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A FRAMEWORK FOR ANALYZING THE IMPLICATIONS OF DOMESTIC AGRICULTURAL POLICIES FOR THE STABILITY OF INTERNATIONAL TRADE

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TABLE OF CONTENTS

TABLE OF CONTENTS (cont.)

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ABSTRACT

On the basis of recent research into international price stability, a generalized model is used to analyze the implications of agricultural and trade policies in an individual country for domestic and world market stability. Emphasis is placed on the way in which specific instruments or combinations of instruments influence the excess function of the country concerned. These instruments are presumed to respond to changing domestic supply conditions and world prices, and can be loosely grouped under pricing policies, storage policies and trade control policies.

In each case, it is shown that specific policies can have markedly different implications for the stability of world prices and trade. To highlight these differences, seven alternative policies which might be used to attain domestic stability are examined in detail. It is demonstrated that under many of these policies world market prices can be more stable than under free trade. The foreign exchange implications of individual policies are also discussed, and an optimal trade control policy which does not involve supply restraints is identified.

The analytical results derived in this study suggest the need for a more careful analysis of existing policies, and a more flexible approach to the development of structural models to describe their effects. Appropriate structural models for seven of the most commonly occurring policy environments are identified.

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INTRODUCTION

International agricultural trade has been a major focus for agricultural economic research in recent years. The complexity of the issues involved has led to a diversity of approaches and analytical models to aid in this research. In the tradition of classical and neo-classical theory, international trade has tended to be analyzed in a static framework in which public policy plays a neutral or residual role. However, the recognition of the importance of domestic agricultural and macroeconomic policies, and their implications for agricultural trade, has led to the development of more realistic analytical frameworks.

Instability, both of prices and production, has traditionally been a feature of trade in agricultural products and has prompted the development of many of the alternative models. However, there have been difficulties in the integration of stability-related research with that which attempts to measure the static effects of trade intervention. Distortions in expected prices and trade flows created by policy intervention have normally been used as measures of the level of protection in a particular country, and in the calculation of the welfare gains from freer trade. In more recent studies, attention has focused on the distortions resulting from the instability generated by domestic policies. Research in this area suggests that single measures of protection, such as effective protection or producer and consumer subsidy equivalents, are insufficient to identify fully the distortions which domestic policies might create, or to evaluate the implications of freer trade. Measures such as subsidy equivalents are primarily designed to capture the effective price distortion caused by the existing policies, and although quantity effects can be evaluated through domestic response elasticities, these do not always accurately reflect the impact of the policies or the implications of their withdrawal. Common problems include the representation of storage policies which may incur relatively modest budgetary outlays and yet have major impacts on trade and its stability, or the treatment of production or delivery quotas which may also include minimal financial outlays but have a dramatic impact on production or trade.

The importance of these factors derives from the extensive use of such policy instruments, and others whose primary focus is the stabilization of prices or quantities. Difficulties in the measurement of protection, or trade distortions, are clearly generated by attempting to reduce the impacts of a complex set of policy instruments to a single financial measure. While a single measure may permit the determination of the approximate effect of a set of domestic policies upon the position of the excess supply or demand function, it is unlikely to capture the impact of these policies upon the shape of the function. In order to reflect this important aspect, it is necessary to focus explicitly upon the impact of specific policies upon the excess functions. Once this impact is determined, indicators of the efficiency or distributional implications of the policies, e.g., their financial implications or effects upon the stability of prices, can be derived.

The framework which is developed in this study demonstrates how individual policies, and combinations of policies used by particular countries interact to affect the excess supply and demand relationships for a product. Such a framework provides an important input in the development of positive models for analyzing the implications of changing policies in specific countries and their repercussions on international trade. While there is no attempt to develop a normative model to determine optimal national or international policies, the framework developed can be used to measure the welfare implications of changes, and can aid in the determination of improved policies.

The framework is based upon a simple, generalized model of an individual country. This model is used to demonstrate how a wide range of specific policy instruments affect the country's excess supply and/or demand curve for a particular product. The implications of these policies for international equilibrium are determined, and comparisions are made between alternative instruments or combinations of instruments which can be used to pursue objectives such as self-sufficiency or the maximization of export revenues. These examples are developed to demonstrate the implications of the wide range of mechanisms which might be encountered in modeling domestic agricultural policy in a particular country. The report concludes with a discussion of an empirical framework for the development of individual country models which might be used for further analysis of the issues discussed.

1.0 A BRIEF REVIEW OF PREVIOUS RESEARCH

In this section, a brief review of the existing research into international price stability is presented. While there has been a considerable amount of research into the general problems associated with international trade instability, it is argued that this research has been fragmented into specific areas which have often been treated in a relatively independent manner. This is not surprising given the scope and nature of the problem, but it is only in recent years that attempts have been made to develop a more comprehensive framework which might be used to analyze both the sources and solutions to the problems of instability. The following discussion outlines the development of this research and describes its major areas.

1.1 The Welfare Implications of Stabilization

One of the earliest, and perhaps the most exhaustively treated, areas of research has been the analysis of the welfare implications of stabilizing prices. Following initial work by Waugh (1944), Oi (1961), and Massell (1969), which analyzed the welfare implications of using buffer stock policies to stabilize market prices, a substantial body of literature has developed using partial equilibrium models to measure the size and distribution of welfare gains both within and between countries. The models developed have become increasingly sophisticated as they have attempted to incorporate more realistic assumptions on market conditions, including nonlinearity of the supply and demand relationships, the nature of disturbances, the manner in which producer expectations are formed, and attitudes to risk. This extensive literature is probably best summarized by Sarris and Taylor (1978), Turnovsky (1978), and Newbery and Stiglitz (1981). Unfortunately, the results are difficult to generalize. Although the studies concur that there is a net social benefit from market price stabilization, distributional implications are dependent on specific market conditions. Logically, this has led to the development of empirical models in which the authors attempted to determine the welfare implications of buffer stock policies in particular markets. These studies cover a wide range of industries and are, in some cases, related to specific proposals to develop buffer stocks for particular industries. Examples of such studies are presented in Adams and Behrman (1978), Adams and Klein (1978) and Labys (1975). Although most of these models relied on specified storage rules which either completely or partially stabilized prices, several models were also developed to estimate optimal storage rules (e.g., Kim, Goreux and Kendrick, 1975; Dalton, 1978; and Lee and Blandford, 1980 and 1981). The major contribution of these empirical studies appears to be in identifying problems associated with specifying the nature of the storage rules and in suggesting the size of buffer stocks which might be required to contribute to stability in world markets.

Research into the welfare effects of price stabilization has provided many insights into the implications of stabilization, but has done little to describe why stabilization is necessary, or whether alternatives to storage policies exist for stabilizing markets. In many of the models developed it has been assumed that markets are competitive and that instability arises from fluctuating supply or demand. In more recent studies, however, it has been recognized that commodity markets are influenced by domestic agricultural and trade policies, or the lack of perfect competition. This has led to several studies of the welfare implications of stabilization under such conditions (Young and Schmitz, 1984; Newbery, 1984; and Sarris and Taylor, 1978). The results of these studies introduce further complications and uncertainties in attempting to evaluate the welfare implications of using storage programs to stabilize markets.

It is possible that a major shortcoming in this area of research has been the focus on stockholding and price stabilization, without considering more basic questions about the causes of instability and why private storage may not be optimal. Recent articles by Sarris (1982) and Chisholm (1982) are examples of a more fundamental approach which attempts to understand the role of storage and causes of market failure in international commodity markets. This is an alternative approach to that of earlier studies in which it was concluded that benefits from stockholding which stabilized markets would be sufficient to justify government or international intervention.

Throughout this body of literature, there appears to be developing a reevaluation of the role of public stockholding and an acceptance of the idea that the justification for public intervention relates to more diverse objectives than simply the maximization of economic surplus. The casual observation that most publicly owned buffer stocks do not function independently but as part of a more comprehensive set of commodity policies, lends support to this view.

1.2 The Role of Domestic Agricultural Policies

As a result of the instability in grain prices in the early 1970s, there developed a growing awareness of the role of national policies in creating international market stability. The nature of the problem was first outlined by Johnson (1975) who stated that, "If governments are interested in price stability for agricultural commodities, their primary interest is in stability of prices within their own country" and as a result that, "The control of imports and/or exports to stabilize internal prices increases the variability of prices elsewhere in the world."

There followed a number of studies in which the authors identified in a more formal manner the relationship between national policies and international price stability. Bale and Lutz (1979) developed a simple theoretical model which showed how trade and pricing policies for stabilizing domestic prices could lead to instability in prices in international markets. A model developed by Shei and Thompson (1977) was used to demonstrate how changes in specific trade policies might destabilize the world wheat market. In other studies, such as those of Zwart and Meilke (1979), Grennes, Johnson and Thursby

(1978), and Bigman and Reutlinger (1979), the trade-off between buffer stock policies and national policies was identified. It was argued that a substantial proportion of price instability in grain markets is attributable to protective pricing policies, and that the modification of domestic policies would provide a viable alternative to buffer stocks for the stabilization of world markets. However, an alternative argument has been made that the creation of buffer stocks would provide the global stability to allow protective policies to be dismantled (Newbery and Stiglitz, 1981, p. 275). While this issue may prove difficult to resolve, the understanding of the relationship between national policies and international stability has grown rapidly, and other areas of research have focused on this issue. Although not mutually exclusive, there are four related areas in which such research has developed in recent years.

The first is represented by studies which have attempted to measure the international implications of changes in the policies of specific countries. These studies are characterized by the acceptance of the given set of policy instruments in a country, and the desire to understand the effect of these upon the stability and level of international prices. Such studies are a logical extension of the conventional analysis of domestic policy changes, but reflect the changing awareness of the international policy interdependence. Many of these studies have been empirically based (see for example Offutt and Blandford, 1984; Sharples and Goodloe, 1984; Schwartz and Ralston, 1983), while others have relied on more general theoretical models (Sampson and Snape, 1980; Schmitz and Koester, 1984) to describe the relationship between individual countries and world markets. More general studies such as that by Bigman (1980) have used simple simulation models to demonstrate the differing impacts of commonly used policy instruments. These studies have confirmed the general hypothesis that while market instability may be initiated by fluctuations in production, attempts by individual countries to insulate themselves from the effects of these fluctuations may further accentuate world instability.

A second area of research has had a more global orientation and has attempted to understand the nature of the policies in individual countries and their contribution to market instability. Increased attention has been paid to the comparison and documentation of policies (Jabara, 1981; and I.W.C., 1983), and to more general discussions which compare national policies and discuss how they interact in world markets (OECD, 1980). In other studies, such as those by Josling (1980) and Blandford (1983), more formal analyses have been performed to evaluate the behavior of individual countries and their contribution to instability. Attention has focused on the responsiveness of domestic stocks and prices to changes in world prices, as a measure of the stabilizing influence of individual countries' policies. Information and analyses of this type may prove to be important in international trade negotiations as an adjunct to existing information on absolute levels of protection.

A third, and markedly different, area of research has developed from theoretical models which are used to derive optimal national policies for individual countries. The most sophisticated of these models developed by Sarris and Freebairn (1983 and 1984) allows the authors to evaluate the interaction of changing national objectives on international trade in wheat and rice. Because they do not necessarily rely on the existing set of policy instruments, and derive optimal policy instruments and levels, the use of such models would appear to have considerable advantages for the analysis of changing policy objectives in individual countries. The major disadvantage, however, stems from the need to estimate national objective functions and their associated weights. In recent studies, these weights have been estimated from observed behavior, but this raises questions about how one country's objectives may change in response to changes in those of other countries. The models also tend to be restricted by the limited range of policy instruments which can be incorporated, although a recent model developed by Paarlberg and Abbott (1984) extends this range beyond the simple pricing instruments used in previous studies. With further research in this area, normative models will undoubtedly become increasingly useful in understanding the development of national agricultural policies.

A fourth area of research has concentrated on the development of models which can be used to evaluate noncompetitive behavior in world trade, especially in grains. Earlier models had relied on competitive assumptions, and equilibrium levels of world prices and trade flows were derived by equating domestic supply and demand relationships across countries, either in econometric models (Rojko, et al., 1971) or in spatial price equilibrium models (Schmitz and Bawden, 1973). The growing awareness of the potential impact of domestic pricing policies discussed previously led to the development of approaches which attempted to incorporate these policies directly. Some of the earlier models, such as those developed by Abbott (1979) and Zwart and Meilke (1979), relied on estimates of the excess supply and demand functions for the individual countries involved in world trade. In these cases, differences between observed excess functions and previous estimates of domestic supply and demand relations were presumed to reflect the distortions which were created by government policies. Other studies, such as Lattimore and Zwart (1978) and Tyers and Chisholm (1982) incorporated more sophisticated models of the relationships between the domestic markets and the excess supplies and demands which formed world prices. This work was closely related to more general studies which identify relationships between domestic and international prices (Bredahl, et al., 1979), and the general problems associated with developing positive models of government behavior (Rausser, et al., 1982).

In these studies, domestic policies have generally been defined in terms of domestic price linkage equations and generalized models of inventory behavior. Other than simulation studies, such as Bigman (1980) or graphical analyses (Josling, 1981), there has been a lack of analysis of the linkages between individual policy instruments, or combinations of instruments, and world market stability.

An alternative framework for analyzing noncompetitive behavior in world grain markets has developed around the concept of individual countries or market intermediaries exercising market power in the pricing and trading in agricultural products. In studies by McCalla (1966), Alaouze, et al. (1978), Carter and Schmitz (1979), and Karp and McCalla (1983), descriptive models have been developed to aid the discussion of how countries might exercise market power, and its implications for international markets. Unfortunately, the hypothesized existence of such market behavior has been subjected to little empirical testing. Furthermore, there would appear to be a potential conflict between these theories and those previously discussed which suggest that international market behavior is primarily determined by attempts to satisfy domestic goals such as internal price stability. Even where there are organizations such as export marketing agencies, it should be noted that these are largely a product of government agricultural policies and must remain responsive to domestic objectives. It is possible that the discrepancies between these two approaches might be resolved by a more careful analysis of the policy instruments which are utilized in individual countries, and the factors which influence the setting of these instruments.

1.3 Summary and Implications

In this brief literature review, the major themes of research into stability problems in agricultural trade have been described. In the discussion, the growing awareness of national policies as a contributor to instability has been highlighted. This development has led to a movement away from studies in which the welfare impacts of stabilization activities such as buffer stocks are analyzed, to more complex models in which the relationships between domestic policies and objectives and international trade are defined. One of the major limitations to existing work in this area has been the tendency to generalize the impacts of alternative policy instruments, or to only consider a limited range of instruments.

In this particular paper, an attempt is made to provide linkages between some of these alternative areas of research. By analyzing the manner in which governments or marketing agencies might utilize particular combinations of policy instruments to attain differing objectives, it is possible to derive more detailed specifications of the excess supply and demand relationships.

2.0 THE GENERAL MODEL

The simple theoretical model developed in this section is used to determine the implications of alternative domestic policies for both internal and external market equilibria. The model is not intended to represent any particular country, but is developed around a set of assumptions which could reflect general conditions in world grain markets. The model is sufficiently general that comparisons can be made between large and small countries, short- and long-run equilibria, and importing and exporting countries. Stochastic elements have been incorporated in the model to reflect the variability associated with domestic production and world prices which a country may face.

After the basic model is described, discussion focuses on the most commonly used types of policy instruments. These can be loosely classified as follows:

(i) pricing instruments;
(ii) storage policies;
(iii) export/import controls;
(iv) production/consumption subsidies;
(v) supply management;
(vi) discontinuous pricing policies.

The primary aim in describing each of these policies is to demonstrate their implications for the excess supply and demand relationships of an individual country. The interaction of these relationships with an excess supply or demand function for the "rest of the world" allows an international equilibrium to be derived. At various stages in the analysis, comparisons between alternative policy instruments are made to demonstrate their international implications.

2.1 Specification of the General Model

The general model used to represent an individual country can be specified in mathematical form as follows

(1) $$Q_c = a - bP_c \ ,$$

(2) $$Q_P = c + dP_{P,t-1} + \varepsilon \ ,$$

(3) $$T = Q_c - Q_P \ ,$$

where[1] Q_c is the quantity consumed in the current period;

[1] For ease of presentation, current time-subscripts are not utilized, but lagged variables are identified using subscripts.

P_c is the consumer price in the current period;

Q_P is the quantity produced in the domestic market in the current period;

P_P is the producer price in the current period. The subscript t-1 denotes the previous period's price;

T is the quantity traded;

a,b,c,d are coefficients in the linear demand and supply functions; and

ε is the random component associated with production, $\varepsilon \sim N\ (0, \sigma^2_\varepsilon)$.

The international component of this model can be specified in the form of a price dependent version of the excess supply function as

(4) $$P_w = g + hT + \theta \ ,$$

where P_w is the world price in the current period;

g,h are the coefficients of the linear function;

θ is the random component associated with world price,

$\theta \sim N\ (0, \sigma_\theta{}^2)$ and $E(\varepsilon, \theta)=0$.

In the model it is assumed that both the supply and demand functions can be represented by linear functions and that the supply curve is a function of lagged producer prices to reflect the typical situation in grain production. At this stage, both producer and consumer prices are assumed to be exogenous and storage is not incorporated in the model. These assumptions are subsequently modified through the incorporation of domestic policies. Although the model has been specified to reflect the case of an importing country, it can be seen that where parameters and prices are such that imports would be negative, this would imply an exporting country, and the world excess function (4) would become a negative function of the level of exports.

2.2 Free Trade Equilibrium

As a base for comparison, a free trade equilibrium can be derived under the assumption that producer and consumer prices equal the world price in any given period. Thus, in equations (1) and (2), $P_c = P_P = P_w$, and the trade demand function can be expressed as follows

$$(5) \qquad T = a - bP_w - c - dP_{w,t-1} - \varepsilon .$$

Excess demand is a negative function of world prices and by equating it with excess supply (4), equilibrium levels of world price and trade can be derived.

Substituting (5) into (4),

$$P_w = g + h(a - bP_w - c - dP_{w,t-1} - \varepsilon) + \theta ,$$

$$(6) \qquad \tilde{P}_w = \frac{g + h(a - c - dP_{w,t-1} - \varepsilon) + \theta}{1 + bh} ,$$

and

$$T = a - b(g + hT + \theta) - c - dP_{w,t-1} - \varepsilon ,$$

$$(7) \qquad \tilde{T} = \frac{a - c - bg - dP_{w,t-1} - \varepsilon - b\theta}{1 + bh} ,$$

where ~ denotes an equilibrium value.

By taking expected values of these expressions, it can be seen that in the short term

$$(8) \qquad E(\tilde{P}_w) = \frac{g + h(a - c - dP_{w,t-1})}{1 + bh} ,$$

and[2]

$$(9) \qquad Var(\tilde{P}_w) = \frac{h^2 \sigma_\varepsilon^2 + \sigma_\theta^2}{(1+bh)^2} ,$$

where $E(\tilde{P}_w)$ in the expected level of world price and $Var(\tilde{P}_w)$ is the variance of the world price. Similarly

$$(10) \qquad E(\tilde{T}) = \frac{a - c - bg - dP_{w,t-1}}{1 + bh} ,$$

and

---

[2] Throughout this paper, expressions of this type are frequently derived. In appendix A an example of such a derivation is presented.

$$(11) \qquad \mathrm{Var}\ (\tilde{T}) = \frac{\sigma_\varepsilon^2 + b^2\sigma_\theta^2}{(1+bh)^2} \ .$$

The general model can be used to derive equilibrium conditions in the long run when $P_{w,t-1} = P_w$ and $E(\varepsilon) = E(\theta) = 0$, and also for the large and small country cases. In the case of a small country, it is assumed that h=0, which implies that the excess function for the world is perfectly elastic. In Table 1 a summary of these conditions is presented. It can be seen that the long-run equilibrium conditions incorporate the effect of the domestic supply response, making the excess trade relationships more elastic in response to changes in the world price. For a small country where it is assumed that h=0, in the free trade case world and domestic prices are not influenced by the volume of trade of the country. The volume of trade, however, is influenced by short-run disturbances in both domestic and international markets.

2.3 Price Intervention

Perhaps the most predominant form of intervention in domestic grain markets are policies which influence either producer or consumer prices. However, the exact nature of this intervention varies widely between individual countries, and ranges from the use of simple import tariffs to government-administered pricing. Although it is possible to develop specific models of policies in a particular country, such models can become complex due to the changing mix and levels of policy instruments. In the following analysis, a generalized model is used to identify some key relationships which exist in pricing policies. It will be seen that this framework can incorporate the effects of many specific types of policies, and provide a basis for estimating empirical relationships to explain how domestic prices change over time.

Assume initially that domestic prices for producers and consumers, respectively, can be represented by the following relationships

$$(12) \qquad P_p = \alpha_p + \gamma_p P_w + \delta_p P_{p,t-1} \ ,$$

and

$$(13) \qquad P_c = \alpha_c + \gamma_c P_w + \delta_c P_{c,t-1} \ ,$$

where P_p P_w P_c are as previously defined, and

α, γ, δ are response coefficients.

These relationships include the key variables which are likely to influence the determination of domestic prices. Other exogenous factors, such as macroeconomic variables, are assumed to be collapsed

Table 1--Free trade equilibrium in the short and long run for large and small countries.

	Large country	Small country
Short run		
$\tilde{P}_w$	$= \dfrac{g + h(a-c-dP_{w,t-1}-\varepsilon) + \theta}{1+bh}$	$= g + \theta$
$\tilde{T}$	$= \dfrac{a - c - bg - dP_{w,t-1}-\varepsilon-b\theta}{1 + bh}$	$= a - c - bg - dP_{w,t-1}-\varepsilon-b\theta$
$E(\tilde{P}_w)$	$= \dfrac{g + h(a-c-dP_{w,t-1})}{1 + bh}$	$= g$
$Var\ (\tilde{P}_w)$	$= \dfrac{h^2\sigma^2_\varepsilon + \sigma^2_\theta}{(1+bh)^2}$	$= \sigma^2_\theta$
$E\ (\tilde{T})$	$= \dfrac{a - c - bg - dP_{w,t-1}}{1 + bh}$	$= a - c - bg - dP_{w,t-1}$
$Var\ (\tilde{T})$	$= \dfrac{\sigma^2_\varepsilon + b^2\sigma^2_\theta}{(1+bh)^2}$	$= \sigma^2_\varepsilon + b^2\sigma^2_\theta$
Long run		
$(P_{w,t-1} = P_{wt}\ ;\ E(\theta) = E(\varepsilon) = 0)$.		
$\tilde{P}_w$	$= \dfrac{g + h(a-c)}{1+h(b+d)}$	$= g$
$\tilde{T}$	$= \dfrac{a - c - g(b+d)}{1 + h(b+d)}$	$= a - c - g(b+d)$

into the intercept term, and movements in the exchange rate are reflected in the world price variable which is measured in domestic currency.

The excess demand function can be derived by substituting these relationships into the general model

$$
\begin{aligned}
T &= Q_d - Q_s, \\
&= a - bP_c - c - dP_{p,t-1} - \varepsilon, \\
&= a - b\,(\alpha_c + \gamma_c P_w + \delta_c P_{c,t-1}), \\
&\quad - c - d\,(\alpha_p + \gamma_p P_{w,t-1} + \delta_c P_{p,t-2}) - \varepsilon .
\end{aligned} \tag{14}
$$

This equation represents a generalized form of the excess demand function. By setting the policy parameters in equations (12) and (13) at particular levels, specific policies can be represented. For example, in the free trade case $P_c, P_p = P_w$, which implies that $\gamma_c, \gamma_p = 1$ and $\alpha_c, \alpha_p, \delta_c, \delta_p = 0$. Equating this function with the excess supply function allows an international equilibrium to be determined, the equilibrium level of world price in the current period can be expressed as follows:

$$
\tilde{P}_w = g + \frac{h\,[a - b\,(\alpha_c + \delta_c P_{c,t-1}) - c - d\,(\alpha_p + \gamma_p P_{w,t-1} + \delta_p P_{p,t-2}] - h\varepsilon + \theta}{(1 + hb\gamma_c)}, \tag{15}
$$

and the equilibrium level of trade as

$$
\tilde{T} = \frac{a - b\,(\gamma_c + \delta_c P_{c,t-1}) - b\gamma_c g - c - d\,(\alpha_p + \gamma_p P_{w,t-1} + \delta_p P_{p,t-2}) - \varepsilon - b\gamma_c \theta}{(1 + hb\gamma_c)} . \tag{16}
$$

The variability of world price and trade can also be derived from the above expressions

$$
\mathrm{Var}(\tilde{P}_w) = \frac{h^2\sigma_\varepsilon^2 + \sigma_\theta^2}{(1 + hb\gamma_c)^2}, \tag{17}
$$

and

$$(18) \qquad \mathrm{Var}(\tilde{T}) = \frac{\sigma_\varepsilon^2 + b^2\gamma_c^2\sigma_\theta^2}{(1+hb\gamma_c)^2} .$$

The variability of domestic producer and consumer prices are related to the variability of world prices

$$(19) \qquad \mathrm{Var}(P_p) = \gamma_p^2 \ \mathrm{Var}(\tilde{P}_w) ,$$

and

$$(20) \qquad \mathrm{Var}(P_c) = \gamma_c^2 \ \mathrm{Var}(\tilde{P}_w) .$$

It should be noted that these measures of variability reflect the instability in the current period only. The lagged response to world prices which is incorporated in equations (15) and (16) would indicate that there is also dynamic instability associated with the medium term equilibrium. For example, in the simplified case where $\delta_c, \delta_p = 0$ it can be shown that world price would oscillate around a long-run equilibrium. This cycle will be stable when the expression $\frac{dh\gamma_p}{1+hb\gamma_c}$ is less than unity. It is obvious that in a situation where the policy parameter $\gamma_p = 0$, or in the small country case (h=0), there would be no dynamic instability or cobweb effect in the model. Other cases would need to be analyzed more carefully, or evaluated in a simulation model, to determine the full dynamic implications of such relationships.

For the general model, the long-run equilibrium conditions can be derived by assuming that the expected values of the random variables are zero and that all prices are stable. Thus, in the long run

$$(21) \qquad \tilde{P}_w = \frac{g + h\left[a - b\left(\frac{\alpha_c}{1-\delta_c}\right) - c - d\left(\frac{\alpha_p}{1-\delta_p}\right)\right]}{1 + bh\left(\frac{\alpha_c}{1-\delta_c}\right) + dh\left(\frac{\gamma_p}{1-\delta_p}\right)} ,$$

and

$$(22) \qquad \tilde{T} = \frac{a - b\left(\frac{\alpha_c}{1-\delta_c}\right) - c - d\left(\frac{\alpha_p}{1-\delta_p}\right) - gb\left(\frac{\gamma_c}{1-\delta_c}\right) - gd\left(\frac{\gamma_p}{1-\delta_p}\right)}{1 + hb\left(\frac{\gamma_c}{1-\delta_c}\right) + hd\left(\frac{\gamma_p}{1-\delta_p}\right)} .$$

Expressions 15 through 22 can be used to identify the impact of a range of specific pricing policies on trade and price stability. Some of these policies are discussed individually in the following sections.

2.3.1 A Fixed Tariff

In the case of a fixed tariff, the domestic pricing relationships (12) and (13) reduce to the following:

$$(23) \qquad P_p = t + P_w ,$$

and

$$(24) \qquad P_c = t + P_w ,$$

where t is the level of the absolute tariff. In this case, $\alpha_c, \alpha_p = t$, $\gamma_p, \gamma_c = 1$, $\delta_c, \delta_p = 0$ and the trade demand function has the following form:

$$(25) \qquad T = a - b\,(t+P_w) - c - d\,(t+P_{w,t-1}) - \varepsilon .$$

In comparison to the free trade case, the intercept of this function is lower, but the slope with respect to the world price remains unchanged. It can be shown that this policy will lead to a lower world price and decreased trade. In the case of an exporting country, an export subsidy of t would have the same effect, except that exports would increase. In both cases, it can be shown that the variance of world price and trade would be equal to that under free trade case.

2.3.2. <u>Ad Valorem</u> Tariff

With an <u>ad valorem</u> tariff, the domestic price relationships would be of the following form:

$$(26) \qquad P_p = (1+t)\,P_w ,$$

and

(27) $$P_c = (1+t)\ P_w\ ,$$

where t is the proportionate tariff, or in the case of an exporting country, the rate of export subsidy applied.

The excess demand relationship would be

(28) $$T = a - b\ (1+t)\ P_w - c - d\ (1+t)\ P_{w,t-1} - \varepsilon\ .$$

In comparison with free trade this policy would cause the excess function to be more elastic with no change in the intercept. This rotation of the function causes world prices to decrease and imports to decrease (or exports to increase for an exporting country) in both the short and long run. Such a policy would stabilize world prices in the short run, but may destabilize trade flows.

2.3.3. Deficiency Payment

Deficiency payments are a common feature in both exporting and importing countries, and are generally used to maintain producer prices above world price levels. Payments are normally made to producers to cover the difference between market prices and a guaranteed price level, while consumer prices are normally determined by market conditions. In some situations, the guaranteed price may be a minimum price, and producers receive the market price when it rises above the guaranteed minimum. This particular case is discussed in a subsequent section on discontinuous pricing policies. Where the guaranteed price is always above the world market price, the pricing mechanism can be defined as follows:

(29) $$P_p = P^*\ ,$$

and

(30) $$P_c = P_w\ ,$$

where P* is the guaranteed price. In the general model, this means that $\alpha_p = P^*$, $\gamma_c = 1$ and all other price policy coefficients are equal to zero.

The excess demand function in this case is of the following form:

(31) $$T = a - bP_w - c - dP^* - \varepsilon\ .$$

While the slope of this function is the same as that under free trade in the short run, the intercept is lower since the guaranteed price is higher than the world price. In the short run, this would not affect the variability of world price and trade, but the lack of producer supply response to changing world prices would make the world price less variable in the medium term. The latter effect is due to absence of the cobweb reaction associated with lagged production response. This conclusion differs from that in other studies where it is assumed that supply responds in the current period (Zwart and Meilke, 1979; Bale and Lutz, 1979). Supply response in the current period would normally have a stabilizing effect during this period due to the increased elasticity of the excess function. In that case, the short-run effect of the deficiency payment policy would destabilize world prices in comparison with free trade.

2.3.4. Variable Levy

Some countries and regions such as the European Community utilize a variable levy to maintain both consumer and producer prices at levels above world prices. By announcing a support price and charging an import levy equal to the difference between this price and the world price, domestic producer and consumer prices are isolated from changes in world prices within a given period. In this case, the policy can be stated in the following simple form:

$$(32) \qquad P_p = P^* ,$$

and

$$(33) \qquad P_c = P^* ,$$

where P* is the target on support prices. The excess demand function

$$(34) \qquad T = a - bP^* - c - dP^* - \varepsilon$$

is seen to be perfectly inelastic with respect to changes in world price. To the extent that the support price is higher than the world price, increased production and decreased consumption would lead to less imports (or greater exports) and hence the world price is lower than in the free trade case. Although the excess demand function is price inelastic, fluctuations in domestic production influence the level of trade, and hence the variability of world price. The variance of world price

$$(35) \qquad \mathrm{Var}(\tilde{P}_w) = h^2\sigma_\varepsilon^2 + \sigma_\theta^2$$

is greater than in the free trade case, but it can be shown that the variability in trade

$$(36) \qquad \mathrm{Var}(\tilde{T}) = \sigma_\varepsilon^2$$

may be less, depending on the size of the country concerned, or more important, how responsive world price is to variations in the trade of the country.

2.3.5 Price Smoothing

A further type of pricing policy can best be described as a price smoothing policy. In this case, prices may be set in such a manner that they reflect changing world market conditions but only in a partial manner. For example, in an administered pricing system where prices are set by a government agency, prices might adjust in the following manner:

$$(37) \qquad P_p = P_{p,t-1} + (1 - \delta_p)\,(P_w - P_{p,t-1}) ,$$

where $\delta_p \leq 1$.

This partial adjustment mechanism reflects the following set of parameters in the generalized intervention model

$$(38) \qquad P_p = (1-\delta_p)\,P_w + \delta_p P_{p,t-1} .$$

This weighted average pricing formula would lead to an excess function of the following form:

$$(39) \qquad T = a - b\,(1-\delta_c)\,P_{c,t-1} - b\delta_c P_w - c - d\,(1-\delta_p)\,P_{p,t-2} ,$$

$$- d\delta_p P_{w,t-1} - \varepsilon .$$

This type of policy introduces more complex dynamic relationships into the model. It can be shown that in the short term such policies will stabilize domestic prices and destabilize world prices in comparison to free trade. In the example shown, where the weights on the prices sum to one, it also can be shown that in the long run expected prices would be the same as under free trade.

2.3.6 Summary

The particular examples of pricing policies which have been discussed have been selected to demonstrate the manner in which such policies influence the excess demand function for a particular country and how this affects world price and trade. In Table 2, a summary of the results obtained is presented. Except for the differences created by the use of a lagged supply function the results are consistent with those in earlier studies such as Bale and Lutz (1979) and Zwart and Meilke (1979). It can be seen that the major factor influencing short-term world price stability is the manner in which the domestic prices respond to changes in the world price in the current period. This price transmission effect is measured in the generalized price

Table 2--Impact of alternative pricing policies on the stability of world prices and trade.

Policy	Var ($\tilde{P}_w$)	Var ($\tilde{T}$)
Free trade (FT)		
$P_p = P_w$ $P_c = P_w$	$\dfrac{h^2\sigma_\varepsilon^2 + \sigma_\theta^2}{(1+bh)^2}$	$\dfrac{\sigma_\varepsilon^2 + b^2\sigma_\theta^2}{(1+bh)^2}$
Generalized price intervention		
$P_p = \alpha_p + \gamma_p P_w + \delta_p P_{p,t-1}$ $P_c = \alpha_c + \gamma_c P_w + \delta_c P_{c,t-1}$	$\dfrac{h^2\sigma_\varepsilon^2 + \sigma_\theta^2}{(1+bh\gamma_c)^2}$ (> FT)	$\dfrac{\sigma_\varepsilon^2 + b^2\gamma_c^2\sigma_\theta^2}{(1+bh\gamma_c)^2}$ (?)
Tariff--specific		
$P_p = P_w + t$ $P_c = P_w + t$	= FT	= FT
Tariff--ad valorem		
$P_p = (1+t)\ P_w$ $P_c = (1+t)\ P_w$	$\dfrac{h^2\sigma_\varepsilon^2 + \sigma_\theta^2}{(1+bh(1+t))^2}$, (< FT)	$\dfrac{\sigma_\varepsilon^2 + b^2\ (1+t)^2\ \sigma_\theta^2}{(1+bh(1+t))^2}$ (?)
Deficiency Payment		
$P_p = P^*$ $P_c = P_w$	= FT	= FT
Variable levy		
$P_p = P^*$ $P_c = P^*$	$h^2\sigma_\varepsilon^2 + \sigma_\theta^2$ (> FT)	σ_ε^2 (?)
Price smoothing		
$P_p = (1-\delta_p)P_w + \delta_p P_{p,t-1}$ $P_c = (1-\delta_c)P_w + \delta_c P_{c,t-1}$ $\delta_p, \delta_c \leq 1$	$\dfrac{h^2\sigma_\varepsilon^2 + \sigma_\theta^2}{(1+bh\delta_c)^2}$ (> FT)	$\dfrac{\sigma_\varepsilon^2 + b^2\delta_c^2\sigma_\theta^2}{(1+bh\delta_c)^2}$ (?)

intervention model by the γ_c coefficient. For any policy where the the consumer price transmission effect is less than unity, world market price will be destabilized and domestic price will be stabilized in comparison to free trade.

The lagged price relationships which are included in the model may lead to complex dynamic relationships in the medium term. While it is possible to specify the form of such relationships and their impacts on the excess demand function, their implications for world price and trade stability are more complex. The full impact of these relationships can only be analyzed numerically.

The policies which have been presented may be oversimplified because they have not accounted for the manner in which the use of policy instruments, and their levels might vary between periods. For example, while support prices such as those used in the variable levy or deficiency payment cases may be fixed within a year, the level of the instruments may respond to price changes over time. Support prices are frequently changed to reflect changing economic conditions both within a country and in world markets. In this case, domestic prices may respond to lagged or expected current world prices, generating a response relationship more similar to the general model. The development of models which incorporate these, or more complex dynamics, would require more sophisticated specifications than have been used in the past.

2.4 Storage and Pricing Policies

Government supported storage is often a major component of domestic agricultural policies. Stockholding objectives can vary widely between countries and may have differing impacts on the level and stability of world trade. Storage policies in larger exporting countries are often perceived to be oriented toward stabilizing world trade and prices, while many smaller countries operate policies which have a greater influence on domestic markets, especially where storage programs are integrated with pricing or trade controls. In this section, a simplified model is developed to demonstrate the manner in which alternative storage policies affect the stability of trade. In the model developed, it is initially assumed that there is no pricing policy, but this is subsequently modified to incorporate both pricing and storage policies.

2.4.1 Storage

The basic model can be modified to include a storage policy through the addition of a function which describes the change in stocks in the current period (ΔS)

$$\Delta S = \beta_s \varepsilon - \beta_p \theta \,, \qquad \beta_s, \beta_p \geq 0 \,, \tag{40}$$

where the coefficient β_s defines how stocks change in response to random variation in domestic production and β_p describes how stocks change in response to random variation in world price.

Under such a policy, it can be seen that unanticipated increases in domstic production will lead to increases in stocks held, and short-term increases in the world price would lead to a decrease in stocks. While such a specification may appear unnecessarily restrictive, it provides a simple description of how the majority of public storage policies operate. The relationship is specified in a first difference form so that in the long run expected stocks are zero, thus ensuring that there is no net accumulation of stocks or change in prices.

To complete the model, the excess demand relationship is modified to incorporate the effect of the storage policy. Thus, equation (3) in the general model is respecified as

$$T = Q_c - Q_p + \Delta S \ . \tag{41}$$

This implies that increases in stocks would have the effect of increasing imports or decreasing exports.

Substituting these relationships into the general model and assuming that there is no separate pricing policy in existence, the excess demand function would have the following form:

$$T = a - bP_w - c - dP_{w,t-1} - (1-\beta_s)\varepsilon - \beta_p\theta \ . \tag{42}$$

It can be shown that this storage policy would not influence the expected level of world price or trade, but would influence the variability in the short term. The expressions for the variability of world price and trade are as follows:

$$\mathrm{Var}(\tilde{P}_w) = \frac{h^2\ (1-\beta_s)^2\sigma_\varepsilon^2 + (h\beta_p - 1)^2\sigma_\theta^2}{(1+bh)^2} \ , \tag{43}$$

and

$$\mathrm{Var}(\tilde{T}) = \frac{(1-\beta_s)^2\sigma_\varepsilon^2 + (\beta_p + b)^2\sigma_\theta^2}{(1+bh)^2} \ . \tag{44}$$

The variability of stocks can also be derived as

$$\mathrm{Var}(\tilde{\Delta S}) = \beta_s^2\sigma_\varepsilon^2 + \beta_p^2\sigma_\theta^2 \ . \tag{45}$$

This can be used to provide an indicator of the potential costs associated with operating the storage policy. As the variability of stocks increases, it would be expected that the cost of providing storage facilities is likely to increase.

It is apparent that the impact of public storage is dependent on the value of the policy parameters. Several cases can be identified.

(i) In the situation where $\beta_s = 1$ and $\beta_p = 1/h$, it can be seen that the world price would be completely stabilized, but at the same time the variability of the country's trade would be greater than free trade since the country would be absorbing all of the variability in world prices. Obviously, for a small country where h tends to be zero, this could lead to unreasonable increases in the variability of trade and stocks.

(ii) If the policy were only used to compensate for variations in domestic production ($\beta_s = 1$ and $\beta_p = 0$), then it can be seen that world prices and equilibrium trade flows would be partially stabilized because the excess function would not be subject to random variations. Such a policy could not be used to stabilize completely domestic prices, but might be used in some cases to minimize the variability in trade for a given country.

(iii) In general, it can be seen that for any policy where $0 < \beta_s \leq 1$ and $0 < \beta_p \leq 2/h$, then the variability of world price would be less than under free trade, but the variability of world trade may be greater.

The examples given above serve to demonstrate how storage policies can have differing impacts on world trade stability, depending on whether the stocks respond to domestic production variability or world prices. For a small country (h=0), response to world price variability would not appear to be practical, but a policy aimed at eliminating the effects of random variations in domestic production would have an impact on the variability of trade.

2.4.2 Pricing Policies

In smaller importing countries it is not uncommon for storage policies to be associated with domestic pricing policies in order to maintain some degree of self-sufficiency. Although self-sufficiency objectives are often not clearly defined, these normally relate to the stability of consumer prices and possibly the maintenance of a minimum proportion of total domestic supply from domestic production. Policies of this type are frequently administered through a government agency which has responsibility for setting prices and handling domestic stocks. To provide an example of such a policy, the storage model previously developed can be modified through incorporation of a simple version of the generalized price intervention relationship. Assume, for example, that domestic prices are determined by the following relationships:

(46) $$P_p = \alpha_p + \gamma_p P_w ,$$

and

(47) $$P_c = \alpha_c + \gamma_c P_w .$$

Lagged domestic price response has been omitted from these equations to simplify the analysis, and because current price response has the greatest influence on short-term stability.

In this model, the trade demand relationship can be specified as follows:

(48) $$T = a - b(\alpha_c + \gamma_c P_w) - c - d\ (\alpha_p + \gamma_p P_{w,t-1}) - (1-\beta_s)\varepsilon - \beta_p \theta .$$

The variability of world price and trade are as follows:

(49) $$\mathrm{Var}(\tilde{P}_w) = \frac{(1-\beta_s)^2\sigma_\varepsilon^2 + (h\beta_p - 1)^2\sigma_\theta^2}{(1+bh\gamma_c)^2} ,$$

and

(50) $$\mathrm{Var}(\tilde{T}) = \frac{(1-\beta_s)^2\sigma_\varepsilon^2 + (\beta_p + b\gamma_c)^2\sigma_\varepsilon^2}{(1+bh\gamma_c)^2} .$$

In comparison with the simple storage policy a consumer price transmission coefficient (γ_c) of less than unity would further destabilize world price, but not necessarily trade volumes. At the same time, however, domestic prices and consumption would become more stable:

(51) $$\mathrm{Var}(P_c) = \gamma_c^2\ \mathrm{Var}\ (\tilde{P}_w) ,$$

(52) $$\mathrm{Var}(P_p) = \gamma_p^2\ \mathrm{Var}\ (\tilde{P}_w) , \text{ and}$$

(53) $$\mathrm{Var}(Q_c) = (b\gamma_c)^2\ \mathrm{Var}\ (\tilde{P}_w) .$$

In the extreme case where domestic prices are fixed (i.e., $\gamma_c, \gamma_p = 0$), then obviously consumer prices and consumption are perfectly stable, and a complementary storage policy which responded only to the variability in domestic production would ensure that trade was also stabilized (i.e., $\beta_s = 1$ and $\beta_p = 0$). Further, if the fixed domestic prices were set at an appropriate level, it can be seen that the particular country could become completely isolated from world trade with zero imports and internal stability that is maintained by the storage policy. In either case, stable and inelastic excess demand would mean that

$$(54) \qquad \mathrm{Var}(\tilde{P}_w) = \sigma_\theta^2 ,$$

which may be greater than or less than under free trade depending on the relative size of the country concerned, the variability of its production, and its elasticity of demand.

2.5 Trade Control Policies

An increasing proportion of countries involved in world trade use state trading organizations to manage imports or exports. Typically, such organizations control export sales or internal distribution of imports, either through licensing or quota arrangements, or by a direct involvement in trading. In a static analysis, control of trade through quotas can be shown to have a similar effect to the internal pricing policies previously discussed, but in a stochastic model they can have markedly different impacts on internal and external stability. In analyzing such policies, the particular mechanism which is used to control trade is not as important as the manner in which the level of trade is allowed to adjust to changing domestic or international conditions. For example, consider a trade intervention relationship of the following form:

$$(55) \qquad T = T^* - \phi_s \varepsilon - \phi_p \theta , \qquad \phi_s, \phi_p > 0 ,$$

where T is the quantity traded, T* is a desired or expected level of trade, and ϕ_s and ϕ_p are coefficients which define how trade levels may adjust to changing domestic supply or world price, respectively.

The desired level of trade (T*), which would be negative for exports and positive for imports, is assumed to be a function of factors which are external to the general model, but could be altered to influence the expected level of internal prices. The relationship specified assumes that a random increase in domestic production would lead to reduced imports (or increased exports) which would stabilize domestic grain availability, and that a random increase in world price could lead to reduced imports (increased exports) which would influence foreign exchange transactions. In the overall model, equation (55) would become the trade demand function which would intersect the world excess supply function to determine world price:

$$(56) \qquad \tilde{P}_w = g + hT^* - h\phi_s \varepsilon + (1-h\phi_p)\, \theta .$$

Hence, the variability of world price in the current period can be expressed as

$$\text{(57)} \qquad \mathrm{Var}(\tilde{P}_w) = (h\phi_s)^2\sigma_\varepsilon^2 + (1-h\phi_p)^2\sigma_\theta^2 .$$

With the level of trade controlled, internal prices are determined independently of the world price

$$\text{(58)} \qquad Q_c = Q_p + T ,$$

and given that Q_p is predetermined in the current period,

$$\text{(59)} \qquad \begin{aligned} P_c &= \frac{a - Q_c}{b} , \\ \tilde{P}_c &= \frac{a - c - dP_{p,t-1} + \varepsilon + T^* - \phi_s \varepsilon - \phi_p \theta}{b} . \end{aligned}$$

The variability of P_c can also be derived as

$$\text{(60)} \qquad \mathrm{Var}(\tilde{P}_c) = \frac{(1-\phi_s)^2\sigma_\varepsilon^2 + \phi_p^2\sigma_\theta^2}{b^2} .$$

Equations 56-60 define an equilibrium model of the trade control policy, but its implications can be seen to change dramatically with alternative values of the policy parameters. Several cases are of particular interest.

(i) Where the volume of trade is held at a constant level (i.e., $T = T^*$, and $\phi_s, \phi_p = 0$), it can be shown that neither the world price nor domestic prices are completely stabilized. Unfortunately, it is not possible to determine whether these prices are more unstable than in the free trade case. In the free trade model developed in this study, an individual country has three major impacts on world price stability. The most obvious effect is its domestic production variability which generally destabilizes world price. The second effect is the price stabilizing influence of the domestic demand curve, and the third, but most complex, effect is the manner in which the size of the country influences the slope of the excess function which it faces. Careful measurement would be necessary to determine whether the insulation of a country through fixed trade would stabilize or destabilize either world or domestic prices.

(ii) The policy parameters can be set in such a manner that domestic prices are stabilized (i.e., $\phi_p = 0$, $\phi_s = 1$) and it can be seen that in this case the world price would be less stable than with free trade. This policy would create the possibility of achieving self-sufficiency for the country, but it should be noted that it would still require variable trade

$$(61) \qquad \mathrm{Var}(\tilde{T}) = \sigma_\varepsilon^2 \ .$$

This effect is equivalent to that of pursuing a fixed domestic price policy.

(iii) An alternative strategy would be to allow trade flows to respond only to changes in world prices. It can be seen that where $\phi_s = 0$ and $\phi_p = 1/h$, then world price would be completly stabilized, but domestic prices would possibly be highly unstable

$$(62) \qquad \mathrm{Var}(\tilde{P}_c) = \frac{(\frac{1}{h})^2 \sigma_\theta^2}{b^2} \ ,$$

especially for a smaller country (where h tends to be zero). A more specific version of this type of policy is considered in a later section, where the influence of such policies on foreign exchange is also considered.

The alternative policies or strategies considered above are seen to be varied in their impacts, but an even wider range of possibilities results when trade control is combined with storage.

2.6 Trade Control with Storage

Many state trading organizations simultaneously utilize storage policies and trade controls, which generates even greater influence on market conditions, especially domestically. This case would normally occur where an agency is involved directly in the purchase or sale of the product. Common examples include the marketing boards of the major wheat exporting countries such as Canada and Australia, but such strategies may also be used by smaller developing countries where control over the quantities imported and stored is utilized as an alternative to price controls.

To analyze such policies, the model developed in the previous section can be modified by the addition of the generalized storage equation described earlier (40)

$$(63) \qquad \Delta S = \phi_s \varepsilon - \phi_p \theta \ ,$$

and through modification of the consumption relationship

$$(64) \qquad Q_c = Q_p + T - \Delta S \ .$$

The excess demand relationship and the mechanism of world price determination remains unchanged, but domestic price determination is modified by the storage policy

$$\tilde{P}_c = \frac{a - c - dP_{p,t-1} + \varepsilon + T^* - \phi_s\varepsilon - \phi_p\theta - \beta_s\varepsilon + \beta_p\theta}{b} . \tag{65}$$

The storage policy does not influence the expected levels of prices, which are primarily determined by the level of trade (T*), but it does have an effect on the stability of domestic price.

Because of the large number of possible combinations of storage and trade control parameters, no attempt is made to discuss each combination in detail. However, a summary is presented in Table 3. Each of the 16 cases presented show alternative settings of the four key policy response parameters. The cell in the upper left corner is the case where all four parameters equal zero, which is the constant trade and no storage situation, and the bottom right cell is where all parameters are at nonzero levels. It can be seen that each of the sixteen cases generate different levels of stability for world and domestic prices. Furthermore, the trade policy parameters are the only ones which influence the stability of world price, and only in the cases where $\phi_s = 0$ and $\phi_p = 1/h$ would the world price be perfectly stable (row 3). To attain domestic price stability at the same time would require that a storage policy be used where $\beta_p = 1/h$ and $\beta_s = 1$. In this case variations in the country's stocks would absorb the instability of the entire market. Such a strategy is similar to the storage policy without trade controls discussed in section 2.4. The potential use of policies to promote domestic price stability is perhaps more realistic, and occurs when either trade or storage is used to absorb fluctuations in domestic production.

Perhaps the most important conclusion to be derived from these results is that the outcomes of combined trade and storage are varied, and are crucially dependent on both the instruments used and their levels. This suggests that considerable care is required in the empirical analysis of any particular country's policies when such measures are in operation.

2.7 Policies Which Influence Demand and Supply Relationships

To complete the analysis of domestic agricultural policies influencing the level and stability of world prices and trade, it is necessary to consider the wide range of measures whose primary influence is on the position or slope of the domestic demand and supply functions. Incorporated in this general category are a wide range of often complex and interacting policies which modify the response of both producers and consumers to changes in product prices. Many of these measures, such as farm input or consumption subsidies, influence more

Table 3--Impact of alternative storage and trade control policies on domestic and world price stability.

Trade control ($T = T^* - \phi_s \varepsilon - \phi_p \theta$)		Storage policies ($\Delta s = \beta_s \varepsilon - \beta_p \theta$)			
		$\beta_s, \beta_p = 0$ (no storage)	$\beta_s = 0, \beta_p$	$\beta_s = 1, \beta_p = 0$	β_s, β_p
$\phi_s, \phi_p = 0$ (fixed trade)	Var $\tilde{P}_c$	$= \frac{\sigma_\varepsilon^2}{b^2}$	$= \frac{\sigma_\varepsilon^2 + \beta_p^2 \sigma_\theta^2}{b^2}$	$= 0$	$\frac{(1-\beta_s)^2 \sigma_\varepsilon^2 + \beta_p^2 \sigma_\theta^2}{b^2}$
	Var $\tilde{P}_w$	$= \sigma_\theta^2$	σ_θ^2	$= \sigma_\theta^2$	σ_θ^2
$\phi_s = 1 \quad \phi_p = 0$	Var $\tilde{P}_c$	$= 0$	$\frac{\beta_p^2 \sigma_\theta^2}{b^2}$	$\frac{\sigma_\varepsilon^2}{b^2}$	$\frac{(1-\phi_s-\phi_p)^2 \sigma_\varepsilon^2 + \beta_p^2 \sigma_\theta^2}{b^2}$
	Var $\tilde{P}_w$	$= h^2 \sigma_\varepsilon^2 + \sigma_\theta^2$	$h^2 \sigma_\varepsilon^2 + \sigma_\theta^2$	$h^2 \sigma_\varepsilon^2 + \sigma_\theta^2$	$h^2 \sigma_\varepsilon^2 + \sigma_\theta^2$
$\phi_s = 0, \phi_p$	Var $\tilde{P}_c$	$= \frac{\sigma_\varepsilon^2 + \phi_p \sigma_\theta^2}{b^2}$	$\frac{\sigma_\varepsilon^2 + (\beta_p - \beta_p)^2 \sigma_\theta^2}{b^2}$	$\frac{\phi_p^2 \sigma_\theta^2}{b^2}$	$(1-\beta_s)^2 \sigma_\varepsilon^2 + (\beta_p - \phi_p)^2 \sigma_\theta^2$
	Var $\tilde{P}_w$	$= (1-h\phi_p)^2 \sigma_\theta^2$	$(1-h\phi_p)^2 \sigma_\theta^2$	$(1-h\phi_p)^2 \sigma_\theta^2$	$(1-h\phi_p)^2 \sigma_\theta^2$
ϕ_s, ϕ_p	Var $\tilde{P}_c$	$= \frac{(1-\phi_s)^2 \sigma_\varepsilon^2 + \phi_p^2 \sigma_\theta^2}{b^2}$	$\frac{(1-\phi_s)^2 \sigma_\varepsilon^2 + (\beta_p - \phi_p)^2 \sigma_\theta^2}{b^2}$	$\frac{\phi_s^2 \sigma_\varepsilon^2 + \phi_p^2 \sigma_\theta^2}{b^2}$	$\frac{(1-\phi_s-\beta_s)^2 \sigma_\varepsilon^2 + (\beta_p - \phi_p)^2 \sigma_\theta^2}{b^2}$
	Var $\tilde{P}_w$	$= (h\phi_s)^2 \sigma_\varepsilon^2 +$ $(1-h\phi_p)^2 \sigma_\theta^2$	$(h\phi_s)^2 \sigma_\varepsilon^2 +$ $(1-h\phi_p)^2 \sigma_\theta^2$	$(h\phi_s)^2 \sigma_\varepsilon^2 +$ $(1-h\phi_p)^2 \sigma_\theta^2$	$(h\phi_s)^2 \sigma_\varepsilon^2 + (1-h\phi_p)^2 \sigma_\theta^2$

than one product. This can make it difficult to isolate the impact of a particular policy on an individual product. Such policies are typically dealt with in the context of international trade by assuming that their effects are incorporated in domestic response functions. The implications of the removal or a change in a specific policy can be evaluated by determining its influence on the position of these functions. In this context, financial measures, such as producer and consumer subsidy equivalents, have proven useful in providing estimates of how a particular policy might shift the intercept of demand and supply functions.

Not all of the policies in this group are amenable to such an approach because they may also influence the slope of the function concerned. An example of such a policy might be production controls which would cause the supply of a product to become perfectly inelastic in the short term. A more subtle example would be a policy under which input subsidies are linked to changes in world prices. In some countries, it is not unusual for input or credit subsidies to be increased when farm incomes fall, often because of low world prices. In such a case, the effective supply function would become more inelastic, which would influence the medium-term instability of world prices. As would be expected, policies which shift the functions have an impact on the expected level of world prices, while policies which alter the slope of the relationships have their primary effect upon the stability of world prices.

In general, the presence of these policies would not normally present any major problems in the development of international models because they can be incorporated in the estimation of the response relationships. It is important, however, to recognize the importance of these policies. In some situations it may be valuable to incorporate intermediate relationships which exist between the policies and other macroeconomic or market variables, especially where the policies are frequently changed.

2.8 Discontinuous Pricing Policies

In the previous analysis of pricing policies, it was assumed that domestic prices are determined by a linear relationship with world prices, and in the specific case where domestic prices are fixed, it is assumed that this price is always effective. In some cases, however, intervention prices are used to provide a minimum below which domestic prices are supported. This is probably most common with deficiency payment policies, where government payments are provided to make up the difference between market price and the support price. Discontinuities are introduced into the excess demand functions for the country concerned, and will influence the stability and expected value of world price. Unfortunately, discontinuous functions are not amenable to the simple analysis of the type employed in this study, and can prove difficult to deal with empirically.

As a simple example, consider a pricing policy of the following form:

$$P_c, P_p = P_w \text{ for } P_w \geq P^* ,$$

(66) and

$$P_c, P_p = P^* \text{ for } P_w < P^* ,$$

where P* is the support price.

When the world price is above the support price, the excess demand function of the particular country would be the same as the free trade case, i.e.,

$$(67) \qquad T = a - bP_w - c - dP_{w,t-1} - \varepsilon ,$$

and the equilibrium world price and trade would be defined by equations (6) and (7). When conditions are such that the world price falls below the support price, then the fixed domestic price would cause the trade demand function to become perfectly inelastic below this price

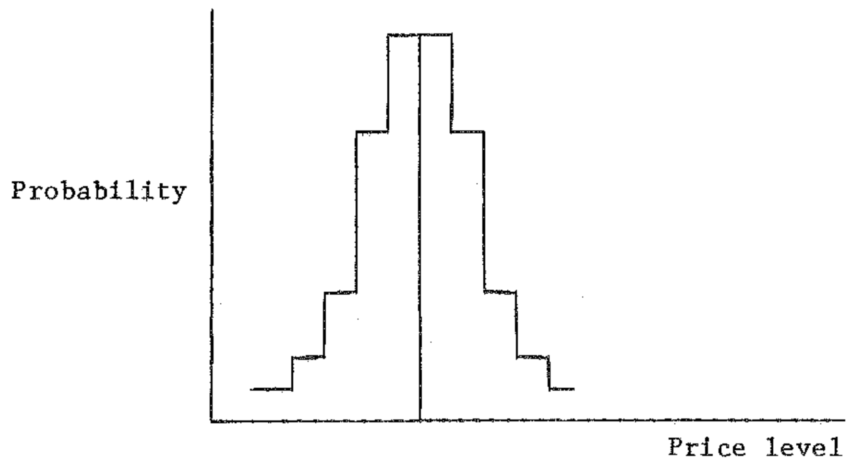
$$(68) \qquad T = a - bP^* - c - dP_{w,t-1} - \varepsilon .$$

In the simple model presented here, it is possible to determine the probability of the world price falling below the support price, given information about the random elements in the model. This makes it possible to determine the implications of such policies on the distribution of world and domestic prices in the short run. In Figure 1, it can be seen that even where the expected value of the free trade price is above the support price, the distribution of prices is influenced by the presence of such policies. Panel A depicts a hypothetical normal distribution of world prices, and it can be seen that with a support price of P* the domestic price distribution is truncated, which reduces domestic price variability and increases the expected value (panel B). At the same time, the variability of the world price would be increased by the skewed distribution, and the expected value of the price would fall (panel C). This simple example has demonstrated the complex effects of such policies, which would become even more complicated in the longer run when supply response and other dynamic effects are incorporated.

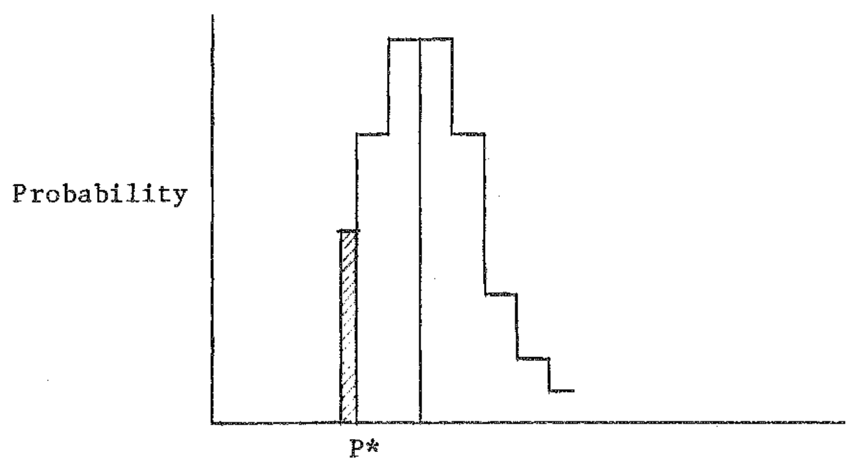
Discontinuous storage policies can create similar distortions and difficulties in analysis. It is not uncommon for governments or marketing agencies to operate storage policies which accumulate stocks to maintain minimum prices. In such a case, the excess demand function would become more elastic as world prices approach the support price, and variability in prices would be moderated by variability in stocks. The distribution of prices and stocks are further influenced by the manner in which stocks are released.

Figure 1. Probability distributions of prices with minimum price policy.

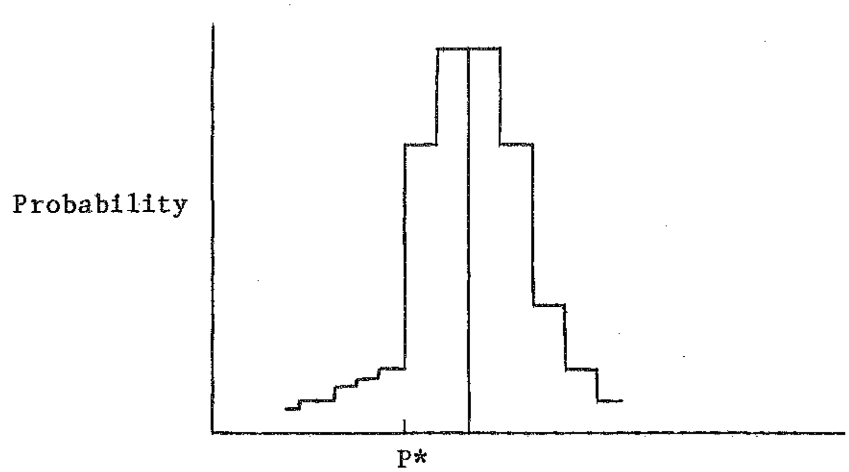
A. Free trade distribution of P_w and P_c



B. With minimum price policy -- domestic price



C. With minimum price -- world price



While the discontinuous relationships described above can be readily simulated with knowledge of the appropriate domestic response functions and support prices, they may prove difficult to estimate econometrically from observed behavior in a particular market, especially where support prices vary between periods. The most feasible approach to estimating these relationships would appear to be use of nonlinear relationships which provide an approximation to the kinked trade demand relationships. The world wheat model estimated in the study by Schwartz (1983) provides some estimates of such relationships for discontinuous storage policies, but the model developed does not allow for variations in real support prices over time. The formulation of such models are further discussed in later sections of this paper.

2.9 Summary

This section has outlined the broad range of policies which are likely to influence a country's trade in a particular product. Policies have been loosely classified into those which influence: product prices, the quantity stored between periods, the quantities traded, and the underlying demand and supply relationships. These policies have been analyzed in a generalized model and it has been clearly demonstrated that many of these policies have quite different implications for the level and stability of price and trade. While this classification has proved useful in understanding the mechanics of particular policies, it contributes little to the understanding of why countries select particular policies, or why some policies are more common than others. To consider these issues, it is necessary to focus attention on objectives which can underlie policy choice.

3.0 AN ANALYSIS OF SELECTED POLICY OBJECTIVES

An exhaustive analysis of the implications of the policies which have been identified earlier is beyond the scope of the present study, but it is useful to demonstrate how alternative policies might be used to attain some commonly held domestic objectives. This can prove useful in understanding the prevalence of particular combinations of instruments, and the manner in which policy response parameters might be determined. Self-sufficiency in grain production is probably the most general and often quoted objective of grain importing countries. There is a range of alternative policies which might be utilized in attaining such an objective, and these alternatives can have different implications for trade stability, storage levels, government costs, and perhaps more important, world price stability. In the following section, the general model is used to derive analytical measures of some of these effects. Subsequently, the model is utilized to demonstrate the effect of different policies on foreign exchange earnings. It is frequently assumed that the primary focus of policies in exporting countries is the maximization of foreign exchange earnings. The analysis presented highlights the differences between alternative export strategies which countries might follow.

The specific examples selected for analysis are intended to demonstrate the implications of combinations of policies which can be found in individual countries, and to identify some key response relationships which would need to be considered in analyzing empirically an individual country's policies.

3.1 Self-Sufficiency

Self-sufficiency is often a loosely defined objective, but it generally implies an attempt to attain domestic consumption stability as well as to reduce the dependence on imports. In this analysis a more specific definition of self-sufficiency will be used in which it is assumed that domestic prices are completely stabilized. In each policy considered it can be seen that trade dependence could be minimized by selecting appropriate instrument levels. In the general model which has been specified in this study, the assumption of consumer price stability would also ensure consumption stability as demand relationships are nonstochastic. In total six alternatives to ensure consumer price stability can be selected from the range of alternative policies previously discussed. The characteristics of each of these are briefly described below.

3.1.1 Pricing Policy

Of the pricing policies previously considered, only the variable levy would ensure domestic price stability. Fixed price levels (P*) would be selected to ensure an appropriate level of expected trade, and trade volumes would vary to reflect the short-term variability in domestic production. In Table 4 the expressions which define the

Table 4--Stability Impacts of Alternative Self-Sufficiency Policies

	Variance of World Price Var $(\tilde{P}_w)$	Variance of Trade Levels Var $(\tilde{T})$	Variability of Stock Var (ΔS)
1. <u>Price Policy</u> $P_c = P_p = P^*$ $T = a - c - (b+d)P^* - \varepsilon$	$h^2\sigma_\varepsilon^2 + \sigma_\theta^2$ (> FT)	σ_ε^2	--
2. <u>Storage Policy</u> $\Delta S = \beta_s\varepsilon - \beta_p\theta$ $(\beta_s = 1 \quad \beta_p = \frac{1}{h})$ $T = a - bP_w - c - dP_{w,t-1} - \frac{1}{h}\theta$	0 (< FT)	$(\frac{1}{h})^2\sigma_\theta^2$	$\sigma_\varepsilon^2 + (\frac{1}{h})^2\sigma_\theta^2$
3. <u>Import Policy</u> $T = T^* - \phi_s\varepsilon$ $(\phi_s = 1)$	$h^2\sigma_\varepsilon^2 + \sigma_\theta^2$ (> FT)	σ_ε^2	--
4. <u>Fixed Import & Storage</u> $\Delta S = \beta_s\varepsilon$ $(\beta_s = 1)$ $T = T^*$	σ_θ^2 (? FT)	0	σ_ε^2
5. <u>Import & Storage</u> $\Delta S = \beta_s\varepsilon$ $T = T^* - \phi_s\varepsilon$ $(\beta_s + \phi_s = 1)$	$(h\phi_s)^2\sigma_\varepsilon^2 + \sigma_\theta^2$ (? FT)	$\phi_s^2\sigma_\varepsilon^2$	$\beta_s\sigma_\varepsilon^2$
6. <u>Strategic Stock</u> $\Delta S = \beta_s\varepsilon - \beta_p\theta$ $T = T^* - \phi_s\varepsilon - \phi_p\theta$ $(\beta_s + \phi_s = 1)$ $(\phi_p = \beta_p)$	$h^2\phi_s^2\sigma_\varepsilon^2 + (1-h\phi_p)^2\sigma_\theta^2$ (? FT)	$\phi_s^2\sigma_\varepsilon^2 + \phi_p^2\sigma_\theta^2$	$\beta_s\sigma_\varepsilon^2 + \beta_p\sigma_\theta^2$

trade demand relationship and its impact on world price, trade and stock stability are presented. By comparing these expressions with those of the free trade equilibrium, (9) and (11), it can be seen that world price is destabilized through the use of the variable levy but trade levels may be either stabilized or destabilized. This type of strategy is similar to that which has been pursued by the European Community for a wide range of products.

3.1.2 Storage Policy

If a country were to rely solely on storage to ensure domestic price stability, it would be necessary to use stocks in such a way as to stabilize world prices. Stocks would have to respond both to variability in world prices created by production fluctuations in other countries and in the country's domestic production. Although not considered here, a tariff would have to be used if the objective were also to change the expected level of trade. A specific tariff would not influence the stability implications presented in Table 4. From Table 4 it can be seen that this strategy would have a beneficial impact on world price stability, but would lead to highly variable levels of imports and stocks for small countries. For a large country, however, (where $h > 1$) the volume of trade may be less variable than under the price policy alternative. Although the United States is not an importing country concerned with self-sufficiency, the impact of its domestic price support program for grains is similar to this type of strategy.

3.1.3 An Import Control Policy

Controls on imports could be used to stabilize domestic prices and change the level of trade dependence. In this case, a country might have a fixed target or expected level of trade, but trade is varied to adjust completely for current period fluctuations in domestic production. In analytical terms, this policy has the same impact as the fixed pricing policy described above, but it would obviously involve quite a different administrative structure. Again, it would lead to destabilized world prices, but not necessarily trade flows. One advantage of both this and the pricing policy is that they do not require public stockholding. This may be an important consideration for many countries. The remaining three strategies which are considered, however, involve both trade controls and storage policies, but with different emphasis in each case.

3.1.4 Fixed Imports and Storage

Where a country uses storage merely to offset variations in domestic production, the level of imports could remain fixed from year to year. Of the policies considered in this analysis, this is the only alternative which would lead to completely stable trade. This would be the situation for a country which attempts to maintain a high level of self-sufficiency by reducing trade, in which case domestic storage would be needed to stabilize domestic consumption or prices. From Table 4 it can be seen that this would lead to a world price which is more stable than in either the pure price or import control policies. However, world prices may be less stable than under free trade, although this is not inevitable. As discussed in section 2.5, the effect would depend on the country's potential net contribution to world price stability in the absence of its policy. What is clear is the variability in stocks would be less than under the "pure" storage case which attempted to stabilize the entire market.

3.1.5 Import and Storage

A more commonly occurring approach involves a mixed strategy of variable imports and the use of storage. This is an intermediate case to the previous two policies which have been considered. Shortfalls in domestic supplies would be made up either from reducing domestic stocks or increasing imports, and surpluses would result in increased stocks or reduced imports. The strategy would be most applicable where trade and stocks are controlled by a single authority such as a marketing board, or a government importing agency, and would represent the stituation in many centrally planned countries. The analytical results in Table 4 show that the world price would be more stable than under any of the previous policies considered, except for the fixed imports and storage policy (section 3.1.4). Trade volumes would be more stable than under pricing or import control policies, and the variability of stocks would be less than in any of the other policies which included storage. Again, it is not possible to demonstrate whether world prices would be more or less stable than under free trade, except for the special case of a small country where there would be no difference.

3.1.6 A Strategic Stock Policy

The previous two strategies which have incorporated domestic storage policies have presumed that stocks and trade in the country do not respond to world price variability. At the other extreme, the pure storage policy assumed that all of the variability in world price was absorbed domestically, but it is possible to define an intermediate strategy. Consider the case where both trade and storage respond to changes in world price in such a manner that in low-priced periods imports are increased and stocks are accumulated, and in high-priced periods imports are reduced and stocks are drawn down.

In the long run, the expected level of the change in stocks would still be zero but because the variability of stocks is greater than in the previous two policies, the expected level of stocks held would need to be greater to avoid premature stock exhaustion. It is for this reason that we have termed this a strategic stock policy.

The impact of strategic stocking on world price variability is complex. It is possible for market prices to be more stable than in the previous strategy (where $h\phi_p < 1$), thus it is also possible for world price to be more stable than under free trade. The variability of both imports and stocks are increased by the same amount, which is to be expected because of the close linkage between imports and storage. The opportunistic purchasing from the world market which is implied by this strategy has implications for foreign exchange flows, and these are discussed to some extent in the following section.

Where a country is concerned primarily with food security, it may be possible to observe a closely related strategy in which a country increases imports in response to increases in world prices in the short term. Because the general model does not incorporate the possibility of production shortfalls or stock-rundowns, such a policy may not seem to be necessary, but this type of behavior has been observed on specific occasions (Schwartz). The implications of this type of strategy can be determined by modifying the signs in the policy response functions to incorporate a positive relationship between fluctuations in world prices and imports and changes in stocks. This will not change the variability of trade or stocks but the variability of world price

$$(69) \qquad \mathrm{Var}(\tilde{P}_w) = h^2\phi_s^2\sigma_\varepsilon^2 + (1+h\phi_p)^2\sigma_\theta^2$$

will be greater than with the negative price response. Perhaps it is not surprising that such a strategy could exacerbate variability in world price, but it is still possible for prices to be less variable than with free trade.

3.1.7 Summary

The simple analysis presented above has demonstrated that there are a wide range of alternative strategies that an individual country could pursue in an attempt to achieve domestic market stability and increased self-sufficiency. With the exception of the pure-pricing and trade control policy, all of the policies have different impacts on the stability of world price, trade and domestic stocks. There are also dissimilarities in their effects on foreign exchange, and government costs, which have not been described. Perhaps the most interesting conclusion which can be drawn from this analysis is that in many of the strategies considered, it cannot be demonstrated that world prices would necessarily be destabilized by the use of a policy which stabilizes domestic markets. This contrasts markedly with some previous analysts' comments about the relationship between domestic policies and world price stability.[3] This conclusion results from considering the more complex interactions which can occur between storage

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[3] Note the quotation from Johnson (1975) in section 1.2.

and trade control policies. They highlight the need to consider, in more detail, the specific elements which make up a domestic policy, and the manner in which such policies respond to changing market conditions.

3.2 Alternative Exporting Strategies

Several of the major exporting countries in world grain markets have export marketing agencies with the responsibility of maximizing returns to producers. The general model can be used to analyze alternative strategies which such an agency might pursue using a coordinated storage and trade control policy, and presuming that they are concerned with the foreign exchange implications of their trading. This is similar to the environment faced by both the Canadian and Australian wheat boards. It is obvious that if such agencies face excess demand curves for their products, then foreign exchange could be maximized in the short term by equating marginal revenues with marginal costs, but with uncontrolled production, this could lead to either an accumulation of stocks or an inability to supply. To avoid this possibility, it is important to consider only strategies which maintain a long-run balance of supply and demand and an expected change in stocks which is zero.

For ease of analysis, the general model, in which a positive level of trade (T) represented imports, can be inverted to represent the situation facing an exporting country. This involves no loss of generality, but simplifies the understanding of the results presented.

The demand and supply relationships specified in equations (1) and (2) would remain unchanged, but an export function is specified to represent the exporting decisions of the agency,

$$(70) \qquad X = X^* + \phi_s \varepsilon + \phi_p \theta \ ,$$

where X is the level of exports in the current period, X* is the expected level of exports, and all other variables are as previously defined. This specification implies that increases in either domestic production or world prices would lead to increased exports.

Although it is not a necessary part of the model, it can be seen that domestic stability could be attained by developing a storage policy which maintain a balance between domestic supply and demand and exports. In this case,

$$(71) \qquad \Delta S = Q_p - Q_c - X \ ,$$

and by substituting in (1) (2) and (70)

$$(72) \qquad \Delta S = c + dP_{w,t-1} + \varepsilon - a + bP_c - X^* - \phi_s \varepsilon - \phi_p \theta \ .$$

Then if

(73) $$X^* = c + dP_{w,t-1} - a - bP_c ,$$

which is the expected level of exports in the current period, the storage policy would be of the following form:

(74) $$\Delta S = (1-\phi_s)\ \varepsilon - \phi_p \theta ,$$

and it can be seen that the expected change in stocks would be zero. A joint export and storage policy of this form would ensure that stocks do not accumulate persistently, and that export levels would still respond to changes in supply and demand within the country. It also allows for independent price intervention within the country.

A world market equilibrium can be determined by equating the export function (70), with the excess demand from the rest of the world,

(75) $$P_w = g + hX + \theta .$$

The equilibrium level and variability of the world price are as follows:

(76) $$\tilde{P}_w = g - hX^* - h\phi_s \varepsilon - h\phi_p \theta + \theta ,$$

(77) $$\text{Var}(\tilde{P}_w) = h^2\phi_s^2\sigma_\varepsilon^2 + (1-h\phi_p)^2\sigma_\theta^2 .$$

The level of exports is determined by equation (70) and their variability is

(78) $$\text{Var}(\tilde{X}) = \phi_s^2\sigma_\varepsilon^2 + \phi_p^2\sigma_\theta^2 .$$

In this model the policy response parameters (ϕ_s, ϕ_p), can be used to represent alternative export strategies which an export agency might follow. For example, if both parameters were set to zero trade would be predetermined, and if $\phi_s = 0$ and $\phi_p = 1/n$ world price would be stabilized. Such policies are equivalent to those already discussed for importers, but the impact of such policies upon foreign exchange earnings has not been identified.

By defining current period foreign exchange earnings (FE) as

(79) $$FE = \tilde{P}_w \cdot \tilde{X} ,$$

and by substituting in equations (70) and (76), and taking expected values, it is possible to derive an expression for the expected level of foreign exchange earnings,

(80) $$E(FE) = X^*g - hX^{*2} - h\phi_s^2\sigma_\epsilon^2 - h\phi_p^2\sigma_\theta^2 + \phi_p\sigma_\theta^2 .$$

This expression is a quadratic function of the policy response parameters and permits an evaluation of the impact of alternative exporting strategies on expected earnings. As well as the policies already defined, optimal levels of the parameters can be derived by maximizing the function. It can be shown that expected foreign exchange earnings are maximized when $\phi_s = 0$ and $\phi_p = 1/2h$.

In Table 5 a summary of the implications of the three alternatives are presented. This is not an exhaustive list of available options but highlights the range of possibilities. The associated storage policies which are required to stabilize domestic markets are also defined, and are seen to absorb all of the domestic variability as well as a varying amount of instability created by the trade policy.

It can be seen from Table 5 that the three policies have markedly different impacts on the variability of exports, stocks and world prices, but both the fixed export policy and the world price stabilizing policy generate the same level of expected foreign exchange earnings. The increased earnings associated with the optimal policy are seen to depend on the variability in world prices, and the slope of the excess demand curve facing the country concerned.

The results suggest that a smaller country which faces a more elastic excess demand curve (h tends to be zero) would have a higher level of expected earnings, but there would be a trade-off between these earnings and the variability of trade flows and stocks required. In the extreme situation, any small country could become a speculator on a world market if they had the finances and storage capacity to do so.

In the optimal policy, exports would change by only one-half of the amount which would be required to completely stabilize world price, but the results show that the world price would be only one-quarter as variable as in the case where exports did not change (the fixed trade case). These results suggest that it may be in the interests of an exporting country to partially stabilize world prices. However, it is unlikely to be in its interests to completely stabilize world prices, but rather to exploit the changes in marginal revenues which are caused by fluctuations in the excess demand curve which it faces. Such a policy should not be confused with the monopolistic exploitation of the excess demand, which would involve a change in the expected level of exports and would require the use of production controls or export taxes.

As might be expected, there is an equivalent strategy that would allow an importing country to minimize the foreign cost of a given level of expected imports. This would result from following the strategic stock policy where imports are a negative function of the

Table 5--Implications of alternative exporting strategies

	Alternative Strategies		
	Fixed Exports $\phi_s = \phi_p = 0$	Stable Prices $\phi_s = 0 \quad \phi_p = \frac{1}{h}$	Maximum Foreign Exchange $\phi_s = 0 \quad \phi_p = \frac{1}{2h}$
Exports ($\tilde{X}$)	X^*	$X^* + \frac{1}{h}\theta$	$X^* + \frac{1}{2h}\theta$
Variability of exports $Var(\tilde{X})$	0	$(\frac{1}{h})^2\sigma_\theta^2$	$(\frac{1}{2h})^2\sigma_\theta^2$
Change in stocks (ΔS)	ε	$\varepsilon - \frac{1}{h}\theta$	$\varepsilon - \frac{1}{2h}\theta$
Variability of change in stocks $Var(\Delta S)$	σ_ε^2	$\sigma_\varepsilon^2 + (\frac{1}{h})^2\sigma_\theta^2$	$\sigma_\varepsilon^2 + (\frac{1}{2h})^2\sigma_\theta^2$
World price ($\tilde{P}_w$)	$g - hX^* + \theta$	$g - hX^*$	$g - hX^* + \frac{1}{2}\theta$
Variability of world price $Var(\tilde{P}_w)$	σ_θ^2	0	$\frac{1}{4}\sigma_\theta^2$
Expected foreign exchange earnings $E(FE)$	$X^*g - hX^{*2}$	$X^*g - hX^{*2}$	$X^*g - hX^{*2} + \frac{1}{4h}\sigma_\theta^2$

disturbances in world prices (θ). The optimal response parameters would be, $\phi_s = 0$ and $\phi_p = 1/2h$, which are equivalent to those in the exporter model. Unfortunately, the simple analytical model developed here makes it difficult to derive conclusions about the variability of foreign exchange earnings under alternative policies.

In summary, this analysis further highlights the differences between policies or strategies which might be followed in a particular country. Although individual policies could be analyzed in considerably greater depth with the derivation of other measures, such as producers' and consumers' surpluses and government costs, the major emphasis has been on understanding the mechanics of policies and the manner in which they interact with the world market. It has been clearly demonstrated that it is important to understand in greater depth how pricing, storage, and trade control elements of a country's policies interact, and how they respond to changing market conditions.

4.0 IMPLICATIONS FOR EMPIRICAL ANALYSIS

It has been noted earlier in this paper that a growing awareness of the importance of domestic policies has led to a movement away from the estimation of simple free trade models of world grain markets, and in many of the more recent analyses, policy reactions have been incorporated or endogenized within the trade model. There appear to have been two major approaches used in direct modelling of such policy reactions. The first of these involves the derivation and estimation of a generalized reduced form relationship for trade. This is presumed to capture the major interactions between world price and either trade itself, or domestic supply and demand, and normally incorporate exogenous variables which influence both supply and demand, as well as the policy decisions. Examples of such models include those of Abbott (1979), Zwart and Meilke (1979) and Blandford and Schwartz (1983).

The second approach has been to develop models which attempt to incorporate more specific elements of the policies. Price intervention and storage response relationships have been estimated in the models developed by Chisholm and Tyers (1982) and Lattimore and Zwart (1978). Models of this type have provided considerable information about the manner in which policies have influenced trade, but perhaps the major short-coming of both approaches has been the dependence on a generalized specification of the structural model for each country or region. With the large number of individual relationships which must be estimated in international trade modelling, such an approach is not surprising, but it may not be adequate to capture the range of diversity which can exist in policies and their effects.

The analytical results in this study have emphasized the complex interactions which can exist between the elements that make up domestic policy. Three general types of intervention have been identified as being of the greatest importance: pricing, storage and trade control. While pricing and storage policies have been incorporated in many existing models, it is commonly presumed that they are either the only policy elements that are involved, or that they also capture the effects of other policies. The model developed here has also included trade control policies, covering a wide range of state trading and producer board activity as well as quotas, and which have been shown to have different impacts on the stability of international trade. This emphasizes the importance of considering the policies of individual countries in more detail than has been evident in previous models, and particularly in cases where trade control policies are employed.

4.1 Alternative Structural Models

It is apparent that combinations of the three general types of policies discussed in this paper could be observed in a country under study. In developing a structural model for a particular country it is, therefore, important to observe and differentiate the key elements of its policy. This requires more than an understanding of the specific instruments which are used, and it is usually necessary to explore the dynamics of the policy formation process itself. Valuable information can be gained by observing how frequently policy instruments are changed, and by whom the decisions are made. For example, if domestic support prices are announced in advance of the crop year and day-to-day importing decisions are made by a government agency, the structural model would be different than in a country where importing decisions are made on an annual basis and prices are changed within the season to absorb the flow of imports. These examples highlight the fact that, in general, a maximum of two of the three types of policies discussed would be operational in a particular country. Although the third policy element might be present in some cases, it would be residual to the other two elements because of the need to clear markets or determine domestic prices.

To clarify this discussion, seven of the most likely combinations of policies are identified in Table 6. For each case the relationships which would be estimated, and the variables which would be derived or solved for, are defined. It can be seen that the approach required in each case is different. While the categorization is obviously not exhaustive, it can prove useful in identifying the key characteristics of national policies, and thus provide a framework for estimating individual country models. Without attempting to describe any of the details of actual policies, it would appear that individual countries readily fall into the categories described. For example, the Economic Community's policies would fall in category B, the United States in F, Canada in G, and the policies of Japan, the USSR and other centrally planned economies would be typified by category D.

It might be envisaged that the approach of estimating different structural models for individual countries would involve considerably more detail in modelling. However, it can be seen that the total number of relationships that would be estimated would be little different than that required to estimate a generalized model which included both storage and price relationships for each country. Increased effort would be required to understand the economic characteristics of the policies. Even where the model is to be estimated in reduced form, this understanding would be valuable in selecting an appropriate equation form, or in imposing constraints on estimation. The theoretical results derived in earlier sections of this paper can be useful in helping to identify the form of excess demand or supply relationships for particular combinations of policies.

4.2 The Specification of Individual Relationships

The model used in the theoretical analysis has assumed a simplified structure, and has included responses to short-run stochastic disturbances which can prove difficult to represent. This section briefly describes how important components might be incorporated in relationships which can be econometrically estimated. Estimation of underlying supply and demand relationships is not discussed as these would be similar to those used in many other models. It is important

Table 6—Alternative approaches to estimating structural models of domestic policies

	Alone	Combined with	
Policy:		Price Policy	Trade Control
No policy	A. Estimate supply and demand functions only --Derive excess demand and solve for trade --Solve for world price		
Price policy	B. Estimate supply and demand functions --Estimate domestic price policy functions --Derive excess demand and solve for trade --Solve for world and domestic prices		
Trade control	C. Estimate supply and demand functions --Estimate trade demand functions --Solve for world price and domestic prices individually	D. Estimate supply and demand functions --Estimate domestic price policy functions --Estimate trade demand functions --Solve for world and domestic prices --Solve for residual stocks	
Storage policy	E. Estimate supply and demand functions --Estimate storage demand function --Derive excess demand function and solve for trade --Solve for world and domestic prices	F. Estimate supply and demand functions --Estimate domestic price policy functions --Estimate storage demand function --Derive excess demand and solve for world and domestic prices	G. Estimate supply and demand functions --Estimate storage demand function --Estimate trade demand function --Solve for world and domestic prices individually

to note however, that these relationships would be required to estimate fully any of the structural models described in Table 6. Discussion centers on estimation of the policy relationships which describe the operation of pricing, storage, and trade control policies.

4.2.1 Pricing Policies

In section 2.3 it was suggested that a wide range of alternative pricing policies could be described by individual linear relationships between domestic prices, world prices, and lagged prices (equations (12) and (13)). Where information is available about the specific form of the price intervention, it has been shown that more specific forms of this relationship might be applicable. In the medium to long run, however, even these policies might require a more general specification to account for the manner in which specific instruments such as support prices or tariffs respond to changing market conditions.

Relationships of this type have been frequently estimated, but attention has normally been focused on measuring short term price transmission relationships between world and domestic prices. These have often proven to be insignificant where price intervention is known to exist, which is not surprising as many of the intervention prices are established in advance of crop seasons. To accurately reflect the formation of domestic prices in such an environment, it may be necessary to identify the lagged relationships between world and domestic prices in more detail.

The presence of discontinuous pricing policies of the form described in section 2.8 might require the specification of more complex nonlinear relationships. At present, this is a relatively unresearched topic which could become increasingly important as work in this area continues. Exogenous variables would normally be included to account for the manner in which macroeconomic or other market variables are expected to influence policy makers' decisions. The selection of such variables would depend on individual market conditions and further analysis of the policies concerned.

4.2.2 Storage Policies

Many of the existing models of international grain markets have incorporated relationships which explain the levels of stocks, especially for major grain exporting countries. For other countries one of the major difficulties has been collecting suitable data, but improved data is continually becoming available, which should make it possible to estimate such relationships for a wider range of countries. A theoretical model has been used in this study to show that the response of storage policies to short-term changes in world price and domestic production has an influence on the stability of world price. It might even be argued that with the prevalence of fixed pricing in the wheat markets it is more important to detail the price responsiveness of storage policies than domestic demand relationships.

The theoretical storage relationship developed in this study is of a specific form which assumes that storage agents respond to stochastic disturbances in markets (equation 40). This might appear somewhat restrictive for a realistic market environment, but the relationship can be modified to reflect the manner in which agents form expectations about the future.

Given the theoretical form of the storage equation (40),

$$\Delta S = \beta_s \varepsilon - \beta_p \theta \,, \tag{81}$$

the short-term variability in domestic production (ε) can be represented by a variable which measures the difference between current production (Q_p) and an expected level of production Q^*_p. The expected level of production could be determined in a number of ways. In a simplified trade model, Blandford and Schwartz (1983) utilized the trend level of Q_p to form such a variable, and Tyers and Chisholm (1982) used a three-year moving average of past production to represent the expected level of production in the current year. The latter method of determing Q^*_p would probably be the most flexible and also the most useful in any simulation analysis where trends may change.

A similar variable could be constructed to reflect variability in world price. It would be assumed that stocks would fall by some function of the degree to which current price is above expectations, and the converse when prices are below expectations. Thus, an estimated storage relationship could be of the following form:

$$\Delta S = f\ (Q_p - Q^*_p,\ P_w - P^*_w) \,, \tag{82}$$

where Q^*_p and P^*_w are the expected levels of production and prices described above.

In the special case where a storage policy is seen to be clearly related to stabilizing the domestic market, and there is no domestic price control, it may be more relevant to assume that the stocks respond to domestic rather than world prices. Also, where stocks are held on a commerical basis Tyers and Chisholm have shown how interest and storage costs might be incorporated in the price expectation relationship. If stocks are publically owned, however, it may be more important to consider the use of alternative function relationships that reflect discontinuities in the storage relationship, or the different rates at which stocks are accumulated and released. The policies which influence grain storage in the United States might be seen as a clear case of the latter situation, and may pose special problems in estimation.

4.2.3 Trade Control Policies

Relationships which attempt to explain the level of trade associated with trade control policies have not been widely used in trade models. Blandford and Schwartz (1983) have used a generalized relationship, somewhat similar to the theoretical model developed in this study, in an attempt to isolate the short-term trade response in countries. They assumed that trade levels responded to deviations around trend in quantity produced and world price and although their analysis was only partially successful, this was probably due to their use of a simple, generalized model.

The theoretical model assumed in this analysis has been specified as follows:

$$(83) \qquad T = T^* - \phi_s \varepsilon - \phi_p \theta \ .$$

In a similar manner to that described in the discussion of storage models, the variables ε and θ could be represented by deviations around expected levels of domestic production and world price, respectively. It is recognized that these variables may incorporate deviations other than those caused by the short-run variability in supply and price, but this may be more realistic in an actual model. The variable T^*, which is presumed to reflect the expected level of trade, provides the possibility of incorporating lagged or exogenous variables which are known to influence trade in the estimated equation. These variables would be specific to a particular country, and could also include constraints such as foreign exchange availability and levels of stocks.

In some of the specific strategies described in this study it was noted that there could be a high degree of complementarity between storage and trade control policies, especially where there is an objective of domestic stability. This situation could require the simultaneous estimation of both storage and trade relationships for an individual country. Particularly for larger countries, simultaneity may exist among trade control policies. The large number of exogenous variables involved often means that models of this type are over-identified, but seemingly unrelated techniques can be employed to reflect the close association between trade policies of larger countries and the constraints imposed by global production.

4.3 Summary and Conclusions

In the preceding discussion no attempt has been made to suggest a general form of structural model which might be applied to all countries. Rather, the importance of developing separate models for individual countries has been stressed. It is suggested that individual models should reflect the combinations of policies used in each case. This requires increased attention to understanding the economic inter-relationships which exist in the policy formation process, and particularly the manner in which policy instruments are changed in both the short and medium term.

The need for this approach is evident from the wide range of alternative specifications of excess demand functions which have been derived in the theoretical analysis of alternative policy combinations. The manner in which policies respond to short-term instability in markets has been shown to be an important part of these relationships and suggests the need to develop stochastic models which accurately reflect the source, as well as the response, to instability.

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APPENDIX A

To derive an expression for $\mathrm{Var}(\tilde{P}_w)$, given that

$$\tilde{P}_w = \frac{g + h\,(a - c - dP_{w,t-1} - \varepsilon) + \theta}{1 + bh}$$

and $\varepsilon \sim N\,(0, \sigma_\varepsilon^2)$,

$\theta \sim N\,(0, \sigma^2)$,

$E\,(\varepsilon, \theta) = 0$,

the variance of $\tilde{P}_w$ can be defined as:

$$\mathrm{Var}(\tilde{P}_w) = E\,(P_w - E(\tilde{P}_w))^2$$

$$= E\,\left(\frac{-h\varepsilon + \theta}{1 + bh}\right)^2$$

$$= E\,\left(\frac{h^2\varepsilon^2 + 2h\varepsilon\theta + \theta^2}{(1+bh)^2}\right)$$

$$= \frac{h^2\sigma_\varepsilon^2 + \sigma_\theta^2}{(1+bh)^2}$$

as $E(\varepsilon)^2 = \sigma_\varepsilon^2$,

$E(\theta)^2 = \sigma_\theta^2$,

and $E(\varepsilon\theta) = 0$.