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SOURCES OF AGRICULTURAL MARKET INSTABILITY

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ABSTRACT

SOURCES OF AGRICULTURAL MARKET INSTABILITY

By

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Agricultural markets are less stable than those in most other sectors of the economy. Indeed instability is often seen as the most pressing policy problem facing agriculture. This dissertation is dedicated to the examination of the meaning, extent, and sources of price and quantity instability. Particular attention is given to the role of marketing institutions in contributing to, or alleviating this instability, and to the relationship between instability and the effectiveness of marketing coordination.

The analysis of the study is in three parts.

First, an annual instability measure is developed for the measurement of a dimension of marketing coordination effectiveness. This measure is then applied to markets for more than 100 different commodities in order to distinguish and identify possibly poorly coordinated markets. Great variation is evident in the degree of instability among different commodities.

In the second part of the analysis, a cross-sectional study is undertaken to examine the sources of agricultural

market instability. It was found that, for annual crops, the greater part of production instability is due to potentially controllable factors rather than uncontrollable yield variation. In addition the contribution of various conventional supply and demand shifters are shown to make only a negligible contribution to total instability. In contrast, marketing institutions are an important explanator of differences in annual instability between commodities. Evidence is also provided that instability itself contributes towards further instability.

The third part of the analysis considers recent changes in instability. It is found that most commodities have experienced increased instability since the early 1970s (especially price instability), but it is the field crops and animal products that have shown the greatest increases. Whilst macroeconomic factors are identified as a source of the increase, the wide differences between commodities and the explanatory power of other sources provides evidence that other factors also are important: in particular, the changes in Government support policies and institutional changes in fruit and vegetable industries.

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Chapter 1

INTRODUCTION

1.1 THE PROBLEM OF INSTABILITY

Many commentators identify instability as being the major long term problem facing United States agriculture. The subject occupies about a quarter of Heady's textbook (1952). Tweeten (1979) gives more space to this topic than any other in his book on farm policy. In addition there is evidence that instability in agriculture is increasing especially for export crops (see for example Tweeten, 1983; Hazell, 1984; Firch, 1977; Mangum, 1984; Myers and Runge, 1985). Why is agriculture so prone to instability that so many see it as a problem. And is it really a problem?

One reason for the concern with the issue is that agriculture is unusual in that input-output relations are relatively uncertain. In most industries the employment of known input quantities is almost certain to lead to the predicted output. The relationship is given by the specifications of the chosen technology. This is not true for agriculture where weather and disease can affect yield. This undoubtably introduces a degree of uncertainty in agriculture, which is absent in most other industries. To be sure other industries face uncertainty in needing to forecast the behavior of competitors and demand patterns of consumers. But these are also uncertainties bourne by agricultural producers. If weather and diseases were the only factors making for the high instability of agriculture then little could be done to improve the situation apart from the development of disease resistent strains and perhaps the development of long term weather forecasting techniques or extensive irrigation. However, there is another difference that makes for greater instability in agriculture than other industries. This is the coordination system within the marketing chain. In many non-agricultural industries marketing arrangements, such as vertical integration and contracts, ensure that only enough product is produced to meet the expected demand. As a result the supply and demand of intermediate products is at least effectively coordinated. This is not so in the food system. This is not necessarily a coordination based on sequenced perfectly competitive markets, but rather one based on mechanisms established to deal with the potential uncertainty of the system. In agriculture, market coordination is perceived to be a problem. The demand for forms of orderly marketing is evidence of this perception. However, most economists see this demand as one based on ignorance or as a thinly veiled request for subsidy assistance. This dissertation focuses on this issue. How much of the instability evident in agriculture might be explained by exogenous, uncontrollable factors, such as weather and demand shifts, which are difficult to alleviate; and how much is due to potentially controllable failures in coordination. It is difficult to analyze these things for any individual commodity market. However much can be elucidated from a comparison of a number of commodity markets with different coordination mechanisms.

1.2 ORDERLY MARKETING

While orderly marketing seems to be desired by participants in agricultural markets, but it is not a well defined concept. It is associated with market stability and some measure of certainty. It also represents some distinct disatisfaction with the coordinating role of the market, where there is evidence that certain participants benefit from an asymmetric distribution of information or unequal power. Orderly marketing therefore has something to do with ensuring that the correct amount of product is produced and distributed in a timely fashion to consumers, when and how they want it. But what is the correct amount. The neoclassical model implies that prices will convey the appropriate market signals to ensure this coordination. However to do so requires conditions of perfect competition with complete certainty, the absence of transactions costs, well defined property rights and intertemporal markets. Some of these conditions are so completely lacking that attempting to promote those conditions can be prohibitively expensive. Hence there is a demand for alternative market coordinating structures (to so called free markets) as articulated by the desire for orderly markets.

1.3 INSTABILITY AND MARKETING COORDINATION

There is a relationship between price and quantity instability and orderly marketing. In fact intertemporal failures in marketing coordination are reflected in market instability. In this sense a measure of instability may be taken as a measure of marketing coordination effectiveness. Of course, such a measure is only a proxy, for there are other factors that cause instability. Indeed prices and quantities must vary somewhat to ensure market coordination. It is of course excessive instability that is both symptomatic of a coordination problem and also contributory to it. This study is directed at the measurement and analysis of market instability (prices and quantities) of agricultural commodity markets with the purpose of identifying poorly coordinated markets.

1.4 STUDY RATIONALE AND METHOD

Thus the approach of this study is principally diagnostic. The intent is to identify possible failures in market coordination and to provide some quantitative estimate of the contributions of various sources of instability, with particular attention given to institutional factors which may be potentially alleviable. The breadth of scope of this study necessitates that it be mainly exploratory and heuristic in its approach. However, the focus upon one dimension of market performance, namely instability, permits the application of quantitative techniques for 'measuring' the relative institutional performance of individual commodity subsectors as evidenced by their instability. It is intended that this study provide both a context and a source of hypotheses for future research into orderly market questions for United States agriculture.

1.5 SUMMARY AND PLAN OF STUDY

The plan of this study is as follows. In the next chapter consideration is given to what the term instability actually means. It will be shown that the mathematical concept of instability is unhelpful and in fact has confused discussion of the issue. Although instability can be thought of as being partly predictable and partly unpredictable, it will be shown that both types are important for market coordination but for different reasons. Instability has been given extensive coverage by the agricultural economics profession and Chapter 3 is devoted to consideration of this literature. Particular attention is given to reasons why market prices may not both efficiently allocate existing production and convey appropriate marketing signals for future production decisions. Little of the historic interest of the profession in instability has been directed at market questions, apart from remedial problems like buffer stock schemes. In Chapter 4, various instability measures are discussed and appropriate measures are developed for the analysis of this study. Measures of instability for more than 100 commodities are examined in the fifth chapter to determine which commodity markets exhibit the most and least market instability (i.e., of prices and quantities). This cross-sectional analysis of commodities allows comparison between markets so that not only can the more unstable markets be identified but also the relative instability of markets can be determined and a context is provided for their relative magnitudes. Then in Chapter 6 consideration is given to the sources of this instability and the relative importance of each. First, the effect of yield instability is examined and shown, as one might expect, that it can explain a major part of observed instability. Area instability is also examined and shown to represent another major source of instability. It is seen to be associated with yield instability indicating that producers of products with unstable yields have difficulty coordinating production decisions. Then the possible influence of various supply and demand shifters, such as population, income and input prices are considered and shown to be of relatively minor importance in explaining year to year variation. The next part of Chapter 6 is devoted to analysis of that part of instability that can be explained by various institutional and physical characteristics of the commodity or market, and a final section considers the empirical evidence for price instability creating further instability.

In Chapter 7 the question of increasing instability is investigated. It is shown that whilst price instability has increased, the increase has been more concentrated in particular commodity groups than others so that it is not as general as some previous analyses have implied. The sources of this increase are then investigated. The final chapter provides conclusions to the analysis and examines directions for further research.

Chapter 2

WHAT IS INSTABILITY?

2.1 INTRODUCTION

Instability is a concept that everyone professes to know but few can define. Moreover, it quickly becomes clear in any discussion that people have very different interpretations of what instability really is. The word itself has a negative aura and instability seems implicitly undesireable. However, there is often a difference of opinion between professional economists and market participants whether the concept is at all relevant to economic markets. Partly the disagreement reflects different understandings of the meaning of the word; and partly it reflects differences in confidence about the ability of markets to operate efficiently or fairly. In this chapter I will describe some different interpretations of the concept and suggest a definition that is appropriate for this study.

2.2 MATHEMATICAL INSTABILITY

The usual mathematician's or physicist's use of the term instability describes a property of dynamic systems in relation to a steady state or equilibrium. A system may be stable if it converges on an equilibrium or unstable if it diverges from an equilibrium. An intermediate case is where a constant cycle is maintained about an equilibrium: neither converging or diverging. Mathematically whether a system is stable or not can be determined by whether the eigenvalues of the equations describing the system fall within the unit circle in cartesian real-imaginary coordinates (Chiang, 1974). An alternative, and equivalent requirement, is that the poles of the equations describing the system must fall in the negative quadrants of the Laplace s-space for stability (Manetch and Park, 1984).

This definition of instability is not very useful for analysis of existing markets. If the structure underlying a market had unstable characteristics in the sense described above, then no market would be possible. If there was an initial equilibrium, the first shock would ensure displacement from equilibrium and prices and quantities would then go to either zero or infinity. Such markets do not generally exist.[1] Thus in this mathematical sense of instability, existing agricultural markets are stable. Clearly this is not a useful description of instability for the purposes of this study. However, it provides the reason why many will assert that agricultural markets are 'stable'. And in this sense they are. However it is clear that agricultural markets exhibit instability of a different

[1] Some markets may experience these characteristics for a period. For example, the dynamic processes underlying "tulip manias" can be described as unstable. In these cases price expectations are based on rates of change in prices so that a spectacular boom is followed by a bust. The source of this descriptive name is such an occurrence in the Dutch market for tulip bulbs in 1634-37.

quality. I will call it economic instability in contrast to the mathematical instability described above.

2.3 SYSTEM INSTABILITY

One approach to describing economic instability is to consider it as the dynamic adjustment path towards equilibrium within a systems perspective (Butler, 1979). This approach recognizes three sources of instability: exogenous input shocks (both controllable and uncontrollable), random shocks in the feedback mechanism, and exogenous behavioral influences. Instability is then measurable in terms of the dynamics of the estimated system using characteristics of the 'transient response' of the dynamic system. These characteristics are typically 'rising time' - the time taken in response to a shock to reach a specified proportion (e.g., 90%) of the new equilibrium; 'overshoot', the percentage by which the maximum value of the actual series overshoots the equilibrium; and 'settling time', the time taken for the series to settle within a specified width band of the equilibrium value (say 5%). (See Manetch and Park, 1984).

This approach is not very useful for choosing a measure and is difficult to operationalize for analysis of actual (as opposed to conceptual) markets. However the approach is very helpful in understanding what the idea of instability might encompass. In particular it distinguishes exogenous and endogenous sources of instability. It also highlights the role of the feedback mechanism for understanding endogenous instability. The marketing institutions are part of this feedback mechanism.

2.4 INSTABILITY AND MARKET COORDINATION

The discussion above provides some insights into the relevance of instability for market coordination. In line with the systems approach, markets exist in an economic environment which generates exogenous shocks to a market system. These shocks may be weather conditions, changes in income growth or government policy changes. Within the supply and demand framework it can be expected that the market clearing equilibrium of prices and quantities will exhibit a degree of variability in response to these exogenous shocks. This variability might be considered as the 'normal' variability or instability that facilitates the allocation of already produced goods within a market.

In addition to this market adjustment source of instability there are other sources identifiable within the systems perspective. These include the dynamic process as economic variables converge on a new equilibrium. The overshoot and settling time characteristics of the transient response are components of the instability generated by the dynamic process which exceed the demands of 'normal' instability described above. On the other hand the rise time characteristic of transient response may be a component that reduces observed instability. Such lags however, probably represent either excessive production or failure to take advantage of potential profitable production opportunities. For example, if an export embargo is imposed on a crop which makes it less profitable to grow, and farmers continue to produce it in unprofitable quantities, then resources are wasted relative to their alternative uses. However, observed market instability is less than if they had reduced production immediately. When they do decrease production they may do so to an excessive degree causing overshoot and with a longer subsequent settling time. These later characteristics will be observed as instability.

These responses are properties of the feedback mechanisms of the market. In other words, they are functions of the institutional design and management of the market. For example market intelligence services, the structure of the market and the existence or lack of futures markets will all affect the transient response to a shock. In this way instability can be seen to be dependent on the coordinating mechanisms of the market, and on the endogenously induced changes in participant behavior.

Thus instability of markets has both desireable and undesireable components. First, some part of instability functions to coordinate markets. It represents the observance of the market signalling function of prices and the subsequent adjustment of quantities. Another part represents instability in excess of (or possibly less than, or different than) that required to achieve this aim.

The discussion above views instability of a market as a measureable output or as a performance indicator of a system. However instability is also an input into the feedback mechanism. Unstable markets are more difficult to predict than stable markets and hence production, marketing and consumption decisions are more difficult to make in such systems. It is reasonable to expect that instabiltiy in these circumstances may breed further instability as participants in uncertainty respond by making poor decisions. In market failure terminology instability can be said to generate an informational externality. In other words participants in unstable markets can not help but make some wrong decisions about production, marketing and purchases, which affect others as well as themselves. Thus instability may be considered as both a cause and a consequence of poor market coordination. However it is only an indicator. For example, it might be desireable to have increased price instability if holding prices constant masks market signals so that inappropriate levels of production are induced or markets do not clear. In fact a number of situations can be conceived where increased instability might have desireable alternative consequences. However, it seems reasonable to consider this dimension as one indicator of market coordination effectiveness despite these difficulties. Most, (except, as shall be seen, some economists!) consider instability or 'excessive' instability to be a bad thing.

2.5 PREDICTABLE AND UNPREDICTABLE INSTABILITY

Instability can be detrimental to market coordination in that it is detrimental to prediction. However some instability is in fact predictable, at least by some participants and to some degree. For example the well attested cycles in beef and hogs may permit a greater degree of predictability than shorter run fluctuations in markets such as for soybeans. In situations where there is predictable instability then participants may adjust to their known economic environment. Hence, they will not produce product for less than the cost of production nor fail to exploit profitable production opportunities. Thus it might be argued that no resource allocation problems are created in this situation. There are two problems with this argument. First, this reasoning is static and ignores the existence of fixed capital inputs in production, processing and marketing. When these inputs are product specific then there will be unutilized capacity at certain times. Second, intertemporal storage costs will likely be higher under more unstable (although predictable) markets than under stable markets. Thus entirely predictable instability will be of concern for market coordination as well as unpredictable instability.

However, when real world commodity markets are examined it is difficult to find much predictable instability. In the examples given above, it is clear that a large proportion of the instability evident in these markets is very difficult to predict. Moreover the cyclical variability of these 'predictable' markets is indicative of the market instability which helped to generate the cycles.[2] Thus although predictable variability may be of less concern than unpredictable variability, both forms of variability may be symptomatic of existing market instability.

This discussion has immediate relevance to the choice of an empirical measure. For the reasons decribed above it seems reasonable to prefer a measure of instability rather than attempt to measure predictability. However, among instability measures there seems some justification to choose a measure that emphasises shorter term variability rather than cyclical phenomena although that too is important. I will return to this issue again when consideration is given to the choice of a measure for analysis in Chapter 4.

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[2] Although the evidence from the theory of partial equilibrium analysis is supportive of the contention that stabilization of a single market is desireable, an example can be provided of a two commodity market where cycles are optimal. Assume that corn can be either consumed, stored (at a cost), or fed to hogs; corn harvests are stochastic; and consumers maximize an intertemporal discounted and concave utility function; then prices oscillate along the optimal path. In this model hogs become an efficient means of utilizing excess grain during good seasons compared with costly corn storage. The hog-corn price ratio oscillates in the optimal strategy (Burmeister, 1978).

2.6 INSTABILITY OVER TIME

It is now obvious that instability is many faceted. One of these facets is the periodicity of the instability. The beef cycle is an example of a relatively long period (10 years) cycle. Other industries also exhibit cyclical instability, for example hogs, eggs (Hartman, 1974), lemons and watermelons. Some of this cyclical phenomena is a result of the length of the production period. This may extend from some weeks in the case of eggs to about a thousand years for the life of an olive tree. The longer the production period the longer the period of possible cyclical instability for an industry. In addition nearly all agricultural industries exhibit annual variation in response to seasonal factors. Thus although olive trees have a long productive life, they produce olives each year, and the annual crop is partly a function of weather conditions. The annual crops (e.g., corn) fit this case most clearly. Eggs are of course an exception in that they are little influenced by weather. Some quickly growing vegetable crops, such as lettuce, also exhibit instability where the week to week movements are probably of more relevance for market coordination than the year to year changes. Even though corn is an annual crop, corn prices fluctuate by the minute. And corn production is not only an annual phenomenon in that production is dependent on fixed costs or on previous investment that has a longer time horizon than one year. Thus for each commodity it would be possible to find a spectrum of instability measures classified by the periodicity of the measure. This discussion is suggestive that there may be virtue in considering instability measures based on autoregressive moving average models (Box-Jenkins) or upon spectral fourier techniques (eg Hannan). In the interests of simplicity and cross commodity compariability I will choose one time frequency and choose one which seems to offer the best means of comparing commodities. This would seem to be the annual frequency.

2.7 CONCLUSION

What does all this mean then for the definition of instabilty and for its measurement? In this chapter I have argued that mathematical instability is an inappropriate concept for the analysis of markets. A more useful approach is provided by systems concepts of transient response or, alternatively, measures of variability. Such a measure can provide a dimension of the effectiveness (or rather the lack of effectiveness) of market coordination in an agricultural market. It is not a perfect measure but it has some virtues for comparing marketing arrangements between industries. In addition the degree of market instability will be of interest to others concerned with broader agricultural policy issues. It is problematic, however, exactly what instability is. I have argued that it is related to, but not limited to, unpredictability. Instability may exacerbate unpredictability and vice versa. I have also argued that instability may be measured according to different time frames: some of more relevance to certain industries than others. However, it would appear that an annual measure is the most useful one for making comparisons between commodities. Thus, for the purposes of this study, I will define market instability to be some arithmetical summary measure of the annual variability of price and quantity for each agricultural commodity. The exact choice of measure will be discussed in Chapter 4.

Chapter 3

APPROACHES TO INSTABILITY

3.1 INTRODUCTION

In this chapter I will give a brief review of the treatment of instability in the economic literature. This will provide a rationale and context for the analysis described in this paper. The major contributions may be classified in five groups as follows:

1. Traditional Marshallian approach
2. Asset fixity
3. Modern risk aversion approach
4. Market failure
5. Associated with poor market coordination

3.2 TRADITIONAL MARSHALLIAN APPROACH

The traditional approach to instability uses the theoretical framework of Marshallian analysis. This approach allows conclusions to be reached about the consequences of instability for welfare of producers and consumers and for society, as measured by producer and consumer surplus. It also permits some conclusions to be reached about the advantages or disadvantages of price stabilization.

Perhaps the first to use this approach was Waugh (1944). He assumed linear demand and supply schedules, a perfectly competitive market and no uncertainty. He showed

that consumers benefit from price instability relative to prices remaining stable at their mean. Apparently unaware of Waugh's contribution, Oi (1961) proved the analogous result for producers, i.e., that producers benefit from unstable prices relative to the mean price. The implication of these results was counter-intuitive: that price instability is desireable. However, each of these approaches considered the welfare of one group, ignoring the effects on the other participants. Subsequently Massell (1969, 1970) synthesized Waugh's and Oi's results to conclude that who gains and who loses depends on the source of the instability: producers gain (lose) and consumers lose (gain) when the source of the instability is on the demand (supply) side. However the gains from instability are insufficient to compensate the losses so that total welfare is always reduced under instability. Samuelson (1972) made a similar point in noting that these analyses are partial and that consideration of general eqilibrium factors demonstrates that the price instability described was infeasible. Unstable prices would not have as their mean the price that would be maintained under stability. So that total welfare is reduced under instability relative to the stable case.

It should be noted that these results are obtained on the basis of a competitive market with linear demand and supply schedules, where the instability is reflected in additive horizontal shifts of the schedules and where prices are certain although variable. Various analyses have been done to investigate the sensitivity of the results to these assumptions. Tisdell (1963, 1978) took issue with the assumption that prices were known when production decisions were made. He demonstrated that Oi's result was not maintained when actual prices (as opposed to the price distribution) were not known at the time of the production decision. Turnovsky (1974) extends this approach by investigating the implications of modelling price expectations with alternative lag structures, namely Nerlovian adaptive and Muthian rational formulations. He shows that the Oi result (namely that producers gain from instability originating from demand fluctuations) depends crucially upon how the expectations are generated. Rational expectations do not change the Oi result, although adaptive expectations may. Not surprisingly his models demonstrate that price instability creates greater losses to net welfare when supply is based on expected prices than on actual prices (i.e., perfect information). Thus instability which is not predictable (uncertain) has greater welfare costs than predictable instability. This has relevance for the measuring of instability in the next chapter. Turnovsky (1976, 1978) also considers the implications of alternative specifications of the stochastic elements of the model. He uses a model with multiplicative shifts and finds that the price elasticity of demand becomes critical in determining the distribution of benefits from reduced instability rather than the source of the instability, as was the case for linear schedules. He shows some modification to Massell's conclusions. In particular the adaptive formulation gives indeterminant results and the extent to which producers lose from reduced price instability depends upon the autocorrelation of the stochastic shifts that provide the instability. However, in all these partial equilibrium analyses, reduced instability provides net welfare gains. The interested reader will find many of these results summarized in Adams and Klein (1978), and Newbery and Stiglitz (1981).

Perhaps the only attempt to use the Marshallian welfare approach in the context of alternative market structures to the perfect competitive model is provided by Bieri and Schmitz (1974). They examine the case of an intermediary who is either a profit maximizing monopolist-monoposonist ('pure middleman') or a producer controlled marketing board. Their example might apply to the international grain trade. They find that the pure middleman can gain by actively manufacturing price instability or by not stabilizing price fluctuations when they are a result of natural causes. This is not true for the marketing board where stabilized prices are desireable for producers.

The general conclusions of this literature is that there seems to be agreement that instability is socially undesireable (as measured by producer and consumer surplus methods) and that there is a redistributive effect among economic agents as a result of the instability. However the form of the instability, the way prices are predicted and the nature of the demand and supply schedules can all modify some of the general conclusions outlined by Massell. Criticisms of these Marshallian approaches can be made on the basis of their partial equilibrium assumptions, the measurement of welfare in terms of uncompensated surpluses (Currie et al, 1971; Willig, 1976), how they deal with uncertainty, the assumption that ex post and ex ante supply are the same, the lack of consideration of dynamic factors in production, their failure to consider costs of stabilization and their reliance (in all but one case) on the assumption of perfect competition.

3.3 ASSET FIXITY THEORY

One of the assumptions in all of the above analyses is that of a static production process. But dynamic factors are particularly important in the study of instability. The commitment of inputs in production, including marketing, may have a stabilizing effect as production decisions may not be revised rapidly. However, the difficulty of revising production decisions where there are fixed factors can lead to long term disequilibrium. Johnson and Quance (1972) argue that this can result in an overproduction trap as producers make optimum decisions for variable inputs based on previous decisions about fixed inputs. Supply functions therefore take different forms depending on whether prices are increasing or decreasing.

This theory demonstrates the importance of dynamic factors for instability. Fixed factors can explain some stabilizing role in the short term coincident with long term disequilibrium and hence instability.

3.4 MODERN RISK APPROACHES

In the last chapter, the relationship between instability and predictability was considered. In summary it was shown that observed instability is partly predictable and partly unpredictable, and that these elements had different consequences for market coordination. In addition instability encourages unpredictability so that there is a complex interrelationship between these elements. In this section I wish to review some of the 'risk' literature as it pertains to market instability. Clearly 'risk' is directly relevant to instability. This section is in three parts. First, the meaning of risk as it is used in the literature is discussed. The second and longest part provides a brief review of how the concept of risk has been developed, how it has been used in economic models of behavior, and some of the principal conclusions of this literature as it pertains to agricultural markets. Third, I mention some of the recent economic modelling studies, which indicate that instability matters also for 'risk-neutral' behaviors although some common perceptions (and statements) often suggest otherwise.

3.4.1 RISK AND UNCERTAINTY

The classic examination of risk in economics is provided by Knight (1921). He notes, inter alia, that a distinction can be made between risk and uncertainty. The distinction between these concepts is that a probability distribution can be formulated for risk whilst it is not possible to do so for uncertainty. Since Savage (1954) this distinction has fallen into disuse on the basis that every individual will be able to form some subjective probability distribution over possible outcomes even though the objective distribution may not be known. Moreover, when one is considering an individual's own utility the subjective, rather than the actual, probability distribution is the relevant one. Despite this, analysts often make some distinctions based on the degree of uncertainty. For example, Newbery and Stiglitz (1981) distinguish systematic and unsystematic sources of instability. Moreover empirical evidence does suggest that lack of knowledge of the underlying probability distribution does affect behavior (e.g., Ellsberg, 1981 who distinguishes 'ambiguity').[1] While there is much discussion of risk, little progress has been made on incorporating uncertainty (or unsystematic risk, or ambiguity) in economic models. It can be argued that market participants will have some idea of the distribution of prices and outputs to be expected in a market. But it can equally well be argued that participants do not form subjective probability distributions. In a later chapter I will present evidence that instability of agricultural markets has increased. In such a situation it is probable that there is a large measure of the instability in these markets that represents uncertainty and can not be described only as risk.

Thus the concept of risk, as it is used in the literature, can be considered to be relevant to only a component of the unpredictable part of instability, as I

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[1] Another example is provided by the so called coin-tack game. Here participants in a controlled experiment are asked how much they would pay for the opportunity to gamble where they can nominate the way a fair coin will fall. They are also asked the same question for a tack which may fall point up or on its side. Typically participants will offer less for the tack game even though they have the choice of calls. As they have the choice of calls the probability of success must be at least as good as a 50-50 chance of the fair coin game. In fact the objective probability favors the point on its side and most will choose this. However the fact that they offer less for the tack game suggests that the underlying subjective probability distribution is insufficient information to predict behavior: the uncertainty of the situation also affects the price offered. Real world situations are likely to be more complex than this simple experiment and 'uncertainty' might be expected to dominate 'risk'.

have defined the term in the last chapter. Nonetheless it is useful to review the literature and this is done below.

3.4.2 RISK IN ECONOMIC MODELS

Early studies that attempted to incorporate risk in agricultural models used various versions of mean-variance analysis. These postulated decision makers making a tradeoff between expected outcomes and the expected variance (or standard deviation) of the same outcomes. However a major thrust of recent conceptual research into the influence of risk has concentrated on the effect of risk averse behavior within the framework of the expected utility hypothesis (see for example the extensive bibliography of this literature in Machina, 1983). This has followed the development of a generally accepted measure of risk aversion by Arrow (1971) and Pratt (1964); and an analogous definition of increasing risk as defined by Rothschild and Stiglitz (1970)[2]. When these concepts are applied in a comparitive static framework they suggest that behavior will often differ in the presence of risk than would be the case otherwise. For example the familar result that fixed costs are irrelevant for a profit maximizer is not generalized for a utility maximizer in the presence of risky output prices (see Sandmo, 1971). In the context of agricultural production decisions, risk averse

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2 The Rothschild-Stiglitz definition of risk can be described as a 'mean preserving spread'. Unfortunately it does not provide a complete ordering and hence is not useful for the comparison of different markets as is done in this study.

individuals (who are assumed to maximize expected utility) apply a discount to risky outcomes. Thus it might be expected that producers will apply less inputs to a product which is more risky than otherwise and that supply would be lower as a result, so that risky enterprises would have higher prices and lower output than would be the case under lower levels of risk. In fact, this expected result is not always forthcoming from models that utilize the expected utility hypothesis, once they are extended to include more realistic formulations. First, the argument of the utility function is unlikely to be prices or even revenue: producers are concerned with income or more likely with consumption, rather than these intermediate parameters. Second, the presence of alternative outputs allows farmers to form a portfolio of production possibilities, which may lead them to choose higher production of the more risky product rather than the reverse.[3] There may, of course, also be markets for shifting risk (eg futures or credit markets or private storage) which make risk of less consequence for individual farmers. In fact when complications are added to economic models of risky markets, there are few unambiguous answers.

[3] An example can show this. If a farmer can produce two crops: one with no risk and another more profitable but riskier crop. Then he may decide to spread his risk by producing both crops. Now if a stabilizaton scheme reduced the price risk of the second crop, the farmer may increase production of this crop as he has less need to spread his risk across the less profitable but sure first crop. If the second crop has elastic demand (say an internationally traded good) and the first is not, then aggregate supply response by producers may lead to them being worse off than before.

This is clear from the extensive study on the economics of risk as applied to commodity price stabilizaton schemes undertaken by Newbery and Stiglitz (1981). This work provides a comprehensive review of recent results in this area and can be recommended to the interested reader.

Notwithstanding these difficulties, the risk literature demonstrates the importance of one type of instability for economic behavior. It highlights the importance of risk management and the possible desireability of institutions to manage risk, either through remedial schemes such as buffer stocks or through the development of appropriate institutions. One result of these studies is to show that risk to one participant is not the same as to another (see, for example, Sharpe, 1964). Thus institutions to shift risk may reduce (or increase) it. The literature also questions many of the received results of neoclassical economics.

Before leaving this literature it is important to note that many of the results are dependent on the validity of the expected utility hypothesis. This was developed by von Neumann and Morgenstern (1944). It can be proved from a series of axioms that the expected utility of an uncertain event is the sum of the utilities of each possible outcome weighted by its probability (see, for example, Savage, 1954; or Luce and Raiffa, 1957). The validity of the theory depends upon the acceptance of the axioms, the acceptance of the concept of utility maximization as a description of human behavior and it is generally also required that there is constant marginal utility for money. The underlying axioms seem ostensibly reasonable but behavior is sometimes contary to them. The Allais (1953) and Ellsberg (1981) paradoxes provide examples of instances where most individuals do not observe the axioms. The utility assumption while debateable is a common one in economics. On the other hand the last assumption (of the constant marginal utility of money) is difficult to support and without it the theory cannot differentiate between risk aversion and declining marginal utility of money (see Fleisher, 1985).

3.4.3 INSTABILITY MATTERS, EVEN WITHOUT RISK AVERSION

It is often asserted that risk averse behavior is necessary for instability to make a difference to outcomes (see, for example, Biswanger, 1979 p392). However it is not necessary to postulate risk aversion to obtain results showing that instability makes a difference. Just (1975) demonstrates a simple model that shows risky costs will alter the optimum production level for an expected profit maximizer. In fact non-linearity of the objective function in static models is a sufficient condition to obtain this result. Antle (1983) shows that risk also matters for dynamic formulations (multi-stage or multi-period) even with risk-neutral agents.

The conclusion to be drawn from this review is that risk or instability does affect the behavior of economic agents with or without the presence of risk-averse behavior in all but the simplest static economic models. Thus there is possible potential to improve economic performance if risk can be managed.

3.5 MARKET FAILURE

The neoclassical model provides abundant rationale for ignoring instability all together. The argument runs as follows. Theory postulates that, under the assumptions of the perfectly competitive model, the operation of markets will ensure the attainment of pareto optimal efficiency. Hence the observed variability in prices and quantities is merely evidence that markets are doing their job. There is therefore no reason to be concerned with instability.

The market failure approach considers what deficiencies there may be in a particular market which violates these assumptions and that may justify appropriate intervention to overcome the failure. It seems worthwhile to consider some of the candidates for market failure in agricultural markets in some depth.

3.5.1 PERFECT INFORMATION

It is clearly counterfactual to assume perfect information. However it is not so clear whether the real world might not approach a situation where 'it acts as if' the perfect information requirement was satisfied. In this section I will examine some of the empirical and theoretical evidence on the subject to ellucidate the relevance of this restriction for the question of instability.

The theoretical work of Rothschild (1973, 1974) shows that relaxation of the assumption of perfect information can have drastic effects on the allocative role of the market. He introduces a consumer search cost into the simple neoclassical model and finds that monopoly pricing can be expected despite unlimited numbers of sellers.

Another approach to the role of information costs is provided by Heiner (1983). He finds that the most economical policy in the presence of uncertainty is to economize on the acquistion of new information. In fact his model finds 'uncertainty to be the origin of predictable behavior'. Moreover he finds that there is little reason to expect firms to act as if the perfect information assumption was satisfied. Successful firms will be satisficers with respect to information requirements.

3.5.2 INFORMATION AND EFFICIENT MARKETS

The efficient markets literature provides some basis for the empirical examination of whether there is sufficient information available for markets to operate efficiently. Samuelson (1965) was the first to prove 'that properly anticipated prices fluctuate randomly'. Fama (1970) formulated this result in tests of the relevant price series as to whether they are thereby consistent with the efficient market hypothesis. A difficulty with this approach is that price series will only be expected to move in a random walk if all available information is utilized. However the acquistion of information, including the knowledge of the model, is not costless. The inclusion of only 'economically' rational expectations need not be unbiased and so correct forecasts on average need not characterize efficient markets (Smith, 1978).

The empirical evidence on commodity markets is at best mixed and inconclusive as to their 'efficiency'. While tests of financial markets were rarely able to reject the hypothesis of 'efficiency' the results have been more mixed for commodity markets. Moreover, there is abundant evidence that relatively simple rules can be profitably employed in commodity markets which is supportive of information impactedness rather than market efficiency (see Smith, 1978). In addition international data on stocks and production are often scanty and of dubious quality, and while there is some modelling of commodity markets, they have not proved to be especially accurate nor are they particularly extensive especially outside the US.

Thus the empirical evidence seems to suggest that information may be insufficient for commodity markets to operate 'efficiently'.

A particularly apt illustration of the importance of information is the distinction between ex ante and ex post prices. Where producers have perfect knowledge the market mechanism will perform its allocative function on already produced goods. The resulting price will be an efficient and unbiased market signal for future production decisions. However in the presence of uncertainty, (as Smith shows) the resulting price will be (in general) biased. Hence the variability of the price obtained in the market will reflect not only stochastic elements, such as weather, but also the mistakes of market participants. Thus prices, in such conditions, can not simultaneously perform their allocative function (for already produced goods) and their signalling function (for future production) in an efficient manner. Clearly this is a potential source of instability in agricultural markets.

3.5.3 INCOMPLETE MARKETS

As is well known, one of the contributions of Arrow and Debreu (1959) to the understanding of the theoretical requirements for pareto-efficiency in general equilibrium is that there must exist a complete set of markets. They show that these are a necessary condition for efficiency. Where there is a temporal dimension and lack of perfect forecasting then complete sets of futures and risk markets are also required. However, only some commodities have futures markets and these typically extend only a short distance into the future so that they only allow producers market information for their short run production decisions.

Market signals, in the form of future prices, are not available for longer run production decisions, such as capital equipment or land purchase decisions.

The situation for risk markets is similar. The problems of moral hazard and adverse selection have discouraged the formation of adequate insurance markets. As a result prices are called upon to not only provide market signals but also to carry risk. They can not do both functions at once and hence they are inefficient (see Newbery and Stiglitz, 1982).

3.5.4 NON COMPETITIVE MARKETS

It is sometimes argued that agriculture provides the closest example of the conditions for perfect competition. However this assertion ignores other parts of the marketing chain where there are fewer participants and many institutions which affect market performance (Parker and Connor, 1979).

3.5.5 MARKET IMPERFECTIONS ELSEWHERE

Where there is at least one imperfection in the economy, the theory of the second best asserts that there is no guarantee that the lack of market imperfections elsewhere will contribute to a pareto efficient outcome (Lipsey and Lancaster, 1956). As all economies have lots of imperfections (including those described above and specific government interventions) there is no presumption that a less regulated market will be more efficient.

This is a rather general and iconoclastic demolishment of the argument for laissez faire. But is there specific evidence that agricultural commodity markets are adversely affected by the absence of the conditions of perfect competition? Wage and price rigidities, and imperfections in the capital market are good candidates (Newbery and Stiglitz, 1981). The commodity boom and bust of 1972-75 were very likely in response to the instability of international liquidity (Bosworth and Lawrence, 1982; Bond et al, 1984). Other sectors of the economy, which have wage and price rigidities, were more insulated from these developments. Hence the agricultural sector experienced the brunt of this instability. Undoubtably these 'imperfections' not only affect instability but also the level of prices and quantities.

3.5.6 OTHER EXTERNALITIES

Other external effects have been noted for agricultural commodity markets (Smith, 1978). These include the macroeconomic effects of agricultural instability, especially inflation and the associated increase in inflationary expectations; and the effect of instability on the exchange rate (especially in developing countries). The difficulty of forecasting future prices in the presence of instability can also be considered an external effect and therefore a source of market failure.

3.5.7 CONCLUDING COMMENTS

The conclusions to be gained from this review of the relevance of market failure theory are straight forward. There is clearly abundant evidence that agricultural markets are likely to exhibit market failure. Thus laissez faire prescriptions are unlikely to be optimal. In addition this review highlights some of the possible areas which may be candidates for institutional reform. These include the possible development of futures and risk markets. Moreover instability is isolated as both symptomatic of market failure (lack of information, incomplete markets, imperfections elsewhere in the economy) and as a characteristic of agricultural markets with undesireable external effects. Hence policies that are directed towards alleviating instability may have desirable external effects.

However the market failure approach, whilst examining the failures of the assumptions for the neoclassical paradigm to apply, still uses that paradigm. Pareto-efficiency becomes the performance measure for analysis, and little attention is given to other performance criteria. An alternative approach will be discussed in the next section.

3.6 MARKET COORDINATION APPROACH

An alternative approach to those described above is described in Shaffer (1980). Shaffer adapts the familiar structure-conduct-performance (SCP) paradigm used to study the industrial organization of markets (Bain, 1959) and generalizes it to apply to policy situations in general and market coordination problems in particular. His approach is to develop a paradigm in terms of environment, behavior and performance. Like the SCP paradigm this formulation allows the analyst to consider multiple performance measures and to choose ones that are appropriate to the analyticl purpose. Moreover it allows examination of behavior in its particular environment rather than what it 'should' be. This approach permits direct policy analysis of the environment in order to direct behavior so that some desired performance is achieved.

The environment of the paradigm is a series of overlapping opportunity sets which are physical, politico-economic and determined by an individuals position in the economy. Each individual's opportunity set is constrained by the organization(s) to which she belongs, market factors, property rights, technology, internal operations of the organization(s) and pervailing uncertainty (especially information impactedness (Williamson, 1979, 1981) etc.

The response of individuals and organizations to their environment can be described as their behavior. Important characteristics of this behavior are bounded rationality in the presence of opportunism (see Williamson, 1979, 1981), satisficing rather than maximizing behavior with consequent development of standard operating procedures, multible goals (Cyert and March, 1963), slackness (Hirchman, 1970; Liebenstein, 1979), selective perception of the environment and the importance of collective action (Olson, 1965) and learning. Performance is then the outcome of the behavior of the sum of all the relevant participants. What counts as performance will be dependent on the political articulation of preferences. Performance outputs will also be part of the new environment.

The analysis problem is to understand the linkages, and the policy problem is to redesign the environment with its structures of incentives and distribution of power, to achieve desired performance.

In the context of this study, instability may be treated as an undesireable performance characteristic, or as an instrumental variable influencing a number of performance characteristics of the marketing system. Clearly the structure of certain commodity markets is such that the behavior of individuals and organizations in the environment leaves something to be desired. Moreover this undesireable performance is likely to reinforce and produce further instability (Skinner, 1974). A part of the problem is that some marketing systems are poorly coordinated.

Some of the heuristic implications of this approach to the study of market instability are:

1. it directs attention to instability as an undesireable performance characteristic in its own right and as an instumental variable influencing performance;

2. it suggests that the analyst consider alternative market coordination mechanisms than spot markets (eg vertical integration, contracting etc) rather than using the perfectly competitive market as a norm with its counter-factual assumptions;

3. it suggests that explicit attention be given to the role of uncertainty rather than assuming it away.

3.7 CONCLUSIONS

This brief review of the extensive literature on instability shows it to be a large and complex area of research which is still far from resolution. This research has concentrated on the possibility of gains to be achieved by stabilization and particularly through remedial policies such as buffer stocks. Agricultural economists have often concentrated on the benefits or otherwise to producers: hence their concern with income (or even producer consumption) stability as the major focus. Most approaches use the neoclassical model of the market as the starting point for analysis. As a result many of the causes of market instability are assumed away before analysis begins. Thus little attention is given to the problems of coordination in markets under real world conditions of uncertainty and hence to the question of institutional reform to improve coordination.

In this study the focus will be on the question of instability with the aim of identifying deficiencies in market coordination. The approach will therefore be to consider the existing instability of agricultural commodity markets; to isolate commodity marketing systems which show excessive instability and hence provide evidence of poorly coordinated market processes; and attempt to come to some understanding of the sources of instability across commodities. To do this it will first be necessary to find a measure of instability. The next chapter is devoted to this task.

Chapter 4

MEASURING INSTABILITY

4.1 INTRODUCTION

In this chapter I will consider the problem of selecting an empirical measure that can be used for the description and analysis of instability. In a previous chapter it was suggested that an instability measure is desired as a proxy for 'coordination effectiveness'. It was also suggested that such an instability measure should have characteristics both of a measure of variability and also of unpredictability. Given this goal, in this chapter, I describe and discuss a number of the single variable instability measures used in the literature. It will be seen that each has certain strengths and weaknesses as appropriate instability measures for this study. On the basis of this discussion I will suggest a new measure which has certain desireable characteristics. I will then provide a detailed description of this method and give an illustration of its use. I will then compare this measure with one of the more common measures in use. This comparison will be undertaken using part of the data set for this study. It will be seen that no single measure is entirely adequate for our task. On the basis of this analysis and discussion I will reach some conclusions about the choice of measures for the rest of this study.

4.2 INSTABILITY MEASURES USED IN THE LITERATURE

Even a quick perusal of the relevant literature reveals a multitude of methods for measuring instability. There is no generally accepted method. This reflects a lack of consensus on what instablility is as well as a desire to match the method to the problem and purpose at hand. In this section I will list and describe some of these methods.

Some of the single variable methods to appear in the literature are:

1. Variance
2. Coefficient of variation (CV)
3. Coefficient of variation about a trend (CVT)
4. Absolute coefficient of variation formulation
5. Firch measure
6. Coppock index
7. Average percentage change measures
8. Moving average measures
9. Tweeten's uncertainty index
10. Percentage range

4.2.1 CHARACTERISTICS OF INSTABILITY MEASURES

1. Variance

Variance is the most commonly used measure of variability. It is simple to calculate and to interpret. Moreover mathematical and statistical techniques are well developed to manipulate it. It has however a number of drawbacks as a measure of instability in the present context. First it is dimensioned in the (square of the) units of the original series. The fact that it is the square is easily solved by using the standard deviation in cases where that is desireable. However the use of a measure dimensioned in the units of its own series makes comparison with other series difficult. For example the variance of the US population is many magnitudes greater than the variance of corn price. However most would agree that the corn price is more 'unstable' in some sense than the US population. Also a change of units will change the variance without changing the underlying character of the series. Even comparison of variances of a series at different times may present difficulties if the relative 'size' changes.

Another difficulty with the variance measure is that it implicitly includes trend in its measurement. For example, if there is a constant increase in a series each year, then the variance measure will register this as deviation from the mean, and hence contributing towards the variance measure. For many purposes such a series may be considered very stable; certainly it is a very predictable. In this case the variance measure will be a measure of relative trend rather than a measure of instability. Some analysts alleviate this difficulty by choosing short time periods over which to calculate the statistic (eg Tweeten, 1983). This entails some cost in terms of accuracy and is only marginally successful in solving the difficulty. Another characteristic of the variance measure (and measures based on it) is that the squaring accentuates the effects of outliers. This implies a quadratic loss function which may be appropriate but is clearly a disadvantage if an outlier is an error. Despite these difficulties the variance is the most used measure of instability (eg Tweeten, 1983; Piggott, 1978; Myers and Runge, 1985).

2. Coefficient of variation (CV)

The coefficient of variation is the standard deviation of a series divided by its mean. The measure is dimensionless and standardized (by the division by the mean). It therefore overcomes a significant disadvantage of the variance as a measure of instability. Instability of quite different series (such as US population and corn prices) may be compared using this measure even though the underlying units of the series are very different. However this gain is obtained at a cost. This measure is not nearly so easily mathematically manipulated as the variance measure. For example the decomposition of instability undertaken by Myers and Runge (1985), and described in Appendix E, is not possible using this measure. Like the variance, the coefficient of variation does not abstract from trend. So this difficulty is not solved by this method.

3. Coefficient of variation about a trend (CVT)

To overcome this last difficulty some researchers (e.g., Mehra, 1981) remove the trend from the series and then form an instability measure as the standard deviation of the residuals divided by the mean of the original series. (Not the mean of the residuals which would have to be zero or close to zero). There are many ways, however, to detrend a series. Commonly an ordinary least squares regression is used to remove a linear trend from the raw data or an exponential trend can be removed from logarithmically transformed data. One difficulty with these methods is seen statistically by the autocorrelation of the residuals. Consequently the measure will give accentuated weight to series where there are long cycles or where trends change. It would seem to have disadvantages as a proxy for 'predictability' as it implicitly assumes that agents know the long term trend before the trend is established and that they expect at each period for an immediate return to the long term trend.

4. Absolute Coefficient of Variation Formulation

This is another variation of the CV. Instead of including the sum of the squares of the deviations from the mean this measure substitutes the sum of absolute deviations. This measure gives a lower weight to outliers than the CV. It is more sensitive to the difference between dispersed and compact series.

5. Firch measure

This measure is described and used in Firch (1977). It is one of the more useful measures for the study of instability in this list, and the measure which I will use is very similar to this one. He uses the variance of the first differences of the natural logarithms of the data series. The Firch measure is dimensionless, abstracts from an exponential trend, gives a lot of weight to short term movements and can be decomposed among multiplicative components. A problem with this measure is that the mean change about which the variance is calculated depends exclusively on the first and last data points. Hence it can be rather unstable depending on the choice of end points.

6. Coppock index

Coppock's main concern is trade instability (Coppock, 1962). His measure is the antilog of the square root of the Firch measure above. The index has the same problem with the end points (see Offutt and Blandford, 1983) as the Firch measure but its added complexity makes it less manipulatable than the former measure.

7. Average percentage change method

There are a number of these methods of which Offutt and Blandford (1983) describe three. These are:

(i) the average of the absolute value of the percentage period to period change;

ii) the average of the square of the percentage of period to period changes;

iii) the same as ii) except that the percentage is calculated over the beginning or the end of each interval depending on which is greater each period.

Each of these methods measures the period to period (i.e. short run) variability. They are thus partly indicies of unpredictability. None of the three make any allowance for trend in the data series. The second measure is the most manageable for manipulation. The first measure gives more moderate treatment to outliers than the others. The third measure gives symmetrical treatment to increases and decreases which the others do not do.

8. Moving average method

This is the average of the absolute value of percentage differences of each data point from its (centered) moving average. The period over which the moving average is calculated is typically 3 or 5 years. Even more than others, this method is a measure of short run instability. It gives very little weight to intermediate-run and cyclical fluctuations.

9. Tweeten's uncertainty index

Tweeten uses this index in Tweeten (1981) to describe the increasing instability of aggregate excess demand for US farm product. The measure is the absolute average annual percentage change minus the algebraic average percentage change. The second term is deducted to compensate for 'the extent that average changes are part of a predictable upward trend that does not surprise market participants.' In fact the method will give a zero value for any monotonically increasing series and is therefore not a good measure for this study.

10. Percentage range

There are two versions of this simple measure. The first is the difference between the lowest and highest values expressed as a percentage of the midpoint of the extremes. The second version is the difference between the smallest and largest absolute percentage changes. Both measures give relatively little information about the series. Both are likely to be dependent on the length of the series, and to be strongly affected by outliers. Neither makes any allowance for trend.

4.3 THE INS METHOD

It is clear from the above discussion that no measure is perfect for the purposes of this study. Any measure that might be used can only provide a proxy for instability. In this section I will describe yet another measure which has certain advantages for this study. I will call it the INS measure in the absence of a more descriptive term. It draws on some of the features of the Firch and the average percentage change methods. The measure may be defined as the variance of annual percentage changes. Mathematically it is Var(100*dQ/Q). Computationally it will be useful to approximate dQ/Q as follows:

$$\frac{dQ}{Q} = \frac{Q_t - Q_{t-1}}{(Q_t + Q_{t-1})/2}$$

This is analogous to (half) the definition of an arc elasticity:

$$\frac{dQ\ P}{Q\ dP} = \frac{(Q_t - Q_{t-1})\ (P_t + P_{t-1})}{(Q_t + Q_{t-1})\ (P_t - P_{t-1})}$$

The variance of (dQ/Q) is calculated in the usual fashion:

$$\mathrm{Var}\ A = \Sigma\ (A - \Sigma\ A/n)^2/n \quad \text{where } A = (dQ/Q)$$

The use of the midpoint of the change as the base for calculating the change has two advantages. First it gives symmetrical treatment (and bounds) to increases and decreases; so that dQ/Q lies between -2 and +2. Second, it allows decomposition of a variable, such as quantity, into yield and area components with less residual error than would occur from using the initial point as the base.

This measure effectively exponentially detrends the series. Thus if the series increased by a constant percentage each year, then there would be a zero variance. The economic implication of this sort of measure is that market participants can readily adjust to constant percentage increases each year, but they will have difficulties if period to period percentage changes are highly variable. It has therefore some of the qualities of an index of unpredictability as well as being an index of variability. This measure shares a disadvantage with the Firch measure in that much weight is given to the end points when the mean change is calculated, although more weight is given to the intermediate points with the INS measure than is true of the Firch measure.

4.3.1 DECOMPOSITION OF INS

An advantage of the INS measure for analyzing sources of instability is that it can be decomposed into multiplicative components. For example, production quantity of crops is a product of area and yield.

$$Q = A * Y$$

hence $$dQ = AdY + YdA$$

and $$dQ/Q = dY/Y + dA/A$$

Now the formula for variance of a sum $(D = B + C)$ is

$$\text{Var } D = \text{var } B + \text{var } C + 2\text{cov}(B,D)$$

thus $\text{var}(dQ/Q) = \text{var}(dY/Y) + \text{var}(dA/A) + 2\ \text{cov}(dY/Y, dA/A)$. (See Goldberger, 1970; Sackrin, 1957; Bohrnstedt and Goldberger, 1969.)

To illustrate the INS measure, and its decomposition, it is useful to look at some simple data. Suppose quantity, area and yields for a commodity for 4 years are as follows:

Year	Q	A	Y
1	100	100	1.00
2	120	110	1.09
3	140	120	1.17
4	135	110	1.23

In this illustration yield is moving gradually, though not uniformly, upward. Most of the variability in quantity is due to variability in areas.

Now consider the period to period percentage changes, where the growth is computed at the mid point of each pair of periods. Hence the first datum for quantity is:

100*(120-100)/((120+100)/2) = 18.2%

i.e., between period 1 and period 2 quantity increased by 18.2% calculated over the midpoint of the periods (at 110). This can now be done for each datum, and the transformed data are now:

Year	dQ/Q	dA/A	dY/Y
2	18	9	9
3	15	9	6
4	-4	-9	5

These have means, and variances about those means as follows:

	dQ/Q	dA/A	dY/Y
Mean	10	3	7
Variance	94	71	2
Covariance (dA/A,dY/Y)		10	

Note that the percentage changes for area and yield each year add to the percentage change in quantity whilst in the original data the relationship was multiplicative. This also holds for the means. The means also show that areas have grown 3% per year whilst yields have grown by about 7% per year on average.

The variances of the transformed data show that there is relatively little instability in yields and most of the quantity instability can be explained by instability in areas. This was also observed from the original data but this methodology allows us to apportion the instability using the formula for decomposition of a sum:

$$\mathrm{var}(dQ/Q) = \mathrm{var}(dY/Y) + \mathrm{var}(dA/A) + 2\ \mathrm{cov}(dY/Y, dA/A)$$

$$\text{i.e.,} \quad 94 = 71 + 2 + 2 * 10$$

or, in percentage terms, the source of instability in quantity is as follows:

area	76%
yield	2%
interaction	21%
Total	100%

The interaction term arises because of some correlation between changes in areas and yields and therefore not all the quantity instability can be uniquely apportioned between the two components.

It is interesting to consider the means, variance and coefficient of variation of the original data:

	Q	A	Y
mean	124	110	1.121
variance	242	50	.0072
CV	.125	.064	.076

The variance of a product Q can be related to the variances of A and Y but the arithmetic for a multiplicative relationship is complex and depends on mixed moments (see Goodman, 1960; Hazell, 1982, 1984; Burt and Finley, 1968). The variances give a measure of instability but they are not comparable between series; they need to be scaled. The coefficient of variation provides a scaling. However the CV measure can not be directly apportioned between area and yield components. Note that the CV for yield is almost as high as that for area. The reason is that the yield CV implicitly includes a trend component. It is calculated around the mean of the series. Thus most of the variability is trend rather than instability. The area data, on the other hand, show little trend. This example shows some of the characteristics of the INS measure and reveals some of the difficulties of instability measures in general.

4.3.2 CHARACTERISTICS OF THE INS MEASURE

The previous discussion allows some comments to be made about this measure for the analysis of instability. Its chief advantages are that:

- it is dimensionless and so can be used to compare different series and different commodities;

- it is a detrended measure; removing an exponential trend from the data;

- it can be decomposed into multiplicative parts relatively easily;

- it has some intuitive appeal as an index of unpredictability because it implicitly assumes that the next period will grow from the current period at the average rate of growth of the series;

- it gives more weight to period to period fluctuations which are possibly what most would mean by instability, and relatively less weight to long term cycles.

Among the measure's disadvantages are the following:

- it gives excessive weight to outliers and hence to data errors;

- the detrending process gives greater weight to the end points;

- it requires data to be relatively precise, eg to have about three significant figures, since percentage changes must be calculated each period;

- it implicitly assumes that agents know the long term exponential trend.

As described earlier in this chapter the CVT measure is among the more useful of the existing measures for our purposes. When these characteristics of the INS measure are compared with the CVT measure we see that they both share some advantages and disadvantages. However the INS measure is possibly superior on the grounds that it is more empirically manipulable, it has elements of an index of 'unpredictability' and the fact that it gives more weight to short run phenomena which are more easily described as instability. For these reasons I will use the INS measure as the major measure for analysis in this dissertation.

4.4 COMPARISON OF INS AND CVT MEASURES

In this section I make an empirical comparison of these two measures to come to some better understanding of the relationship between them. I do this in two ways. First, I conduct some statistical tests on the actual data set of the study to see how the two measures relate and how they differently rank the commodity data. Second, I create some synthetic data with known statistical characteristics and analyze the two measures as applied to this synthetic data. Then I will overlay these results with actual commodity data points to see how the two measures compare.

4.4.1 STATISTICAL ANALYSIS

In this section I will compare the CVT and INS measures using some simple statistical tests. First a simple statistical regression is done on two series (production and deflated prices) and then the ability of the two measures (INS and CVT) to rank the data is compared using a non-parametric test.

For each of 108 commodities, the INS instability measure is calculated for annual production for the period 1950-82. For the same data set the CVT instability measure is also calculated. When the INS measure is regressed on the

CVT measure for both these quantity data, the results are as follows:

$$\begin{array}{llll} INSQ = -316 + 4.51\ CVTQ & R^2 = .52 & Corr = .72 \\ \quad (-4.0) \quad (10.7) & N = 108 & \end{array}$$

A similar regression may be done for the 105 commodities with deflated price data:

$$\begin{array}{llll} INSPD = -202 + 3.28\ CVTPD & R^2 = .49 & Corr = .70 \\ \quad (-3.1) \quad (8.6) & N = 105 & \end{array}$$

The numbers in parentheses are t-values. The correlation coefficients are Pearson measures. They are reported here for comparison with the Spearman rank correlations below.

While there is clearly a correlation between the two measures it is not very strong. Moreover the significant intercept term is suggestive of misspecification. It is possible that a stronger relationship between the two measures might be obtained if the INS measure was replaced by its square root. The INS is a variance, and hence a square, measure and it might be expected that the root would show a closer relationship with the CVT measure, which is based on the standard deviation. When the square root of the INS measure was regressed on the CVT measure for both the quantity data and the price data, the results were as follows:

$$\begin{array}{lll} INSQ = 1.80 + .0930\ CVTQ & R^2 = .64 & Corr = .80 \\ \quad (1.4) \quad (13.7) & & \end{array}$$

$$\begin{array}{lll} INSPD = 2.49 + .0825\ CVTPD & R^2 = .63 & Corr = .79 \\ \quad (2.0) \quad (13.3) & & \end{array}$$

There is an improvement in the relationship, however the correlation is not perfect. It is clear that the two measures are quite different. Does this difference extend to the way the two measures rank the instability of commodities?

To answer this question the Spearman non-parametric test is conducted on the way the two measures rank the instability of commodities. This is of concern for this study because one of its objectives is to rank the instability of commodities in order to identify possibly poorly coordinated market processes for future research and analysis.

Spearman Rank Correlations

Quantities	.82
Prices	.83

These are similar to the Pearson parametric correlations and again demonstrate that while there is a high correlation between the way the two measures rank the commodities, the measures are not at all identical in what they are identifying as instability.

4.4.2 SIMULATION STUDY

In this section I will describe a Monte Carlo simulation study using artificial data to examine the relationship between the CVT and the INS measures. It would seem possible that the existence or otherwise of autocorrelation between successive data points in a series might provide some of the explanation for the difference between the two measures. With this in mind, a series of random numbers were generated with a normal distribution and known means and variances. Serial correlation was imposed on successive data points. No trend was imposed on the data. In this way the empirical relationship between the two measures can be established. Each case consisted of 30 random numbers generated as described. These represented 30 period's (or year's) data, roughly the length of period of the actual data. For each case coefficients of variation and INS measures were calculated. These were then averaged over 100 runs and recorded. It was found that the serial correlation parameter did indeed make a significant difference to the relationship between the two instability measures. As to be expected from the previous analysis it was found that the square root of the INS measure provided a better, and an almost linear, relationship with the CVT measure. The resulting linear relationships are graphed in Figure 4.1 for various values of the serial correlation coefficient. Superimposed on the figure are the scatter of the CVT and (the square root of the) INS measures for the 108 commodity quantity data. Most of the commodities fall in the region where the serial correlation coefficient lies between 0 and .8. It would seem that the simulation does a reasonable job in modelling important characteristics of the data for this purpose. Again the importance of serial correlation in the

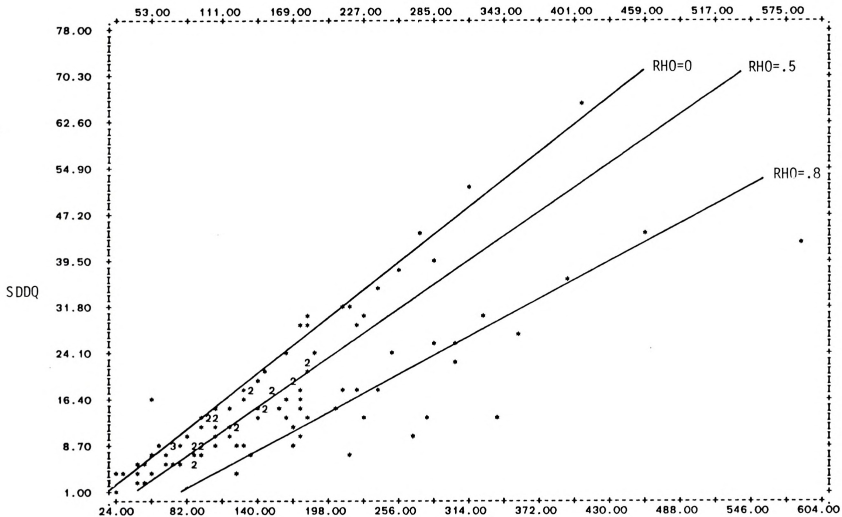

Figure 4.1

GRAPHS OF SDDQ AND CVTQ INSTABILITY MEASURES: Monte Carlo Simulation (Lines) and Actual Data (Points) data is confirmed as an important difference between the two measures of instability.

The BASIC computer program that generated these data is attached in Appendix D.

Thus, this simulation study suggests three conclusions. First, a major reason for differences in the two measures is the different way they treat serial correlation within the data series. This was suggested in an earlier section and is confirmed by this analysis. Second, it confirms that there may be advantages in using the square root of the INS measure in doing analytical work rather than the raw measure. If the objective is ordinal, i.e., to purely rank commodities, then whether the square root is taken or not will make no difference. But when the measure is used cardinally then the root seems called for. Thirdly, there is a significant difference in the way these methods measure instability. It is suggested that sometimes it may be useful to use both measures.

4.5 DEFLATING THE PRICE SERIES

A question which often arises when economic analysis is done is whether it is appropriate or not to deflate the price series. This study is no exception. Is the instability observable in nominal prices more or less appropriate for market coordination issues than the variability observed in real (deflated) prices?

In a classical monetarist world, where money is neutral, inflation represents a response to the money supply with no effects on real variables. Money is a veil and all input and output prices would move with the inflation rate. Under these assumptions, deflating the price series would reduce the amount of observed price instability equally across all commodities. Moreover deflation would be entirely appropriate as inflation would have no effect on predictability (of quantities or real prices) and would be an irrelevant part of variability.

This is the usual, albeit implicit, assumption made by economists analyzing markets. Demand and supply studies are usually calculated in real variables and the estimated elasticities are therefore essentially real parameters. In this sort of world, the rate of inflation will be irrelevant to decision making concerning market decisions. The assumptions would appear to be particularly applicable to the long term where most empirical studies support the neutrality of money and the overiding importance of money supply in determining inflation rates.

This argument has a proviso in that some evidence suggests that a relationship exists between real agricultural prices or costs and inflation. Institutional factors may lead to sticky adjustment of real prices to inflation. A particular example is the capital market where often nominal interest rates are fixed and repayments are made in nominal dollars so that capital costs, and hence investment decisions, are sensitive to the inflation rate. In addition, it is possible that agricultural prices may respond to variations in the money supply which also affects the inflation rate. Some agricultural prices are formed in auction type markets that respond more quickly to inflationary trends than other parts of the economy. In fact the auction-contract market literature would suggest that these markets are likely to have accentuated the movements in prices as money supply feeds into these markets first. (These issues are given more atttention in Chapter 7.) Moreover there is evidence that overshooting occurs (Frankel, 1984). One consequence of this is that the response to inflation might be expected to differ between commodities depending on their market structure. For these reasons it is not entirely appropriate to assume that nominal price instability can be broken down into two non-interacting components of inflation and real factors.

However, it also seems likely that the instability of real prices is more relevant to most market participants than that of nominal prices. Prices and costs do tend to move together. (See Gardner, 1977 and Tweeten, 1983 for some analysis of the relationship between prices and costs in the most inflationary period of the mid 1970s.) Certainly a large portion of the fluctuation in nominal prices is due to fluctuations in inflation and probably most of that fluctuation is of minimal concern for coordination and for predictability. For these reasons the presumption is that deflated prices are probably more relevant to questions of price instability and will be measured that way in this dissertation.

In fact deflation makes little empirical diference for this anlysis. This can be seen from consideration of the relationship between nominal and real prices and from the correlation between the measured instability of the two data sets.

If nominal prices are decomposed among inflation and real prices as follows:

$$P = PD * CPI$$

and, using the decomposition technique described in the last chapter:

$$var(dP/P)=var(dPD/PD)+var(dCPI/CPI)+2*Cov(dPD/PD,dCPI/CPI)$$

For the 33 year period, the average values of these terms are as follows:

var(dP/P)	397
var(dPD/PD)	397
var(dCPI/CPI)	12
2*cov(dPD/D,dCPI/CPI)	-12

Thus the instability measure is not very much different on average whether for nominal prices or for deflated prices. Moreover the simple correlation between the nominal and deflated price series is .999. Thus analysis will be very insensitive to whether prices are expressed in nominal terms or in deflated terms.

This is not always the case. Myers and Runge (1985) have recently done a series of studies decomposing price and quantity instability among supply and demand components for corn, wheat and soybeans. They use an adaption of a methodology first used by Piggott (1978). They choose not to deflate their price series. However their results are particularly sensitive to this methodological choice as can be seen from the discussion in Appendix E.

4.6 CONCLUSION

In this chapter I have discussed a number of contenders as measures for the analysis of instability. The INS measure was developed and seen to be a useful one for the purposes of this study, but it too has deficiences. Comparison of this measure with the CVT measure showed that although there were similarities, they were quite different and that it might be useful to use both methods on occasion. Consequently it is intended to use both the INS and CVT methods for the classification study in the next chapter. However the analysis in Chapters 6 and 7 requires the choice of one method: so I will use the INS method which has the advantages that it is mathematically tractable and that it has more the characteristics of an unpredictability measure than its rival. While there may be some debate about the appropriateness of deflating price series, in this analysis there is little empirical difference. However, it is decided that the balance of the argument is in favor of deflation and so the analysis is pursued in real terms.

Chapter 5

THE EXTENT OF INSTABILITY AMONG COMMODITIES

5.1 INTRODUCTION

This chapter is devoted to a classification of commodities according to their degree of market instability. A major reason for doing this study is to identify unstable commodity markets. Such an understanding could focus analysis on the marketing arrangements for some of these commodities that may be amenable to institutional reform. But it is not only the unstable markets that are of interest. Analysis of stable commodities may enable understanding of what contributes to successful coordination in agricultural markets.

The chapter is organized as follows. In the next section the data sources for this study are discussed. Then quartile analysis is employed to identify stable and unstable commodity markets using the CVT and INS measures: the two instability measures described in the last chapter. The initial description uses an aggregate index of market instability. This is then decomposed among price and quantity components to enable an appreciation of the type of market instability that is present. The following two sections consider quantity and price instability separately giving attention to what the INS and CVT measures reveal about the choice of the set of unstable commodities. Then a listing is provided of the more stable commodity markets identified by the analysis. Another section asks whether the choice of time period makes a difference to the instability rankings. The penultimate section compares these quantitative measures of agricultural commodity market instability with the experience of other non-agricultural markets. This provides some perspective to the magnitudes of the instability evident in agricultural markets relative to other economic series. Some concluding comments are made in the final section.

Since a large number of commodities are considered, the presentation of the results is necessarily rather unwieldy. To facilitate interpretation, the results are presented in two places. Summary tables are provided in the text of this chapter whilst the comprehensive results are presented in Appendix C.

5.2 DATA

The data for this chapter are mostly taken from various issues of Agricultural Statistics. The quantity series are total utilized production. Price series are gross farm prices deflated by the Consumer Price Index. The time period for data analysis is from 1950 to 1983. When this length of data is not available, then a shorter period was used. Thus, where a trade-off was necessary between comprehensiveness and comparability, the choice was generally made in favor of comprehensiveness. The decision to do so was made on the basis that comprehensiveness will facilitate the work of those identifying commodity markets for future analysis. However only those commodities that had an annual gross value of production in excess of one million dollars in some part of this period were included in this study. The non-agricultural data are taken from The Economic Report of the President. Details on the length of each series are provided in Appendix A.

For each agricultural data series two instability measures, the INS and CVT measures, were calculated. This was performed using the Times Series Processor (TSP) programming package. In each case a linear trend was removed in calculating the CVT measure. The cross-sectional analysis of this and later sections was done using the Statistical Package for the Social Sciences (SPSS).

5.3 CLASSIFICATION METHODS

There is, of course, no unambiguous means of deciding which commodity markets are more stable than others. Nor is there any objective bench mark against which the instability of individual commodity markets can be compared. The best that can be done is to provide a number of ways of ranking these commodity markets according to some measures of instability. In this section I will suggest a number of criteria that are based on the instability measures discussed in the last chapter.

The first measure used is a composite index of 'market instability'. This measure incorporates both price and quantity instability measures and utilizes both the INS and CVT definitions. It therefore has four components. This index is one fourth of the sum of each measure divided by its individual mean. This procedure is used to scale the two measures and give them equal weight in a composite index. Hence commodities with average instability will have an index value of 1.00. Unstable commodities will have higher values and stable commodity markets will have lower values. Before presenting the results it may be useful to discuss the implications of such a measure.

In the previous chapter it was shown that there was a high correlation betwen the CVT and INS measures of instability. To do such a transformation it is necessary to assume a somewhat stronger measuring rod than a purely ordinal measure. It is not possible to claim that the measures proposed have a one to one cardinal representation with either 'market instability' or 'coordination effectiveness'. Nor do the arguments advanced in the last chapter make it obvious that the two identified measures should have equal weight in the proposed representation function. However, in the absence of a better available alternative I propose to use this index initially to rank the 105 commodities of this study. In support of this compostite index the following technical and conceptual comments may be made. First, it was demonstrated in the last chapter that the square root of the INS measure was a more appropriate measure to compare with the CVT one than the original INS measure. Second, it can be seen from Table 5.1 that standardizing the two series by dividing each series by its mean gives similar standard deviations and skewness measures. Subsequent aggregation of the two measures should therefore give a reasonably meaningful index. The question remains whether it is appropriate to give equal weight to each of the components on conceptual grounds. Should the INS and CVT measures be equally weighted? Should the price and quantity components be similarly equally weighted? If the index alone was to be relied upon these would be significant questions. However the index will be used here only as a first approximation. I will consider the information provided by the individual components: price and quantity, and CVT and INS, later in this chapter. In addition it will be seen that it is possible to use quartile analysis to group commodities without resorting to composite indicies.

Table 5.1

CHARACTERISTIC STATISTICS OF COMPONENTS OF INDEX

Standardized Series[1]	Standard Deviation	Skewness	Range
INS (Price)	.54	.89	.22 - 2.84
CVT (Price)	.50	.40	.15 - 2.41
INS (Quantity)	.68	1.56	.10 - 3.92
CVT (Quantity)	.61	1.46	.15 - 3.66
Composite Index	.50	1.04	.19 - 2.63

[1]The series are as described in the text. Each series is standardized by dividing by its mean so that all standardized series have means equal to 1.00.

5.4 AGGREGATE INDEX OF INSTABILITY

As can be seen from Tables 5.1 and 5.2, the aggregate instability index on the commodities under study range from .19 to 2.63: a very wide range. The instability values for each of the 105 commodities are presented in four quartiles in Table 5.2. The results are instructive in their diversity. The first five commodities have double the measured amount of instability of the 'average' commodity and 13 times the instability of the most stable. Indeed the wide differences in instability between commodities is supportive of the efficacy of an inter-commodity approach to the study of market instability. The two most unstable commodities are both subtropical tree crops, namely olives and avocados. Perhaps it is not surprising that these should head the list as they are crops with very long lags from

Table 5.2

COMMODITIES GROUPED BY QUARTILES ACCORDING TO COMPOSITE INSTABILITY INDEX [1]

I QUARTILE

NO	COMNAME	PQINSTAB
1	OLIVES	2.63
2	AVOCARDO	2.54
3	SUNFLOWR	2.45
4	TRT CHER	2.25
5	PECANS	2.09
6	DRY PEAS	1.98
7	ALMONDS	1.96
8	TEMPLES	1.64
9	SPEARMNT	1.63
10	FLAXSEED	1.61
11	LIMES	1.57
12	FILBERTS	1.57
13	POPCORN	1.50
14	TANGELOS	1.49
15	GARLIC	1.48
16	BUSH BER	1.47
17	RYE	1.42
18	TANGERIN	1.38
19	PAPAYA	1.37
20	LEMONS	1.36
21	PRUNES	1.36
22	CTONSEED	1.35
23	APRICOTS	1.34
24	DRY BEAN	1.34
25	SORGHUM	1.33
26	POMERGRN	1.33

II QUARTILE

NO	COMNAME	PQINSTAB
27	SUGARCAN	1.31
28	PLUMS	1.28
29	ORANGES	1.27
30	VEAL	1.26
31	NECTARIN	1.22
32	PEPPERMT	1.22
33	PEARS	1.20
34	WALNUTS	1.18
35	FIGS	1.14
36	ONIONS	1.13
37	GRAPEFRT	1.13
38	POTATO	1.12
39	SUGARBET	1.10
40	COTTON	1.09
41	SWT CHER	1.09
42	GRAPES	1.09
43	WOOL	1.08
44	WHEAT	1.06
45	DATES	1.06
46	RICE	1.05
47	SWT POT	1.04
48	MACADAMI	1.03
49	ALFALFA	1.02
50	BARLEY	1.00
51	SOYBEANS	.97
52	CRANBERR	.96

III QUARTILE

53	CABBAGE	.92
54	PR TOMAT	.92
55	CORN	.90
56	OATS	.89
57	ARTICHKE	.89
58	HOPS	.85
59	HONEYDEW	.83
60	BROCCOLI	.83
61	APPLES	.82
62	LAMB MUT	.82
63	BRUS SPR	.80
64	FR SPNCH	.80
65	BEETROOT	.79
66	PORK	.79
67	EGGPLANT	.77
68	PR SW CN	.76
69	LIMA BEN	.75
70	ESCAROLE	.75
71	PEANUTS	.75
72	MAPL SIR	.75
73	WATERMEL	.73
74	PEACHES	.71
75	TURKEY	.71
76	BROILERS	.71
77	GRN PEAS	.66
78	CAULIFLR	.63

IV QUARTILE

79	PICKLES	.62
80	BEEF	.62
81	CARROTS	.58
82	STRAWBER	.58
83	ASPARAGS	.57
84	CELERY	.57
85	PR SPNCH	.57
86	BANANAS	.57
87	PR SNPBN	.56
88	CANTALOP	.55
89	FR CUCUM	.54
90	FR TOMAT	.52
91	MUMS	.51
92	HAY	.49
93	MINI MUM	.49
94	GRN PEPP	.46
95	TOBACCO	.46
96	LETTUCE	.45
97	EGGS	.45
98	CARNATNS	.43
99	TARO	.43
100	F SNPBEA	.41
101	FR SW CN	.35
102	MILK	.28
103	POT MUMS	.26
104	MUSHROOM	.24
105	TEA ROSE	.19

[1] The composite instability index gives equal weight to prices and quantities, and the INS and CVT measures. It has a mean of 1.00 where high values represent less stable commodities.

planting to production. Olives may continue to produce for 2000 years. But then the third most unstable market is an annual crop namely sunflower seed. Both the most stable and the most unstable markets seem to be commodities with relatively low gross value of production. The more important commodities tend to be in the middle of the list. But then milk, with a very stable market, is an exception. In fact it is relatively difficult to make general statements about this list without finding many exceptions. The next chapter will provide multivariate analysis to determine what order can be gleaned from these instability measures concerning differences between commodity markets.

5.5 PRICE AND QUANTITY INSTABILITY

The last section provided composite (price and quantity) market instability indicies. In this section the series will be disaggregated and information on both price and quantity instability will be presented. Again I will examine indicies using both the INS and CVT measures. As might be expected there is correlation between the price and quantity instability series. The Pearson correlation coefficient between the price and quantity instability indicies is +.58 and is significantly different from zero at the .001 level. This indicates that the more quantity unstable commodities also tend to be the more price unstable: a not unexpected result. In practice the correlation means that any listing of commodities appearing in the upper quartiles of either series will have a high degree of overlap. This is indeed the case.

Table 5.3 presents a listing of the 40 commodities that appear in the top quartiles for either quantity instability or price instability. The first column lists those 12 commodities which appear in both the top quantity and price quartiles. The second column lists those 14 which appear in the top quantity instability quartile and not in the corresponding price instability quartile. The third column provides a listing of those which appear in the top quartile for price instability but not for quantity instability. Most of these commodities also appear in the top quartile of the composite measure described in the last section and listed in Table 5.2. These include all those in the first column and those with asterisks in the other two columns. Of all the 40 commodities listed here only broccoli does not fall in the first two quartiles of the composite instability index shown in Table 5.2. The listings are in descending order of instability in each column. For the interested reader, Appendix C gives values for all commodities from which these tables are compiled.

Table 5.3

UNSTABLE COMMODITIES: AGGREGATE INDICIES[1]

Both	Quantity only	Price only
Olives	Spearmint*	Sugar cane
Avocados	Filberts*	Bush berries*
Sunflower seed	Garlic*	Onions
Tart cherries	Rye*	Potatoes
Pecan	Papaya*	Dry edible beans*
Dry edible peas	Apricots*	Wool
Almonds	Sorghum*	Grapefruit
Temples	Prunes*	Sweet cherries*
Flaxseed	Macadamia nuts	Lemons*
Limes	Tangerines*	Oranges
Popcorn	Pomergranites*	Figs
Tangelos	Plums	Pears
	Broccoli	Sugarbeet
	Nectarines	Peppermint

[1] Commodities listed are those in the top quartile for instability as measured with the aggregate index of the INS and CVT measures. They are listed in descending order. Commodities in the first column appear in the top quartiles for both quantity and price. Commodities in the first column and those with asterisks in the second and third columns appear in the top quartile of the composite measure as listed in Table 5.2

This analysis allows identification of markets which are quantity and/or price unstable. Commodities which are price unstable but not quantity unstable may be so because of highly inelastic demand relations. These may provide interesting cases for marketing studies. However for some of these commodity markets the price instability may not arise from this source but rather from inherently unstable marketing mechanisms. These will also be of interest for marketing policy.

5.6 GREATEST QUANTITY INSTABILITY

In this section the commodities that exhibit the greatest quantity instability will be considered. A similar methodology for identifying these commodities will be used as was done in the last section. Using both the INS and CVT measures those commodities that appear in the top quartile according to both measures will be identified, as will those that appear in the top quartile of one of these measures and not the other. These results appear in Table 5.4.

Table 5.4

QUANTITY INSTABILITY: INS AND CVT UPPER QUARTILES

Both Measures		INS Only	CVT Only
Olives	Sunflower	Prunes	Macadamia Nuts
Avocados	Pecans	Tangerines	Broccoli
Almonds	Filberts	Pomergranites	Nectarines
Dry Ed Peas	Tart Cherries	Plums	Fresh Spinach
Spearmint	Garlic	Sweet Cherries	Honeydews
Flaxseed	Rye	Lemons	Veal
Limes	Popcorn	Cotton	Walnuts
Temples	Papaya		
Apricots	Sorghum		
Tangelos			

This analysis is instructive for a number of reasons. First it identifies the commodities which exhibit the greatest quantity instability. Secondly, the use of two measures provides an indication of the type of instability experienced by some of these commodities. For example, those commodities that have a high ranking on the INS measure and a lower ranking on the CVT measure can be expected to exhibit greater instability from year to year than those that do not. While those that score highly on the CVT measure and not on the INS measure will have experienced changing trends or cyclical behavior over the period of the study. Thus it is not surprising that almost all those in the INS-only column are tree fruit with the more geographically concentrated growing areas. A characteristic of many tree crops is that they have a two year cycle as a good production year causes depletion of the sugars in the plant which makes lower production in the following year more likely.

5.7 GREATEST PRICE INSTABILITY

In this section those commodities that exhibit the greatest price instability are presented. The methodology is identical to that of the previous section. Those commodities that appear in the upper quartile for price instability for both (in the first column) or for either of the INS and CVT measures (in the second and third columns) are noted in Table 5.5.

Table 5.5

PRICE INSTABILITY: INS AND CVT UPPER QUARTILES

Both INS and CVT Measures		INS Only	CVT Only
Tart Cherries	Avocados	Pecans	Flaxseed
Sugar Cane	Olives	Pears	Popcorn
Dry Edb Peas	Bush Berries	Plums	Figs
Sunflower Seed	Onions	Cabbage	Sugar beet
Dry Edb Beans	Temples	Pomergranates	Peppermint
Potatoes	Wool	Tangerines	Spearmint
Almonds	Tangelos	Prunes	Cranberries
Grapefruit	Cottonseed		
Limes	Lemons		
Oranges			

5.8 MOST STABLE COMMODITIES

Up to now the discussion in this chapter has concentrated on the identification of unstable markets. But, as was suggested at the beginning of this chapter, it would also be very useful to know which markets are stable.

Further research may profitable consider these markets in order to determine what makes them to be stable. This may be useful information in the development of improved coordinating mechanisms. This might not always be the case: often the factors that make one market stable are commodity specific and are not characteristic of other markets. Moreover some markets may be stable at very high costs so that there may be little desire to transfer this experience to other markets. Milk may fall in this category. However these questions should follow detailed examination of individual markets. In this section I will present the group of commodities that have both stable prices and quantities. Selections for further research might be made from these lists.

Table 5.6

STABLE COMMODITIES: QUANTITY AND PRICE UPPER QUARTILES

Both Measures	Quantity stable	Price stable
Milk	Eggs	Tobacco
Hybrid Tea Roses	Lettuce	Miniature Mums
Mushrooms	Celery	Broccoli
Fresh Sweet Corn	Hay	Maple Sirup
Potted Mums	Broilers	Peanuts
Taro	Fresh Tomatoes	Bananas
Fresh Snap Beans	Carrots	Proc Spinach
Green Peppers	Turkeys	Cauliflower
Carnations	Beef	Chrysanthemums
	Pork	Fresh Spinach
	Onions	Lima Beans
	Fresh Cucumbers	Asparagus
	Wool	Strawberries
	Sugarcane	Honeydew
	Watermelon	Peaches

As in previous tables, the first column lists those commodities that appear in both the most stable quartile for quantity as well as for price. The second column lists those commodities that are in the most stable quantity quartile but not in the most stable price quartile. Similarly, the third column gives price stable commodities.

It is noteworthy that the floriculture crops from the commodity set appears in these lists. It would be interesting to know how these industries maintain such stablility. It is also noteworthy that milk, which has possibly the most extensive support and control mechanisms, is the most stable commodity market. This suggests that the program is quite successful in this respect. The tobacco program also appears to have been very successful in stabilizing price. It may be surprising to see some vegetables with very short growing seasons, such as lettuce, in this list. The instability measures used here are annual measures. Lettuce may exhibit high market instability during the year, but this can not be captured in annual averages. It will be seen in the next chapter that the apparent stability of the lettuce market, implied by these annual averages, hides a coordination problem that annual area data helps to elucidate.

Another observation that can be made from this analysis is the appearance of a number of animal commodities among the list of quantity stable commodities. This is reflective of the more certain yield relationships for these commodities.

5.9 RECENT INSTABILITY

It is worth knowing whether the commodities identified here as unstable, based on analysis of a 33 year period, are the same ones that would have been identified in the latter third of the period. In other words, to what degree is this classification dependent on the time period chosen? Differences between the two periods may reflect changing relative instability over time, or they may just be reflective of some lack of robustness in the analysis. The question of changing instability will be addressed in Chapter 7; the concern here is whether the more recent period gives a different ranking or identifies different commodities as being unstable or not.

In fact the data reveals a reasonably high degree of agreement in the rankings of price and quantity instability between the two periods. The Spearman rank correlation between the two periods for the INS measure is 0.91 for quantity and .89 for price.

Examination of the top quartiles for the INS measure for price and quantity shows some changes in representation but is not radically different. Of the twenty-six commodities of the top quantity quartiles twenty-one are common to both periods. For the top price quartiles

Table 5.7

CHANGES IN REPRESENTATION OF UPPER INSTABILITY QUARTILE IN RECENT PERIOD[1]

QUANTITY		PRICE	
Total period	Recent period	Total period	Recent period
Temples	Cottonseed	Temples	Flaxseed
Tangelos	Lima Beans	Tangelos	Popcorn
Tangerines	Peanuts	Tangerines	Sugarbeet
Pomergranites	Grapes	Grapefruit	Rice
Sweet Cherries	Artichokes	Limes	Figs
		Oranges	Walnuts
		Pears	Wheat
		Cabbage	Alfalfa
		Prunes	Sweet Potatoes

[1] As measured by the INS instability measure

Table 5.8

COMMODITIES IN THE TOP INSTABILITY QUARTILE FOR BOTH PERIODS[1]

BOTH	QUANTITY	PRICE
Olives	Flaxseed	Sugarcane
Dry Ed Peas	Popcorn	Bushberries
Pecans	Prunes	Onions
Avocados	Filberts	Wool
Sunflower Seeds	Apricots	Dry Ed Beans
Tart Cherries	Limes	Potatoes
Almonds	Spearmint	Pomergranites
Lemons	Cotton	
Sweet Cherries	Rye	
Plums	Garlic	
	Sorghum	

[1] As measured by the INS instability measure.

seventeen of twenty-six are common to both periods. There are no changes in the top half of the quartiles. Again it can be seen that the same group of very unstable commodities reoccurs in every list.

5.10 NON-AGRICULTURAL INSTABILITY

The previous sections have described the instability of certain agricultural markets. In this section the INS measure will be applied to a number of non-agricultural industries and series with the intention of placing agricultural instability in context. Many non-agricultural industries experience marked instability. However, such industries experience most of their instability as a result of fluctuations in demand: supply instability pays a much less important role. Some industries are very susceptible to the fluctuations of the business cycle (e.g., cars, new housing) whilst others are less so. The level of aggregation presents difficulties for comparitive purposes. The greater the degree of aggregation, the greater the level of stability to be expected. Production of a certain type of car is likely to be less stable than the car industry in total. Likewise food production in total will be more stable than most of the component commodities. Hence the comparison of individual agricultural commodities with the instability of entire sectors of the US economy is likely to make agriculture look more unstable than otherwise. Therefore the results in the next table should be used with some caution.

These data are presented to provide a context for the INS measure itself.

Table 5.9

INSTABILITY IN OTHER ECONOMIC SECTORS

	INS Instability Measure
Quantity Series	
Mean Agricultural Commodity	405
Consumer Cars	228
Defence and Space Equipment	296
Primary Metals Production	178
Chemical Production	33
Transportation Equipment	130
Federal Govt Expenditure	41
Business Equipment	78
Price Series (deflated)	
Mean Agricultural Commodity	390
Dow-Jones Index	166
Other Series	
Population	.1
Consumer Price Index	12
Disposable Income per capita (deflated)	5

5.11 CONCLUDING COMMENTS

The primary purpose of this chapter has been to identify stable and unstable agricultural commodity markets. Various instability measures on prices and quantities were used for this purpose. In addition, consideration was given to whether the ranking provided over a long (33 year) period also is applicable to more recent experience. It was found that there is a relatively high degree of agreement between the two measures and periods as to what commodity markets are unstable. In addition the different measures provide information on the type of instability evident in markets. Where commodities are more unstable on the INS measure than on the CVT measure is indicative of shorter run instability (e.g., tree fruit) rather than longer term cycles or secular taste changes, which the CVT measure emphasizes. Commodities that display more price instability than quantity instability can also be identified by this analysis (and vice-versa). The final section compares the agricultural commodity market instability with that of some non-agricultural series to provide a context for their relative magnitudes.

Chapter 6

SOURCES OF INSTABILITY

6.1 INTRODUCTION

In the last chapter measures of the extent of instability for a large number of agricultural markets were presented. It was shown that there were wide differences in instability among the different commodities. In this chapter an attempt is made to come to an understanding of the sources of this market instability. An attempt will also be made to measure some of these sources to gain a perspective on their relative contribution to total market instability.

To do this a variety of methods will be used. First, possible sources of instability will be listed and various hypotheses are suggested to explain agricultural market instability. The relative importance of yield, the most likely candidate to explain agricultural quantity instability, will then be considered. To do this a particular empirical virtue of the chosen instability measure is utilized to decompose production instability between area and yield factors. This will provide a perspective on the extent to which instability in agriculture is due to this (partly) biological charcteristic of agriculture. Consideration is then given, in the fourth section, to the contribution to instability provided by fluctuations in the demand factors of income and population and also the supply factor of input prices. This is done by building a simple commodity market model and inserting likely values for various key parameters and noting how much instability could be obtained from the interaction of these factors. A cross-sectional regression analysis is undertaken in the fifth section to determine how much of the differences in instability among commodities can be explained by their various production and institutional characteristics. This approach has a secondary value in raising interesting questions about the nature and results of these institutional variables. In the sixth section the relationship between area, quantity and price instability is examined to see if there is evidence that price instability leads to area instability. If so then this is indicative of the role of price instability in contributing to market coordination problems. A final section provides a summary of the results and some concluding comments.

6.2 SOURCES OF INSTABILITY

This section simply lists some possible sources of instability for agricultural markets. These may be summarized as supply, demand and institutional factors.

Supply Factors

Weather

Other yield factors
- Use of inputs e.g., fertilizer
- Geographical distrinbution of production
- Diversity of genetic stock

Supply Response of farmers
- Errors in price forecasts
- Asset fixity - especially with perennial crops
- Responses to risk
- Interest costs, debt equity etc

Demand Factors

Domestic demand shifters
- Income, population and tastes
- Prices of substitutes and complements

Export demand shifters
- Foreign supply and demand conditions
- Exchange rate volatility
- Volatility of international liquidity

Institutional Factors

Structure of markets and coordinating mechanisms
Government policy shifts

6.3 YIELD

A major source of instability in agriculture is of course the weather. Perhaps no other economic sector has to suffer, not only uncertain demand and input supplies, but also very uncertain production functions with a large stochastic component.[1] It is very likely that this uncertain input and output relationship makes choice of input decisions suboptimal. In this section I will investigate the extent to which instability in agriculture can be traced to yield fluctuations.

Yield variability is not just related to weather. The theory of production economics posits output as a function of various inputs: archetypically land, labor and capital. Yield, which is output over land input, will then be a function of the same inputs. In an economic context then, yield will be a function of the input prices and the available technology. In practice, however, those who model agricultural markets, usually acknowledge the high correlation of land with the other inputs and hence its overwhelming importance in explaining output. In addition, the stochastic infuence of weather on yields is implied. The usual procedure is to assume that the major decision variable is land, which depends on prices of outputs and inputs. Some analysts have had some success modeling yield as a function of economic variables and occasionally some find a proxy variable for the weather (see, for example, Gadson et al, 1982; or the MSU model). However, the usual practice is to resort to a trend alone to model the non-

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[1] Other sectors do, of course, experience some uncertainty about production relations. Labor economists have given particular consideration to the quantity and quality aspects of labor inputs in the literature on principal agents. However the instability due to this source is likely to be much smaller than the effects of yield.

stochastic elements. The trend variable is intended to encompass technological change among other factors. This practice is pursued also because of the difficulty of determining how inputs are allocated among products in multi-output enterprises. For these reasons the usual procedure, which is followed in this study, is to assume that the major portion of yield variability can be attributed to weather and therefore to treat it as being generally unrelated to other economic variables. It is recognized that this represents some oversimplification and is not entirely supported by the evidence which follows.

6.3.1 YIELD AND INSTABILITY

As suggested above it seems likely that yield is a major source of market instability. Partly this instability will be a direct effect and partly it will be indirect, as a result of the poor decisions it induces. To investigate the direct effect, quantity instability for 65 commodities is decomposed among area and yield components. It should be noted that the choice of these commodities is made on the basis of data availability. In particular there is very little data available on areas of perennial crops. Moreover, animal products are necessarily excluded from this part of the study.

The methodology described in the fourth chapter allows quantity instability to be decomposed among areas and yields. There is also a covariance term that represents an interaction effect and which is often quite significant.

How much variability in agricultural production is due to the direct effect of yields? For the 65 commoditity markets with yield information production instability can be allocated between yield and areas as shown in Tables 6.1 and 6.2. Table 6.1 provides the instability measures and Table 6.2 gives the percentage of quantity instability explained by the components.

Table 6.1

DECOMPOSITION OF PRODUCTION INSTABILITY AMONG YIELD AREA AND INTERACTION COMPONENTS [1]

COMMOD	VARDQ	VARDY	VARDA	COV2AY
EGP	152.	99.	151.	-98.
GAR	763.	105.	661.	2.
WAT	89.	54.	52.	-17.
BRU	298.	130.	122.	50.
LMA	323.	57.	217.	52.
SPF	109.	57.	97.	-45.
SPP	195.	27.	147.	22.
ART	283.	308.	29.	-55.
BET	306.	114.	213.	-20.
ESC	70.	59.	104.	-93.
AS	56.	52.	23.	-20.
CB	105.	47.	37.	21.
CP	67.	37.	82.	-52.
DEW	170.	105.	210.	-144.
PEA	160.	80.	62.	18.
BC	198.	80.	100.	19.
CE	18.	13.	21.	-16.
CT	65.	54.	59.	-47.
SWP	233.	36.	131.	67.
CR	95.	65.	44.	-13.
TAR	41.	56.	52.	-68.
PO	84.	22.	53.	9.
SCF	18.	16.	18.	-16.
TOF	29.	33.	26.	-29.
LT	10.	14.	19.	-23.
ON	89.	44.	82.	-38.
SCP	212.	54.	102.	58.
SBP	107.	31.	83.	-7.
TOP	425.	109.	215.	104.
CUF	58.	48.	39.	-30.
GP	60.	41.	59.	-40.
CUP	141.	41.	111.	-9.
SBF	40.	23.	27.	-9.
STW	68.	71.	59.	-62.
CRB	138.	137.	5.	-4.
HOP	179.	33.	129.	17.
PEP	232.	98.	139.	-4.
SPR	947.	159.	563.	240.
CTS	458.	154.	298.	8.
FLX	1199.	557.	637.	21.
POP	993.	249.	611.	151.
SUN	1775.	2092.	3185.	-3400.
MAC	180.	265.	69.	-153.
PEN	403.	280.	93.	35.
MUS	12.	5.	15.	-8.
BY	205.	49.	175.	-18.
OT	215.	92.	80.	44.
SB	179.	76.	46.	58.
SG	859.	192.	539.	164.
WH	200.	81.	124.	-3.
CN	132.	108.	41.	-17.
SGC	70.	43.	60.	-33.
SGB	200.	39.	145.	16.
DBE	230.	83.	144.	4.
DPE	1614.	1020.	548.	89.
RYE	630.	104.	324.	209.
RIC	156.	26.	178.	-47.
TOB	121.	33.	60.	29.
HAY	31.	18.	6.	7.
COT	483.	170.	299.	17.
WOL	19.	1.	16.	2.
PAP	478.	260.	218.	2.
BAN	182.	164.	82.	-63.
BB	328.	139.	61.	128.
ALF	185.	205.	369.	-390.

[1] The column headings represent, in order, the commodity code, production instability, yield instability, area instability and an interaction covariance term.

Table 6.2

PERCENTAGE DECOMPOSITION OF PRODUCTION INSTABILITY [1]

COMMOD	YPERQ	APERQ	INTERACT
EGP	65.	99.	-64.
GAR	14.	87.	.
WAT	61.	58.	-19.
BRU	44.	41.	17.
LMA	18.	67.	16.
SPF	52.	89.	-41.
SPP	14.	75.	11.
ART	109.	10.	-19.
BET	37.	70.	-7.
ESC	84.	149.	-133.
AS	93.	41.	-36.
CB	45.	35.	20.
CP	55.	122.	-78.
DEW	62.	124.	-85.
PEA	50.	39.	11.
BC	40.	51.	10.
CE	72.	117.	-89.
CT	83.	91.	-72.
SWP	15.	56.	29.
CR	68.	46.	-14.
TAR	137.	127.	-166.
PO	26.	63.	11.
SCF	89.	100.	-89.
TOF	114.	90.	-100.
LT	140.	190.	-230.
ON	49.	92.	-43.
SCP	25.	48.	27.
SBP	29.	78.	-7.
TOP	26.	51.	24.
CUF	83.	67.	-52.
GP	68.	98.	-67.
CUP	29.	79.	-6.
SBF	58.	68.	-23.
STW	104.	87.	-91.
CRB	99.	4.	-3.
HOP	18.	72.	9.
PEP	42.	60.	-2.
SPR	17.	59.	25.
CTS	34.	65.	2.
FLX	46.	53.	2.
POP	25.	62.	15.
SUN	118.	179.	-192.
MAC	147.	38.	-85.
PEN	69.	23.	9.
MUS	42.	125.	-67.
BY	24.	85.	-9.
OT	43.	37.	20.
SB	42.	26.	32.
SG	22.	63.	19.
WH	41.	62.	-2.
CN	82.	31.	-13.
SGC	61.	86.	-47.
SGB	20.	73.	8.
DBE	36.	63.	2.
DPE	63.	34.	6.
RYE	17.	51.	33.
RIC	17.	114.	-30.
TOB	27.	50.	24.
HAY	58.	19.	23.
COT	35.	62.	4.
WOL	5.	84.	11.
PAP	54.	46.	.
BAN	90.	45.	-35.
BB	42.	19.	39.
ALF	111.	199.	-211.

[1] The column headings represent, in order, the commodity code, yield instability as a percentage of production instability, area instability as a percentage of production instability, and an interaction term. Note that the percentages add to 100.

These results are summarized in Table 6.3, which shows averages of the instability measures of the 65 commodities and their percentage decomposition among components. Note that the percentage decomposition is made by weighting each commodity equally (i.e., averages from Table 6.2), and not from the averages of the instability measures.

Table 6.3

SUMMARY OF DECOMPOSITION OF PRODUCTION INSTABILITY

Source of production Instability	Instability Measure	Percentage
Yield	140	55
Area	196	72
Interaction	-53	-27
Total	280	100

Thus yield variability directly contributes a major portion of the instability in agriculture. Before discussing these results it would be useful to know how the covariance term should be interpreted. Its presence indicates that yield and areas are related. Four hypotheses might be suggested:

1. Poor weather may lead to some areas planted not being able to be profitably harvested and hence left unharvested (e.g., grazed) when yields are low.

2. Low prices, associated with a large crop area, may lead to less area being harvested with effort being

concentrated on the better yielding portions of the planted area.

3. Low prices, associated with a large crop area, may lead to the area harvested being less intensely or less frequently collected.

4. When price prospects are good, production is often extended to marginal, lower yielding, areas.

Clearly one factor that has a bearing on the reasons behind these relationships is the definition of area. These data are derived from statistics on "area harvested" for all these commodities except for vegetables grown for the fresh market. In this latter case the area data are "area for harvest which includes any acreage partially harvested or not harvested because of low prices or other economic factors. Area for processing is area harvested" (Agricultural Statistics 1981 p 151). Those crops whose area measure is "areas for harvest" are indicated in Appendix A.

Each of the four hypotheses above might explain covariance between yield and area. However, the first one is the only one of the four that implies a positive correlation between yield and area instability. Such is clearly counterfactual for these commodities in aggregate. However, Table 6.2 shows that almost half of these commodities, 30 of 65, displayed positive covariance terms. Interestingly, the crops that may be utilized either for grazing or for harvest have relatively high positive correlations. These include rye, hay, oats, and soybeans.

The second and third hypotheses describe a common pattern in some vegetable markets. For example, the lettuce industry shows how the choice of area harvested is a means of coordination in response to prices and or yields. If there is a large area planted and prices are low, then not all of the area is harvested and/or the planted area is harvested less frequently to reduce harvesting costs, principally labor (Hammig and Mittlelhammer, 1980). As a result yields are low. For this reason quantity produced is more stable than yields or areas. In this case, yield is a controllable parameter which is used to coordinate supplies to market. However, this is achieved by committing (non-harvesting) inputs that are not reflected in output. Hence resources are wasted. Thus, the relative stability of production, on an annual basis, belies a coordination problem that leads to non-labor input costs which are not reflected in output. Thus costs and prices may be higher than under different marketing arrangements that lead to more stable areas planted.

It might be expected that those vegetable crops grown predominantly for the fresh market and for which the area data are "area for harvest" rather than area harvested, might have a larger negative correlation than other crops. The second hypothesis could provide a second explanatory factor in these cases. In addition, fresh vegetable crops are frequently marketed on spot markets which can be very volatile week to week. This is less true of markets for crops grown for processing, where contracting is more common. Examination of the data supports this expectation. The mean of the covariance term is -30 for vegetables reported on an "area for harvest" basis and +12 for those reported on an "area harvested" basis. Again this is indicative that some resources allocated to production do not appear in the composition of the final product since areas are left unharvested.

The fourth hypothesis may be more likely to apply to some of the field crops where production is very extensive so that yields might be responsive to changes in areas. This would seem an unlikely explanation for vegetable crops that require relatively small areas individually and thus where an abundance of suitable alternative land is available. However the small negative covariances for corn, wheat and rice may be due to this factor.

It seems likely that some of the explanation for the covariance terms may come from one or more of these hypotheses. For each case the covariances are true interaction terms which can not legitimately be allocated to either area or yield instability.

6.3.2 THE RELATIVE IMPORTANCE OF YIELD INSTABILITY

Returning again to Table 6.3, it would seem that although yield is a very important factor contributing to quantity instability it is clearly not the only factor. In fact, in aggregate, instability of areas dominates instability of yield as a source of production instability. Although this result is not general for all the commodities considered here. For 22 of these 65 commodities (34%), yield instability is more important than area. In particular, the following crops exhibit much greater yield variability than area variability: corn, soybeans, peanuts and hay, and the perennial crops included in this selection, namely asparagus, artichokes, cranberries, bushberries, macadamia nuts and bananas. It might be expected that other perennials, such as tree fruits and nuts, would also show greater yield variability than area variability. However, area data are not available for these crops.

If it is naively supposed that yield variability is uncontrollable, whilst area variability is controllable, or potentially controllable, then this analysis suggests that there may be potential for reducing the instability of production instability in American agriculture (of annuals) by more than half. This of course does not mean that this would necessarily be economic or desireable. However, it is indicative of the extent to which potentially controllable factors contribute to instability.

6.3.3 IS HIGH PRODUCTION INSTABILITY MAINLY CAUSED BY YIELDS?

A question raised by this analysis is whether commodities with particularly high production instability are in this category because they are particularly suspectible to yield variation. For example, if production of some commodities were highly concentrated geographically, then yields might be observed to be very unstable without the alleviating benefit of counteracting yield affects elsewhere. Commodities with high production instability might be high for this reason alone. If this were so, it might be expected that those commodities with greater production instability would have a higher proportion of their instability deriving from yield variability. In fact, the data do not support this hypothesis. Of the 26 commodities with the most yield variability (40% of the sample), only 7 have yield variability predominant. This is not a dissimilar proportion to that for all of the 65 commodities, (27% compared to 34%). A simple correlation of production instability against the ratio of yield to area instability gives an insignificantly negative value of -.06. The data do not support this hypothesis. Hence there is no support for the contention that highly unstable commodities are such because of highly unstable yields. Unstable plantings are also important.

6.3.4 INDIRECT EFFECT OF YIELDS ON PRODUCTION INSTABILITY

It is clear from the above discussion that yield instability has a direct effect on production instability. However, it is also possible that instability of yields may affect instability of areas and thereby have an additional indirect effect on production instability. It might be expected that if yields are unstable, decisions about areas become more difficult and more prone to readjustment. A positive correlation between yield variabililty and area variability would be supportive of this indirect effect of yield instability on production instability. It is also possible, however, that the causal relationship works in the opposite direction, i.e., those commodities with greater area instability cause them also to have greater yield variability. In fact, the previously mentioned hypotheses advanced to explain the covariance terms might also be used to suggest reasons for a relationship between area and yield variability. Hence, if it was somehow possible to allocate the covariance term between the other two components, then a positive correlation between the adjusted area and yield variability measures would be better evidence of an indirect yield effect than otherwise. However, as already discussed, there is no completely satisfactory way to allocate the covariance terms. In the absence of a better alternative it could be useful arbitrarily to allocate the covariance term equally between the other two terms. The correlation between the yield and area instability measures is +.91. When the covariance term is allocated as suggested, then the correlation is +.61. Both these correlations are significant at the 1% level. Hence, whether the data are adjusted or not, there is a high correlation between yield variability and area variability. This seems to be very suggestive that yield variability not only has a direct effect on production instability but also an indirect effect through inducing poor decisions about areas to be planted.

It is difficult to explain this relationship by appealling to beliefs about the ability of producers rationally to discount yield effects when making production decisions. Producers in industries with unstable yields clearly find it more difficult to decide the appropriate amount to plant each year. They therefore make mistakes. This finding supports the contention of Chapter 2 that instability begats instability.

6.3.5 SUMMARY OF YIELD EFFECTS

In this section production instability is decomposed among yield, area and interaction effects and the influence of each are investigated. Although yield is an important explanation of production instability (at least for the commodities of the sample) area instability was a more important contributor to total production instability. Thus yield effects can not be blamed for the greater part of production instability. Moreover yield did not show a greater than proportional contribution in explaining the greater instability of the more unstable commodities. It was seen that in some cases (e.g., lettuce) yield is, in fact, a coordinating mechanism. It was also determined that yield and area instability is correlated between commodities. This is suggestive that producers of commodities with unstable yields have difficulty in making appropriate choices of how much area to plant. Thus instability is seen to induce poor coordination of supply with demand.

6.4 DEMAND AND SUPPLY FACTORS

In this section I wish to consider some of the sources of instability in agricultural commodity markets. In particular I wish to ask the question: "how much instability can be ascribed to those factors that are general to microeconomic commodity markets?" The factors considered here are:

demand shifters, ie income and population

supply shifters, ie input prices

There are of course other sources of agricultural instability, such as weather, taste changes, monetary forces and the instability of particular complements and substitutes in both production and consumption - all of which will impinge upon instability in any individual market. However, in this section I will consider only the above sources to attempt to gain a perspective on their magnitude. It will then be possible to compare the instability derived from these sources with the observed amount of instability in commodity markets to gain a perspective on their relative contribution.

To estimate the degree of instability likely to arise from these sources it is useful to build a model of a simple commodity market.

Consider first a perfectly competitive commodity market where all participants are aware of the price to be received, the quantity to be produced and the levels of the supply and demand shifters. Prices and quantities may be determined by a two equation model of the form (in logarithms):

supply $Q = a_0 + a_1P + a_2P_f$

demand $P = b_0 + b_1(Q - POP) + b_2I$

where Q = quantity

P = price

P_f = supply shifter such as input price

I = demand shifter such as income

POP = population

The reduced forms are:

$$Q = D(a_0+a_1b_0) + Da_2P_f + Da_1b_2I - Da_1b_1POP$$

$$P = D(b_0+a_0b_1) + Da_2b_1P_f + Db_2I - Db_1POP$$

where $D=1/(1-a_1b_1)$

For analytical purposes it is useful to express the variables as percentage period to period changes:

$$Q' = (dQ/dT)/Q$$

$P' = (dP/dT)/P$ etc

where the right hand side is approximated by:

$Q' = 2*(Q_t-Q_{t-1})/(Q_t+Q_{t-1})$ etc

Despite the assumption of perfect knowledge, this market will exhibit variability in response to the variability of the supply and demand shifters.

$$\begin{aligned}var(Q) = {} & D^2a_2{}^2*var(P_f) + D^2a_1{}^2b_2{}^2*var(I) + D^2a_1{}^2b_1{}^2*var(POP) \\ & + D^2a_1a_2b_2*cov(Pf,I) - D^2a_1a_2b_1*cov(P_f,POP) \\ & - D^2a_1{}^2b_1b_2*cov(I,POP)\end{aligned}$$

$$\begin{aligned}var(P) = {} & D^2a_2{}^2b_1{}^2*var(P_f) + D^2b_2{}^2*var(I) + D^2b_1{}^2*var(POP) \\ & + D^2a_2b_1b_2*cov(P_f,I) - D^2a_2b_1{}^2*cov(P_f,POP) \\ & - D^2b_1b_2*cov(I,POP)\end{aligned}$$

The dependent and independent variables in these equations are now the INS instability measure used in this study. Thus, these equations relate the instability of prices and quantities in a market to the instability of demand and supply shifters described above.

If I now relax the assumption of perfect foresight and assume that producers know only the structure of this model and can make a forecast of the supply and demand shifters, the model becomes a rational expectations model. The reduced forms are identical to the previous model except that the values of the shifters are replaced by their expectations. If it is assumed that these expectations are generated by an autoregressive process, as is typically done in rational expectations models, then :

$$I_t\hat{} = c_0 + cI_{t-1}$$

where the parameters may be estimated by an ordinary least squares (OLS) model:

$$I_t = c_0 + cI_{t-1} + e$$

In this example the variance of the forecast will be lower than the variance of the actual series:

$$var(I_t) = var(I_t\hat{}) + var(e)$$

as the covariance term is zero under the assumptions of the OLS model. Consequently the variances of prices and quantities will also be lower under rational expectations than under perfect foresight.

These models differ according to the degree of information available to agents. They demonstrate how increased knowledge can be a source of instability. Under perfect knowledge agents might be expected to react to every small change. However, a more conservative strategy is implied under rational expectations where changes in trends in the exogenous variable must be established before response is made. Indeed Heiner (1983), using a much more general formulation, shows that uncertainty can be the origin of predictable and stable behavior.

Using this model it is now possible to estimate the extent of instability attributable to these factors.

Let us now choose possible values for a_1, a_2, b_1 and b_2. The initial values for the b terms are flexibilities derived from the own price and income elasticities averaged across all commodities from the demand study of George and King (1971). The simple average of the farm level elasticities of the commodities in the George and King study are -.4 and .3 for the price and income demand elasticities respectively. The initial values for a_1 and a_2 are guestimates. It is important to note that this is a simulation of a representative commodity market rather than of the total farm sector, and hence simple averages are appropriate.

$$a_1 = .5$$
$$a_2 = -.5$$
$$b_1 = -2.0$$
$$b_2 = .75$$

and the variables are defined as follows:

P_f Prices paid by farmers index deflated by the CPI[2]
I Deflated disposable income per caput
POP Total US population

The variance-covariance matrix for these variables calculated in terms of percentage changes over the period 1950-1983 is as follows:

	P_f	I	POP
P_f	5.15	.31	-.13
I	.31	4.76	.02
POP	-.13	.02	.10

For these variables, the variance figures on the diagonal represent the measures of instability according to

[2] The P_f index is an aggregate one and therefore underestimates the input price instability faced by a producer of any individual commodity.

the INS method described in Chapter 4. Hence if these variances and covariances, and the values for the a and b coefficients, are substituted into the previous equations describing the instability of prices and quantities, then the contribution of these factors can be estimated. When this is done the expected instability of quantities and prices measured by the method are .5 and 2.2. These can be compared with the average quantity and price instability measures for commodity markets of 405 and 390 respectively. Thus only a small proportion of annual instability in prices and quantities (in aggregate) can be attributed to fluctuations in real income and population and fluctuations in the aggregate level of real input prices. They are not likely, therefore, to be important sources of instability for commodity markets, and the source of agricultural market instability must be sought elsewhere. The next section will consider various physical and institutional factors as possible sources for commodity market instability.

6.5 INSTITUTIONAL FACTORS

In this section the influence of various physical, economic and institutional factors on market instability are investigated. In the previous chapter it was shown that there were wide differences in instability among commodities. Here I will attempt to explain some of these inter-commodity differences. To do this a cross-sectional regression analysis is conducted with measures of instability regressed against various factors. This analysis also allows the examination of various hypotheses about the sources of instability.

Before presenting the analysis some methodological points ought to be discussed. Clearly price, quantity, and area instability are related to one another. I have presented evidence in earlier sections of this chapter to empirically support the theoretical assumptions that each affects the other. Hence there is some simultaneity of these variables, and if they are to appear in the same regression equation then a simultaneous estimation technique is called for. However, for some of the independent variables examined in this study it is not immediately clear whether they most directly influence quantity, area or prices. It is difficult, if not arbitrary, to build an appropriate structural model. Note that this is not a familiar demand-supply model but rather one where price and quantity instability are linked not only by supply and demand factors but by other factors as well. It can also be argued that the purpose of this analysis is primarily exploratory rather than an attempt to build a structural model. For these reasons the (initial) discussion will concentrate on the estimation and interpretation of reduced form equations; rather than attempt a structural model that takes account of the interactions of the endogenous variables. The estimated equations will therefore have relatively low explanatory power. Moreover all of the independent variables (listed below) will be included in the equations. Exclusion of non-significant variables would increase the explanatory power of these equations as measured by the diagnostic tests. However, such a procedure would invalidate the supposed significance levels of these tests. For this reason and because the purpose of the analysis is primarily exploratory, the procedure described above will be followed. In later analysis the equations will be reestimated in a simultaneous model to investigate whether any additional information is provided by this formulation, but with the caveats given above.

The dependent variables in these regressions are the instability measures for area, quantity and real prices. A composite market instability measure was also tried but did not appear to add anything to the analysis that was not observable from the individual components and therefore it is not presented. As before the square root of the INS measure is chosen. Not only does the square root measure provide a closer data fit, it also has better distributional properties (see Chapter 5). A fuller description of the variables is given in Appendix B, but for ease of interpretation they are briefly described here.

The dependent variables for these regressions are:

SDDQ quantity instability
SDDPD price instability
SDDA area instability

The independent variables are as follows:

MDQ average rate of quantity growth
MDPD average rate of growth in prices
GVP gross value of production
PROC percentage of production which is processed
M dummy for an import commodity
X dummy for an export commodity
ANN dummy if commodity is annual rather than perennial
DS dummy for commodities with government price supports
DF dummy for markets with futures markets
DMO dummy for markets with federal marketing orders
DVOL dummy for markets with marketing orders that include volume management provisions
DMF dummy for markets with marketing orders that include market flow provisions

These regressions are presented in Tables 6.4 to 6.6. In each table models are presented with and without the processing variable for which there is a smaller sample (72). There is also a smaller sample (64) for the area instability.

Table 6.4

SOURCES OF QUANTITY INSTABILITY: REDUCED FORMS

Independent Variables[1]	Model 1		Model 2	
	Coefficient	t-Value	Coefficient	t-Value
CONS	17.20	7.36	14.07	5.15
MDQ	.64	2.38	.80	2.74
MDPD	-1.46	-1.95	-.78	-.70
GVP	-551	-1.87	-4082	-1.15
M	3.01	1.03	3.64	1.12
X	7.01	1.89	6.57	.96
DMO	4.40	1.34	5.03	1.49
DVOL	-2.03	-.51	-5.74	-1.34
DMF	-3.31	-.86	-1.70	-.47
DF	-5.10	-1.52	-6.40	-1.04
DS	-.72	-.19	-4.35	-.65
ANN	6.86	-2.77	-5.49	-2.14
PROC			.72	1.94
$\bar{R}^2$, F[2]	.24	4.0	.33	3.9
N[3]	104		72	

[1] A fuller description of the variables is given in Appendix B.

[2] Measures of fit are the corrected R^2 value and the F-statistic.

[3] N is the number of observations.

Table 6.5

SOURCES OF AREA INSTABILITY: REDUCED FORMS

Independent Variables[1/]	Model 1 Coefficient	Model 1 t-Value	Model 2 Coefficient	Model 2 t-Value	Model 3 Coefficient	Model 3 t-Value
CONS	7.69	3.69	8.07	3.39	8.73	8.05
MDQ	1.18	5.56	1.39	6.03	1.03	4.91
MDPD	-1.46	-2.07	-1.19	-1.21	-1.84	-2.96
GVP	-740	-2.21	-758	-.23		
M	-3.42	-.98	-3.10	-.77		
X	1.71	.55	-.56	-.08		
DMO	-.31	-.09	-.27	-.07		
DVOL	1.68	.36	-.68	-.14		
DMF	-6.43	-1.40	-4.44	-.91	-5.66	-1.47
DF	.01	.00	-1.10	-.17	-4.60	-1.89
DS	.30	.10	-1.12	-.17		
ANN	1.83	.78	.02	.01		
PROC			.23	.74		
$\bar{R}^2$, F[2/]	.38	4.5	.47	4.6	.35	9.7
N[3/]	.64		50		65	

[1/]A fuller description of the variables is given in Appendix B.

[2/]Measures of fit are the corrected R^2 value and the F-statistic.

[3/]N is the number of observations.

Table 6.6

SOURCES OF PRICE INSTABILITY: REDUCED FORMS

Independent Variables[1/]	Model 1		Model 2	
	Coefficient	t-Value	Coefficient	t-Value
CONS	17.25	9.24	18.83	7.38
MDQ	.15	.69	.16	.59
MDPD	-.37	-.62	-1.25	-1.20
GVP	-601	-2.56	-2186	-.66
M	1.82	.77	3.00	.98
X	6.43	2.17	5.01	.78
DMO	3.68	1.40	1.63	.52
DVOL	-.76	-.24	1.87	.47
DMF	5.73	1.86	5.33	1.59
DF	6.59	2.45	13.94	2.42
DS	-2.00	-.67	-6.58	-1.05
ANN	-6.04	-3.05	-6.52	-2.71
PROC			-.22	-.64
$\bar{R}^2$, F[2/]	.29	4.8	.31	3.6
N[3/]	104		72	

[1/] A fuller description of the variables is given in Appendix B.

[2/] Measures of fit are the corrected R^2 value and the F-statistic.

[3/] N is the number of observations.

It can be seen from these tables that the major influences on market instability are:

1 annual versus perennial production
2 processing versus fresh production
3 price supports
4 gross value of production
5 futures markets
6 market flow provisions of marketing orders
7 long run growth or decline in prices and quantities
8 trade

I will discuss each in turn.

6.5.1 ANNUAL VERSUS PERENNIAL PRODUCTION

It is not surprising that this variable helps to explain market instability. Perennial crops and products of larger livestock are characterized by decisions which are difficult to reverse except over long time periods. Consequently adjustment to changing market conditions and to mistakes takes a long time. For example the high fixed costs of investment in the planting of fruit trees results in fruit production for a long period to come at low variable costs. This form of asset fixity is more likely to be a problem for perennial crops than annual crops. The regressions indicate that perennial commodities have about 53% greater price instability and 67% greater quantity instability than annual crops, when allowance is made for other variables. This production characteristic is clearly a very important source of market instabililty.

6.5.2 PROCESSING

This parameter is also a proxy for contractual institutional arrangements as the processing industries frequently rely on contractual exchange mechanisms to ensure reliable supply. The available data on the extent of contracting (e.g., Mighell and Jones, 1963; Mighell and Hoofnagle, 1972; Lang, 1977) have insufficient commodity coverage for this analysis. These regressions indicate that commodities which are processed have a greater degree of quantity instability but possibly less price instability than commodities which predominantly go to fresh markets. The reduced price instability may not be surprising given that most contracts are price contracts rather than being quantity contracts (McLaughlin, 1983). Moreover, it is possible that the data do not always reflect the full extent of the price instability experienced by producers where the contracting arrangements are through producer owned cooperatives. In these cases, part of the producers returns from a crop may be in the form of a dividend payment (Staatz, 1984). The dividend portion of the total price received may be more variable than the nominal price paid on or near delivery. Hence there may be instances when there is some under-reporting of the instability of prices.

The apparent price stabilizing role of contracting arrangements has not apparently led to greater stability of quantities. It is possible that processing firms which process relatively unstable commodities have sought out contracting arrangements to reduce their instability but that these commodities remain relatively unstable, though perhaps less stable than otherwise, but the data can not show this. It might be noted that tart cherries is one of the most unstable markets and practically all production is processed.

It should be noted that the greater quantity instability can not be attributed purely to the fact that perennial crops tend to be produced under contract: for this factor has already been accounted for by the ANN variable described above.

6.5.3 PRICE SUPPORTS

This study provides some evidence (though not significant) to suggest that government price support programs have been associated with more stable prices to producers but little different production stablility than other comparable commodities. It is possible that this is because of the nature of the production characteristics of supported commodities, but there is quite wide variety in this respect, for example, between tobacco, corn and milk. The fact that price is more stable for these commodities and production stability is little different from other commodities, suggests that these institutional arrangements may be relatively successful in their price stablization objectives but that this is not being transferred through to improving coordination with resulting reductions in area or production instability. This aggregated study can not give firm conclusions in this respect but these results are suggestive of useful lines of inquiry concerning the differential impact of price supports on price and quantity instability.

6.5.4 GROSS VALUE OF PRODUCTION

It might be expected that the industries with greater gross value would be able to use the 'voice' of the political process to obtain government programs that are effective in reducing instability (Hirshman, 1970). Whilst price supports and marketing orders are explicitly considered in this study, government participation in the food system is not limited to these institutions. This study is supportive of this hypothesis. Commodities with high gross value of production have both lower quantity and price instability (taking into account other variables) than commodities which are less economically important. However there are alternative hypotheses that could be advanced to explain the relationship between GVP and stability. For example industries with high value probably have a lower cost per unit for the acquistion of information which aids in coordination. The optimum amount of information to gather under such conditions will be greater and less costly per unit for high value industries than other industries. This reason is related to the first in that a large part of government provided market information and statistical services are concentrated on the higher valued industries. The cut back in statistical collection for many 'minor' industries in the early 1980s, is evidence of this relationship.

6.5.5 FUTURES MARKETS

Tomek and Robinson (1981, p266) ask the question "does trading in futures contracts increase the magnitude of the variance of annual cash prices?" They suggest that "futures markets may, in some instances, help stabilize production by providing relatively stable forward prices that can be assured by hedging. In addition,... available evidence suggests futures prices tend to have smaller annual variances than cash prices. The influence of futures prices on annual variability of cash prices, if any, would seem to be in the direction of reducing them." (See also Cox, 1976; and Powers, 1970). The evidence presented here from the cross-sectional analysis is in agreement with Tomek and Robinson's suggestion concerning production stabilization. Both areas harvested and production show either less, or at least no greater, instability for commodities which have established futures markets than those which do not. However the evidence of our study is that these markets exhibit greater price instability than other markets. There is, of course, a popular conception that the existence of futures markets has a destabilizing influence on prices, which is at

odds with the inference drawn by academic economists. What reasons can be advanced then to explain the apparently greater price instability in these markets?

It is possible that futures markets have been developed for commodities that are less price stable than others. It seems likely that the increased use of futures markets for grains in the 1970s has been encouraged by an increase in price variability. The existence of a sufficient degree of price variability seems to be a prerequisite for an effectively operating futures market. Thus the fact that these institutions have evolved for particular industries with unstable prices is a possibility. There are of course other factors which are important for an effectively operating futures market. These include the technical feasibility of writing contract terms that are satisfactory to both buyers and sellers, and the market organization of the commodity. This argument, however, does not explain why production may be more stable in these commodities.

Another possible explanation can be advanced that relies on the interaction of futures and storage markets. It is likely that the optimum amount of storage in a market for buyers and sellers is different when there is a futures market than when there is not. For example, grain buyers may be able to satisfy their precautionary needs for adequate supplies through participation in the futures market rather than holding their own stocks. In such a case the total amount of inventory may average lower where a futures market is in existence than otherwise. Lower average inventories make the cash market more susceptible to fluctuations in supply or demand. Thus spot prices could well be more unstable.

A third possible explanation derives from the possible effect of the futures marketing institution on the demand curve of buyers. If buyers are able to lock in a price for themselves then they may be less responsive to changes in the spot price, i.e., their demand becomes more inelastic. This would explain both greater price instability and greater stability in the quantity demanded but not necessarily quantity produced.

The greater spot price instability of commodities with futures markets is an important finding of this study and warrants further investigation. There is some empirical work in this area (e.g., Powers, 1970; and Cox, 1976) but the question is still an open one.

6.5.6 MARKETING ORDERS

Marketing orders are government supervised marketing arrangements for certain fruit, vegetables and speciality crops, which have as their purpose the aim of fostering orderly marketing. Some 48 federal orders are currently in operation. The provisions of the orders differ among commodities and among geographical areas. However they all authorize certain restrictions on the qualities and/or quantities of products that can be marketed. The restrictions vary among orders and may include packaging standards, minimum requirements for grade and size, limitations on quantities shipped during certain periods within the marketing season, limitations on quantities going to the fresh market and, in some cases limitations on total marketings. All but three of the current orders include quality standards. In addition, most orders include provisions which may be described as market support activities. These include standardization of containers, levies for research and sometimes for advertising. About half the marketing orders have various types of quantity controls. These represent the strongest form of regulation available from orders as they may be used to affect prices. These are of two types: volume management provisions and market flow regulations. The volume management provisions are of three types: producer allotments, market allocation provisions and reserve pools. The market flow provisions may be handler prorates or shipping holidays. The market flow provisions are aimed at distributing the seasons' production over the crop year to avoid seasonal gluts and shortages. In principle all of the production is sold. On the other hand the volume management provisions attempt to increase price by reducing the quantity sold on the primary market. (See Heifner et al, 1981; Jesse, 1979; Jesse and Johnson, 1981).

The diversity of these provisons are summarized in this study with three dummy variables. The first for commodities with any type of order, second those with volume management provisions and third those with market flow regulations.

As it is an explicit aim of these orders, it might be expected that commodities with marketing orders would experience less instability than other commodities. The evidence of this study does not support such a view. Industries with orders tend to have greater price and quantity instability, though not significantly so. This may be interpreted to imply that these orders are not being effective, or it could be that the relatively unstable industries are more likely to demand marketing order institutions than other industries. No unambigous statement can be made about the direction of causality. However it is clear that industries with marketing orders are no more stable than those without them.

However those orders which have market flow provisions are somewhat different. These industries appear to exhibit greater price instability but less production and area instability than other industries with marketing orders. It is not immediately clear why this should be the case. It is reasonable to suppose that the market flow provisons permit greater intraseasonal price stability, which gives clearer market signals to producers about how much to plant. However this does not seem to be translated into greater annual price stability.

6.5.7 LONG RUN CHANGES IN PRICES AND QUANTITIES

Hamm (1981) has suggested that certain commodities which exhibit marked instability will not survive among the constellation of available agricultural goods. He argues that marketing institutions are less able to cope with unstable commodities (or varieties) and that these will experience declining demand from marketing and processing institutions despite consumer level acceptance. Examples of such commodities might be apricots and asparagus. One empirical test of this hypothesis would be if there was a negative relationship between price and quantity instability and growth in production. In fact, the data do not support this hypothesis. Quantity instability is significantly and positively related to production growth. The relationship between price instability and production growth is also positive but it is not at all significant. A better test of this hypothesis is provided in the next chapter where the relationship between increased instability (rather than the level of instability) and production growth is investigated.

The data do provide some evidence that growth industries and those with the greatest declines in real prices experience greater production instabiliity. It does seem intuitively likely that, in periods of growth or rapid technological change, decisions about optimum investment strategies are likely to be more difficult to make. It is not surprising, in turn, that coordination is more difficult under these circumstances than under more stable conditions.

6.5.8 TRADE

It is often argued that many international agricultural markets are residual markets which remain after other countries have insulated their own agricultural sectors. Hence the equilibrating and stabilizing role of the market is left to the residual, and sometimes thin, international market, which must absorb most of the instability that would otherwise be spread more evenly. Thus those commodities which enter international trade are more likely to be unstable. The data provide some support for this hypothesis. Internationally traded commodities do give evidence of being less stable than other commodities. This is especially true of prices of export commodities. The evidence is not so strong for import commodities. However a number of these are tropical fruits which are only grown in quite small quantities in the US (e.g., bananas in Hawaii), and where a substantial proportion of world production enters world trade.

6.5.9 SIMULTANEOUS MODEL

In this section I will present some results from a simultaneous specification of a model of market instability. This may increase the understanding of the factors influencing instability above that available from the reduced form equations discussed above. The proposed model incorporates some of the above discussion, but the choice of which independent variables to include in each equation is a little arbitrary. However, a choice needs to be made for this analysis. The proposed formulation is as follows:

SDDA=f(SDDPD, ANN, GVP, MDQ, PROC)

SDDQ=f(SDDA, SDDPD, ANN)

SDDPD=f(SDDQ, M, X, DF, DS, DMO, DVOL, DMF, MDPD)

The rationale behind this model spoecification is as follows. The main factors directly affecting area instability are price instability, the gestation period of production (ANN), the degree of processing (or contracting), and factors which might influence information costs such as value and growth rate of production. Quantity instability is hypothesized to be affected by area instability, and factors which might affect yield instability such as gestation period of production and price instability (for reasons described in section 6.3 above). Most factors probably affect price instability more directly than area or production instability and the model is specified that way. In addition demand relationships are likely to ensure that the commodities with the more unstable quantities are also price unstable, and so this is included in this specification. Hence the endogenous variables in this formulation are SDDA SDDQ and SDDPD; all others are exogenous. This structure clearly satisfies the rank and

Table 6.7

SOURCES OF AREA QUANTITY AND PRICE INSTABILITY:
TWO-STAGE LEAST SQUARES ESTIMATION

Dependent / Independent Variables	SDDA		SDDQ		SDDPD	
	Coefficient	t-Value	Coefficient	t-Value	Coefficient	t-Value
CONS	5.69	1.44	5.48	2.02	3.70	1.41
SDDA			.84	8.55		
SDDQ					.72	3.88
SDDPD	.11	.55	.02	.12		
MDQ	1.14	5.36				
MDPD					.78	1.31
GVP	-499	-2.06				
M					-.38	-.18
X					.34	.13
DMO					.94	.35
DVOL					.99	.35
DMF					7.71	2.74
DF					9.72	3.55
DS					-1.39	-.52
ANN	3.24	1.53	-1.21	-.87		
$\bar{R}^2$, F	.34	9.23	.74	61.24	.43	9.47
N	65		65		104	

order conditions for over-identification, so that two stage least squares regression estimation techniques are appropriate (Pindyck and Rubinfeld, 1976). The estimated equations are shown in Table 6.7. In general these results support the conclusions of the previous analysis and do not offer a great deal more information than the reduced form equations. The exception is found in the discussion in a subsequent section (6.6) concerning the part played by price instability in contributing to area instability.

6.5.10 CONCLUSION

The discussion in this section provides support for some views, calls others into question, and suggests some hypotheses for further consideration. It is clear that production characteristics of a commodity are important determinants of market instability. Whether the product has a short or long gestation period (annual or perennial) affects the degree of instabilty. Perennial commodities are more unstable. Although this is a production characteristic, it is the economic implications of the greater role of fixed inputs that leads to the greater instability of perennial commodities. But the analysis also considers the influence of various institutional and economic characteristics which are of importance. The analysis confirms the popular view that export commodities have greater price instabilty than other commodities. An unexpected result of this analysis is that commodities with futures markets provide evidence of greater price instability than other comparable commodities. A number of reasons were advanced which might explain these results. However this study provides good reason for closer investigation of the influence of this market institution on spot price instability. Another result of interest from this study is that commodities with marketing orders tend to be more unstable than those without. This may be because of the phenomenum of 'self selection', however it may not be. Further examination of these arrangements seems to be desireable since the avowed intent of these orders is orderly marketing. In addition the greater instability of commodities which are processed is suggestive that the distribution of market power for these commodities may push risk on to those participants who have difficulty coping with that risk (e.g., farmers) thereby acerbating instability. Other results seem to be suggestive of the importance of information costs. The reduced instability of the more valuable commodities is suggestive that these have greater information available, so that more stability is evident. The greater production instability of commodities in growth phases may also be associated with the uncertainties of the actions of competitors and processors. This analysis therefore provides some interesting areas for detailed examination.

6.6 PRICE INSTABILITY AS A SOURCE OF AREA INSTABILITY

In this section I wish to examine whether there is any evidence that price instability directly affects area instability. It would be expected that if demand relations were fairly stable, and not systematically dissimilar between commodities, then commodities with greater area instablility, and hence greater production instability, would also have greater price instability. Hence a correlation between price instability and area instability could be expected because of this 'demand-side' relationship. The evidence of a correlation between these two variables is supportive of either (or both) of price instability causing area instability or the reverse. However, the demand side relationship requires transmittal through production instability while this is not true of the supply side.

$$\begin{tikzcd} \text{PRICE} \arrow[dr] & & \text{QUANTITY} \arrow[ll] \\ & \text{AREA} \arrow[ur] & \end{tikzcd}$$

This has testable implications for the relative size of the correlations between these parameters. If it were only the demand side that created the relationship between between price and area instability, it would be expected that the price-quantity correlation would be higher than the price-area correlation (unless the area-quantity correlation was perfect in which case yield would not be a source of instability and the price-area and price-quantity correlations would be equal). In fact it would be expected that the correlation between price and area would be equal to the product of the two other correlations. Examination of the data suggests that this is not the case. For the 64 commodities for which there are data on all three series, the correlations between the instability measures are as follows:

quantity-area	.87
price-quantity	.28
area-price	.26

As can be seen the price-area correlation is not appreciably lower than the price-quantity correlation. It would appear that price instability and area instability may be directly related in a way not dependent on the quantity relationship alone. It is possible to determine the correlation between area and price allowing for the relationships between quantity and price, and quantity and area. The appropriate statistic to use here is the partial correlation coefficient (see, for example, Pindyck and Rubinfeld, 1976, p92). The estimated value for this statistic is +.05. This has a t-value for being statistically different from zero of 0.35. While this is a low level of significance, it is positive, as expected, and is suggestive of a relationship of the type described.

It was noted in an earlier section that areas are sometime reported on an area harvested basis and sometimes on an area for harvest basis. For those 22 commodities (see Table 6.2), for which the data are for area for harvest (i.e., planted area), the partial correlation is .06 and the t-value is .28. Thus the positive result obtained in the previous paragraph does not seem to be attributable to a price effect on the proportion of area harvested but rather on areas planted.

Correlation does not mean causality; nor does it give direction of relationship. However, it is difficult to conceive of ways in which price instability might be caused by area instability, independently of the quantities produced. This does not seem likely. It seems more likely that the causality, if it exists, is in the opposite direction: i.e., that price instability is a cause of area instability. Note that this is quite different from the normal supply assumption that areas are a function of prices. Here it is postulated that commodities with greater price instability also experience greater area instability and to a greater degree than that can be explained by demand relationships alone. Hence it would appear that growers of commodities with unstable prices have greater difficulty in deciding upon appropriate areas to plant and they find more need to make annual revisions; i.e., price instability begats area instability. Again this provides further evidence of coordination problems in American agriculture.

The simultaneous formulation described in section 6.6.9 allows a better test of the role price instability plays in promoting area instability. This formulation allows the effect of other variables to be taken into account. Moreover the simultaneous interaction can be isolated in this way. However, this is true only to the extent that the formulated model is specified 'correctly'. Omitted variables, non-linearities or other misspecification or violations of the statistical requirements for regression analysis would lead to modification of the results obtained here.

In the equation explaining area instability the coefficient of the price instability variable is positive, although with low statistical significance. This is supportive of the contention that price instability itself is conducive to poor coordination. This is a point that is often made (especially in connection with possible benefits of stabilization schemes, e.g., Newbery and Stiglitz, 1981 p23) but I have not seen any evidence. This study provides some evidence, although it is not at a high level of statistical confidence.

6.7 SUMMARY AND CONCLUSIONS

In this chapter various questions about the sources of instability have been investigated. In Chapter 4 it was seen that the instability of agricultural commodities was generally in excess of that of other sectors of the economy. In the first section of this chapter it was suggested that an important difference for agricultural commodities was the stochastic nature of the production function. Indeed, the third section showed that yield variation was an important source of variability in agricultural production. However, for the annual crops, the instability of areas planted was on average more important than yield effects in contributing towards total production instability. The fourth section then considered the role of various demand and supply shifters exogenous to the farm sector to explain the extent of instability. It was shown, in fact, that only a very small part of total market instability can be explained by these sources. The fifth section considered various economic and institutional factors which might impinge upon the extent of market instability. The results of this examination are summarized at the end of that section. It would appear that these economic and institutional factors are together responsible for about a third of market instability and there would seem to be some opportunities for institutional reform to alleviate some of the sources of instability. The sixth section of this chapter is devoted to an examination of whether instability is itself a source of further instability. It was found that there is some evidence that price instability is a factor contributing to area instability. The next chapter will consider the possibility that instability has increased in agriculture and investigate possible reasons for this occurrence.

Chapter 7

CHANGING INSTABILITY: EXTENT AND SOURCES

7.1 INTRODUCTION

It has been suggested that instability in agricultural commodity markets is increasing. Tweeten (1983), Firch (1977), Myers and Runge (1985), Mangum (1983), Harrington and Edwards (1984a, 1984b), Edwards (1984), Blandford and Schwartz (1982, 1983), Gardner (1977), ERS (1982), all address the question in some way or another. Most concentrate on the influence on farm income. Some consider some individual markets, such as Myers and Runge, and Edwards, whilst others consider the total farm sector, like Firch. As far as I am aware no one has considered a large number of agricultural markets and drawn inferences from their collective diversity. In this chapter I attempt to do that.

This chapter is organized as follows. In the next section the question of whether there has been an increase in instability in commodity markets or not is examined. I then consider which commodity markets and which commodity types have demonstrated an increase or decrease in instability. In a third section I discuss some of the major reasons advanced to explain possible increases in agricultural instability. The following section provides a cross-sectional regression analysis to uncover indications of the sources of any increase in commodity market instability. It will be shown that such a cross-sectional study can help isolate the importance of factors that can not be disentangled through a typical time series analysis. Concluding comments are made in the fifth and final section of the chapter.

7.2 HAS INSTABILITY INCREASED?

In this section changes in instability of agricultural commodity markets are investigated. The 33 year period from 1950 to 1982 is broken into three periods of 11 years each to allow the examination of changes in instability across these three periods.

7.2.1 CHANGES IN AGGREGATE MARKET INSTABILITY

The first question asked is whether or not there has been an increase in commodity market instability. Here the concern is with markets rather than aggregate gross value; so each market is weighted equally.

Table 7.1 shows the means for the square root of the INS instability measure for the three 11 year periods of the study. The two values for the second period are the means of the sub-samples that are comparable with those of the first and third periods. This was done because the number of markets for which there are meaningful data varied among the periods. A t-test was used to compare the paired means for each period.

Table 7.1

MEAN INSTABILITY MEASURES FOR 3 PERIODS

	Period 1	Period 2	Period 3	t-value	signif	N
Quantity	17.15	15.29		-1.81	.074	90
		15.77	16.69	1.07	.286	95
Price	15.95	14.06		-2.25	.027	88
		14.72	20.31	5.02	.000	93

Table 7.1 shows that there was a small fall in instability between periods one and two. However the fall in quantity instability, while significant at the ten percent level, is not quite significant at the five percent level. The fall in price instability is significant at the 5 percent level. This result is consistent with Firch's (1964) results where he finds that farm income became more stable over this time period. Firch attributed the greater stability in this period to the development of 'automatic stabilizers' in the macroeconomy.

The differences between the second two periods are more dramatic. Quantity instability appears to increase slightly but not significantly. In fact quantities are more stable in the last period than they are in the first. The increase in quantity instability in the third period only partially makes up for the decline in the second period. Price instability, on the other hand, shows a large and highly significant increase. According to this measure, price instability in agricultural markets has increased 38%. This is confirmation of the popular conception that instability has increased in agriculture. However this evidence suggests that the increase was confined mainly to price rather than extending to quantity as well.

7.2.2 INCREASES IN INSTABILITY IN COMMODITY GROUPINGS

These results are rather general and it would be of interest to know whether there has been an across the board increase or whether it is restricted to particular commmodity groupings. To investigate this question the data was disaggregated into commodity groupings and the analysis repeated for each. These results are presented in Table 7.2. The statistical test used is identical to that above, i.e., on the differences of paired means. The classification was made on physical or production characteristics of commodities. The listings of which commodities are included in each group can be found in Appendix F.

Table 7.2

CHANGES1 IN QUANTITY AND PRICE INSTABILITY BY COMMODITY TYPE

Commmodity Type	Quantity							
	Period 1-2				Period 2-3			
	Change	N	t-val	signf	Change	N	t-val	signf
Tree Fruit	4.2	12	1.2	.28	-3.6	16	-1.3	.23
Tropical Fruit	-.6	5	-.2	.84	2.8	5	1.4	.23
Berries & Vines	-1.5	4	-.8	.48	.7	4	.3	.77
Mint,oil,swtnrs	2.1	6	1.7	.16	1.7	6	.7	.52
Tree Nuts	-6.9	5	-.6	.60	2.5	5	.6	.61
Vegetables	-2.3	33	-2.3	.03	-.3	33	-.4	.68
Field Crops	-6.3	16	-2.6	.02	6.7	17	2.4	.03
Animal Products	-1.1	9	-1.2	.25	.3	9	.3	.81
Total	-1.9	90	-1.8	.07	.9	95	1.1	.29

	Price							
	Period 1-2				Period 2-3			
	Change	N	t-val	signf	Change	N	t-val	signf
Tree Fruit	5.6	12	1.9	.09	-2.4	16	-.8	.43
Tropical Fruit	-6.2	5	-1.4	.25	4.7	5	1.1	.33
Berries & Vines	-6.9	4	-6.6	.01	2.0	4	1.0	.38
Mint,oils,swtnrs	-1.8	5	-1.3	.27	13.2	5	3.3	.03
Tree Nuts	-3.8	5	-.6	.56	7.9	5	1.1	.32
Vegetables	-3.4	33	-2.8	.01	2.1	33	2.4	.02
Field Crops	-.6	16	-.5	.64	17.1	17	6.7	.00
Animal Products	-3.0	8	-2.8	.02	7.4	8	4.4	.00
Total	-1.9	88	-2.3	.03	5.6	93	5.0	.00

1 The changes are absolute increases or decreases in the instability measures for quantities and prices. Their means for each period are shown in Table 7.1.

The top part of Table 7.2 confirms the aggregate analysis. The only commodity group to show a significant change in quantity instability between the second and third periods is that of field crops. Interestingly the increase is mainly a recovery to the level existing in the first period.

The second part of the table indicates that the aggregate changes are quite general across all but one of the commodity groups. Nearly all commodity groups showed a decrease in instability between the first two periods and a more than compensatory increase in the last period. The most dramatic change is for the field crop commodity category. Although animal products also showed a large increase in instability. This, too, may be a consequence of increased field crop instability, as some animal products (e.g., beef, pork, broilers, eggs) use field crop inputs. (See, for example, Offutt, 1982 who uses a simulation model to demonstrate how animal products, especially beef, respond to corn price instability). These results are confirmed in Table 7.3 which shows the proportional change in instability for each commodity group, in the two periods. These results differ from the analysis above in that that relative, rather than absolute, changes are weighted equally.

Table 7.3

MEAN PROPORTIONAL CHANGES IN INSTABILITY FOR COMMODITY GROUPS1

Commmodity Type	Quantity Period 1-2	Quantity Period 2-3	Price Period 1-2	Price Period 2-3
Tree Fruit	1.69	.90	1.32	.98
Tropical Fruit	1.03	1.07	.85	1.23
Berries & Vines	.92	1.03	.59	1.30
Mint,oil,swtnrs	1.12	1.08	.87	2.15
Tree Nuts	.96	1.19	1.34	1.96
Vegetables	.91	1.02	.91	1.38
Field Crops	.83	1.75	1.14	3.06
Animal Products	.88	1.26	.81	1.63
Total	1.02	1.17	1.00	1.70

1The values in the table represent the ratio of the instability measures in two periods. A value of 1.00 indicates there was no change on average for the commodity group between the two periods.

Table 7.3 shows clearly that there has been a substantial increase in price instability in nearly all commodity groupings. However, the field crop group showed the most dramatic increase and this was also reflected in (or a reflection of) a large increase in quantity instability.

The aggregate results are interesting in that they imply that the average commodity market experienced a significant increase in quantity instability in the later period. This is at apparent variance with the results from the previous table where the increase was statistically insignificant and merely counteracted the decline in instability in the previous period. The reason for these different conclusions from the two approaches reflects the hetergeneous nature of the commodity groupings. It is suggestive that more information can be elicited from the examination of individual commodities. This will be done in the next section. Before doing so, it is worthwhile to draw some conclusions from this commodity group analysis. It is clear that there has been a substantial increase in instability in commodity markets, especially of price instability. This increase has been general across commodity markets but it has been especially strong among field crops. This result is consistent with the hypothesis that increasing instability has entered the agricultural sector through field crop markets and has spread to other commodities through the interrelationships between markets. It is noteworthy that the later period is also a period of increased uncertainty about inflation which may lead to increased price variability in the auction markets which are common in agriculture. More consideration will be given to these factors in a later section.

7.2.3 INCREASES IN INSTABILITY BY COMMODITY

In the last section it was seen that the grouping of commodities leads to some loss of information. In this section I will consider some statistical analysis and ranking of individual commodities by the extent to which their instability has increased. This is done in Table 7.4.

Table 7.4

PROPORTIONAL CHANGE IN INSTABILITY BY COMMODITY [1]

COMMOD	QINC32	PINC32
DPE	4.13	4.97
PEN	3.56	2.24
SB	2.59	3.08
HAY	2.54	2.26
BY	2.38	2.94
BRU	2.10	1.40
WOL	1.96	1.78
OT	1.89	4.16
AS	1.74	1.06
ART	1.72	2.44
PK	1.72	1.41
LMA	1.71	1.63
ALM	1.66	5.17
RIC	1.63	7.33
LEM	1.60	1.43
LIM	1.54	1.09
LM	1.52	1.39
PRN	1.51	1.12
APR	1.46	.83
GRP	1.43	1.27
CTS	1.42	1.92
MK	1.41	1.49
BET	1.40	1.57
COT	1.39	1.47
SG	1.38	2.41
TOB	1.35	1.34
CP	1.35	.78
WAL	1.32	1.79
OCH	1.31	0
WAT	1.30	1.37
FIL	1.30	1.18
TAR	1.29	1.25
EG	1.29	1.40
FLX	1.28	3.69
SGB	1.23	5.13
CE	1.22	1.09
DAT	1.17	.70
OLV	1.16	1.27
SBF	1.15	1.81
PEA	1.12	2.88
ON	1.12	1.49
CT	1.10	.76
RYE	1.09	2.36
SBP	1.06	3.75
WH	1.06	2.20
HON	1.04	0
BR	1.03	1.96
MAP	1.03	1.67
AVO	1.02	1.19
FIG	1.00	2.18
LT	1.00	1.29
CRB	1.00	.82
PAP	1.00	.79
CR	.99	1.25
DBE	.98	2.57
STW	.97	1.12
SPF	.94	1.55
TOP	.94	1.18
CN	.93	2.09
ESC	.93	1.01
PLM	.91	1.61
SWP	.89	1.76
APP	.89	1.35
NEC	.89	1.51
PEP	.88	1.98
TGL	.86	.68
PCH	.86	.87
MAC	.85	.86
SGC	.84	3.12
SPR	.83	1.49
PO	.83	1.06
PEC	.82	.82
CHT	.80	1.30
GP	.79	.64
BC	.75	.73
CB	.74	1.08
CUF	.72	.91
TEM	.72	.48
GAR	.71	.66
HOP	.71	2.01
CHS	.70	1.09
POP	.70	2.31
EGP	.66	.53
DEW	.66	.62
SCP	.65	3.33
ORG	.62	.64
CUP	.59	1.01
SPP	.59	2.24
SCF	.58	.74
BF	.57	1.76
TK	.53	1.91
GPF	.48	.47
TOF	.40	.79
PRS	.32	.59
TGR	.25	.58

[1] The column headings are, in order, the commodity code; the ratio of the quantity instability measures for the third and second periods; and the comparable ratio for price instability.

As in Table 7.3 the statistic in Table 7.4 is the ratio of the square roots of the INS measures, but here it is for the second and third periods only. They are listed in descending order of increases in quantity instability. It is noteworthy that there has been much greater increases in instability for prices than quantity.

It would be expected that the commodities experiencing an increase in price instability would also be the ones to have experienced an increase in quantity instability. For example, if price instability increased then producers may respond to fluctuating profitability by frequently changing output mix and thereby increasing the instability of individual commodity production. This may occur when they can make reasonable judgements about future prices. It would also occur if their judgements become more uncertain and their mistakes increase. Moreover, if production was to become more unstable and there was a fixed demand curve, then prices would also become more unstable. The empirical evidence does suggest that those commodities that had greater increases in price instability also experienced greater increases in quantity instability. The correlation between the proportional increase in price and quantity instability between the second and third periods is .44. This is of the expected sign and is significantly different from zero at the 6% level.

Table 7.5

COMMODITIES WITH HIGHEST INCREASES IN PRICE AND QUANTITY INSTABILITY

Price Instability		Quantity Instability	
Rice	7.33	*Dry Ed Peas	4.13
Sugarbeet	5.13	Peanuts	3.56
*Dry Ed Peas	4.97	*Soybeans	2.59
Almonds	4.16	Hay	2.54
Proc Snp Beans	3.75	Barley	2.38
Proc Swt Corn	3.33	Bruss Sprouts	2.10
Sugarcane	3.12	Wool	1.96
*Soybeans	3.08	Oats	1.89

The figures are the ratio of the instability measures for the periods 1961-71 and 1972-82. Commodities with asterisks are common to both lists.

Among the top eight commodities of those showing the largest increases in instability two are common between the price lists and the quantity lists (see Table 7.5). These are dry edible beans and soybeans. Dry edible beans have been in a substantial decline in this period and their instability may reflect or be associated with this decline. Soybeans are a crop that is not covered by a commodity program and which is a close substitute in production to corn. Thus fluctuations in areas under corn (that may be program induced) may be magnified in soybean areas.

Many of those commodities that exhibit the largest increases in price instability are those for which US production is small and which are imported by the US. Both sugarcane and sugarbeets appear in this group. Their increased instability probably reflects a greater frequency in US domestic policy changes coincident with developments on world markets. On the other hand, the increase in rice price instability probably reflects an increasingly thin world market (see ERS, 1984). These may all be useful questions for future study.

7.3 EXPLANATIONS FOR INCREASING INSTABILITY

In this section a number of the explanations which have been advanced to explain increasing agricultural market instability will be listed and then discussed. Then the following section will provide an empirical analysis which will give an indication of the more likely reasons behind the increase in instability.

1 Increased export demand - USSR, LDCs
2 Less stable world monetary policy
3 The shift to flexible exchange rates
4 Change in US farm price supports
5 Unusual weather
6 US export embargos
7 Narrowing of the genetic base for grains
8 Transfer of risk to farmers
9 Expansion on to marginal lands
10 Growth in protectionist measures

7.3.1 INCREASED EXPORT DEMAND

It is sometimes suggested that there has been an increase in export demand for grains which has led to greater instability in these markets as experienced by the US. However an increase in export demand would, ceteris paribus, be expected to lead to a more elastic export demand for US products than without the increase in export demand. This could be expected to lead to more stable prices in response to supply fluctuations. Thus, to argue that an increase in export demand leads to greater price instability, it is necessary to also postulate an increase in the instability of the export demand schedule itself. The empirical evidence that exists suggests that both these events have occurred: the demand elasticity faced by US producers has become more elastic and the export schedule itself has become more unstable. (See, for example, Tweeten, 1983; Myers and Runge, 1985).

7.3.2 LESS STABLE INTERNATIONAL MONETARY POLICIES

The second reason sometimes advanced is that the major economies have entered a period when their monetary policies have become less stable. The various oil crises have contributed to this development. The first large increase in oil prices occured in 1972. In the last three months of that year most of the larger Western nations had elections. All these countries chose to increase their money supplies to accommodate the increased oil prices with a consequent dramatic increase in international liquidity and national inflation rates. In contrast the subsequent oil price hikes in the late 1970s were met with deflationary monetary policies in most developed nations. The 1970s were thus characterized by large swings in international liquidity and by much less stable monetary and other economic policies relative to that experienced in previous decades. It is argued by some that these developments have had a magnified effect on agriculutural commodity markets. (See Bond et al, 1984, for a brief exposition and Bosworth and Lawrence, 1982 for an extensive evaluation of these arguments). These arguments depend upon the division of markets between 'auction' and 'custom' markets (following Okun); or, alternatively, the economy can be divided between 'market' and 'planning' sectors (Galbraith, 1967). The chief distinction between auction markets and custom markets is that price is an important coordinating mechanism in the former but is not in the later. The Galbraithian distinction is identical in this respect. Thus an increase in the money supply will lead to increases in prices in the auction sector whilst the custom sector will respond sluggishly to price, if at all. Prices in the auction sector will increase at a faster rate, and in excess of the rate of inflation, because the measurement of the inflation rate will depend also on goods and services produced in custom markets. The same conditions will operate when the money supply is reduced. Hence auction markets will respond to changes in the money supply by exhibiting price instability (and hence quantity instability) in excess of the rate of inflation and in excess of others parts of the economy. In addition these markets are susceptible to 'overshooting' (see Frankel, 1984). It is argued that agricultural product markets tend to be auction markets and hence exhibit greater instability as a consequence. Moreover, the instability evident in the recent decade can then be traced to variability in international liquidity in the same period. These arguments explain agricultural instability as essentially a monetary phenomenum, with the moral that stable monetary policies could be expected to lead to more stable agricultural commodity markets. It would seem that differences in instability between commodities should then be explainable by (or alternatively indicative of) the degree to which the market structure approaches an auction or a custom market.

7.3.3 FLEXIBLE EXCHANGE RATES

This is a view that was advanced initially by Schuh and has had wide currency. The argument is that the shift in the international exchange rate regime from a fixed peg to a bloc floating system, that occurred with the breakdown in the Bretton Woods agreement in 1972, has had wide repercussions for agriculture. This change in institutional arrangements was a response to, and resulted in, substantial capital flows. Moreover it has lead to frequently changing border prices for internationally traded goods and may well be a source of increased instability in agriculture. Certainly the US dollar depreciated greatly from 1972 to 1979 and then to 1985 appreciated strongly. Grain exports seem to have responded to these changing international prices. This argument would imply that internationally traded commodities would have experienced greater increases in instability than other commodities.

7.3.4 CHANGES IN US PRICE SUPPORT ARRANGEMENTS

Another possible source of instability is the sometimes frequent changes in US agricultural price supports. Since 1950 two major changes in support policies may be noted. The first of these occurred in the early 1960s when there was a shift from a high loan rate to a lower loan rate with the addition of deficiency payments. The second change occurred with the 1973 Agriculture and Consumer Protection Act. The support arrangements at this time changed from essentially an income support arrangement to a price support system. In addition support prices came to be adjusted more frequently. Deficiency payments, that had only been paid on the domestic allotment, were thereafter paid on total production (Tweeten, 1979). This represented a new and less stable regime than had operated in the 1960s (D. Gale Johnson, 1979). An implication of this hypothesis is that commodities under price supports (and deficiency payments), should experience an increase in instability in the period since 1972 relative to the 1961-71 period, in excess of that experienced by other commodities.

7.3.5 UNUSUAL WEATHER

This is perhaps both the most popular and most unpopular reason advanced to explain production and price fluctuations. It is popular in that it is commonly held. It is unpopular among those who find it difficult to believe coincident changes in weather patterns in different parts of the world. Moreover such a reason seems to ignore economic and institutional factors. Harrington and Edwards (1984a, 1984b) conclude that weather only contributes a little towards increased market instability in the period.

7.3.6 US EXPORT EMBARGOS

This is sometimes advanced as a partial explanation for increased market instability. In 1980 the US led a trade boycott of the USSR in response to the USSR's part in the hostilities in Afghanistan. This was the major one of a number of examples of the use of trade as a weapon of foreign policy in the 1970s and 1980s. Some, especially producer organizations, have suggested that these embargoes have had an unsettling effect on agricultural markets; both directly and indirectly as they temporalily change patterns of comparitive advantage and induce inappropriate investment.

7.3.7 NARROWING OF THE GENETIC BASE FOR GRAINS

Hazell (1984) investigates the variability in yields over time and between states. He finds that yield instability for maize has increased in ways that have reduced the compensating changes in yields between states. As a result total production variability has increased. He attributes this to a narrowing of the number of grain varieties grown at any one time. Thus a new disease outbreak or particular weather conditions can affect almost all the crop in a year as it becomes equally susceptible. This apparently occurred with maize in 1970 when the southern corn leaf blight spread throughout the US because the particular hybrid widely grown that year was particularly susceptible. Hazell identifies maize as a crop where this may be a factor: however it is difficult to explain large or general changes in instability with such a reason.

7.3.8 THE TRANSFER OF RISK TO FARMERS

Larry Hamm (1981) has reported on the changing institutional structure of food industries. One of his findings is to note the evolving nature of marketing institutions in such a manner as to shift the incidence of risk back towards farmers. In particular the vertical integration between processing and marketing has been broken to be replaced with an integration link between farmers and processors. The development of producer cooperatives provides an example of this trend. These developments are more pronounced for certain processed commodities where contractual and other institutional arrangements facilitate these trends. This process is likely to be more important in periods like the 1970s when high real and nominal interest rates, high and variable inflation rates, and more variable output prices increase the risk burden on such industries.

If this is the case then greater increases in instability can be expected where there is processing.

7.3.9 EXPANSION OF PRODUCTION ON TO MARGINAL LANDS

Another hypothesis sometimes advanced to explain increased instability is that growth in demand has led to production being expanded on to marginal lands. As a result commodity markets are more suseptible to weather conditions and experience more yield and production variability than before. This hypothesis would be supported by evidence that commodities with strong growth in production had greater growth in quantity instability than other commodities.

7.3.10 GROWTH IN PROTECTIONIST PRESSURES

It is also suggested that there has been an increasing trend towards countries insulating their own agricultural industries through protective trade arrangements. Where such measures are successful at reducing domestic instability they effectively export instability to the international market. Those countries, such as the US, which have fewer agricultural trade barriers, could then be expected to experience an increase in instability. The greater instability of the rice market, noted in the last section, probably reflects this phenomenon.

7.4 EMPIRICAL ANALYSIS OF SOURCES OF INCREASED INSTABILITY

In this section I report on a cross-sectional regression study undertaken in order to throw some light on a number of these hypotheses. This is done by regressing increases in price and quantity instability against various economic and institutional variables. In this manner it can be investigated, for example, whether commodities that are exported experience greater increases in instability than those that are not. Similarly for internationally traded commodities in general, for commodities with government price supports, for those which are predominately processed and various other characteristics suggested by this group of hypotheses.

Two forms of the dependent variable (ie the increase in instability) were used, namely the proportional (or ratio) increase and the absolute increase in instability. These two formulations were tried for the instability growth of both quantity and price.

The dependent variables for these regressions are:

QINC32 proportional increase in quantity instability
between 1961-71 and 1972-82
DQINC32 absolute increase in quantity instability
PINC32 proportional increase in price instability
DPINC32 absolute increase in price instability

The independent variables are as follows:

SDDQ quantity instability
SDDPD price instability
MDQ average rate of quantity growth
MDPD average rate of growth in prices
GVP gross value of production
PROC percentage of production which is processed
M dummy for an import commodity
X dummy for an export commodity
ANN dummy if commodity is annual rather than perennial
DS dummy for commodities with government price supports
DF dummy for markets with futures markets
DMO dummy for markets with federal marketing orders
DVOL dummy for markets with marketing orders that include volume management provisions
DMF dummy for markets with marketing orders that include market flow provisions

The regression procedure used was as follows. Initially all variables were included in the regression. Then those which provided the least explanatory power were excluded and a model was selected which included most of the variables of interest and which had a reasonable statistical fit. It is recognized that this two stage procedure makes the significance of the statistical tests, as applied to subsequent models, of less accuracy as such tests assume one and only one attempt at a model. However the purpose in this study is primarily explorative so that the strict statistical method is not entirely appropriate (Leamer, 1983). Hence I will also present model formulations which add to the understanding of the underlying relatonships. Consequently at least two models will be presented in each case: one including all variables and others including only those variables with a high degree of explanatory power or interest.

7.4.1 FACTORS BEHIND THE INCREASE IN QUANTITY INSTABILITY

Of the two different formulations (ie proportional instability increase and absolute instability increase), the former formulation appeared to be a little better and it is those results that are presented in Table 7.6. However neither formulation provided a great deal of explanatory power. Clearly other factors, perhaps mostly commodity specific, are important in explaining differences in growth in instability. In these models the variable with the most explanatory power is the export dummy. The second model indicates that products which were not exported had very little change in their instability between the two periods while those that were exported experienced about a 70% increase in quantity instability. The third model confirms the importance of international trade as a source of instability by showing that import commodities also experienced more instabililty in production than those which were not. Hamm's hypothesis is also supported by this data. When allowance is made for the other variables in these models the more processed a commodity was in marketing then the greater the growth in instability in this period. For example, fresh market vegetables did not experience the growth in instability that processing vegetables did. This provides further support for the finding that risk is being

Table 7.6

REGRESSION COEFFICIENTS EXPLAINING INCREASE IN QUANTITY INSTABILITY:[1/] 1961-71 TO 1972-82

Independent Variables[2/]	Model 1		Model 2		Model 3	
	Coefficient	t-Value	Coefficient	t-Value	Coefficient	t-Value
CONS	.973		1.077		.991	
SDDQ	.010	1.05			.008	1.15
SDDPD	-.005	-.47				
MDQ	-.029	-1.44			-.027	-1.47
MDPD	.020	.33				
GVP	-10.3	-.46				
PROC	.025	.99			.017	.89
DM	.218	1.09			.134	.80
DX	.704	2.57	.715	3.57	.644	3.07
ANN	.083	.44				
DS	-.015	-.06				
DF	-.022	-.08				
DMO	-.365	-1.52			-.295	-1.91
DVOL	.011	.04				
DMF	.286	.97				
Mean	1.17		1.17		1.17	
$\bar{R}^2$, F[3/]	.09	1.50	.15	12.71	.19	3.57

[1/]The dependent variable in each model is the ratio of the square roots of the INS measures for 1972-82 over 1961-71. Hence, a value of 1.00 represents no change in instability between the two periods. Values greater than 1.00 represent an increase in instability and less than 1.00, a decrease.

[2/]A fuller description of the variables is given in Appendix B.

[3/]Measures of fit are the corrected R^2 values and the F-statistic.

shifted towards the farmer. It is interesting that this is occurring with production and it will be seen in the next section that this is true for price as well. Processed commodities, especially vegetables, are often grown under production contracts which facilitate an increase in instability being transferred to the farm sector through quantities as well as through prices.

This study provides no support for the contention that expansion of production on to marginal lands has been a factor contributing to added instability. Models 1 and 3 show that those commodities with the strongest growth (i.e., high MDQ) have, on the contary, exhibited lesser increases in instability rather than the reverse as suggested by the hypothesis.

Also commodities covered by marketing orders apparently did not experience the general increase in instability. In fact they had a decrease in instability in the period. Does this suggest that marketing orders are becoming more effective over time? The first model shows that those commodities with volume management or market flow provisions may have had less improvement than those without such provisions. However these results have low statistical significance and not much confidence should be placed on them. There is some evidence from this study though, that marketing orders may have contributed to greater stability of production over this period.

Table 7.7

REGRESSION COEFFICIENTS EXPLAINING INCREASE IN PRICE INSTABILITY: 1961-71 TO 1971-82

Independent Variables	Model 1 Coefficient	Model 1 t-Value	Model 2 Coefficient	Model 2 t-Value	Model 3 Coefficient	Model 3 t-Value
CONS	.452		.441		.454	
SDDQ	-.006	-.37				
SDDPD	.030	1.51	.027	1.95	.024	1.65
MDQ	.003	.08				
MDPD	-.033	-.31				
GVP	-31.5	-.82			-37.2	-1.19
PROC	.120	2.82	.125	3.96	.126	3.84
DM	.302	.88			.325	1.02
DX	.336	.72			.416	.98
ANN	.566	1.74	.555	2.06	.567	1.93
DS	.647	1.44	.730	2.05	.589	1.44
DF	-.134	-.29				
DMO	.779	-1.89	-.700	-2.35	-.740	-2.45
DVOL	.286	.55				
DMF	.171	-.34				
Mean	1.70		1.70		1.70	
$\bar{R}^2$, F	.30	3.03	.37	8.79	.36	5.74

7.4.2 FACTORS BEHIND THE INCREASE IN PRICE INSTABILITY

The same sort of analysis can be applied to price instability. These results are presented in Table 7.7. The explanatory power of the variables is somewhat better, perhaps because price is partly the mechanism through which information for production decisions is derived. Hence the relationship is closer for price than quantity. Also instability arising from yield is not included in the variables to explain production instability.

As with quantity, the regressions explaining the relative increase in instability showed marginally better statistical properties than those explaining absolute increases. In addition, models with the dependent variable being the absolute increase in instability gave a high explanatory role to the price instability term (SDDPD) which is evidence of misspecification. For these reasons models with proportional dependent variables are used in this analysis.

This analysis fails to identify the trade variables as very significant contributors to the explanation of increased price instability. Model formulations that include the trade variables do show that traded commodities did experience an increase in price instability. In particular, the third model indicates that both exported and imported commodities experienced large increases in instability relative to non-traded commodities, when allowance is made for other variables in that regression equation, but they are not significant at the 10% level. Instead commodities with government price supports showed significant increases in price instability in this period. There is some correlation between the export and support dummies: many exported commodities are also subject to government price supports. However the simple correlation coefficient is only .48 which is suggestive that multicorrelation is not likely to be an overwhelming problem for interpretation. So it would appear that supported commodities have experienced an increase in price instability that can not be traced only to the tendency of such commodities to be exported in less stable markets. This analysis is suggestive that changes in government price supports have been a significant factor behind the increase in price instability in American agriculture in the 1970s and 1980s. By contrast, this does not seem to have been an important factor behind the increase in quantity instability noted in the last section. There it was clear that export commodities had experienced an increase in instability not explained by the existence of price supports.

This analysis of the sources of increased price instability confirms the Hamm hypothesis discussed in the last section. Again it is clear that the commodities which had more of their production being processed experienced a significant increase in instability. This is consistent with the suggestion that risk is being shifted towards producers.

In the last section it appeared that commodities with marketing orders experienced a decrease in quantity instability in the 1970s relative to those commodities not under such orders. This analysis of increases in price instability parallels this result. These commodities did not have the increase in price instability to the extent that commodities not under such orders did. Again this is suggestive that such orders are being more effective in fulfilling their market stabilizing objective.

The significantly higher growth in price instability for annual rather than perennial commodities can be explained in the following way. It probably reflects the greater importance of longer term production factors for perennial crops (mainly fruits and nuts) over shorter run 'market' factors. In particular, perennial crops were already more unstable than annuals in the first period and it is possible that the major factor behind their instability is yields which are unlikely to have shown any increase in variability between the two periods. Table 7.6, Model 1 also indicates some lower increase in quantity instability of perennial crops but it is not statistically significant.

Some limitations to this study should be noted. First, although it is not surprising that cross-sectional regressions across commodity markets should not have very high explanatory power, (because commodity specific

characteristics will also be important explanators,) the implication is that there must be omitted variables. Hence there will be some bias to the estimated coefficients. In addition the chosen variables will often be highly correlated with other omitted variables where the real cause of the estimated relationship is to be found. Second, the results are dependent on both the measure of instability selected for the study and on the time periods chosen.

7.5 SUMMARY AND CONCLUDING COMMENTS

The analysis of this chapter provides some perspective on the extent, location and sources of increasing market instability in agriculture.

It is clear that the increase in instability in the recent period is, to some measure, a recovery from a decline in instability in the previous period. However the increases in price instablity far outweighed the previous decreases. The evidence on quantity instability in this respect is ambiguous. Despite this, there is a significant relationship between quantity and price instability. Moreover the recent increases in instability have been quite general across different commodity groupings, notwithstanding much greater increases for field crops and, to a lesser extent, for animal products.

The cross-sectional analysis has allowed investigation of various of the hypotheses advanced to explain increasing

instability in agricultural commodity markets. In addition it has provided some additional ones for study. It is interesting and encouraging that there is a measure of agreement between the factors explaining quantity and price instability. It might be expected that some agreement would exist because price is an important market coordinating mechanism, but it is not the only mechanism, so differences can be expected.

The analysis described in this section gives support for the role of international trade as a contributor towards the increase in production instability of the 1972-82 period. Both export and import commodities experienced increased price instability although not at significant levels. However quite a number of the hypotheses could explain this relationship. The fact that export commodities seem to have been more strongly affected than import industries may give some credence to the hypotheses that source instability in external export demand or in export embargos - the only suggested hypothesis which would operate solely on the export side of the international market. However differences are small and not too much weight should be put on such a conclusion. On the contary, the fact that price instability has increased in both import and export markets is suggestive of macroeconomic sources.

The analysis is also supportive of the contention that government price support policies have contributed to the

increase in price instability in the same period. This seems to be in addition to the international trade effect. Moreover, the data gives support to Hamm's conclusions that the processing sector is passing back instability to the farm sector. However, the study provides no support for the hypothesis that extension of production onto marginal lands lies behind increased instability. Another conclusion of this study is that commodities under marketing orders have not experienced the growth in instability that has characterized commodities not covered by such orders. This has been true of both production and price instability. This is supportive of the contention that marketing orders have had some success as a stabilizing mechanism.

Chapter 8

CONCLUSIONS AND IMPLICATIONS

8.1 RATIONALE FOR STUDY AND APPROACH

Instability is a major problem facing American agriculture. This dissertation has been dedicated to the examination of the meaning, the extent, and sources of instability. In doing so a diagnostic and heuristic approach is used. The foci of the study are the identification of possibly poorly coordinated markets which may be amenable to more orderly marketing arrangements, and also of marketing arrangements that may explain the instability of current commodity markets.

In a world characterized by the conditions for perfect competition, the observed variability of prices and quantities would be a response to the changing supply and demand conditions underlying the market. These prices would simultaneously efficiently allocate ex post production and provide appropriate market signals for future production decisions. However, the world does not have these characteristics. Rather market transactions are expensive, uncertainty is pervasive and information is costly. As a result market signals, provided by prices received for already produced production, are inefficient and biased for the making of future production decisions. (There are other economic reasons why instability is problematical for market coordination and these are discussed in Chapter 3.) Under these real world conditions instability is both a consequence of and a contributor to a lack of orderly marketing. It is a contributor, because it serves to increase the cost of information acquisition for decision making, thereby enhancing the prospect of the divergence between the ex post allocation and the ex ante signalling functions of prices. It is a consequence, because it is reflective of poor coordination in the food marketing chain, both from the making of wrong decisions and from poorly performing marketing institutions. For these reasons instability can be considered as one proxy measure for market coordination. Thus it can be used to compare the performance of alternative marketing institutions.

There is, however, no agreed upon concept or generally acceptable variable for the measurement of instability. A measure (called here INS for lack of a suitable name) is developed, which has certain desireable properties for this study. In particular it has characteristics of being both a measure of variability and of predictabilty. In addition, it is a detrended dimensionless measure, that can be used to compare different commodities at different time periods, and is readily decomposed among multiplicative components. This is useful for the analysis of the yield and area components of production in Chapter 6 and for the modelling of supply

and demand shifters in the same chapter. It is also a useful measure for exploring, by means of cross-sectional regression analysis, the sources of instability (in Chapter 6) and of increases in instability (in Chapter 7).

8.2 MAJOR FINDINGS

The analysis in the dissertation provides support for the following findings (with the sections where they are discussed):

1. There are very large differences in the degree of price and quantity instability among different commodities. When a composite measure is used, a thirteen-fold range in instability between the least unstable and most unstable commodities is observed (section 5.4).

2. Agricultural instability is large relative to other sectors of the economy (section 5.10).

3. For annual crops, yield instability (which may be thought of as mainly 'uncontrollable') is less important than area instability (which is mainly 'controllable'). Hence for these commodities there is evidence that most of the observed production instability is due to decisions made by producers (section 6.3).

4. Many commodities exhibit marked correlation between area and yield instability (section 6.3).

5. The demand shifters, population and income, and a supply shifter, aggregate input prices, contribute only a negligible proportion of the total annual price and quantity instability observed in commodity markets (section 6.4).

6. Institutional factors are important determinants of the differences in observed instability among commodities. Thus the empirical evidence is that institutional arrangements of markets do matter for instability; and hence the institutional structure of markets is a relevant concern for policy directed at the coordination of supply with demand (section 6.5).

7. For example, commodities with futures markets exhibit greater price instability, but not quantity instability, than those without futures markets (section 6.5.5).

8. In addition, commodities under federal marketing orders are less stable than commodities without such orders. However, whilst other commodities showed an increase in instability between 1961-71 and 1972-82, this was less true of those with orders. Thus, the study provides evidence that marketing orders may not have been very successful stabilizing instruments, but have nonetheless been a moderating influence in the latter period. In addition, it would seem that the different types of orders had differential effects on instability (sections 6.5.6 and 7.4).

9. The analysis indicated that processed commodities experienced a greater increase in instability relative to other commodities. This provides some empirical support for Hamm's conclusion that marketing risk is being transferred back towards farmers within the marketing chain. This is likely to be more pronounced for processed commodities which are often produced under contracting arrangements where this shift may be facilitated (sections 7.3.8 and 7.4.1).

10. There has been an increase in instability between 1961-71 and 1972-82. However, the increase has been much more pronounced for prices than for quantities. In addition, the small increase in quantity instability represents a partial return to that existing in the previous decade. Price instability in the most recent period is, however, much greater than that of the 1950's (section 7.2.1).

11. The increase in price instability has been widespread among commodity groups. However it is the field crops and, to a lesser extent animal products, that have demonstrated the largest increase in instability. Increases in quantity instability have also been most pronounced in these commodity groups (sections 7.2.2 and 7.2.3).

12. Trade provides some of the explanation for these increases in instability. In particular export commodities showed marked increases in quantity instability (sections 7.3.1 and 7.4)

13. This study also provides evidence that changing government price support policies have been important contributors to changing instability (sections 7.3.4 and 7.4).

14. Perennial crops are more unstable than annual crops.

15. The study provides evidence that instability begets instability. First, the commodities with unstable yields also have unstable plantings. In addition, price and area instability are related to a greater extent that can be accounted for by demand relationships alone. Thus, it would appear that instability makes the possibility of wrong decisions more likely, thereby exacerbating the problem (sections 6.3 and 6.6).

16. The general increase in instability is indicative of macroeconomic causes. However, the wide differences between commodities and the explanatory power of other sources, provides evidence that macroeconomic causes can not be the reason for most of the increase (sections 7.3.2 and 7.4).

8.3 SOME IMPLICATIONS

1. A clear implication of this research is that the form of marketing institutions is important in determining the instability of markets.

2. In addition it is clear that decisions made by producers are an important source of the instability of agriculture. For annual crops, area instability dominated yield instability implying that most of production instability is potentially controllable.

3. The analysis and discussion in this dissertation is suggestive that the INS measure of instability, developed in this study, appears to be one reasonable proxy for measuring the effectiveness of market coordination.

4. The covariances between areas and yields are often quite large, so that the common procedure of estimating each component separately in many econometric models may not be appropriate. In addition, these covariances imply that attempts to reduce the instability of one component must also take account of the other, if it is desired to reduce production instability.

8.4 FUTURE RESEARCH

1. The present study has investigated the instability of prices and quantities on the assumption that these are the parameters of interest in marketing. It would also be of interest to investigate the stability of gross revenue. It may be that marketing orders, for example, are more effective in stabilizing gross revenue than either prices or production. Moreover, producers may have some interest in planting those commodities with relatively stable gross

revenues, even though prices and quantities may be relatively unstable.

2. The present study shows that instability is a many faceted concept and to summarize it in one measure ignores other aspects. In particular, intraseasonal instability is not treated in this study. For many commodities the intraseasonal coordination problem is of greater concern for orderly marketing policy. Moreover, it is possible that federal marketing orders and futures markets are more successful in their stabilizing role within seasons than between seasons. By concentrating on annual instability measures this study necessarily avoids issues pertaining to more frequent coordination problems. Clearly the present analysis could, with modification, be extended to the analysis of intraseasonal instability.

3. Another extension of the present study would be to consider a different annual measure, such as the coefficient of variation about a trend. Such a study would not only adduce the relative robustness of these results but also throw some light on alternative aspects of instability. The analysis and discussion of Chapter 4 showed that the CVT measure had quite different qualities to the INS measure, so that if similar conclusions were obtained to those of this study then this would be very supportive of the conclusions of the present analysis.

4. This study concentrates on crops, especially annual crops. The decision to do so partly reflects data availability and partly ease of comparison between commodities. It may be useful to extend the study to consider animal products more carefully. Yield factors are less important for animal products. Moreover, the dynamics of the production process are such that for many of these industries decisions must be made whether the output is sold or reinvested into producing stock. This produces a dynamic process which is well documented elsewhere (eg see Offutt 1982 for a review) but is distinctly different from those for crops.

5. It was mentioned that sometimes one source of instability in a commodity market can be found in another commodity market. This is particularly evident in livestock industries, where crop inputs, such as corn, make up a large proportion of total input costs. In addition the cyclical instability of the larger animal industries creates instability of those substitutes in consumption such as chicken. Production substitutes can also lead to the inter-commodity transfer of instability. Much of the instability observed in sorghum production appears to be a result of the wheat program, where sorghum is grown when wheat is not. These interrelationships between markets, as sources of instability, are probably best studied using one of the large econometric models that include livestock and policy variables (eg the MSU model or FAPSIM).

6. The INS measure allowed the ranking and quantification of the instability of many commodities. Each commodity had its own production and institutional characteristics. If a similar analysis was performed for many commodities and across countries, then some control could be made for the unique production characteristics of each commodity. Thus an intercountry comparison could provide a greater test of the influence of institutional characteristics where they differ between countries. For example, if some commodity was highly unstable in the US but very stable in another country, it would be of interest to see how the production, institutional and economic characteristics differed between the two nations. If the major differences were institutional and susceptible to policy, then an analysis of the impacts of these differences could be very useful. An intercountry analysis will therefore be likely to raise interesting hypotheses for study.

7. The present study raises some doubts about the efficacy of futures markets for reducing annual price instability. This is a significant and perhaps disturbing finding of the dissertation and is worthy of more study. Often the establishment of futures markets are commended as appropriate means of promoting price discovery, and market coordination, and reducing instability (e.g., Newbery and Stiglitz, 1981). However, research on the issue tends to be done with relatively short-run data. Longer-run data is less

often analyzed. It would be of interest to see if a shorter-run instability measure showed less price instability for markets with futures.

It is of interest that some before-and-after time series studies of the influence of futures markets on cash prices were done in the early 1970s (eg Powers 1970). At that time it appeared that there was a decline in price instability for those commodities for which futures markets had been established during the period of observation. However, the present study notes that most commodities were experiencing reduced price instability at the time, whether or not they had futures markets. It seems opportune therefore to redo some of this research now that price instability has again increased, but now controlling for the changes evident in other commodity markets.

8. Marketing orders also are under fire as an appropriate institution. The present study does not provide strong evidence that they are particularly efficacious in promoting stability. Close attention to some particular commodities is called for to consider whether they really are effective in their role.

9. A contribution of this dissertation is to identify commodity markets that exhibit marked year-to-year instability and that therefore may be candidates for institutional reform to improve their orderly marketing or market coordination. Many of the commodities in the top

quartile of Table 5.2, particularly those that are annuals, could be profitably analysed as individual sub-sector studies. In doing so, the reasons for their individual instability might be determined and possible policy proposals to improve their market coordination evaluated.

In addition, it may be useful to examine particularly stable commodities to determine what institutional arrangements contribute to their stability. Such arrangements may provide a model for other industries. The floriculture crops (chrysanthemums, hybrid tea roses), included in this study, provide an example of candidates in this category.

APPENDICES

APPENDIX A

COMMODITY CODES AND DATA COVERAGE

In this appendix a listing is given of the coverage of the commodity data. The code used for each commodity is provided with the commodity name. In addition, the availability of area, price and quantity data is given, along with the length of the time period used in the analysis. An asterisk indicates data availability. In general, data were sought for the 33 year period 1950-82; and in most cases this length of data was were was available. However, some commodity data did not extend this far back, and more commonly, data collection was terminated for many commodities in 1981. Hence not all commodities have data for the full time period. As mentioned in Chapter 6, for some commodities areas are reported on an area for harvest basis while for others the area is area harvested. (See Agricultural Statistics 1981, p151). Those commodities where the area is 'area for harvest' are marked with a double asterisk in the following listing. The sources of the commodity data for the study are various issues of Agricultural Statistics.

Table A.1

COMMODITY CODES, TYPE AND DATA COVERAGE

CODE	COMMODITY	AREA	QUANTITY	PRICE	PERIOD
ALF	Alfalfa seed	*	*	*	1966-80
ALM	Almonds		*	*	1950-82
APP	Apples		*	*	1950-82
APR	Apricots		*	*	1950-82
ART	Artichokes	**	*	*	1950-81
AS	Asparagus	*	*	*	1950-81
AVO	Avocardos		*	*	1950-82
BAN	Bananas	*	*	*	1968-82
BB	Bushberries	*	*	*	1966-79 1
BC	Brocolli	**	*	*	1950-82
BET	Beetroot	*	*	*	1950-81
BF	Beef		*	*	1950-82
BR	Broilers		*	*	1950-82
BRU	Brussel sprouts	**	*	*	1950-81
BY	Barley	*	*	*	1950-82
CAR	Carnations		*	*	1968-81
CB	Cabbage	**	*	*	1950-81
CE	Celery	**	*	*	1950-82
CHS	Sweet cherries		*	*	1950-82
CHT	Tart cherries		*	*	1950-82
CN	Corn	*	*	*	1950-82
COT	Cotton	*	*	*	1950-82
CP	Canteloupe	**	*	*	1950-81
CR	Cauliflour	**	*	*	1954-82
CRB	Cranberries	*	*	*	1950-82
CT	Carrots	**	*	*	1950-82
CTS	Cottonseed	*	*	*	1950-82
CUF	Fresh cucumbers	**	*	*	1950-81
CUP	Processing cucumbers	*	*	*	1950-81
CYM	Minature Chyrsanthemums		*	*	1956-81
CYP	Potted Chyrsanthemums		*	*	1956-81
CYS	Chyrsanthemums		*	*	1956-81
DAT	Dates		*	*	1950-82
DBE	Dry edible beans	*	*	*	1959-82
DEW	Honeydew melons	**	*	*	1950-82
DPE	Dry edible peas	*	*	*	1950-81
EG	Eggs		*	*	1950-82
EGP	Eggplant	**	*	*	1950-81
ESC	Escarole	**	*	*	1950-81
FIG	Figs		*	*	1950-82
FIL	Filberts		*	*	1950-82
FLX	Flaxseed	*	*	*	1950-82
GAR	Garlic	**	*	*	1950-81
GP	Green Peppers	**	*	*	1950-81

1 Quantity data 1966-82

Table A.1 (cont'd)

CODE	COMMODITY	AREA	QUANTITY	PRICE	PERIOD
GPF	Grapefruit		*	*	1950-82
GRP	Grapes		*	*	1950-82
HAY	Hay	*	*	*	1950-82
HON	Honey		*		1950-82
HOP	Hops	*	*	*	1950-82
LEM	Lemons		*	*	1950-82
LIM	Limes		*	*	1950-82
LM	Lamb and mutton		*	*	1950-82
LMA	Lima beans	*	*	*	1950-81
LT	Lettuce	*	*	*	1950-82
MAC	Macadamia Nuts	*	*	*	1950-82
MAP	Maple Sirup		*	*	1950-81
MK	Milk		*	*	1950-82
MUS	Mushrooms	*	*	*	1966-71
NEC	Nectarines		*	*	1950-82
OCH	Other chicken		*	*	1950-82
OLV	Olives		*	*	1950-82
ON	Onions	**	*	*	1950-82
ORG	Oranges		*	*	1950-82
OT	Oats	*	*	*	1950-82
PAP	Papaya	*	*	*	1950-82
PCH	Peaches		*	*	1950-82
PEA	Green peas	*	*	*	1950-82
PEC	Pecans		*	*	1950-82
PEN	Peanuts	*	*	*	1950-82
PEP	Peppermint	*	*	*	1950-82
PIN	Pineapple		*		1968-82
PK	Pork		*	*	1950-82
PLM	Plums		*	*	1959-82
PO	Potatoes	*	*	*	1950-82
POM	Pomergranites		*	*	1968-82
POP	Popcorn	*	*	*	1950-81
PRN	Prunes		*	*	1959-82
PRS	Pears		*	*	1950-82
RIC	Rice	*	*	*	1950-82
ROS	Hybrid tea roses		*	*	1968-81
RYE	Rye	*	*	*	1950-82
SB	Soybeans	*	*	*	1950-82
SBF	Fresh snap beans	*	*	*	1950-81
SBP	Processed snap beans	*	*	*	1950-82
SCF	Fresh sweet corn	**	*	*	1950-82
SCP	Processed sweet corn	**	*	*	1950-82
SG	Sorghum	*	*	*	1950-82
SGB	Sugarbeet	*	*	*	1950-81
SGC	Sugarcane	*	*	*	1954-81 2
SPF	Fresh Spinach	**	*	*	1950-81
SPP	Processed Spinach	*	*	*	1950-81
SPR	Spearmint	*	*	*	1950-82

2 Quantity data 1954-82

Table A.1 (cont'd)

CODE	COMMODITY	AREA	QUANTITY	PRICE	PERIOD
STW	Strawberries	**	*	*	1950-82
SUN	Sunflower seeds	*	*	*	1950-82
SWP	Sweet potato	*	*	*	1950-82
TAR	Taro	*	*	*	1950-82
TEM	Temples		*	*	1955-82
TGL	Tangelos		*	*	1955-82
TGR	Tangerines		*	*	1950-82
TK	Turkey		*	*	1950-82
TOB	Tobacco	*	*	*	1950-82
TOF	Fresh Tomatoes	**	*	*	1950-82
TOP	Processed Tomatoes	*	*	*	1950-82
VL	Veal		*	*	1950-82
WAL	Walnuts		*	*	1950-82
WAT	Watermelons	**	*	*	1950-81
WH	Wheat	*	*	*	1950-82
WOL	Wool	*	*	*	1950-82

APPENDIX B

DEFINITION OF VARIABLES USED IN TABLES AND REGRESSIONS

The purpose of this appendix is to list and define the variables used in the tables and in the regression analysis throughout this dissertation.

ANN (or ANNUAL) is a dummy for agricultural commodities with a production period of one year or less. Annual crops fall in this category while perennial tree crops do not. Livestock products with short production periods such as eggs, broilers are classed as 'annual'; whilst beef and hogs are not placed in this category.

COV2AY is twice the covariance of annual percentage increases in areas and yields. It represents the interaction term. This term with VARDA and VARDY add to VARDQ

CVTP is the coefficient of variation about a linear trend for nominal prices, for the period 1950-82.

CVTPD is the coefficient of variation about a linear trend for real (deflated) prices, for the period 1950-82.

CVTPDI is an index of real price instability formed by dividng the CVTPD value for a commodity by the mean for all commodities.

CVTQ is the coefficient of variation about a linear trend for production, for the period 1950-82.

CVTQI in an index of quantity instability formed by dividing the CVTQ value for a commodity by the mean CVTQ for all commodities in the study.

DF (or DFUTURE) is a dummy for commodities with operating futures markets in 1980. These commodities are listed in Agricultural Statistics.

DM (or DIMPORT) is a dummy for commodities which were imported in 1980. Import proportions vary substantially from year to year. In addition, it is often difficult to determine the actual proportion when production and imports are measured in different physical forms or units. Moreover it was hypothesized that there would be differences in price formation for imported and non-imported commodities which would not be dependent on proportions imported but rather on whether imports existed or not. Hence the dummy was chosen rather than a variable.

DMF (or DMKTFLOW) is a dummy for those commodities under federal marketing orders that have market flow provisions.

DMO (or DMORDER) is a dummy for all those commodities with any form of federal marketing order in 1980. A listing of these is provided in Heifner et al (1981).

DS (or DSUPPORT) is a dummy for those commodities with price supports in 1980.

DVOL (or DVOLMAN) is a dummy variable for commodities with federal marketing orders that have volume management provisions.

DX (or DEXPORT) is a dummy for export commodities. However most US agricultural commodities are exported but in small quantities. For example, many fruit and vegetables are exported to Canada. Where small proportions of the crop were exported it seems unlikely that that these markets would perform appreciably differently from markets for non-exported commodities. Hence the dummy was used only for commodities where more than 10% of production was exported in 1980.

DPINC32 is the absolute increase in the SDDPD measure between 1961-71 and 1972-82.

DQINC32 is the absolute increase in the SDDQ measure between 1961-71 and 1972-82.

GVP is the gross value of production of the commodity in 1980. It is therefore a measure of the relative economic importance of the commodity.

INSTAB is half the sum of SDDQ and SDDPD each divided by their means. Thus this measure has a mean of 1.0 and represents a composite INS measure of market

instability where real prices and quantities are given equal weights.

MDPD (or MEANDPD) is a measure of the average annual increase in real prices over the period for which the instability measure is calculated. It is the average rate of growth about which the variance of annual percentage changes is calculated for the SDDPD instability measure.

MDQ (or MEANDQ) is the comparable measure for production growth.

PINC32 is the proportional increase in the instability or real prices between the periods 1961-71 and 1972-82. This is the ratio of the SDDPD measures for the latter period over the former. It is therefore a relative measure of the increase in instability. A value of 1.00 is indicative of no change; whilst values above 1.00 represent an increase in instability and values below 1.00 a decrease in instability.

PINSTAB is a measure of price instability based on both the CVT and INS measures. It is half the sum of SDDPD and CVTPD each divided by their means.

PROC (or PROCESS) is the proportion of the commodity processed in 1980. Proportions are rounded down to the nearest decile, so that they range from 0 to 9.

PQINSTAB is an aggregate measure of market instability. For each commodity, it is a quarter of the sum of SDDQ, SDDPD, CVTQ and CVTPD, each of which is divided by their means. Thus it gives equal weight to the INS and CVT measures and equal weight to real price and quantity instability. The average commodity has a value of 1.0 with more unstable commodities having higher values and less unstable having lower values.

QINC32 is the comparable measure to PINC32 for the increase in production instability.

QINSTAB is a measure of instability based on both the CVT and INS measures. It is half the sum of SDDQ and CVTQ each divided by their means.

SDDA is a measure of area instability comparable to the SDDQ and SDDPD measures. It is the square root of VARDA.

SDDPD is a measure of real price instability. It is the square root of the INS measure for real prices, namely VARDPD, for 1950-82 or for the available period.

SDDPDI is an index of real price instability created by dividing the SDDPD value by its mean.

SDDQ is a measure of quantity instability. It is the square root of the INS measure for the 33 year period 1950-1982 or for the available period. See Chapter 4 for the derivation of this measure.

SDDQI is an index of the above measure made by dividing the SDDQ value for each commodity by the mean value for all commodities.

TYPE is a code for the commodity group; the commodities are grouped as follows :

1 tree fruit
2 tropical and subtropical fruit
3 berries, vines and mushrooms
4 mints, oils and sweeteners
5 tree nuts
6 vegetables
7 field crops
8 animal products
9 floriculture

VARDPD is the INS measure for deflated prices, for the 1950-82 period.

VARDPD1 is VARDPD applied to the 1950-60 period.

VARDPD2 is VARDPD applied to the 1961-71 period.

VARDPD3 is VARDPD applied to the 1972-82 period.

VARDQ is the INS measure for production for the 1950-82 period. See Chapter 4 for details of the measure and its derivation.

VARDQ1 is VARDQ for the period 1950-60.

VARDQ2 is VARDQ for the period 1961-71.

VARDQ3 is VARDQ for the period 1972-82.

VARDY is the INS measure for yield for the period 1950-82.

VARDA is the INS measure for area for the period 1950-82.

APPENDIX C

INSTABILITY MEASURES BY COMMODITY

This appendix provides a number of instability measures for the commodity set of this study. These are shown in Table C.1. The definition of each measure is given in Appendix B.

Table C.1

INSTABILITY MEASURES BY COMMODITY

CASE-NO	COMNAME	QINSTAB	PINSTAB	PQINSTAB	SDDQI	SDDPDI	CVTQI	CVTPDI
1	OLIVES	3.24	2.02	2.63	3.92	2.37	2.56	1.66
2	AVOCARDO	2.76	2.33	2.54	2.66	2.67	2.86	1.98
3	SUNFLOWR	3.09	1.81	2.45	2.53	1.52	3.66	2.10
4	TRT CHER	1.94	2.57	2.25	2.28	2.84	1.61	2.30
5	PECANS	2.54	1.65	2.09	3.13	1.98	1.95	1.31
6	DRY PEAS	2.10	1.86	1.98	2.41	1.71	1.79	2.00
7	ALMONDS	2.34	1.57	1.96	2.21	1.70	2.48	1.45
8	TEMPLES	1.61	1.67	1.64	1.81	1.79	1.41	1.55
9	SPEARMNT	1.94	1.32	1.63	1.84	1.18	2.03	1.47
10	FLAXSEED	1.79	1.44	1.61	2.08	1.25	1.50	1.63
11	LIMES	1.66	1.48	1.57	1.53	1.53	1.79	1.43
12	FILBERTS	2.17	.97	1.57	2.64	1.07	1.71	.86
13	POPCORN	1.61	1.39	1.50	1.89	1.02	1.33	1.75
14	TANGELOS	1.49	1.50	1.49	1.43	1.48	1.55	1.53
15	GARLIC	1.93	1.03	1.48	1.66	.92	2.21	1.14
16	BUSH BER	1.09	1.86	1.47	1.08	1.99	1.11	1.72
17	RYE	1.70	1.14	1.42	1.50	.96	1.89	1.31
18	TANGERIN	1.45	1.31	1.38	1.77	1.38	1.13	1.25
19	PAPAYA	1.60	1.15	1.37	1.31	1.19	1.88	1.11
20	LEMONS	1.25	1.48	1.36	1.38	1.59	1.13	1.37
21	PRUNES	1.46	1.26	1.36	1.79	1.31	1.13	1.20
22	CTONSEED	1.20	1.49	1.35	1.28	1.42	1.13	1.55
23	APRICOTS	1.58	1.10	1.34	1.87	1.25	1.29	.95
24	DRY BEAN	1.00	1.68	1.34	.91	1.55	1.08	1.80
25	SORGHUM	1.58	1.08	1.33	1.76	.91	1.39	1.26
26	POMERGRN	1.40	1.25	1.33	1.72	1.49	1.09	1.00
27	SUGARCAN	.54	2.07	1.31	.50	1.73	.58	2.41
28	PLUMS	1.32	1.24	1.28	1.47	1.55	1.17	.94
29	ORANGES	1.06	1.48	1.27	1.02	1.38	1.09	1.58
30	VEAL	1.24	1.28	1.26	1.09	1.21	1.40	1.36
31	NECTARIN	1.30	1.14	1.22	1.10	1.10	1.49	1.19
32	PEPPERMT	1.09	1.34	1.22	.91	1.10	1.27	1.59
33	PEARS	1.05	1.36	1.20	1.21	1.48	.89	1.24
34	WALNUTS	1.21	1.16	1.18	1.09	1.30	1.33	1.02
35	FIGS	.90	1.39	1.14	1.00	1.29	.79	1.49
36	ONIONS	.50	1.76	1.13	.57	2.09	.43	1.42
37	GRAPEFRT	.76	1.49	1.13	.73	1.50	.78	1.49
38	POTATO	.49	1.76	1.12	.55	1.94	.43	1.58
39	SUGARBET	.87	1.34	1.10	.85	1.22	.89	1.46
40	COTTON	1.23	.96	1.09	1.32	.90	1.14	1.03
41	SWT CHER	1.25	.93	1.09	1.47	1.03	1.03	.84
42	GRAPES	.98	1.20	1.09	1.10	1.20	.86	1.21
43	WOOL	.52	1.64	1.08	.26	1.70	.78	1.59
44	WHEAT	.92	1.20	1.06	.85	1.06	.99	1.34
45	DATES	.97	1.15	1.06	1.08	1.05	.86	1.25
46	RICE	.90	1.19	1.05	.75	1.13	1.05	1.25
47	SWT POT	.92	1.15	1.04	.91	1.25	.92	1.06
48	MACADAMI	1.45	.61	1.03	.80	.52	2.10	.70
49	ALFALFA	.74	1.30	1.02	.82	1.26	.66	1.34
50	BARLEY	.89	1.12	1.00	.86	.87	.92	1.36
51	SOYBEANS	.90	1.03	.97	.80	.88	1.01	1.18
52	CRANBERR	.67	1.24	.96	.70	1.09	.64	1.39
53	CABBAGE	.57	1.28	.92	.61	1.52	.53	1.03
54	PR TOMAT	1.08	.76	.92	1.24	.66	.93	.85
55	CORN	.74	1.06	.90	.69	.87	.78	1.24
56	OATS	.81	.97	.89	.88	.84	.74	1.11
57	ARTICHKE	1.01	.76	.89	1.01	.71	1.02	.82
58	HOPS	.96	.75	.85	.80	.58	1.11	.92
59	HONEYDEW	1.09	.57	.83	.78	.66	1.41	.48
60	BROCCOLI	1.30	.35	.83	.84	.29	1.76	.40
61	APPLES	.56	1.08	.82	.55	1.16	.56	1.00
62	LAMB MUT	.77	.86	.82	.48	.64	1.07	1.08
63	BRUS SPR	.91	.68	.80	1.03	.66	.79	.70
64	FR SPNCH	1.15	.44	.80	.63	.41	1.68	.47
65	BEETROOT	1.01	.58	.79	1.05	.51	.96	.64
66	PORK	.49	1.08	.79	.51	1.08	.48	1.07
67	EGGPLANT	.74	.79	.77	.74	.82	.74	.76
68	PR SW CN	.76	.76	.76	.87	.65	.65	.88
69	LIMA BEN	1.01	.49	.75	1.08	.51	.94	.48
70	ESCAROLE	.64	.86	.75	.50	.94	.78	.78
71	PEANUTS	1.13	.37	.75	1.20	.34	1.06	.40
72	MAPL SIR	1.13	.36	.75	1.21	.29	1.06	.43
73	WATERMEL	.55	.92	.73	.57	1.09	.54	.75
74	PEACHES	.85	.57	.71	.82	.52	.89	.62
75	TURKEY	.47	.95	.71	.51	.89	.43	1.02
76	BROILERS	.38	1.03	.71	.36	.76	.40	1.31
77	GRN PEAS	.71	.60	.66	.76	.51	.66	.70
78	CAULIFLR	.84	.43	.63	.58	.40	1.09	.45
79	PICKLES	.66	.59	.62	.71	.41	.60	.78
80	BEEF	.49	.76	.62	.39	.67	.58	.84
81	CARROTS	.43	.73	.58	.48	.84	.38	.62
82	STRAWBER	.65	.51	.58	.49	.50	.81	.52
83	ASPARAGS	.65	.50	.57	.45	.46	.84	.54
84	CELERY	.29	.85	.57	.25	.99	.33	.71
85	PR SPNCH	.71	.42	.57	.84	.32	.59	.53
86	BANANAS	.72	.41	.57	.81	.47	.63	.35
87	PR SNPBN	.68	.44	.56	.62	.45	.74	.43
88	CANTALOP	.54	.56	.55	.49	.60	.58	.53
89	FR CUCUM	.50	.58	.54	.46	.67	.54	.49
90	FR TOMAT	.43	.62	.52	.32	.52	.53	.72
91	MUMS	.59	.44	.51	.53	.51	.65	.37
92	HAY	.30	.69	.49	.33	.58	.26	.80
93	MORE MUM	.67	.31	.49	1.00	.35	.34	.27
94	GRN PEPP	.43	.50	.46	.46	.53	.40	.47
95	TOBACCO	.65	.26	.46	.66	.28	.64	.24
96	LETTUCE	.24	.67	.45	.19	.80	.29	.53
97	EGGS	.13	.77	.45	.10	.86	.15	.69
98	CARNATNS	.44	.43	.43	.34	.46	.53	.39
99	TARO	.36	.50	.43	.38	.55	.33	.44
100	F SNPBEA	.41	.42	.41	.38	.44	.44	.39
101	FR SW CN	.25	.45	.35	.25	.47	.25	.42
102	MILK	.19	.37	.28	.12	.29	.26	.45
103	POT MUMS	.33	.19	.26	.35	.23	.31	.15
104	MUSHROOM	.20	.27	.24	.21	.33	.19	.22
105	TEA ROSE	.19	.19	.19	.22	.22	.16	.16
106	PINEAPPL	.42	0	0	.37	0	.46	0
107	HONEY	.73	0	0	.82	0	.63	0
108	OTH CHCK	.90	0	0	.46	0	1.34	0

Table C.1 (cont'd)

CASE-NO	COMNAME	VARDPD	VARDQ	CVTPD	CVTQ	VARDPD3	VARDQ3
1	OLIVES	1698.	4286.	300.	409.	1672.	5505.
2	AVOCARDO	2155.	1976.	357.	457.	2819.	2124.
3	SUNFLOWR	699.	1775.	379.	586.	906.	2000.
4	TRT CHER	2427.	1442.	414.	257.	4209.	1413.
5	PECANS	1179.	2733.	237.	312.	1054.	2924.
6	DRY PEAS	886.	1614.	361.	287.	2491.	3637.
7	ALMONDS	868.	1359.	262.	396.	1629.	1218.
8	TEMPLES	967.	914.	280.	225.	459.	513.
9	SPEARMNT	419.	947.	265.	324.	629.	841.
10	FLAXSEED	471.	1199.	294.	240.	1293.	1645.
11	LIMES	709.	650.	258.	287.	508.	974.
12	FILBERTS	348.	1933.	155.	273.	317.	1326.
13	POPCORN	316.	993.	316.	213.	670.	570.
14	TANGELOS	658.	566.	275.	248.	438.	467.
15	GARLIC	258.	763.	206.	354.	72.	576.
16	BUSH BER	1193.	323.	311.	177.	1647.	356.
17	RYE	276.	630.	237.	303.	573.	649.
18	TANGERIN	571.	869.	226.	180.	360.	81.
19	PAPAYA	425.	478.	200.	301.	377.	520.
20	LEMONS	761.	527.	247.	180.	1260.	1057.
21	PRUNES	520.	894.	216.	180.	622.	1370.
22	CTONSEED	610.	458.	280.	180.	1234.	740.
23	APRICOTS	469.	975.	172.	207.	409.	1028.
24	DRY BEAN	728.	230.	324.	173.	1309.	201.
25	SORGHUM	248.	859.	227.	223.	465.	522.
26	POMERGRN	673.	823.	181.	174.	833.	393.
27	SUGARCAN	900.	70.	435.	93.	2251.	57.
28	PLUMS	724.	599.	169.	187.	1119.	587.
29	ORANGES	574.	290.	284.	175.	398.	228.
30	VEAL	442.	328.	245.	224.	-0	-0
31	NECTARIN	366.	335.	214.	239.	640.	163.
32	PEPPERMT	362.	232.	286.	203.	630.	224.
33	PEARS	665.	406.	223.	142.	441.	111.
34	WALNUTS	508.	331.	183.	212.	885.	361.
35	FIGS	500.	279.	268.	127.	900.	366.
36	ONIONS	1324.	89.	256.	68.	1534.	85.
37	GRAPEFRT	681.	150.	268.	125.	271.	51.
38	POTATO	1138.	84.	285.	68.	943.	56.
39	SUGARBET	452.	200.	263.	142.	1420.	224.
40	COTTON	243.	483.	185.	182.	483.	770.
41	SWT CHER	318.	602.	151.	164.	306.	441.
42	GRAPES	431.	335.	218.	137.	492.	566.
43	WOOL	870.	19.	286.	125.	1435.	23.
44	WHEAT	337.	200.	242.	158.	864.	112.
45	DATES	332.	324.	225.	137.	133.	257.
46	RICE	384.	156.	226.	168.	1075.	239.
47	SWT POT	470.	233.	191.	147.	669.	111.
48	MACADAMI	82.	180.	126.	336.	101.	165.
49	ALFALFA	481.	185.	242.	106.	784.	149.
50	BARLEY	227.	205.	246.	147.	572.	307.
51	SOYBEANS	231.	179.	213.	161.	560.	376.
52	CRANBERR	361.	138.	250.	103.	186.	99.
53	CABBAGE	700.	105.	186.	84.	434.	22.
54	PR TOMAT	133.	425.	154.	148.	210.	321.
55	CORN	229.	132.	224.	125.	533.	169.
56	OATS	213.	215.	200.	119.	537.	339.
57	ARTICHKE	154.	283.	147.	163.	261.	545.
58	HOPS	101.	179.	166.	178.	125.	94.
59	HONEYDEW	131.	170.	86.	225.	80.	115.
60	BROCCOLI	26.	198.	73.	282.	17.	95.
61	APPLES	408.	85.	181.	90.	525.	63.
62	LAMB MUT	122.	64.	194.	171.	146.	62.
63	BRUS SPR	132.	298.	126.	127.	122.	194.
64	FR SPNCH	50.	109.	85.	268.	72.	75.
65	BEETROOT	78.	306.	116.	154.	148.	438.
66	PORK	355.	71.	193.	77.	504.	109.
67	EGGPLANT	205.	152.	137.	118.	106.	71.
68	PR SW CN	126.	212.	158.	104.	310.	75.
69	LIMA BEN	78.	323.	86.	151.	168.	611.
70	ESCAROLE	269.	70.	141.	124.	309.	19.
71	PEANUTS	34.	403.	72.	170.	45.	610.
72	MAPL SIR	25.	408.	77.	169.	39.	514.
73	WATERMEL	356.	89.	135.	86.	223.	61.
74	PEACHES	81.	186.	112.	142.	87.	156.
75	TURKEY	238.	72.	184.	68.	517.	35.
76	BROILERS	172.	37.	236.	64.	338.	17.
77	GRN PEAS	77.	160.	127.	105.	207.	179.
78	CAULIFLR	48.	95.	82.	174.	53.	52.
79	PICKLES	51.	141.	140.	96.	58.	48.
80	BEEF	137.	43.	151.	93.	190.	36.
81	CARROTS	213.	65.	112.	61.	156.	70.
82	STRAWBER	76.	68.	93.	129.	54.	68.
83	ASPARAGS	65.	56.	97.	135.	66.	88.
84	CELERY	297.	18.	128.	53.	366.	15.
85	PR SPNCH	30.	195.	95.	94.	40.	60.
86	BANANAS	68.	182.	64.	100.	66.	224.
87	PR SNPBN	60.	107.	77.	118.	155.	102.
88	CANTALOP	107.	67.	96.	93.	67.	102.
89	FR CUCUM	135.	58.	89.	87.	102.	38.
90	FR TOMAT	82.	29.	129.	85.	53.	34.
91	MUMS	78.	78.	66.	104.	95.	97.
92	HAY	102.	31.	144.	41.	163.	58.
93	MINI MUM	37.	281.	48.	55.	49.	26.
94	GRN PEPP	84.	60.	84.	64.	36.	41.
95	TOBACCO	24.	121.	43.	103.	36.	166.
96	LETTUCE	192.	10.	96.	46.	342.	5.
97	EGGS	221.	3.	124.	24.	302.	5.
98	CARNATNS	65.	32.	71.	85.	84.	27.
99	TARO	92.	41.	79.	53.	28.	57.
100	F SNPBEA	59.	40.	71.	71.	69.	24.
101	FR SW CN	68.	18.	75.	40.	27.	9.
102	MILK	25.	4.	82.	41.	29.	6.
103	POT MUMS	16.	35.	27.	50.	21.	40.
104	MUSHROOM	33.	12.	39.	30.	-0	-0
105	TEA ROSE	14.	14.	29.	25.	15.	18.
106	PINEAPPL	-0	39.	-0	74.	-0	45.
107	HONEY	-0	187.	-0	101.	-0	217.
108	OTH CHCK	-0	58.	-0	214.	-0	38.

APPENDIX D

BASIC PROGRAM FOR SIMULATION STUDY

```
100 DIM DVAL(22),X(150),C(150),MEAN(101),SD(101),VAR(101),B(101)
101 MX=0
102 SX=0
103 MK=0
104 SK=0
106 VK=0
107 SC=0
110 DVAL(1)=-3.5
120 DVAL(2)=-1.645
130 DVAL(3)=-1.281
140 DVAL(4)=-1.037
150 DVAL(5)=-.841
160 DVAL(6)=-.674
170 DVAL(7)=-.524
180 DVAL(8)=-.386
190 DVAL(9)=-.253
200 DVAL(10)=-.126
210 DVAL(11)=0
220 DVAL(12)=-DVAL(10)
230 DVAL(13)=-DVAL(9)
240 DVAL(14)=-DVAL(8)
250 DVAL(15)=-DVAL(7)
260 DVAL(16)=-DVAL(6)
270 DVAL(17)=-DVAL(5)
280 DVAL(18)=-DVAL(4)
290 DVAL(19)=-DVAL(3)
300 DVAL(20)=-DVAL(2)
310 DVAL(21)=-DVAL(1)
320 DX=.05
340 MUX=10
345 CV=.15
350 RHO=0
355 SDX=CV*SQR((1+RHO)/(1-RHO))*MUX
360 X(0)=0
370 RANDOMIZE TIMER
500 FOR K=1 TO 100
510 SUM=0
515 SUMX=0
520 SUMSQ=  0
525 SUMSQX=0
530 FOR I =1 TO 30
540 GOSUB 2000
```

```
545 SUMX=SUMX+X(I)
546 SUMSQX=SUMSQX+(X(I))^2
550 IF I=1 GOTO 600
570 M(I)=(X(I)-X(I-1))/(X(I)+X(I-1))*2
580 SUM=SUM+M(I)
590 SUMSQ=SUMSQ+(M(I))^2
600 NEXT I
610 VAR(K)=(SUMSQ-(SUM^2)/29)/29
620 SD(K)=SQR(VAR(K))
630 MEAN(K)=SUM/29
635 MEANX=SUMX/30
636 SDXX=SQR((SUMSQX-(SUMX^2)/30 )/30 )
637 CVX=SDXX/MEANX
640 PRINT MEANX SDXX CVX      SD(K)
641 MX=MX+MEANX
642 SX=SX+SDXX
643 MK=MK+MEAN(K)
644 SK=SK+SD(K)
645 VK=VK+VAR(K)
646 SC=SC+CVX
650 NEXT K
700 SMX=MX/100
710 SSX=SX/100
720 SCV=SC/100
730 SSK=SK/100
740 SVK=VK/100
750 PRINT SMX SSX SCV SSK SVK    CV RHO
2000 R=RND(1)
2010 A=1+ R/DX
2020 B=INT(A)
2030 C(I)=DVAL(B)+(R-DX*(B-1))*(DVAL(B+1)-DVAL(B))/DX
2040 X(I)=(SDX*C(I)+MUX)+RHO*X(I-1)
2050 IF X(I)<0 THEN X(I)=0
2060 RETURN
```

APPENDIX E

A COMMENT ON MYERS AND RUNGE'S ARTICLE

In a recent article, Myers and Runge describe a method to decompose instability in the US corn market among supply and demand components. They reach the surprising conclusion that demand factors are far more important than supply factors in explaining recent market instability. MR find that their results are quite robust under likely ranges for supply and demand elasticities. However, the results are not so robust on further examination. In particular, if the price series is deflated, which MR do not do, then the principal conclusions of the decomposition are radically reversed, and supply effects predominate. Table E.1 compares MR's results under ranges of elasticity assumptions with those when the price series is deflated by the CPI. Only two of nine entries have demand effects predominant compared to nine of nine using MR's nominal prices.

Table E.1

Ratio of Variance in the Demand Intercept to Variance in the Supply Intercept (DSR) for Corn under a range of Elasticity Assumptions: 1971-72 through 1982-83

SUPPLY ELASTICITY	DEMAND ELASTICITY					
	-.3		-.7		-1.1	
	NOMINAL	DEFLATED	NOMINAL	DEFLATED	NOMINAL	DEFLATED
.2	1.62	.37	3.03	.67	5.26	1.67
.4	1.45	.24	2.72	.43	4.73	1.07
.6	1.13	.16	2.12	.29	3.68	.73

An entry of 1.00 would indicate that the variances of the supply and demand intercepts were equal over the period under the elasticity assumptions shown.

Initially it is not obvious why deflating the price series makes so much difference to the conclusions reached, and it may not be obvious whether it is better to deflate or not. To elucidate this point it is useful to examine the expression which generates the figures in Table E.1. The authors use a static partial equilibrium model with linear supply and demand functions:

$$Q_t^d = a_t + bP_t \quad \text{(demand)}$$

$$Q_t^s = c_t + dP_t \quad \text{(supply)}$$

$$Qtd = Qts \qquad \text{(equilibrium)}$$

where Q_t^d and Q_t^s are quantities demanded and supplied and P_t is the (farm) price received; a_t and c_t are net supply and demand intercepts which incorporate exogenous demand and

supply shifters; b and d are constant slope parameters which are calculated from prior estimates of elasticities at the means:

$$b = e^{d} * \text{mean}(Q)/\text{mean}(P) < 0$$

$$d = e^{s} * \text{mean}(Q)/\text{mean}(P) > 0$$

then solving for a_t and c_t and taking variances gives:

$$\text{var}(a) = \text{var}(Q) + b^2 * \text{var}(P) - 2b * \text{cov}(P,Q)$$

$$\text{var}(c) = \text{var}(Q) + d^2 * \text{var}(P) - 2d * \text{cov}(P,Q)$$

and $$DSR = \text{var}(a)/\text{var}(c)$$

Thus the value of DSR is dependent upon, among other parameters, the covariance of price and quantity. In the present case, production increases steadily throughout the period whilst inflation ensures a similar growth to the nominal price series. Consequentally the covariance is highly positive. To accommodate such a high covariance it is necessary to have significant shifts in the demand curve. However this shift is mainly in one direction (ie outward). It is difficult to attribute this shift to 'instability' in supply and demand. It would be more accurate to attribute it to trend factors. It is noteworthy that deflating the series leads to a negative value for the covariance term, with the consequent result that supply factors predominate over demand factors when 'instability' is decomposed. Thus this analysis shows that there is a danger of confusing trend factors with instability and that when they are confused then anomolous results are possible. At a minimum

the analyst should deflate price series and, for relatively long periods such as the present case, then detrending of the series should also be considered.

What do these considerations mean for the substance of MR's analysis? It is useful to analyze price and quantity instability analogously to MR's Table 3 but with deflated and detrended prices. This is done in Table E.2 below. It would appear now that a good case can be made for the argument that demand factors have been of increasing importance in explaining the increased instability in the corn market. However the case must now be made on the basis of an increase in the estimates of the farm level demand elasticity. Assumption of fixed elasticities is insufficient to produce this conclusion alone. This result is consistent with the work of Tweeten (1983) and other researchers who conclude that the growth in export demand has led both to increased instability and to an increase in the elasticity of demand. It is noteworthy that even with the higher elasticity estimate, quantity instability must be attributed mainly to supply effects.

Table E.2

Decomposition of corn price and quantity into supply, demand and interaction components.

Elasticity assumption			
Supply	.4	.4	.4
Demand	-.3	-.3	-1.1
Time Period	1962-70	1971-82	1971-82
Decomposition	%	%	%
Variance of price	100	100	100
Supply effect	488	81	18
Demand effect	228	18	42
Interaction	-616	1	41
Variance of quantity	100	100	100
Supply effect	28	72	212
Demand effect	24	29	66
Interaction	48	-1	-177
DSR	.47	.22	2.35

APPENDIX F

DERIVED DATA FOR THE ANALYSIS OF THE STUDY

This appendix provides the data set for the analysis of the study. The data in this appendix have been calculated from published data (mainly from various issues of Agricultural Statistics) as described in the text. The following tables list the derived data, from which the tables are compiled and the regression analysis is made. The meaning of the variables codes that head each column are given in Appendix B; and the meaning of the commodity codes are found in Appendix A.

Table F.1

DERIVED DATA FOR ANALYSIS OF THE STUDY

CASE-NO	COMMOD	TYPE	VARDPD	VARDQ	VARDY	VARDA	COV2AY	CVTPD	CVTP	CVTQ
1	EGP	6.	205.	152.	99.	151.	-98.	137.	183.	118.
2	GAR	6.	258.	763.	105.	661.	2.	206.	263.	354.
3	WAT	6.	356.	89.	54.	52.	-17.	135.	321.	86.
4	BRU	6.	132.	298.	130.	122.	50.	126.	166.	127.
5	LMA	6.	78.	323.	57.	217.	52.	86.	224.	151.
6	SPF	6.	50.	109.	57.	97.	-45.	85.	231.	268.
7	SPP	6.	30.	195.	27.	147.	22.	95.	225.	94.
8	ART	6.	154.	283.	308.	29.	-55.	147.	370.	163.
9	BET	6.	78.	306.	114.	213.	-20.	116.	233.	154.
10	ESC	6.	269.	70.	59.	104.	-93.	141.	284.	124.
11	AS	6.	65.	56.	52.	23.	-20.	97.	312.	135.
12	CB	6.	700.	105.	47.	37.	21.	186.	273.	84.
13	CP	6.	107.	67.	37.	82.	-52.	96.	200.	93.
14	DEW	6.	131.	170.	105.	210.	-144.	86.	219.	225.
15	PEA	6.	77.	160.	80.	62.	18.	127.	212.	105.
16	BC	6.	26.	198.	80.	100.	19.	73.	244.	282.
17	CE	6.	297.	18.	13.	21.	-16.	128.	237.	53.
18	CT	6.	213.	65.	54.	59.	-47.	112.	194.	61.
19	SWP	6.	470.	233.	36.	131.	67.	191.	312.	147.
20	CR	6.	48.	95.	65.	44.	-13.	82.	218.	174.
21	TAR	6.	92.	41.	56.	52.	-68.	79.	292.	53.
22	PO	6.	1138.	84.	22.	53.	9.	285.	324.	68.
23	SCF	6.	68.	18.	16.	18.	-16.	75.	197.	40.
24	TOF	6.	82.	29.	33.	26.	-29.	129.	166.	85.
25	LT	6.	192.	10.	14.	19.	-23.	96.	213.	46.
26	ON	6.	1324.	89.	44.	82.	-38.	256.	351.	68.
27	SCP	6.	126.	212.	54.	102.	58.	158.	265.	104.
28	SBP	6.	60.	107.	31.	83.	-7.	77.	159.	118.
29	TOP	6.	133.	425.	109.	215.	104.	154.	185.	148.
30	CUF	6.	135.	58.	48.	39.	-30.	89.	197.	87.
31	GP	6.	84.	60.	41.	59.	-40.	84.	19.	64.
32	CUP	6.	51.	141.	41.	111.	-9.	140.	190.	96.
33	SBF	6.	59.	40.	23.	27.	-9.	71.	211.	71.
34	LIM	1.	709.	650.	-0	-0	-0	258.	406.	287.
35	GPF	1.	681.	150.	-0	-0	-0	268.	252.	125.
36	LEM	1.	761.	527.	-0	-0	-0	247.	265.	180.
37	TGR	1.	571.	869.	-0	-0	-0	226.	205.	180.
38	GRP	3.	431.	335.	-0	-0	-0	218.	355.	137.
39	NEC	1.	366.	335.	-0	-0	-0	214.	252.	239.
40	CHS	1.	318.	602.	-0	-0	-0	151.	186.	164.
41	CHT	1.	2427.	1442.	-0	-0	-0	414.	606.	257.
42	TEM	1.	967.	914.	-0	-0	-0	280.	309.	225.
43	TGL	1.	658.	566.	-0	-0	-0	275.	312.	248.
44	FIG	2.	500.	279.	-0	-0	-0	268.	408.	127.
45	OLV	2.	1698.	4286.	-0	-0	-0	300.	301.	409.
46	AVO	2.	2155.	1976.	-0	-0	-0	357.	416.	457.
47	STW	3.	76.	68.	71.	59.	-62.	93.	186.	129.
48	CRB	3.	361.	138.	137.	5.	-4.	250.	442.	103.
49	DAT	2.	332.	324.	-0	-0	-0	225.	482.	137.
50	PIN	2.	-0	39.	-0	-0	-0	-0	-0	74.
51	HOP	3.	101.	179.	33.	129.	17.	166.	341.	178.
52	PEP	4.	362.	232.	98.	139.	-4.	286.	367.	203.
53	SPR	4.	419.	947.	159.	563.	240.	265.	323.	324.
54	CTS	4.	610.	458.	154.	298.	8.	280.	332.	180.
55	FLX	4.	471.	1199.	557.	637.	21.	294.	369.	240.
56	HON	4.	-0	187.	-0	-0	-0	-0	-0	101.
57	POP	7.	316.	993.	249.	611.	151.	316.	476.	213.
58	SUN	4.	699.	1775.	2092.	3185.	-3400.	379.	312.	586.
59	ALM	5.	868.	1359.	-0	-0	-0	262.	335.	396.
60	FIL	5.	348.	1933.	-0	-0	-0	155.	212.	273.
61	PEC	5.	1179.	2733.	-0	-0	-0	237.	285.	312.
62	WAL	5.	508.	331.	-0	-0	-0	183.	295.	212.
63	MAC	5.	82.	180.	265.	69.	-153.	126.	390.	336.
64	PEN	7.	34.	403.	280.	93.	35.	72.	186.	170.
65	MUS	3.	33.	12.	5.	15.	-8.	39.	49.	30.
66	BY	7.	227.	205.	49.	175.	-18.	246.	329.	147.
67	OT	7.	213.	215.	92.	80.	44.	200.	316.	119.
68	SB	7.	231.	179.	76.	46.	58.	213.	288.	161.
69	SG	7.	248.	859.	192.	539.	164.	227.	306.	223.
70	WH	7.	337.	200.	81.	124.	-3.	242.	331.	158.
71	CN	7.	229.	132.	108.	41.	-17.	224.	298.	125.
72	BF	8.	137.	43.	-0	-0	-0	151.	261.	93.
73	BR	8.	172.	37.	-0	-0	-0	236.	281.	64.
74	EG	8.	221.	3.	-0	-0	-0	124.	187.	24.
75	MK	8.	25.	4.	-0	-0	-0	82.	255.	41.
76	LM	8.	122.	64.	-0	-0	-0	194.	303.	171.
77	OCH	8.	-0	58.	-0	-0	-0	-0	-0	214.
78	PK	8.	355.	71.	-0	-0	-0	193.	269.	77.
79	TK	8.	238.	72.	-0	-0	-0	184.	246.	68.
80	VL	8.	442.	328.	-0	-0	-0	245.	349.	224.
81	SGC	7.	900.	70.	43.	60.	-33.	435.	519.	93.
82	SGB	7.	452.	200.	39.	145.	16.	263.	385.	142.
83	DBE	7.	728.	230.	83.	144.	4.	324.	318.	173.
84	DPE	7.	886.	1614.	1020.	548.	89.	361.	429.	287.
85	RYE	7.	276.	630.	104.	324.	209.	237.	330.	303.
86	RIC	7.	384.	156.	26.	178.	-47.	226.	285.	168.
87	TOB	7.	24.	121.	33.	60.	29.	43.	210.	103.
88	HAY	7.	102.	31.	18.	6.	7.	144.	275.	41.
89	COT	7.	243.	483.	170.	299.	17.	185.	297.	182.
90	WOL	8.	870.	19.	1.	16.	2.	286.	326.	125.
91	ORG	1.	574.	290.	-0	-0	-0	284.	317.	175.
92	APP	1.	408.	85.	-0	-0	-0	181.	232.	90.
93	APR	1.	469.	975.	-0	-0	-0	172.	257.	207.
94	PCH	1.	81.	186.	-0	-0	-0	112.	231.	142.
95	PRS	1.	665.	406.	-0	-0	-0	223.	191.	142.
96	PLM	1.	724.	599.	-0	-0	-0	169.	261.	187.
97	PRN	1.	520.	894.	-0	-0	-0	216.	266.	180.
98	POM	1.	673.	823.	-0	-0	-0	181.	203.	174.
99	PAP	2.	425.	478.	260.	218.	2.	200.	266.	301.
100	BAN	2.	68.	182.	164.	82.	-63.	64.	125.	100.
101	CYS	9.	78.	78.	-0	-0	-0	66.	61.	104.
102	CYP	9.	16.	35.	-0	-0	-0	27.	56.	50.
103	CYM	9.	37.	281.	-0	-0	-0	48.	44.	55.
104	CAR	9.	65.	32.	-0	-0	-0	71.	98.	85.
105	ROS	9.	14.	14.	-0	-0	-0	29.	75.	25.
106	MAP	4.	25.	408.	-0	-0	-0	77.	268.	169.
107	BB	3.	1193.	328.	139.	61.	128.	311.	306.	177.
108	ALF	7.	481.	185.	205.	369.	-390.	242.	185.	106.

Table F.1 (cont'd)

CASE-NO	COMMOD	VARDPD1	VARDO1	VARDPD2	VARDO2	VARDPD3	VARDO3	GVP	MEANDO	MEANDPD
1	EGP	150.	235.	377.	161.	106.	71.	10.	1.3	-.1
2	GAR	602.	613.	164.	1138.	72.	576.	34.	7.1	-1.3
3	WAT	818.	188.	119.	36.	223.	61.	150.	.1	.9
4	BRU	240.	731.	62.	44.	122.	194.	16.	1.6	-1.8
5	LMA	21.	220.	63.	210.	168.	611.	25.	-.7	-.5
6	SPF	47.	33.	30.	85.	72.	75.	29.	-1.5	-.9
7	SPP	45.	39.	8.	173.	40.	60.	15.	1.3	-2.2
8	ART	144.	128.	44.	185.	261.	545.	24.	4.4	-.5
9	BET	27.	267.	60.	224.	148.	438.	10.	-.5	-1.7
10	ESC	208.	153.	301.	22.	309.	19.	16.	2.0	.8
11	AS	66.	36.	59.	29.	66.	88.	82.	-2.2	1.0
12	CB	1416.	274.	374.	40.	434.	22.	175.	-.8	1.1
13	CP	157.	48.	110.	56.	67.	102.	161.	.5	.1
14	DEW	136.	167.	208.	268.	80.	115.	43.	3.5	-.8
15	PEA	9.	174.	25.	142.	207.	179.	101.	-.1	-1.4
16	BC	30.	343.	32.	168.	17.	95.	145.	4.3	-.9
17	CE	232.	26.	309.	10.	366.	15.	170.	.9	-.4
18	CT	270.	83.	267.	58.	156.	70.	161.	1.0	-.3
19	SWP	624.	485.	215.	139.	669.	111.	131.	-1.9	-1.3
20	CR	37.	153.	34.	53.	53.	52.	96.	3.4	.2
21	TAR	265.	37.	18.	34.	28.	57.	1.	-1.8	.7
22	PO	1926.	134.	841.	82.	943.	56.	1720.	.9	-.9
23	SCF	156.	22.	49.	27.	27.	9.	149.	.7	-.3
24	TOF	112.	28.	85.	213.	53.	34.	532.	1.2	-.2
25	LT	75.	22.	204.	5.	342.	5.	565.	2.4	-.4
26	ON	2198.	126.	694.	68.	1534.	85.	347.	1.5	-1.3
27	SCP	67.	408.	28.	177.	310.	75.	114.	2.5	-.7
28	SBP	23.	141.	11.	91.	155.	102.	110.	2.4	-3.1
29	TOP	61.	742.	152.	365.	210.	321.	375.	3.0	-1.3
30	CUF	209.	64.	122.	73.	102.	38.	83.	1.9	-.6
31	GP	143.	79.	89.	65.	36.	41.	124.	2.9	-.2
32	CUP	26.	248.	57.	136.	58.	48.	101.	3.7	-1.2
33	SBF	101.	84.	21.	18.	69.	24.	83.	-2.1	.1
34	LIM	1257.	602.	429.	411.	508.	974.	14.	5.1	-.5
35	GPF	566.	189.	1246.	220.	271.	51.	300.	2.1	-2.2
36	LEM	372.	146.	620.	415.	1260.	1057.	161.	2.4	-3.0
37	TGR	311.	1280.	1078.	1263.	360.	81.	38.	.1	.2
38	GRP	518.	194.	306.	275.	492.	566.	1337.	2.4	-.5
39	NEC	199.	649.	279.	207.	640.	163.	44.	8.1	-2.7
40	CHS	402.	489.	259.	890.	306.	441.	91.	1.5	-1.0
41	CHT	820.	820.	2489.	2227.	4209.	1413.	44.	-.9	-1.6
42	TEM	-0	-0	1958.	988.	459.	513.	3.	1.0	-1.1
43	TGL	-0	-0	941.	625.	438.	467.	27.	11.5	-3.5
44	FIG	487.	147.	190.	364.	900.	366.	14.	-2.4	-1.3
45	OLV	2801.	4050.	1034.	4074.	1672.	5505.	38.	2.9	-2.2
46	AVO	1940.	2072.	2001.	2025.	2819.	2124.	121.	6.5	-2.5
47	STW	151.	69.	43.	72.	54.	68.	289.	2.5	-1.7
48	CRB	703.	250.	275.	99.	186.	99.	89.	3.4	1.7
49	DAT	620.	609.	270.	187.	133.	257.	14.	1.4	-.1
50	PIN	-0	-0	-0	-0	-0	45.	-0	-2.3	-0
51	HOP	153.	278.	31.	187.	125.	94.	114.	.9	-1.1
52	PEP	360.	209.	161.	292.	630.	224.	46.	2.3	-2.6
53	SPR	414.	867.	285.	1230.	629.	841.	21.	3.3	-.5
54	CTS	310.	323.	336.	367.	1234.	740.	577.	.4	-4.7
55	FLX	71.	1188.	95.	1001.	1293.	1645.	59.	-3.7	-2.9
56	HON	-0	175.	-0	202.	-0	217.	120.	-1.7	-0
57	POP	188.	1455.	126.	1154.	670.	570.	57.	3.3	.2
58	SUN	-0	-0	-0	-0	906.	2000.	410.	24.5	-2.3
59	ALM	1000.	2520.	61.	440.	1629.	1218.	473.	6.1	-2.4
60	FIL	528.	3874.	227.	789.	317.	1326.	17.	3.0	-2.2
61	PEC	1033.	1152.	1568.	4383.	1054.	2924.	143.	1.4	-1.7
62	WAL	386.	448.	276.	206.	885.	361.	182.	4.0	-1.0
63	MAC	10.	140.	137.	230.	101.	165.	24.	11.8	.3
64	PEN	50.	637.	9.	48.	45.	610.	554.	1.6	-1.8
65	MUS	-0	-0	-0	-0	-0	-0	369.	6.7	-.3
66	BY	68.	302.	66.	54.	572.	307.	1035.	1.7	-2.1
67	OT	96.	25.	31.	95.	537.	339.	823.	-2.5	-2.0
68	SB	30.	137.	59.	56.	560.	376.	13875.	6.3	-.8
69	SG	251.	2023.	80.	276.	465.	522.	1774.	3.7	-1.3
70	WH	17.	445.	179.	100.	864.	112.	9397.	3.2	-2.7
71	CN	29.	52.	122.	195.	533.	169.	21687.	3.5	-2.1
72	BF	189.	85.	61.	110.	190.	36.	25454.	.3	-1.8
73	BR	104.	52.	88.	16.	338.	17.	4304.	6.9	-4.4
74	EG	251.	3.	154.	3.	302.	5.	3268.	.2	-2.8
75	MK	37.	3.	13.	3.	29.	6.	16883.	.5	-.4
76	LM	152.	94.	76.	27.	146.	62.	402.	-1.5	-2.0
77	OCH	-0	85.	-0	22.	-0	38.	-0	-2.8	-0
78	PK	359.	79.	255.	37.	504.	109.	8873.	.3	-.9
79	TK	87.	61.	141.	125.	517.	35.	1269.	4.4	-3.8
80	VL	-0	-0	-0	-0	-0	-0	-0	-3.2	-1.7
81	SGC	167.	89.	231.	81.	2251.	57.	691.	1.8	.3
82	SGB	25.	205.	54.	148.	1420.	224.	745.	2.3	-1.1
83	DBE	-0	-0	198.	208.	1309.	201.	688.	1.3	-2.3
84	DPE	330.	1462.	101.	213.	2491.	3637.	31.	-1.4	-1.2
85	RYE	164.	732.	103.	547.	573.	649.	42.	-.1	-2.4
86	RIC	99.	172.	20.	90.	1075.	239.	1740.	4.3	-3.0
87	TOB	19.	128.	20.	91.	36.	166.	2709.	-.1	-.5
88	HAY	134.	31.	32.	9.	163.	58.	8166.	1.2	-.6
89	COT	46.	339.	223.	401.	483.	770.	4078.	.5	-3.2
90	WOL	796.	5.	453.	6.	1435.	23.	93.	-2.3	-4.0
91	ORG	394.	74.	969.	586.	398.	228.	1304.	1.7	-.8
92	APP	476.	122.	290.	79.	525.	63.	757.	1.1	-.4
93	APR	470.	1670.	596.	479.	409.	1028.	34.	-2.1	-.6
94	PCH	43.	20.	116.	209.	87.	156.	368.	-.3	-.5
95	PRS	392.	49.	1266.	1101.	441.	111.	175.	.5	-1.6
96	PLM	-0	-0	434.	714.	1119.	587.	72.	1.2	.8
97	PRN	-0	-0	497.	597.	622.	1370.	112.	-.7	-2.5
98	POM	-0	-0	-0	-0	833.	393.	4.	8.4	-1.1
99	PAP	342.	471.	599.	524.	377.	520.	10.	5.9	.9
100	BAN	-0	-0	-0	-0	66.	224.	1.	-.9	2.1
101	CYS	-0	-0	-0	-0	95.	97.	26.	-2.9	-4.1
102	CYP	-0	-0	-0	-0	21.	40.	68.	6.6	-3.0
103	CYM	-0	-0	-0	-0	49.	26.	38.	1.7	-4.6
104	CAR	-0	-0	-0	-0	84.	27.	42.	-3.8	-4.0
105	ROS	-0	-0	-0	-0	15.	18.	84.	.1	-1.3
106	MAP	26.	296.	14.	485.	39.	514.	16.	-1.2	.4
107	BB	-0	-0	-0	-0	1647.	356.	62.	-1.8	.2
108	ALF	-0	-0	-0	-0	784.	149.	40.	-1.0	1.5

Table F.1 (cont'd)

CASE-NO	COMMOD	ANNUAL	PROCESS	DIMPORT	DEXPORT	DMORDER	DVOLMAN	DMKTFLOW	DFUTURE	DSUPPORT
1	EGP	1.	0	0	0	0	0	0	0	0
2	GAR	1.	0	0	0	0	0	0	0	0
3	WAT	1.	0	0	0	0	0	0	0	0
4	BRU	1.	8.	0	0	0	0	0	0	0
5	LMA	1.	9.	0	0	0	0	0	0	0
6	SPF	1.	0	0	0	0	0	0	0	0
7	SPP	1.	9.	0	0	0	0	0	0	0
8	ART	0	1.	0	0	0	0	0	0	0
9	BET	1.	9.	0	0	0	0	0	0	0
10	ESC	1.	0	0	0	0	0	0	0	0
11	AS	0	6.	0	0	0	0	0	0	0
12	CB	1.	1.	0	0	0	0	0	0	0
13	CP	1.	0	0	0	0	0	0	0	0
14	DEW	1.	0	0	0	1.	0	0	0	0
15	PEA	1.	9.	0	0	0	0	0	0	0
16	BC	1.	3.	0	0	0	0	0	0	0
17	CE	1.	0	0	0	1.	1.	1.	0	0
18	CT	1.	4.	0	0	0	0	0	0	0
19	SWP	1.	1.	0	0	0	0	0	0	0
20	CR	1.	3.	0	0	0	0	0	0	0
21	TAR	1.	0	0	0	0	0	0	0	0
22	PO	1.	6.	0	0	1.	0	0	1.	0
23	SCF	1.	0	0	0	0	0	0	0	0
24	TOF	1.	0	1.	0	1.	0	0	0	0
25	LT	1.	0	0	0	1.	0	1.	0	0
26	ON	1.	1.	0	0	1.	0	1.	0	0
27	SCP	1.	9.	0	0	0	0	0	0	0
28	SBP	1.	9.	0	0	0	0	0	0	0
29	TOP	1.	9.	1.	0	1.	0	0	0	0
30	CUF	1.	0	0	0	0	0	0	0	0
31	GP	1.	0	0	0	0	0	0	0	0
32	CUP	1.	9.	0	0	0	0	0	0	0
33	SBF	1.	0	0	0	0	0	0	0	0
34	LIM	0	4.	1.	0	1.	0	1.	0	0
35	GPF	0	6.	0	0	1.	0	1.	0	0
36	LEM	0	5.	0	0	1.	0	1.	0	0
37	TGR	0	4.	0	0	1.	0	1.	0	0
38	GRP	0	8.	0	0	1.	1.	1.	0	0
39	NEC	0	0	0	0	1.	0	0	0	0
40	CHS	0	5.	0	0	1.	0	0	0	0
41	CHT	0	9.	0	0	1.	1.	0	0	0
42	TEM	0	5.	0	0	1.	0	1.	0	0
43	TGL	0	6.	0	0	1.	0	1.	0	0
44	FIG	0	9.	1.	0	0	0	0	0	0
45	OLV	0	8.	1.	0	1.	0	0	0	0
46	AVO	0	1.	1.	0	1.	0	1.	0	0
47	STW	0	3.	1.	0	0	0	0	0	0
48	CRB	0	8.	0	0	1.	1.	0	0	0
49	DAT	0	9.	1.	0	1.	1.	0	0	0
50	PIN	0	5.	1.	0	0	0	0	0	0
51	HOP	0	9.	0	0	1.	1.	0	0	0
52	PEP	0	9.	0	0	0	0	0	0	0
53	SPR	0	9.	0	0	1.	1.	0	0	0
54	CTS	1.	9.	0	1.	0	0	0	0	0
55	FLX	1.	9.	0	0	0	0	0	0	0
56	HON	1.	1.	1.	0	0	0	0	0	1.
57	POP	1.	-0	0	0	0	0	0	0	0
58	SUN	1.	9.	0	0	0	0	0	0	0
59	ALM	0	-0	1.	0	1.	1.	0	0	0
60	FIL	0	-0	1.	0	1.	1.	0	0	0
61	PEC	0	-0	0	0	0	0	0	0	0
62	WAL	0	-0	0	1.	1.	1.	0	0	0
63	MAC	0	-0	0	0	0	0	0	0	0
64	PEN	1.	9.	0	1.	0	0	0	0	1.
65	MUS	1.	5.	1.	0	0	0	0	0	0
66	BY	1.	-0	0	1.	0	0	0	0	1.
67	OT	1.	-0	0	0	0	0	0	1.	1.
68	SB	1.	-0	0	1.	0	0	0	1.	0
69	SG	1.	-0	0	1.	0	0	0	0	1.
70	WH	1.	-0	0	1.	0	0	0	1.	1.
71	CN	1.	-0	0	1.	0	0	0	1.	1.
72	BF	0	-0	1.	0	0	0	0	1.	0
73	BR	1.	-0	0	0	0	0	0	1.	0
74	EG	1.	-0	0	0	0	0	0	1.	0
75	MK	0	-0	1.	0	0	0	0	0	1.
76	LM	0	-0	1.	0	0	0	0	0	0
77	OCH	1.	-0	0	0	0	0	0	0	0
78	PK	0	-0	1.	0	0	0	0	1.	0
79	TK	1.	-0	0	0	0	0	0	1.	0
80	VL	0	-0	0	0	0	0	0	1.	0
81	SGC	0	9.	1.	0	0	0	0	1.	1.
82	SGB	1.	9.	1.	0	0	0	0	1.	1.
83	DBE	1.	-0	0	1.	0	0	0	0	0
84	DPE	1.	-0	0	1.	0	0	0	0	0
85	RYE	1.	-0	0	0	0	0	0	0	1.
86	RIC	1.	-0	0	1.	0	0	0	0	1.
87	TOB	1.	9.	0	1.	0	0	0	0	1.
88	HAY	1.	-0	0	0	0	0	0	0	0
89	COT	1.	-0	0	1.	0	0	0	1.	1.
90	WOL	0	9.	1.	0	0	0	0	1.	1.
91	ORG	0	8.	0	0	1.	0	1.	1.	0
92	APP	0	4.	0	0	1.	0	0	0	0
93	APR	0	1.	0	0	1.	0	0	0	0
94	PCH	0	5.	0	0	1.	0	0	0	0
95	PRS	0	6.	0	1.	1.	1.	0	0	0
96	PLM	0	0	0	0	0	0	0	0	0
97	PRN	0	9.	1.	0	1.	0	0	0	0
98	POM	0	0	1.	0	0	0	0	0	0
99	PAP	0	1.	0	0	0	0	0	0	0
100	BAN	0	0	0	0	0	0	0	0	0
101	CYS	1.	-0	0	0	0	0	0	0	0
102	CYP	1.	-0	0	0	0	0	0	0	0
103	CYM	1.	-0	0	0	0	0	0	0	0
104	CAR	1.	-0	0	0	0	0	0	0	0
105	ROS	1.	-0	0	0	0	0	0	0	0
106	MAP	0	-0	1.	0	0	0	0	0	0
107	BB	0	7.	0	0	0	0	0	0	0
108	ALF	0	0	0	0	0	0	0	0	0

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