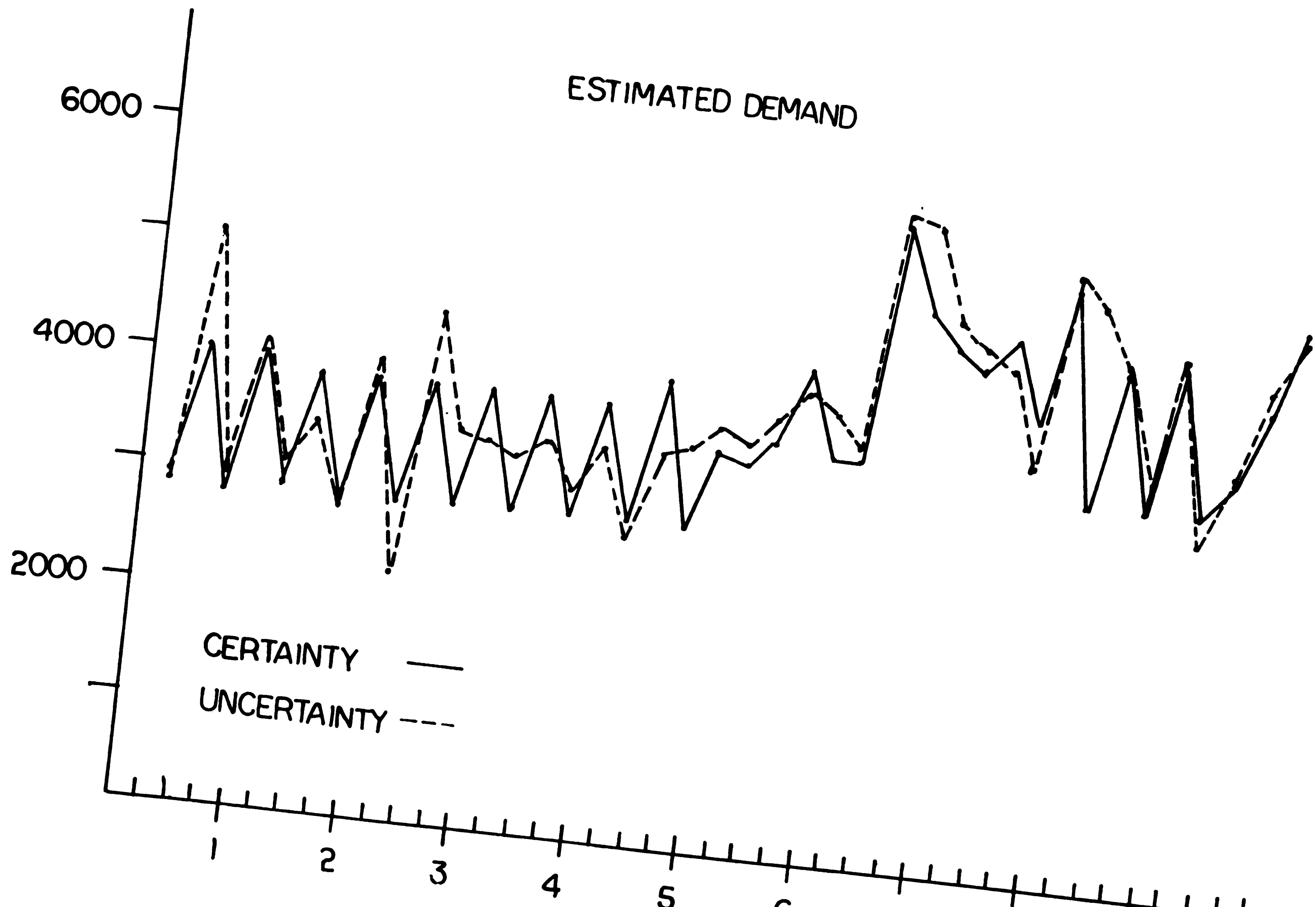

FIGURE 6–14
PRICE BAND POLICY

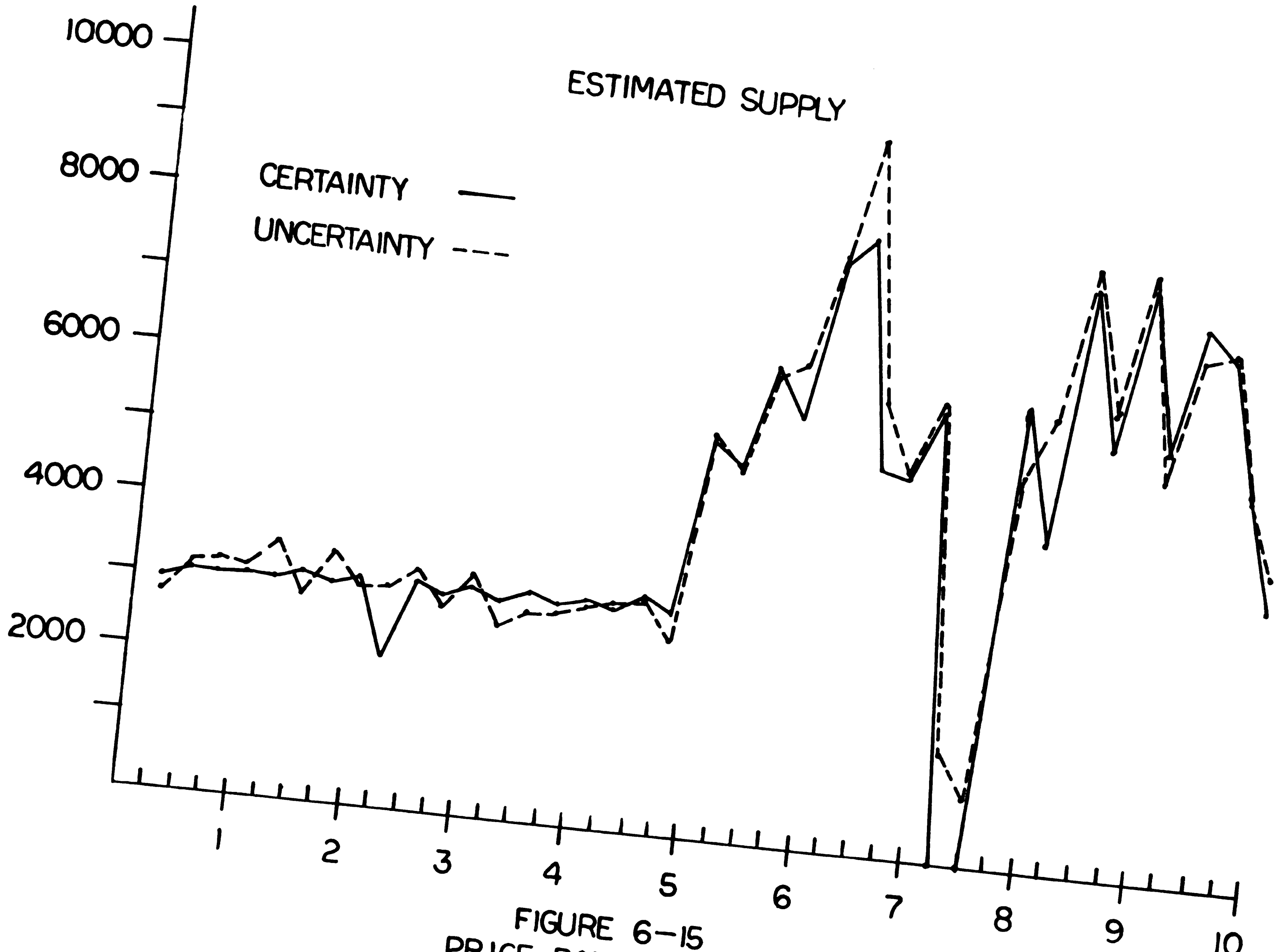

FIGURE 6–15
PRICE BAND POLICY

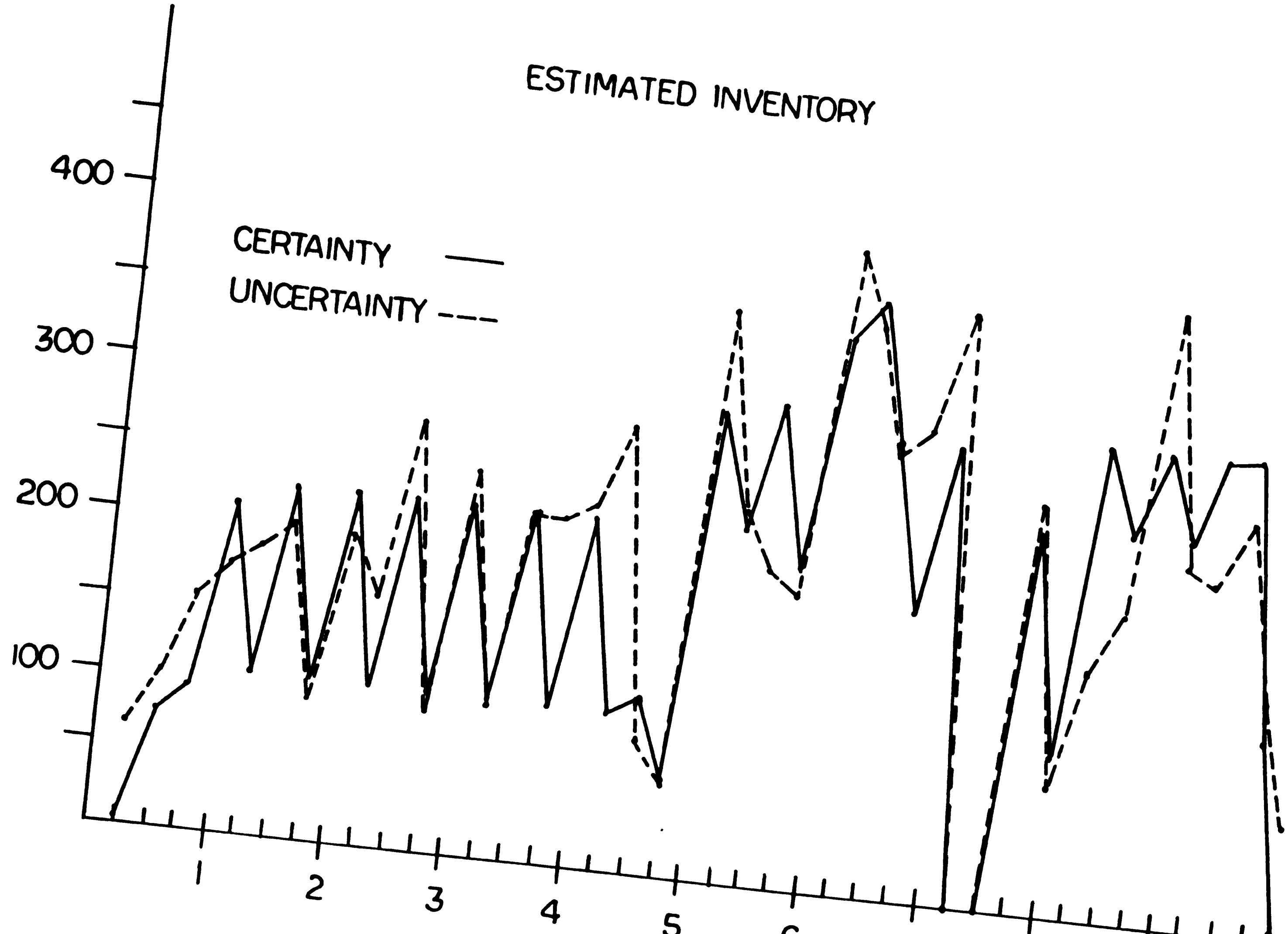

FIGURE 6-16
PRICE BAND POLICY

Table 6.8

Summary Statistics for an Annual Price Band Policy

	Mean	Standard Deviation	Coefficient of Variation
Under Certainty			
Price	50.8	12.4	0.244
Supply	4302	2718	0.632
Demand	4686	1779	0.379
Inventory	279	386	1.383
Under Uncertainty			
Price	51.7	16.6	0.321
Supply	4414	3849	0.872
Demand	4529	2309	0.510
Inventory	283	411	1.453

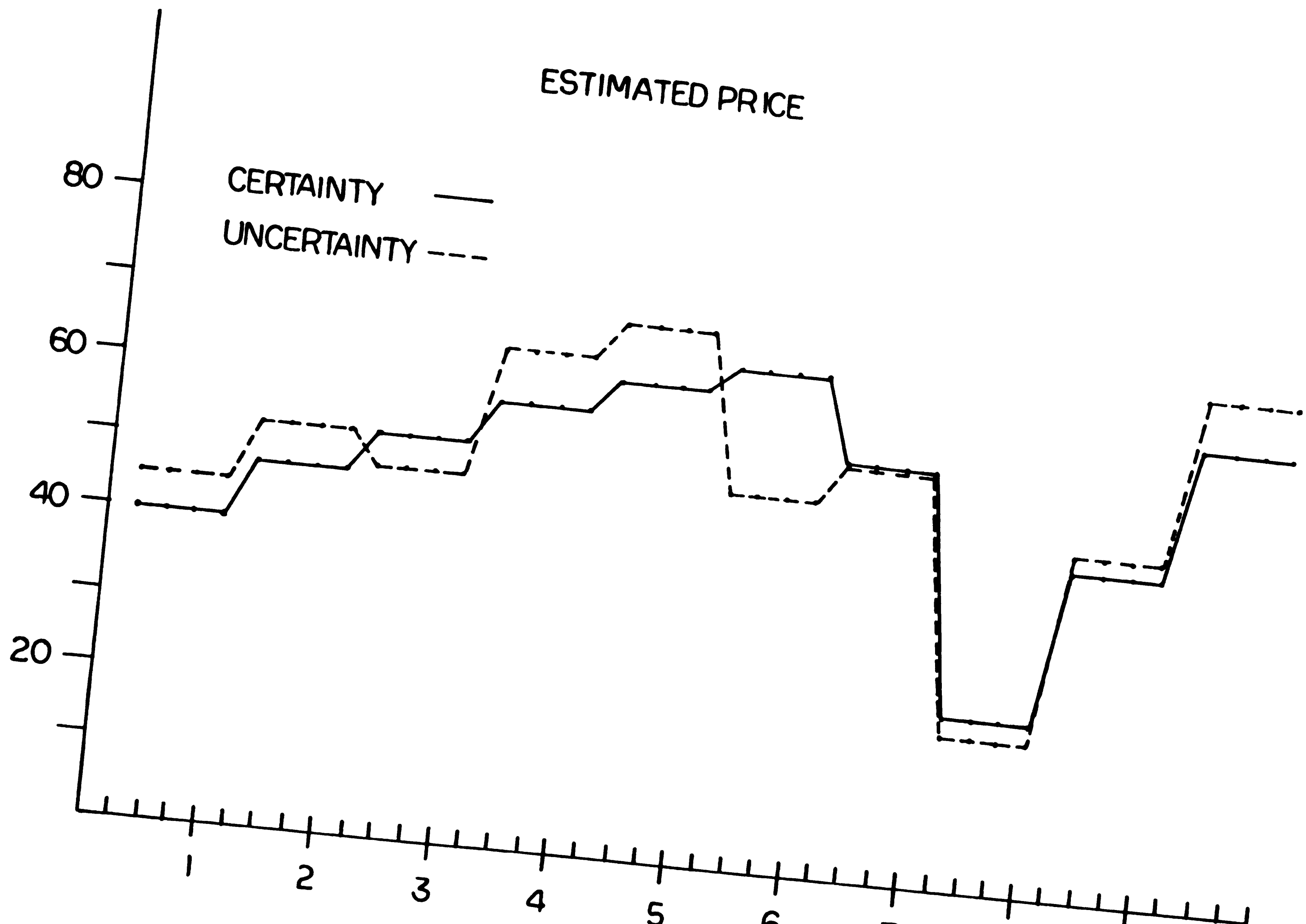

FIGURE 6-17
ANNUAL PRICE BAND POLICY

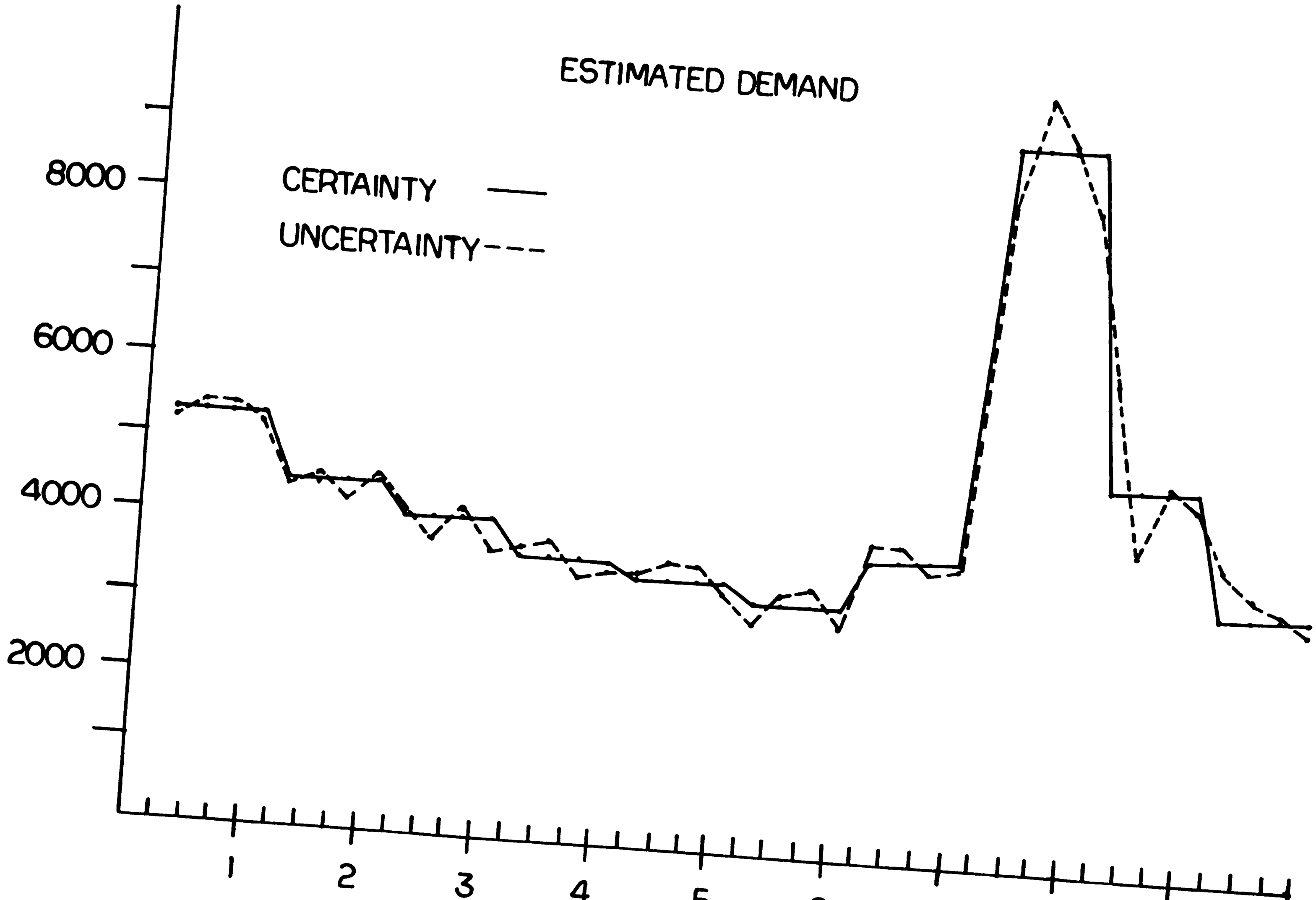

FIGURE 6-18
ANNUAL PRICE BAND POLICY

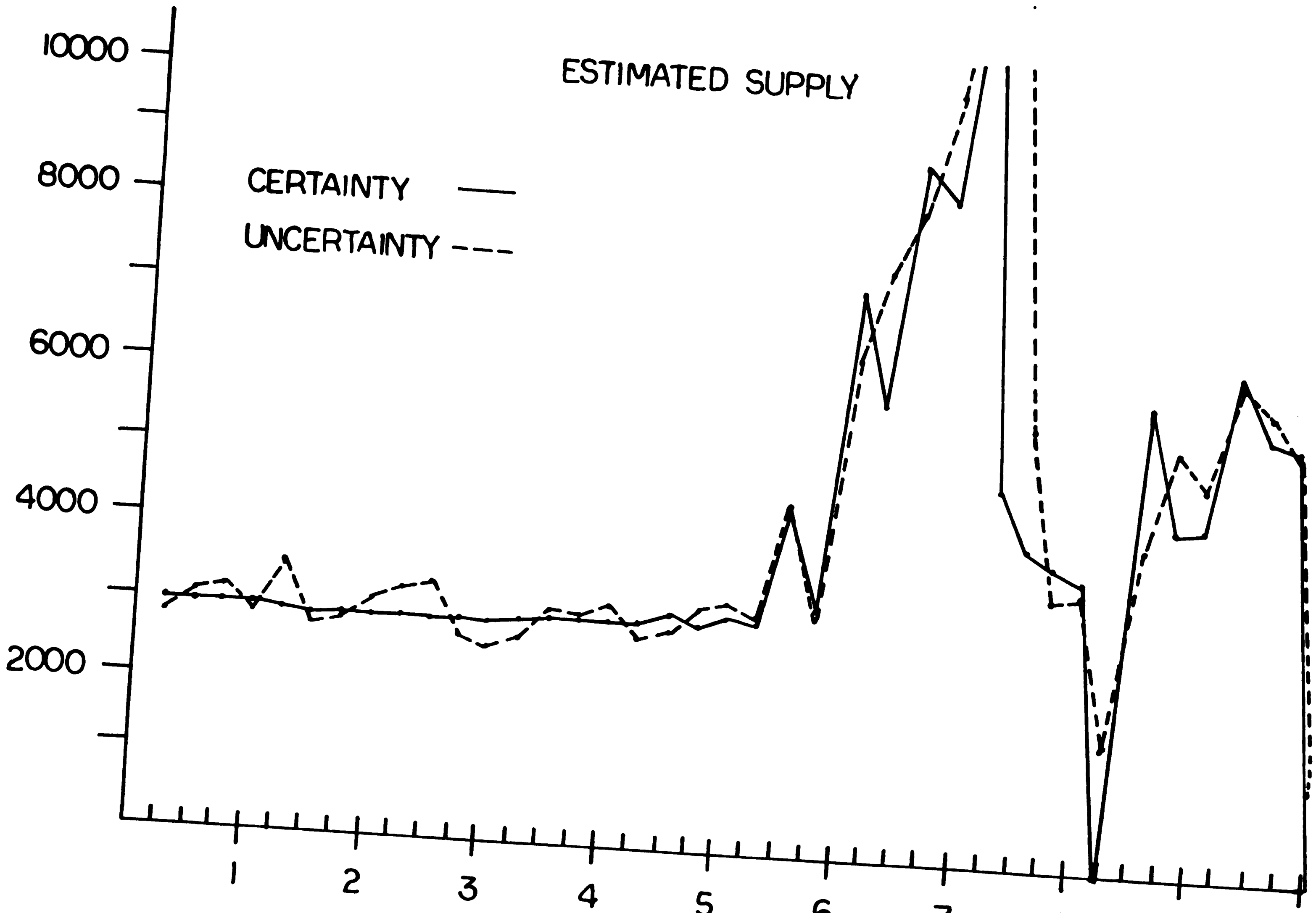

FIGURE 6-19
ANNUAL PRICE BAND POLICY

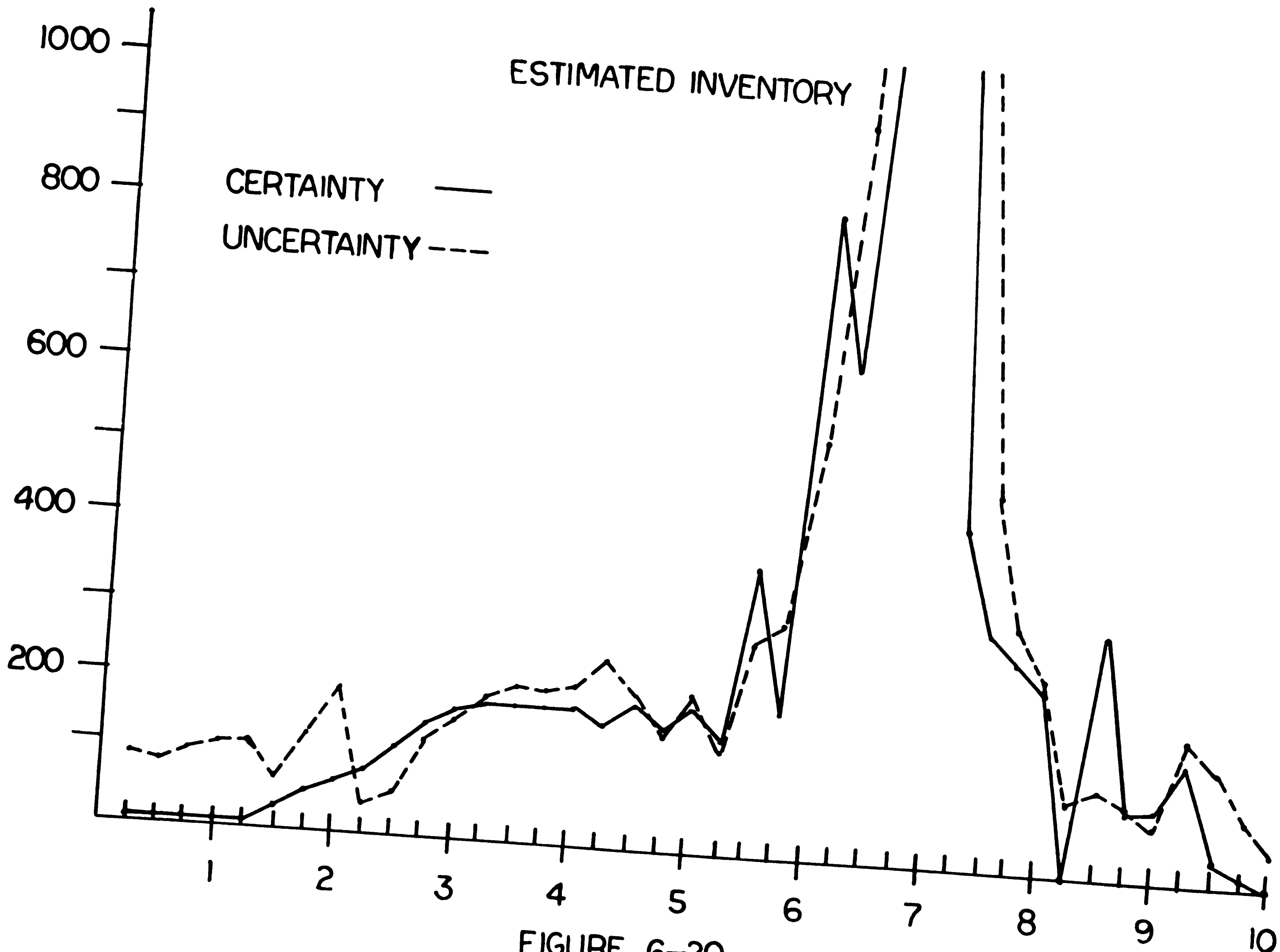

FIGURE 6-20
ANNUAL PRICE BAND POLICY

Table 6.9

Summary Statistics for a Price Band Policy
With Inventory Control

	Mean	Standard Deviation	Coefficient of Variation
Under Certainty			
Price	56.1	12.9	0.229
Supply	4122	2392	0.580
Demand	4117	979	0.238
Inventory	177	112	0.634
Under Uncertainty			
Price	55.2	16.4	0.298
Supply	4232	3047	0.720
Demand	4180	1299	0.311
Inventory	196	180	0.921

Table 6.10

Summary Statistics for an Annual Price Band Policy with Inventory Control

	Mean	Standard Deviation	Coefficient of Variation
Under Certainty			
Price	46.4	11.9	0.258
Supply	4244	2819	0.664
Demand	5149	1969	0.382
Inventory	293	418	1.428
Under Uncertainty			
Price	50.1	16.1	0.322
Supply	4624	4541	0.982
Demand	4772	2586	0.542
Inventory	296	482	1.630

Summary of Scenarios

Before summarizing the results of the tests performed, and drawing some conclusions from them, it is necessary to reiterate the purpose of the empirical exercise. In Chapter 4, it was concluded that while theoretical results appear to support the need to stabilize prices, the outcome of doing so depends upon the overall effects of the policy. In Chapter 5, a nonlinear systems simulation model is developed which emphasizes the importance of time (and dynamics) and uncertainty.

While the model is simple and specific to the fed-beef sector, some demonstration of the possible underlying causes of price instability is possible. In this chapter, the model is used to explore the possibilities of control, in order to attempt to investigate the possibility of improving the system with certain broad policies. It should be remembered that because of the specific nature of the model and the policies used to attempt to gain control of the system, the results are not generalizable.

The purpose of the scenarios explored here is much more of a demonstration of the possibilities of control, than of actual results. The results in general tend to support the theoretical result that:

1. price control policies do not, by themselves, stabilize the market over time or substantially reduce long run price uncertainty;
2. there is a substantial tradeoff between efficient allocation of resources in the agricultural sector and the reduction in uncertainty or stabilization of price (although, the magnitude of the tradeoff is not shown in the results);

3. price controls and other control measures may substantially reduce instability and/or uncertainty in the short run at some expense in the long run; and
4. there is no single consistent rule which can be used to stabilize prices <u>and</u> reduce uncertainty without a tendency to destabilize some other aspects of the system.

CHAPTER 7

A MODIFICATION TO THE NEOCLASSICAL APPROACH

Introduction

Much of the approach to analysis of instability in this study has stemmed from the specification of a different methodological framework outlined in Chapter 3, together with some criticism of the "conventional" static approach under certainty in Chapter 2. There is, however, a need to explore some possibilities for developing a modified neoclassical approach which might be useful in examining the question of price instability within the neoclassical framework by attempting to introduce the concepts of uncertainty and time at the analysis level (i.e., given structure and conduct, determine performance).

Introducing Uncertainty

In Chapter 2 some criticism is levelled at past studies of price instability where uncertainty had either been ignored, or introduced at the behavioral level (supply and demand functions). The modified approach introduces uncertainty at the utility function level and derives the relevant supply and demand schedules. This approach to a simple static market exchange model is utilized by Robison and Carmen (1979). The market is initially characterized by two individuals, A and B, both of whom have different absolute risk aversion coefficients ($\lambda_A \neq \lambda_B$). It is assumed that individual A will exchange a safe asset (money) in return for a risky asset supplied by B. Individual A begins with an initial endowment (X_1^0) of the safe asset and individual B with an initial endowment (X_2^0) of the risky asset. Both have investment opportunities which can earn rate of return (r_1) on the safe asset and (r_2 on the risky asset. Sinxe X_2 is a risky asset, its rate of return (r_2) has a variance of σ^2. In the market, the amount traded and the price are determined by value equilibrium. That is $P_1X_1=P_2X_2$. Each individual's utility function can therefore be described as follows:

(1) $U_A = r_1(X_1^0-X_1) + r_2PX_2-\lambda_A P^2X_2^2\sigma^2$

(2) $U_B = r_1X_1+r_2P(X_2^0-X_2)-\lambda_B P^2(X_2^0-X_2)^2\sigma^2$

where $r_1(X_1^0-X_1)+r_2PX_2$ and $r_1X_1+r_2P(X_2^0-X_2)$ are the portfolio expected wealth for individuals A and B respectively, and $X_2^2P^2\sigma^2$ and $(X_2^0-X_2)^2P^2\sigma^2$ are the variances associated with their portfolios. Since $P_1X_1=P_2X_2$ in equilibrium, then $X_1= \frac{P_2}{P_1} X_2$ and $P= \frac{P_2}{P_1}$ in the above utility functions. Since $X_1=PX_2$, then (1) and (2) can be rewritten as:

(3) $U_A = r_1(X_1^0-PX_2)+r_2PX_2-\lambda_A P^2X_2^2\sigma^2$

(4) $U_B = r_1PX_2+r_2P(X_2^0-X_2)-\lambda_B P^2(X_2^0-X_2)^2\sigma^2$

Differentiating (3) and (4) with respect to X_2 (risky asset), setting them equal to zero and solving for X_2 in each case gives:

(5) $X_2^A = \frac{r_2-r_1}{2\lambda_A P\sigma^2}$ demand

(6) $X_2^B = \frac{r_1-r_2}{2\lambda_B P\sigma^2} + X_2^0$ supply.

Since in equilibrium $X_2^A = X_2^B$, by setting (5) and (6) equal, it is possible to solve for equilibrium price P:

$$(7)\quad P = (\lambda_A+\lambda_B)(r_2-r_1)/2\lambda_A\lambda_B X_2^0\sigma^2.$$

X_2^A and X_2^B are typically demand and supply functions where from (5) and (6)

$$\frac{\partial X_2^A}{\partial P} = -\frac{r_2-r_1}{2\lambda_A P^2\sigma^2} < 0$$

$$\frac{\partial X_2^B}{\partial P} = \frac{r_2-r_1}{2\lambda_B\sigma^2 P^2} > 0$$

where $r_2 > r_1$ always.[1] From (7), the following conditions hold:

$P'(r_1) < 0$ $\qquad$ $P'(\sigma^2) < 0$

$P'(r_2) > 0$ $\qquad$ $P'(\lambda_A) < 0$

$P'(X_2^0) < 0$ $\qquad$ $P'(\lambda_B) < 0$

--all of which are intuitively acceptable results. These upward sloping supply curves and downward sloping demand curves contain substantial information which pertains to the risky nature of trading in the market. The rate of return on both risky and safe assets, the variance of the rate of return on risky assets, and individual absolute risk aversion coefficients all contribute to shifts in the equilibrium, while shifts along the curve are explained by changes in X_2 and P.[2]

In addition to the substantial information on risk yielded by this approach, a comparatively new measure of utility is also offered. While it is possible to measure consumers' and producers' surplus as a proxy to a measure of welfare, such an operation is not necessary. Since the utility functions (3) and (4) are, among other things, the measured certainty equivalents of individuals A and B, then adding the two utility functions together will give the sum of their certainty equivalents. Summing (1) and (2) yields:

$$(8) \quad U_A + U_B = r_1X_1^0+r_2PX_2^0-\lambda_AP^2X_2^2\sigma^2-\lambda_BP^2(X_2^0-X_2)^2\sigma^2.$$

Letting $U_A+U_B=W$ and substituting equilibrium P (equation 7) and equilibrium X_2[3] into (8) gives:

$$(9) \quad W = r_1X_1^0+(\lambda_A+\lambda_B)(r_2^2-r_1^2)/4\lambda_A\lambda_B\sigma^2.$$

This expression allows the analysis of the effect of changes in the parameters on the sum of the certainty equivalents, which is a proxy for welfare. The following conditions hold from equation (9):

$W'(X_1^0) > 0 \qquad W'(\lambda_A) < 0$

$W'(r_2) > 0 \qquad W'(\lambda_B) < 0$

$W'(r^2) < 0$

$W'(r_1) \lesseqgtr 0$ depending on $X_1^0 \lesseqgtr \dfrac{r_1(\lambda_A+\lambda_B)}{\lambda_A\lambda_B\sigma^2}$

The results are intuitively acceptable and the magnitudes of changes will depend on whether or not it is assumed that risk is additive or multiplicative.[4]

A comparison of this modified approach to welfare with consumers' and producers' surplus yields some interesting results. It can be shown that the two measures are equal only if it is assumed that $\lambda_A=0$ and $\lambda_B=0$.[5] This is a significant result because it implies that the measure of consumers' surplus and producers' surplus assumes that the marginal utility of wealth (or money or income) is constant, since if $\lambda_A=0$ and/or $\lambda_B=0$ then the individuals concerned have constant absolute risk aversion.

This approach to market equilibrium conditions under uncertainty yields many interesting implications for decision making under uncertainty. However, only the conclusions with respect to price instability will be discussed here. It should be noted how much more complex the analysis of instability becomes in this approach. Because of the multiplicative, nonlinear conditions of supply and demand functions, simple two variable variance analysis becomes highly complex. There is a price feedback mechanism implicit in the model since price variation will affect nearly all the parameters. Rates of return to safe and risky assets (r_1 and r_2) will clearly be affected by changes in price. Therefore, the variance of the risky asset (σ^2) will also be affected by price changes. The risk aversion coefficients (λ_A and λ_B) will also be affected by price variations. Using Pratt's (1964) measure of risk aversion:

$$R_A(W) = -U_2(W)/U_1(W)$$

where U_1 and U_2 are the first and second derivatives of the utility function with respect to wealth (W), and since wealth is determined by relative prices, then λ_A and λ_B will change in complex ways as prices change.

Aggregation and Operationalization

Aggregate supply and demand equations are obtained as follows:

$$(10)\quad \sum_i X_{2i} = [(r_2-r_1)/2\sigma^2 P)]\Sigma^1/\lambda_i$$

$$(11)\quad P = (r_2-r_1)\sum_j{}^1/\lambda_j/(\Sigma X^0_{2j}-\Sigma X_{2j})2\sigma^2.$$

Equation (10) is aggregate demand and (11) is aggregate supply. These can be conveniently linearized by logarithmic transformation. Since the λs represent the absolute risk aversion coefficients of individuals, the Σ^1/λ in (10) and (11) above, will represent average absolute risk aversion of the participants in the trade. However, λs cannot be expected to remain constant over time. Robison and Barry (1977) have shown that changes in Σ^1/λ_i is the change in demand associated with changes in wealth or income, and that shifts in the E.V. function are reflected by changes in the value of λ. Thus, it is necessary to estimate approximating equations for Σ^1/λ_i and $\sum_i^1/\lambda_j$. This is done by choosing convenient forms such as:

$$(12) \quad \Sigma^1/\lambda_i = e^{\beta_0}(r_2-r_1)^{\beta_1}\sigma^{2\beta_2}P^{\beta_3}e^{\varepsilon_t}$$

where ε_t is assumed to be normally distributed. Taking the logarithmic transformation of (12) yields:

$$(13) \quad \log\Sigma^1/\lambda_i = \beta_0+\beta_1\log(r_2-r_1)+\beta_2\log\sigma^2+\beta_3\log P+\varepsilon_t.$$

A similar expression for Σ^1/λ_j after transformation would be:

$$(14) \quad \log\sum_j{}^1/\lambda_j = \gamma_0+\gamma_1\log(r_2-r_1)+\gamma_2\log\sigma^2+\gamma_3\log P+\gamma_4\log\sum_j X^0_{2_j}+U_t$$

where U_t is log-normally distributed. However, it is not necessary to estimate these approximating functions separately. Taking the logarithmic transformations of equations (10) and (11) (aggregate demand and supply) gives:

$$(15) \quad \log\sum_i X_{2_i} = \log\sum_i{}^1/\lambda_i+\log(r_2-r_1)-\log\sigma^2-\log P$$

$$(16) \quad \log P = \log\sum_j{}^1/\lambda_j+\log(r_2-r_1)-\log\sigma^2-\log(\Sigma X^0_{2_j}-\Sigma X_{2_j}).$$

Substituting (13) into (15) and (14) into (16) yields:

(17) $\log\sum_i X_{2_i} = \beta_0 + (\beta_1+1)\log(r_2-r_1) + (\beta_2-1)\log\sigma^2 + (\beta_3-1)\log P + \varepsilon_t$ and:

(18) $$\log P = \frac{\gamma_0}{1-\gamma_3} + \frac{\gamma_1+1}{1-\gamma_3}\log(r_2-r_1) + \frac{\gamma_2-1}{1-\gamma_3}\log\sigma^2 + \frac{\gamma_4}{1-\gamma_3}\log\sum_j X^0_{2_j} - \frac{1}{1-\gamma_3}\log(\sum X^0_2 - X_{2_j}) + U_t.$$

Equations (17) and (18) can be estimated directly by ordinary least squares methods. Since the model is just identified, estimates for $\sum_i {}^1/\lambda_i$ and $\sum_j {}^1/\lambda_j$ can be obtained and do not have to be estimated beforehand. These estimates of λ_i and λ_j can also be used to estimate the welfare expression (8) or (9).[6]

Apart from some problems associated with the assumptions underlying the E.V. approach (see, for instance, Hadley, 1964; Freund, 1956; Pratt, 1964; Robison and Barry, 1977; Robison and Carmen, 1979), two major problems are associated with this type of model with respect to analysis of instability. The first problem is one of time and dynamics. The second is with respect to actually getting at instability of prices. The time/dynamics problem is one which is common to all such models. Analysis of price instability requires a methodology to get at changes in price over time. As in the simple model described in Chapter 3, this requires that a time dimension be specified in the form of lagged relationships. In the above modified approach, these relationships can be specified in the form of distributed lags involved with both expected prices ($\hat{p}$) and expected rates of return ($\hat{r}_1$, $\hat{r}_2$). As previously mentioned, Turnovsky (1977) has described the widely varying results that occur when different forms of lagged relationships enter the model. There is little doubt that the same problems will occur in the modified model.

The second problem of actually getting at the instability is, of course, related to this time/dynamic problem. On a more practical level, it is possible that some analysis of instability can be achieved by examining the relationships of the variances of the relevant parameters. This, however, requires some knowledge of the interrelationships between the various parameters. For example, if the effects of reducing the variance of the risky asset on the variance of price are examined, it can be shown that reducing the variance of the risky asset may not necessarily lead to a reduction in the variance of price (i.e., it is indeterminate). The function is a complex interaction of variances, covariances, and correlation coefficients. In order to achieve some manageable mathematical functions, several simplifying assumptions are necessary.

Introducing Time

Despite the problems of specifying lags for price and rate of return in the modified approach, it is worth investigating the possibilities of introducing time into the model, since it has been the subject of some criticism in Chapter 2. Specifically, there are two aspects to be examined:

1. The ways in which price and rate of return lag can be introduced into the model
2. Measuring utility over time

In most econometric models of supply response, the problem of expected prices has to be dealt with, since supply response will be determined by lagged price expectations. Economists have dealt with this difficulty in varying ways, usually by introducing expectations models into the supply relationships in the form of lagged prices. Some of the more sophisticated techniques include polynomial distributed lags and rational lags. In the modified approach, both price and rate of return expectations have to be dealt with. However, since rates of return are dependent, to a large extent, on prices, then it is plausible that estimates of $\hat{r}_1$ and $\hat{r}_2$ can be derived in much the same way as price expectations. Nevertheless, such procedures still pose problems for the practical economist wishing to operationalize the model. There is no definitive answer to this difficulty (Butler and Thompson, 1979).

It may be more practical to treat (r_2-r_1) as a single variable--thus requiring an estimate of $r_2-\hat{r}_1$). In a systems model, there is an argument for treating $\hat{r}_2$ or $(r_2-\hat{r}_1)$ as a random variable. Treating $\hat{r}_2$ as a random variable allows estimation of σ^2 but requires $\hat{r}_1$ to be estimated separately. On the other hand, treating $(r_2-\hat{r}_1)$ as a single random variable, while convenient, does not allow automatic estimation of σ^2.

The second aspect of the introduction of time into the modified model is that of measuring utility over time. Since it has been shown that it is possible to estimate the total utility function in a single period, it is worth examining the possibility of measuring utility (or welfare) over time.

Anderson, Dillon, and Hardaker (1977) suggest and outline three methods of multidimensional utility assessment, of which they suggest the easiest and most used is the additive utility function approach (page 87):

> Though the necessary requirements for an additive utility function to be true will rarely be met, the assumption of additivity may not be too bad since what is required of the multidimensional utility function is the power to discriminate between alternative acts....In by far the majority of multi-dimensional situations...main (i.e., additive) effects tend to swamp interaction (i.e., multiplicative) effects.

In the case of the modified model, it should be possible to simply add utilities over time in order to discriminate between various policies, the assumption being that the higher the total utility, the better the result. Of course, it should be noted that this approach to measuring utility is superior to the conventional economic surplus in only one aspect: that of introducing uncertainty. The welfare measure used in this modified approach still violates the performance criterion that total (aggregate) utility is a valid measure of performance. That is, it is still assumed that interpersonally valid common denominators allow aggregation of individual utilities, and that compensation of the losers by the gainers is achieved.

Intertemporal Changes under Uncertainty

In each period, the equilibrium quantity is given by:

$$(19) \quad X_1 = \frac{\lambda_B X_2^0}{\lambda_A + \lambda_B} = kX_2^0$$

if $\frac{\lambda B}{\lambda A + \lambda B}$ remains constant over time. It can be seen that X_2^0 will vary in each time period due to price fluctuations, price expectations, and expectations on rate of return to risky assets. In the same way, a buffer stock scheme assumes that control over X_2^0 enables the producer or agency to attempt to reduce price fluctuations by holding inventories from period to period so that fluctuating supplies do not create price disturbances. That is, inventories are held in each period such that:

$$(20)\quad X_{2t}^{0}+e = X_{2t+1}^{0} - e$$

where e represents the amount by which initial endowments of X_2 exceed or fall short of a desired equilibrium level.

From equation (8), total welfare (utility) in any period is:

$$W = r_1X_1^0+r_2PX_2^0 - \lambda_A P^2 X_2^{2\;2} - \lambda_B P^2 (X_2^0-X_2)^2\sigma^2$$

When equilibrium quantities (equation 19) is substituted into (8), then:

$$(21)\quad W = r_1X_1^0 + r_2PX_2^0 - P^2X_2^{0^2}\sigma^2\left[\frac{\lambda_A\lambda_B}{\lambda_A+\lambda_B}\right]$$

Now, if time subscripts are used to distinguish between two different periods, then from (21):

$$(22)\quad W_t = r_1X_1^0 + r_2P_t(X_{2t}^0 + e) - P_t^2\sigma^2(X_{2t}^0 + e)\left[\frac{\lambda_A\lambda_B}{\lambda_A+\lambda_B}\right] \text{ and:}$$

$$(23)\quad W_{t+1} = r_1X_1^0 + r_2P_{t+1}(X_{2t+1}^0 - e) - P_{t+1}^2\sigma^2(X_{2t+1}^0 - e)\left[\frac{\lambda_A\lambda_B}{\lambda_A+\lambda_B}\right]$$

Summing (22) and (23) and differentiating with respect to e, then:

$$(24)\quad \frac{\partial(W_t+W_{t+1})}{\partial e} = r_2(P_t - P_{t+1}) + 2\sigma^2\left[\frac{\lambda_A\lambda_B}{\lambda_A+\lambda_B}\right][P_{t+1}^2(X_{2t+1}^0-e) - P_t^2(X_{2t}^0 + e)].$$

From (20) this can be further reduced to:

$$(25)\quad \frac{\partial(W_t+W_{t+1})}{\partial e} = r_2[P_t-P_{t+1}] + 2\sigma^2X\left[\frac{\lambda_A\lambda_B}{\lambda_A+\lambda_B}\right][P_{t+1}^2 - P_t^2]$$

where X is the equilibrium quantity. Clearly, the conditions necessary to maximize total welfare (utility) is that $\frac{\partial(W_t+W_{t+1})}{\partial e} = 0$ which is readily achieved if, from (25), $P_t=P_{t+1}$. That is, welfare is maximized when prices are perfectly stabilized over time.

It should be remembered, however, that the above result only occurs when r_2, σ^2, λ_A and λ_B are held constant over time. If r_2 and σ^2 are allowed to vary over time, then:

$$(26) \quad \frac{\partial(W_t+W_{t+1})}{\partial e} = r_{2t}P_t - r_{2t+1}P_{t+1} + 2[\frac{\lambda_A\lambda_B}{\lambda_A+\lambda_B}][P_{t+1}^2\sigma_{t+1}^2 - P_t^2\sigma_t^2]X$$

and, even if $P_t = P_{t+1} = P$, then:

$$\frac{\partial(W_t+W_{t+1})}{\partial e} = (r_{2t}-r_{2t+1})P + 2[\frac{\lambda_A\lambda_B}{\lambda_A+\lambda_B}][\sigma_{t+1}^2 - \sigma^2]PX$$

and total welfare (utility) is only maximized when $r_{2t}=r_{2t+1}$ and $\sigma_t^2=\sigma_{t+1}^2$; which is clearly a very restrictive condition, although reducing price fluctuations may also result in a reduction in fluctuations of r_2 and σ^2.

In addition, if λ_A and λ_B vary over time, even more restrictive conditions would exist. Moreover, since P, r_2, σ^2, λ_A and λ_B will interact in complex ways together with other exogenous factors, the conditions under which welfare (utility) is maximized becomes extremely complex and restrictive in this model.

Summary

While this model is quite different to the institutional/systems approach adopted earlier in this study; and is also somewhat at odds with the philosophy followed there, it is felt that there is a need to explore some possibilities for developing a model which may be useful in examining some quantitative aspects of welfare (utility) under uncertainty and intertemporally.

The model developed does not, by any means, provide answers for the questions raised in Chapters 2 and 4, but does demonstrate that the simple static models discussed in Chapter 2 can be expanded to include uncertainty and time. The major issues raised in Chapter 4 still exist. Most importantly, the welfare measures used in this modified approach violate the performance criterion that total (aggregate) utility is a valid measure of performance and of welfare. With respect to price instability, the assumption that acquisition price is equal to salvage value is ample provision for this model to be replaced by one where this assumption does not hold.

Footnotes: Chapter 7

[1]It is assumed that $r_2 > r_1$, always, since, while the reverse is possible ($r_2 < r_1$), it is not probable because it implies that returns to safe assets are greater than returns to risky assets, and trade would not (rationally) take place.

[2]It could be assumed that risk enters multiplicatively where $\bar{r}_2 = r_2\gamma$, where the expected value and variance of γ are 1 and σ^2 respectively. Under this assumption, the expected return and variance $\bar{r}_2$ equal r_2 and $r_2^2\sigma^2$ respectively. The new demand and supply equations obtained after allowing for multiplicative risk are:

$$X_2 = (r_2 - r_1)/2\lambda_A\sigma^2 r_2^2 P \qquad \text{(demand)}$$

$$X_2 = X_2^0 - (r_2 - r_1)/2\lambda_B\sigma^2 r_2^2 P^2 \quad \text{(supply)}$$

and equilibrium price is therefore:

$$P = (\lambda_A + \lambda_B)(r_2 - r_1)/2\lambda_A\lambda_B\sigma^2 r_2^2 X_2^0.$$

[3]Equilibrium X_2 is given by:

$$X_2 = \frac{X_2^0\lambda_B}{\lambda_A + \lambda_B}$$

[4]See Footnote 2.

[5]See Appendix A.

[6]See Footnote 2.

CHAPTER 8

SUMMARY AND CONCLUSIONS

Price instability is an extremely large and complex subject. To the extent that this study has attempted to identify the "real" difficulties, there would appear to be several interrelated yet separable problems pointing ultimately to the need for extensive review of policies dealing with instability. That is not to say that current policies are wrong or even unnecessary. The real question is, are they adequate to deal with the problems of instability and its related aspects?

Much of the current policy has stemmed from analysis of the problem of instability using somewhat simple static models which have been directed toward stabilizing price using buffer stocks. Many of the past studies have simplified four basic aspects of the problem in order to deal with instability. These four difficulties are:

1. definition of instability
2. analytical technique
3. performance criteria
4. the existence of a differential between acquisition cost and salvage value for fixed inputs

While the fourth issue is an important one, it has already been dealt with adequately elsewhere (Johnson, 1972), and is only briefly considered in this study. Much more emphasis is centered in this study on the first three issues.

In order to deal with the breadth of the problems involved with price instability, a much broader framework is presented in Chapter 2. This framework or model provides the essential links between structure, conduct and performance, and analysis, design and management. When the structure of an economic system is examined, it is possible to identify the potential components of instability--namely the participants in the system, the price mechanism and the random variation involved in the system. It is to these components that the major causes of instability can be attributed.

While this study criticizes the neoclassical paradigm both explicitly and implicitly, the criticism is not intended to be damaging to it. The SCP/ADM model simply puts the neoclassical paradigm into a broader setting. Furthermore, the criticism is not necessarily being directed at the neoclassical paradigm itself, but at the way in which it has been used in the past to analyze and, to some extent, to justify the use of specific policy measures to overcome some of the problems of price instability. The "problem of price instability" is as much to do with the economists' approach to it as it is to do with the practical problems of doing something about it.

Chapter 4 attempts to deal with a definition of instability since previous definitions have been found to be inadequate. In approaching the definition, there is separation of performance criteria into two distinct areas. First, the "question of price instability" itself and its definition; and secondly, the effects of instability. That is, defining instability requires separating out "cause" and "effect." Defining instability in terms of its "causes" without reference to its "effects" is an extremely challenging task. The extent to which it is achieved in this study is disappointing, yet allows reference to some more tangible concepts than the movement of supply and demand curves, or that which the simple cobweb model offers. The definition, as such, is certainly not new or innovative. Most economists know what is meant by instability, but rarely articulate on it because it involves both "cause" and "effect" and a series of value judgements which may or may not be questionable. It might be concluded that there is really no satisfactory definition for instability--but it nevertheless seems necessary to separate cause from effect.

Problem identification is complex because of the interacting components of price instability and its "causes"and "effects." Summarily, since prices are used in the economic system as indicators of the correspondence between production and demand, it is necessary that some movement in prices exists. This movement in prices dictates the allocation of resources in the economy. A conflict therefore exists between the undesirable nature of movement in prices, and the desire to allocate resources efficiently. On the other hand, if price instability is the cause of inefficient resource allocation, then price movement becomes an undesirable output. The problem becomes much more complex when the potential causes of instability are examined. A conflict arises between the desire to reduce uncertainty and a desire to stabilize prices. Both uncertainty and instability are "causes" <u>and</u> "effects" of price instability. Therefore, it becomes of interest to examine some current price stabilization policies in order to determine whether or not either uncertainty or instability or both are reduced. Since these are empirical problems, a simple nonlinear systems simulation model of the fed beef sector of the beef industry is developed.

As with any empirical research, such a model has limitations. First, because of its specificity, the model refers only to a single sector of the beef industry. The results are therefore not generalizable to other sectors. Second, while in theory, there are three potential sources of instability (participants, mechanism and random variation), it is not possible to be specific about the participants of the system. Uncertainty due to behavioral reactions to the market is assumed to be reflected in the random variation within the supply and demand curves. In addition to this, certain market participants are not included in the system. These include government, bureaucrats, and market functionaries--the so-called "middle men." An interesting but complex addition to the model would be the inclusion of institutions which stand between the producers and the consumers. The effects of these institutions on the outcome of the pricing process is the subject for another entire study, but is surely an important aspect of price instability. The model developed assumes that marketing margins are constant, thus preventing analysis of such policies as the futures market and forward contracting.

While the modeling effort in this study has provided for some insights into the complexity of the problem of price instability--some aspects of it are disappointing. Perhaps the toughest problem to grapple with has been the conceptualization of price instability in terms of transient response. Redefining instability in terms of the transient response of the system provides an exciting possibility of redirecting the performance criteria away from the unmeasurable and problematic area of utility and welfare implications, towards tangible tradeoffs in the form of rising time, overshoot and settling time. The concept of transient response provides an opportunity of entering into the optimal control field. However, in order to get at the possibilities of optimal control, the system must be described in terms of transfer functions. Economic systems are unfortunately not conducive to being defined in terms of transfer functions, at least not transfer functions which can handle the complexity of the price mechanism. A fruitful and sorely needed study is required in this field.

To the extent that transient response is not, as yet, an operational conceptualization of price instability, the major results of this study are not new. Indeed, the results are rather mundane and, to some extent, intuitively obvious. The major conclusions that might be drawn from the study are mostly in its conceptualization of the problem, rather than in its quantitative results.

Chapter 7 presents a somewhat different aspect to that of the institutional/systems approach presented earlier. Two modifications are made to the static and linear neoclassical approach of Chapter 2 in that uncertainty and time are explicitly introduced into the utility function and the conditions for maximizing welfare (utility) are examined. This model is not the answer to the difficulties which arise in the main body of the study, but rather is a demonstration that it is possible to account for uncertainty and time within the confines of the quantitative welfare model. As is common in agricultural economics, theory is far ahead of the empirical tools necessary to quantify the concepts stated. This is not a reason to conclude that the concept is unworkable or that the problem is insoluble. To the contrary, it is a sincere hope that this study forms the basis of some ongoing research in the area of price instability, both theoretical and empirical.

APPENDIX

APPENDIX A

In comparing economic surplus concepts with the above model, the conditions under which the derived welfare measures are equivalent are as follows:

Demand:

Since $U_A = r_1X_1^0 + (r_2-r_1)PX_2 - \lambda_A P^2X_2^2\sigma^2$, then substituting the equilibrium price and quantity back into U_A yields the certainty equivalent measure for individual A at equilibrium--given by

$$\overline{U}_A = r_1X_1^0 + \frac{(r_2-r_1)^2}{4\lambda_A\sigma^2}$$

It will be noted that the derived demand curve is in fact a type of compensating demand curve since substitution of alternative value of price and quantity in accordance with the demand curve will give the same result, i.e., if X_2-b, then $P|_{X_{2=b}} = \frac{r_2-r_1}{2\lambda_{Ab}\sigma^2}$. Substitution of these values into U_A gives:

$$\overline{U}_A = r_1X_1^0 + \frac{(r_2-r_1)^2}{4\lambda_A\sigma^2}$$

which is the same as previously found.

The limits of the demand curve are infinite on both axes, therefore, $\int_{P_e}^{\infty} D(P)dP$ is an improper integral which diverges. Putting limits on the areas under consideration, let X_2=b and $P|_{X2=b} = \frac{r_2-r_1}{2\lambda_{Ab}\sigma^2}$, then:

$$\int_{P_e}^{P_{X=b}} D(P)dP = \frac{r_2-r_1}{2\lambda_A\sigma^2}\left[\frac{b(\lambda_A+\lambda_B)}{\lambda_B X_2^0} - 1 - \ln\frac{b(\lambda_A+\lambda_B)}{\lambda_B X_2^0}\right]$$

In order to compare the two methods, $\int_{P_e}^{P_{X=b}} D(P)dP$ must be compared to $\bar{U}_A|_{P_e} - \bar{U}_A|_{P_{X=b}}$. From the above results, it is clear that $\bar{U}_A|_{P_e} - \bar{U}_A|_{P_{X=b}} = 0$.

The conditions under which $\int_{P_e}^{P_{X=b}} D(P)dP = 0$ are that $\lambda_A = 0$, i.e.,

$\int_{P_e}^{P_{X=b}} D(P)dP = \frac{r_2-r_1}{2\lambda_A\sigma^2}[Z-1-\ln Z]$ where $Z = \frac{b(\lambda_A+\lambda_B)}{\lambda_B X_2^0}$ and $Z-1-\ln Z=0$ only when $Z=1$.

Supply:

Since $U_B = r_2PX_2^0 - (r_2-r_1)PX_2 - \lambda_BP^2(X_2^0-X_2)^2\sigma^2$, then substitution of equilibrium P and X_2 into U_B gives:

$$\bar{U}_B = \frac{r_2^2-r_1^2}{4\lambda_B\sigma^2} + \frac{r_1(r_2-r_1)}{2\lambda_A\sigma^2}.$$

Unlike U_A, this function changes for various values of X_2 and P. If $X_2=b$, then:

$$P|_{X2=b} = \frac{r_2-r_1}{2\lambda_B\sigma^2(x_2^0-b)} \text{ and } \bar{U}_B = \frac{r_2-r_1}{2\lambda_B\sigma^2}\left[\frac{(r_2+r_1)X_2^0 - (r_2-r_1)b}{2(X_2^0-b)}\right].$$

Hence, if $b=0$, then $\bar{U}_B = \frac{r_2^2-r_1^2}{4\lambda_B\sigma^2}$.

Finding producers' surplus yields:

$$\int_{P_{X=0}}^{P_e} S(P)dP = \frac{r_2-r_1}{2\lambda_B\sigma^2}\left[\frac{\lambda_B}{\lambda_A} - \ln\frac{\lambda_A+\lambda_B}{\lambda_A}\right].$$

In comparison, $\bar{U}_B|_{P_e} - \bar{U}_B|_{P_{X=0}} = \frac{r_1(r_2-r_1)}{2\lambda_A\sigma^2}$. For $\int_{P_{X=0}}^{P_e} S(P)dP = \bar{U}_B|_{P_e} - \bar{U}_B|_{P_{X=0}}$,

then $\frac{r_2-r_1}{2\lambda_B\sigma^2}\left[\frac{\lambda_B}{\lambda_A} - \ln\frac{\lambda_A+\lambda_B}{\lambda_A}\right] = \frac{r_1(r_2-r_1)}{2\lambda_A\sigma^2}$ which results in $(1-r_1)\frac{\lambda_B}{\lambda_A} = \ln\frac{\lambda_A+\lambda_B}{\lambda_A}$

which is only true if $\lambda_B=0$. These results are significant, since they show that the consumers' and producers' surplus measures imply that the marginal utility of money (income or wealth) is constant, since if λ_A and λ_B both equal 0, then both individuals are assumed to have constant absolute risk aversion.

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