Commodity Price Stabilization and the Developing Countries:
The Problem of Choice

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This paper deals with the problem of choosing those primary commodities whose price stabilization at the international level would benefit most the developing countries as producers or consumers. It focuses on the welfare and income effects of price stabilization as criteria for choice.
FOREWORD

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SUMMARY AND CONCLUSIONS

1. The problem of instability in primary commodity prices and export earnings is well known. The causes of this instability and its effects on developing countries' economies have been the subject of much theoretical and empirical investigation and controversy. Even greater has been the controversy on the appropriate international policy actions to deal with this problem. Despite considerable political pressure by developing countries and various technical proposals elaborated mostly by UN agencies, practical progress in this field has been slow during the past 25 years.

2. The problem has recently been brought into focus again largely as the result of efforts made by UNCTAD on behalf of developing countries. UNCTAD has elaborated a specific action program on commodities (the "Integrated Program") that has become one of the key items in the ongoing negotiations between developed and developing countries on the new international economic order.

3. Despite this new and in many respects original effort to work out a precise and comprehensive program to deal with the commodity problem, several important questions have not been given sufficient theoretical and empirical attention by the international community. More often than not, developed countries' representatives have pictured commodity agreements aimed at stabilizing international prices and compensatory financing schemes aimed at stabilizing export earnings as equivalent policy alternatives for dealing with the same problem. On the other hand, when attention has been clearly focused on commodity price stabilization, the distribution of benefits from international action in this field has been almost completely overlooked.

4. The purpose of this paper is to look at commodity price stabilization in terms of specific objectives and instrumental choices. It first examines the different effects of commodity price instability at the micro- and macro-economic levels in order to bring into focus the difference between price and export revenue stabilization at the international level. Second, the paper examines in detail the relationship between price stabilization, revenue stabilization and revenue maximization in the context of international commodity agreements and buffer stocks in particular. Third, the paper--focusing on the distribution of benefits from price stabilization--attempts to establish guidelines for the choice of the specific commodities whose price stabilization via international commodity agreements is likely to benefit the developing countries as producers or consumers of these commodities.

5. Theoretical analysis (conducted within the framework of a simple market model that assumes linear demand and supply schedules, instantaneous reaction of supply and demand to changes in market prices, additive stochastic disturbances and price stabilization at the mean of the prices that would have prevailed in an unstabilized market) shows quite clearly that: (a) the source of commodity price instability—together with the value of the price elasticities of demand and supply over the relevant range—is an important factor in determining whether price stabilization will also bring about revenue stabilization; (b) the source of commodity price instability is the critical factor that determines whether price stabilization via buffer stocks increases or decreases producers' income (or exporters' revenue); and (c) since pure
welfare gains from price stabilization are always positive for both producers (exporters) and consumers (importers), the determination of who gains or loses in terms of income becomes a determinant element in assessing which one of the two groups will stand to gain more from stabilization in a particular commodity where compensation between losers and gainers does not take place.

6. If commodity price instability originates mostly from the demand side, price stabilization will stabilize (destabilize) revenue if demand is price-inelastic (elastic), irrespective of the value of the price elasticity of supply. If supply is the prevalent source of price instability and demand is price-elastic, price stabilization will destabilize revenue irrespective of the value of price elasticity of supply. Only if both demand and supply are price-inelastic, can price stabilization also bring revenue stabilization when price instability originates for the most part from the supply side.

7. Measured in terms of savings in the cost of producing a commodity (pure producer's welfare) and utility derived from the consumption of a commodity (pure consumer's welfare), the gains from price stabilization can be shown to be always positive for both producers and consumers, irrespective of the source of price instability. The source of price instability, however, determines who gains and who loses in terms of income (measured by export revenue or import expenditure). If market price instability originates mostly from supply shifts, producers (exporters) will gain from price stabilization in terms of income and consumers (importers) will lose. The opposite is the case if market price instability is essentially a demand phenomenon. It follows, therefore, that producers (exporters) would clearly gain from price stabilization via buffer stocks when price instability originates mostly from supply instability, while the net impact of price stabilization on consumers (importers) is uncertain; they would lose in terms of income and gain in terms of pure welfare. Conversely, consumers (importers) would clearly gain from price stabilization in a market where demand fluctuations are the prevalent cause of price instability while the net impact of price stabilization on producers (exporters) is uncertain. They would lose in terms of income and gain in terms of pure welfare.

8. It is thus clear that if price stabilization is aimed at helping developing countries as producers (exporters) or consumers (importers), the assessment of the income effect of price stabilization is a very important factor in choosing the commodities whose prices can be stabilized to the benefits of developing countries. Given that the pure welfare effect of price stabilization is always positive, a first approximation criterion for choice would call for price stabilization in those commodities where the income effect is also positive for developing countries as exporters or importers. This criterion seems to be quite reasonable and intuitively appealing.

9. An extensive empirical investigation on the income effect of price stabilization was conducted on a sample panel of 17 primary commodities considered to be technically and economically suitable for international market price stabilization through buffer stocks. The results suggest that in agricultural commodities the income effect would be positive to developing countries as exporters of cocoa, coffee, wool, jute, cotton and sugar. However, the
results are statistically conclusive only for the first four commodities. The case of the other two commodities—cotton and sugar—where developing countries could clearly gain from price stabilization as net exporters rests on weak empirical grounds. Developing countries as net importers would stand to gain from international price stabilization only in wheat.

10. In minerals and metals, where developing countries are net exporters, the income effect of price stabilization would be negative and the balance between pure welfare gains and income losses is uncertain at best. Developing countries could probably derive greater revenue stability from price stabilization in these commodities, but given the probable losses in export revenue that would follow and the costs involved in price stabilization, the objective of export revenue stability might be better achieved by compensatory financing. Only if one accepts that with compensation between gainers and losers price stability is superior to price instability from a standpoint of global welfare, could the inclusion of some minerals and metals in a large-scale commodity price stabilization program be justified as a vehicle to achieve some kind of rough and ready automatic compensation between likely income gainers and losers.

11. This analysis of the benefits of price stabilization focuses on income and pure welfare gains of exporters (and importers) of primary commodities. Other potential benefits of price stability that can accrue to exporters—such as possible improvements in the long-term demand prospects for their products, reduction of the incentive to develop man-made substitutes, and greater bargaining strength of commodity sellers in international markets—were not considered. They could conceivably be quite important and in some cases be sufficient to justify price stabilization even when income gains are likely to be negative for the developing countries that export primary commodities.

12. Finally, the results reached in this paper are based on rather strong assumptions. It is worth emphasizing that: (a) demand and supply are assumed to be linear in prices, (b) adjustment costs and lags in supply and demand are assumed away, (c) stochastic disturbances are assumed to be additive in nature, (d) storage is assumed to be costless and (e) price stabilization—here defined as a price smoothing operation—is assumed to take place around trends which are considered to be known. Given the state of the arts and the almost complete lack of empirical work in this field, the paper only intends to offer first approximation criterion for choice. Its findings should, therefore, be treated with caution. Any decision to undertake market price stabilization in a commodity should be based on careful study of the institutional and economic features of the market in question in order to arrive at reliable estimates of the costs and benefits that are involved and their likely distribution between importers and exporters. An in-depth commodity specific analysis should represent a necessary condition for economically rational decision-making in a field as complex as that of commodity price stabilization.
I. THE PERSPECTIVE

1. The problem of instability in primary commodity prices and export earnings is well known. Developing countries have, for more than two decades, emphasized the adverse impact of prices and export revenue fluctuations on their economies. The problem has also been intensely studied by individual economists as well as by international organizations, including the IMF and the World Bank. 1/ However, despite the considerable effort that went into the study of the causes and effects of primary commodities price instability, progress in devising practical solutions and implementing them has been slow.

2. The debate itself has been marred by considerable confusion: failure to differentiate between the problem of short-term instability of prices and earnings and that of long-term growth of export revenue from primary commodities has clouded the discussion over possible solutions and has often led to confusion as to the objectives of national and international action in this field. Even where the short- and long-term problems were clearly differentiated and attention was focused on short-term price and export earnings instability, there has often been a further element of confusion: the assumption that price stabilization would automatically yield revenue stabilization as well. Furthermore, the critical question of the distribution of gains of price stabilization between producers and consumers, although quite intensely debated at the theoretical level, has received little, if any, empirical attention. Primary commodities—as candidates for international action aimed at stabilizing their market prices—have often been chosen on the basis of technical criteria (e.g., ease of storage) and their importance to developing countries as revenue earners. This procedure for choice is clearly unsatisfactory, since it rests on the implicit assumption that producers (most often developing countries) would automatically benefit from price stability.

3. In the recent past, mostly as a result of the UNCTAD Integrated Program for Commodities, there has been a revival of interest in international commodity trading arrangements—buffer stocks in particular—designed to reduce short-term fluctuations in the prices of primary commodities exported by the developing countries. 2/ Attention has been focused on the short-term problem, but the concentration on international buffer stocks as the main market regulatory instrument has again somewhat disguised the relationship between price and revenue stabilization.

4. The international discussion over the UNCTAD program, however, has shown that the difference between buffer stock commodity agreements and export earnings stabilization schemes of the IMF or Lome type has not been

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fully appreciated. Moreover, the choice of the commodities to be included in the stabilization program was still made with no apparent regard to the welfare and income distribution effects of international price stabilization.

5. The purpose of this paper is to look at the problem of commodity stabilization in terms of specific objectives and instrumental choices. Chapter II briefly analyzes the difference between the effects of price and revenue fluctuations on the economies of developing exporting countries. The analysis will bring into focus the first general choice that needs to be made: commodity price stabilization arrangements or compensatory financing schemes. Chapter III deals with the relationship between price and export revenue stabilization within the framework of international commodity agreements. Chapter IV analyzes the income distribution effects of commodity price stabilization through buffer stocks. Chapter V focuses on the welfare effects of price stabilization through buffer stocks and integrates the income and welfare analysis. It is from the analytical framework developed within this chapter, that the criteria for choosing the primary commodities whose price stabilization would clearly benefit the developing countries are derived. Chapter VI is devoted to the empirical analysis of the income effects of commodity price stabilization and Chapter VII presents the policy conclusions that can be drawn from the analysis together with their most important qualifications.
II. THE EFFECTS OF COMMODITY PRICE AND REVENUE FLUCTUATIONS ON THE ECONOMIES OF DEVELOPING EXPORTING COUNTRIES

6. The difficulties caused by commodity export revenue fluctuations for the economies of developing countries are well known. A short summary will suffice here. Three areas are of particular concern to developing countries:

(a) balance of payments (BOP) management;

(b) employment; and

(c) fiscal policies.

To smooth out fluctuations in foreign exchange earnings from commodity exports requires conservative foreign exchange reserve policies. The limited international borrowing capacity of developing countries makes the need for such policies even stronger. The opportunity cost of holding relatively large amounts of foreign exchange reserves to cope with largely unpredictable shortfalls in export earnings is substantial.

7. When an export revenue shortfall causes a BOP deficit, the dampening effect of this deficit on the economy of the country concerned is actually larger than the deficit itself. The cost of adjustment to the economy at large depends on the size of the external deficit and the value of the marginal propensity to import. The smaller the marginal propensity to import, the greater the dampening effect on income of any given external imbalance whose impact cannot be reduced by the use of reserves or borrowing abroad. 1/ Severe employment difficulties are likely to arise unless counter-cyclical policies can be implemented promptly. On the other hand, if a commodity revenue boom causes a BOP surplus, inflationary pressures in the domestic economy are usually the end result. Given that factor mobility is limited in most developing countries, they normally suffer from either cause of external imbalance.

8. Export fluctuations also have a considerable impact on fiscal revenue and government spending in developing countries. High export revenues increase the tax base and government fiscal revenue and create a powerful incentive for governments to expand development spending, as well as expenditure on social services with high recurrent costs that are difficult to cut during times of low export revenue. Thus, during periods of low export revenue, governments often resort to deficit financing to maintain the level of expenditure for welfare services and thereby stimulate domestic inflation. Furthermore, depending on the tax mode, the effects of export fluctuations on government revenues can be even stronger.

9. The effects of export instability on economic growth have been studied extensively in the past, and even though some dispute exists on the matter, 1/ the basic conclusion seems to be that the growth of export revenue is a more important determinant of the growth of GNP than the degree of instability of export revenue. 2/ However, even if instability in export earnings does not seem to be an insurmountable obstacle to the achievement of GNP growth, it is clear that economic management is made more difficult by the disruptions caused by fluctuations in export earnings.

10. Commodity export price fluctuations that are not compensated by changes in the volumes of exports in the opposite direction lead to revenue instability and cause the same difficulties at the macro level that were described above. In addition, however, price fluctuations always have negative effects at the micro level. Price volatility causes serious economic inefficiencies. During periods of tight supply and high prices, strains on production resources are generated at both the producer and consumer ends. Similarly, during periods of low demand and low prices, productive capacity remains unused with reductions in profits and labor income in the producing country's economy. These are the effects of price instability that are formally considered by welfare economists. Price instability, moreover, complicates investment planning in the industry and often causes unjustified investment booms during periods of high prices and underinvestments during periods of low prices. For some commodities—such as tree crops and minerals—the close correlation that seems to exist between the price and investment cycles is a cause of serious economic losses.

11. Export earnings stabilization schemes of the IMF or Lomé (STABEX) type can alleviate the economic difficulties that are caused by export revenue fluctuations at the macro level. 3/ One can argue the need for liberalizing the conditions under which these schemes became operative and the repayment rules that are built into such schemes, but the effects of the choice of this policy instrument are quite clear. On the other hand, if the objective is to avoid the economic inefficiencies of unused resources at the


2/ IBRD internal analysis confirms this basic conclusion.

micro level and to provide suppliers with a more certain planning environment as well as more proper investment incentives, then commodity prices have to be stabilized. To the extent that commodity price stabilization also brings about revenue stabilization, this policy instrument can achieve two objectives at the same time. This, however, is by no means assured.
III. PRICE STABILIZATION AND REVENUE STABILIZATION

12. Two-state analysis—even within the framework of a simplified commodity market model—is useful to illustrate the revenue effect of price stabilization. The following assumptions are made for the specification of the market model used in the analysis:

(a) linear and negatively sloped demand curve, linear and positively sloped supply curve;

(b) instantaneous reaction of supply and demand to price changes;

(c) parallel shifts of demand and supply curves over the two periods (additive stochastic disturbances); and

(d) price stabilization at the mean of the prices that would have prevailed in the absence of market price stabilization.

In general, whether or not price stabilization entails revenue stabilization depends on: (a) the source of the price change, viz. demand or supply shifts; and (b) the price elasticities of the demand and supply schedules of the product whose market prices are stabilized.

13. Specifically, it can be shown that if the market for a commodity is characterized by demand instability, price stabilization will—over two periods of time—also bring about revenue stabilization, provided that demand is price-inelastic over the relevant range (Figure 1). On the contrary, if demand is price-elastic over the relevant range, price stabilization will destabilize revenue (Figure 2). Both of these results hold regardless of the value of the price elasticity of supply. \(^1\)/

14. Under the same conditions, it can be shown that if the market for a product is characterized by supply instability, price stabilization would destabilize revenue if demand is price elastic over the relevant range (Figure 3). This result holds regardless of the value of the price elasticity of supply. If, on the contrary, both demand and supply are price inelastic over the relevant range, price stabilization can bring about revenue stabilization as well (Figure 4). \(^1\)/

15. The validity of these conclusions clearly depends on the assumptions made in specifying the very simple market model used in the analysis as well as its behavior during the two periods covered by the analysis. Within these limits, however, the conclusions arrived at are independent of any specific form of market price stabilization.

\(^1\)/ Annex I contains the proofs for these conclusions.
Figure 3: SUPPLY SHIFT MARKET: PRICE ELASTIC DEMAND

\[
\frac{(OP^* \times OQ^*_2)}{(OP^* \times OQ^*_1)} < \frac{(Op_1 \times Oq_1)}{(Op_2 \times Oq_2)}
\]

Price Stabilization at \( p^* = \frac{Op_2 + Op_1}{2} \) is Revenue Destabilizing.

Figure 4: SUPPLY SHIFT MARKET: PRICE INELASTIC SUPPLY AND DEMAND

\[
\frac{(OP^* \times OQ^*_2)}{(OP^* \times OQ^*_1)} < \frac{(Op_1 \times Oq_1)}{(Op_2 \times Oq_2)}
\]

Price Stabilization at \( p^* = \frac{Op_2 + Op_1}{2} \) is Revenue Stabilizing.
IV. THE EFFECT OF COMMODITY PRICE STABILIZATION VIA BUFFER STOCK ON THE SIZE OF EXPORT EARNINGS OF PRODUCING COUNTRIES

16. In deciding whether or not buffer stock operations benefit producing (exporting) countries, one important question to be answered regards the impact of price stabilization on total export earnings of producers. As observed by Grubel, any a priori answer to this question is quite difficult. While the shape of the demand and supply curves, as well as the price elasticities of these curves, will obviously have a bearing on the answer, it is not immediately clear that the source of the price instability (demand or supply shifts) is the key.

17. By using two-state analysis within the framework of the simplified market model used to examine the relationship between price and revenue stabilization, some a priori conclusions about the relationship between the source of the price instability and the effects of a buffer stock scheme on the export earnings of the producing countries can be derived.

18. Under the assumptions made, it can be shown that over two periods of time: (a) price stabilization would decrease the total earnings of the commodity exporting countries, if demand shifts are the cause of the price change (Figure 5); and (b) price stabilization would increase the total earnings of the commodity exporting countries, if supply shifts are the cause of the price change (Figure 6). These general conclusions hold as long as the demand and supply curves are well behaved. While price elasticities determine the size of the difference between stabilized and unstabilized export revenue, the validity of the general conclusions stated above does not depend on specific elasticity values.

19. The important point that this analysis brings out is that whenever developing countries are net exporters of a certain commodity, price stabilization via buffer stocks in a supply shift market would increase their total export revenues. Conversely, in a demand shift market, developing countries as net importers of a primary commodity would gain in terms of lower import expenditure from price stabilization via buffer stocks. Therefore, if the objective of commodity price stabilization is to benefit developing countries, the determination of the source of price instability becomes an important factor in the choice of the commodities whose prices can be effectively stabilized through the market action of buffer stocks.

1/ See page 6 above.

2/ This result was proved by Grubel, who only examined the demand shift case, even though in the context of his analysis the author dropped the assumption of parallel shifts of the demand schedule and examined the consequences of possible changes in the slope of the demand schedule in Period 2. See Herbert G. Grubel, "Foreign Exchange Earnings and Price Stabilization Schemes," The American Economic Review, Vol. LIV, No. 4 (June 1964), pp. 378-385.

3/ Algebraic proofs of the above-mentioned conclusions are contained in Annex II.
Figure 5: DEMAND SHIFT CASE

\[
[(\text{Op}_1 \times \text{Oq}_1) + (\text{Op}_2 \times \text{Oq}_2)] = \text{export revenue without buffer stock}
\]

\[
2(\text{Op}^* \times \text{OQ}^*) = \text{export revenue with buffer stock}
\]

\[
((\text{Op}_1 \times \text{Oq}_1) + (\text{Op}_2 \times \text{Oq}_2)) > 2(\text{Op}^* \times \text{OQ}^*)
\]

Price Stabilization at \( p^* = \frac{\text{Op}_2 + \text{Op}_1}{2} \)

Decreases Export Revenue.

Figure 6: SUPPLY SHIFT CASE

\[
[(\text{Op}_1 \times \text{Oq}_1) + (\text{Op}_2 \times \text{Oq}_2)] = \text{export revenue without buffer stock}
\]

\[
2(\text{Op}^* \times \text{OQ}^*) = \text{export revenue with buffer stock}
\]

\[
((\text{Op}_1 \times \text{Oq}_1) + (\text{Op}_2 \times \text{Oq}_2)) < 2(\text{Op}^* \times \text{OQ}^*)
\]

Price Stabilization at \( p^* = \frac{\text{Op}_2 + \text{Op}_1}{2} \)

Increases Export Revenue.

Note:

In period 1, the buffer stock would have to buy \( Q^*\) of the commodity in question; its total expenditure would be \( (\text{Oq}_1 \times \text{Op}^*) \).

In period 2, the buffer stock would have to sell \( Q^*\) of the commodity in question; its total receipts would be \( (\text{Oq}_2 \times \text{Op}^*) = (\text{Oq}_1 \times \text{Op}^*) \).

Under the assumptions made, the buffer stock would break even over the two periods.
V. THE WELFARE IMPACT OF PRICE STABILIZATION

20. The desirability of price stabilization from the standpoint of welfare has long been debated in economic literature. Government programs designed to stabilize the prices of agricultural commodities stimulated economic analysis of welfare gains and losses of producers and consumers. Waugh demonstrated that consumers having a downward sloping demand curve gain from price fluctuations that originate from random supply shifts. \(^1\) Similarly, Oi showed that producers having an upward sloping supply curve gain from price fluctuations caused by random demand shifts. \(^2\)

21. Massell generalized the analysis of Waugh and Oi within the framework of a linear demand-supply market model. \(^3\) He assumed instantaneous reaction of demand and supply to price changes, parallel shifts of the demand or supply curves (additive stochastic disturbances), and price stabilization at the mean of the prices that would prevail without stabilization. By using --as Waugh and Oi had done before--the expected value of the change in producer and consumer surplus as a measure of gain, \(^4\) Massel showed that:

(a) (1) Producers gain from price stabilization if price instability originates from random shifts in supply, and (2) lose if price instability originates from random shifts in demand.

(b) (1) Consumers gain from stabilization if the source of price instability is random shifts in demand, and (2) lose if price instability originates from random shifts in supply.

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\(^4\) Massell's results continue to hold - with minor modifications - if demand and supply functions are non-linear, provided that the stochastic disturbances are still additive in nature. If stochastic disturbances are instead multiplicative in nature, some of Massell's results no longer hold, unless alternative definitions of producers' surplus are used. See, for example, P.B.R. Hazell and P.L. Scandizzo, "Market Intervention Policies When Production is Risky," American Journal of Agricultural Economics, No. 57 (Nov. 1975), pp. 641-649.
(c) Price stabilization brought about by a buffer stock provides a net gain to producers and consumers taken together. The total gains from stabilization are always positive from a global welfare standpoint: gainers can compensate losers. If this happens, consumers and producers are better off with price stability than with price instability. 1/

Finally, Hueth and Schmitz 2/ extended Massell’s analysis to internationally traded goods (both final and intermediate). 3/

22. The prima facie importance of the Massell-Hueth-Schmitz results is quite evident. If demand and supply schedules can be assumed to be linear and stochastic disturbances additive in nature, the indication that compensation arrangements between consumers (importers) and producers (exporters) may increase the joint welfare of the two groups is a good reason for looking at international price stabilization via buffer stocks as a way of increasing world welfare. Once this is recognized, then international compensation could conceivably take place more or less automatically when price stabilization arrangements cover a sufficiently large range of commodities pooled together. An integrated buffer stock that would stabilize the prices of an appropriate mix of commodities could help to solve the sticky problem of international compensation and help to generate a net welfare gain to world producers and consumers.

1/ The underlying assumption here is that the buffer stock authority acts as storage agent and makes no profit. The buffer stock operation is here assumed to be costless (both in terms of storage costs — including general overhead and interest costs on the capital used). Obviously the economic costs of the buffer stock operation need to be considered to arrive at estimates of net benefits.


3/ If it is postulated that the supply decision is based on expected instead of actual prices, then some of Massell’s results need to be modified. These modifications depend on the type of price expectations which are assumed. Under the assumption of rational expectations, Massell’s results (a) (1), (b) and (c) continue to hold. Result (a) (2) holds if the random demand disturbance is positively or negatively autocorrelated. Under the assumption of adaptive expectations, Massell’s results (c), (a) (1), and (b) (2) continue to hold, while (a) (2) and (b) (1) remain quite indeterminate. See Stephen J. Turnovsky, "Price Expectations and the Welfare Gain from Price Stabilization," American Journal of Agricultural Economics, Vol. 56, No. 4 (Nov. 1974), pp. 706-716. It is very difficult, however, on both theoretical and empirical grounds to decide whether one type of price expectation hypothesis is superior to another in portraying what really happens in the various commodity markets.
23. Furthermore, when each commodity is being considered separately as a candidate for a price stabilization arrangement or when international compensation between commodity exporters and importers is not envisaged, the Massell-Hueth-Schmitz results apparently provide a criterion for choosing those commodities whose prices should be stabilized to the advantage of developing countries. For instance, if producers (exporters) benefit from stable prices in terms of welfare (Massell-Hueth-Schmitz result) when price instability is primarily caused by supply shifts, then developing countries as net exporters of many primary commodities would gain from buffer stock arrangements in commodities whose prices fluctuate mostly because of instability in export supply. Conversely, if price instability comes from the demand side, developing countries would gain from price stabilization in terms of welfare in those few commodities where they are the dominant consumers (importers).

24. In terms of criteria for the choice of commodities whose price stabilization could benefit developing countries, the welfare results of Massell-Hueth-Schmitz are parallel to the income (revenue) results reached in the previous section. A closer scrutiny of the results of Massell and Hueth-Schmitz, however, reveals that their welfare conclusions are really a combination of the pure welfare and income effects of price stabilization. The decomposition of the Massell and Hueth-Schmitz welfare results into pure welfare and income can be shown graphically. 1/ Pure producers' welfare gains are defined as the expected difference between the costs of producing a commodity in a stabilized and non-stabilized markets. Pure consumers' welfare gains are defined as the expected difference in utility obtained from consumption of a commodity in a stabilized and a non-stabilized market, while the income effect is defined as the difference between the expected value of revenue (of expenditure) in a stabilized and a non-stabilized market. If the resource cost of producing a commodity is lower (higher) in a stable than in an unstable market, producers gain (lose) from price stabilization. If the total utility derived by consumers from the consumption of a certain good is higher (lower) in a stable than in an unstable market, consumers gain (lose) from stabilization. If exporters of a certain commodity derive a higher revenue from selling their product in a stable than in an unstable market, they gain from stabilization (and importers lose from it).

25. It may be recalled that in a supply shift market Massell's results are as follows: the expected value of producers' gains from price stabilization expressed in terms of producers' surplus (G\text{pw}) = e_1 + e_2 + e_1'; the

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1/ The algebraic decomposition of the Massell results into "income" and "pure welfare" is contained in a separate paper. See E. Brook, E. Grilli and J. Waelbroeck, "The Welfare Impact of Price Stabilization: A Rule of Thumb Based on Massell's Results," (February 1977, Mimeo). Previous drafts of this paper, including the summary of it that appeared in the March 1977 issue of Finance and Development, did not take this point into account.
expected value of consumers' gains from price stabilization expressed in terms of consumers' surplus \( G_{cw} = -e_1 \) and, assuming compensation, the expected value of joint net gains \( G_{ww} = e_1 + e_2 \) (See Figure 7). In such a supply shift market it can be shown that: \( G_{pw} = G_{ppw} \) (pure welfare gains to producers) + \( G_{py} \) (income gains to producers); \( G_{cw} = G_{cpw} \) (pure welfare gains to consumers) - \( G_{cy} \) (income losses to consumers) and \( G_{ww} = G_{ppw} + G_{cpw} \) (See Figure 7).

26. This decomposition of Massell's results clearly brings out the point that pure welfare gains from market price stabilization are positive to both producers and consumers and, therefore, to the world economy as a whole. It also brings out the point that while producers (exporters) would also gain from price stabilization from the standpoint of revenue in a supply shift market, consumers (importers) would lose from it (their import expenditure would be higher than in an unstable market). Producers (exporters), therefore, would necessarily gain from price stabilization in a supply shift market in terms of both pure welfare and income, while the net impact of price stabilization on consumers would be uncertain in such a market: \( G_{cw} > G_{cy} \), pure welfare gains could be greater or smaller than income losses. Finally, joint net producer-consumer gains from price stabilization can be seen to be positive. Income gainers can compensate income losers leaving to the world the pure welfare benefits of price stabilization: greater efficiency in production and greater utility from consumption of goods when prices are stable.

27. Similarly it can be recalled that in a demand shift market, Massell's results are as follows: the expected value of producers' gains from price stabilization expressed in terms of producers' surplus \( G_{pw} = e'_1 \); the expected value of consumers' gains expressed in terms of consumers' surplus \( G_{cw} = e'_1 + e_1 + e_2 \) and--assuming compensation--the expected value of joint net gains \( G_{ww} = e_1 + e_2 \) (See Figure 8). It can again be shown that in such a market: \( G_{pw} = G_{ppw} \) (pure welfare gains to producers) - \( G_{py} \) (income losses to producers); \( G_{cw} = G_{cpw} \) (pure welfare gains to consumers) + \( G_{cy} \) (income gains to consumers) and \( G_{ww} = G_{ppw} + G_{cpw} \) (See Figure 8).

28. This decomposition of Massell's results for the demand shift market case illustrates the point that--as in the supply shift market case--pure welfare gains from price stabilization are positive to both consumers and producers. Disregarding storage costs, price stabilization via buffer stocks would, therefore, represent a pure welfare gain to the world economy as a

1/ Disregarding storage costs.
A. Expected value of "welfare" gains from stabilization (Massell's results):

\[ G_{pw} = \frac{1}{2} \left( p_1 p_2 L_N - (p_2 L_{2w}) \right) \]
\[ G_{cw} = \frac{1}{2} \left( \frac{p_1^2 M q_2}{2} - \left( p_1^2 L_{2w} \right) \right) \]
\[ G_{ww} = G_{pw} - G_{cw} = e_1 + e_2 \]

B. Expected value of income (revenue/expenditure) from stabilization:

\[ G_{py} = \frac{1}{2} \left\{ 2(p_2 Z q_2) - (p_2 M q_2 + p_1 N q_1) \right\} = (h + h') = 2e_1 \]
\[ G_{cy} = -2e_1 \]

C. Expected value of pure welfare gains from stabilization:

\[ G_{ppn} = \frac{1}{2} \left\{ (O V N q_1 + U M q_2) - (O V L q_3 + O U R q_4) \right\} = \frac{1}{2} (R M q_4 q_2 - N L q_1 q_3) = \frac{1}{2} (f + m) = e_2 \]
\[ G_{cppw} = \frac{1}{2} \left\{ 2(O T Z q^*) - (O T M q_2 + O T N q_1) \right\} = \frac{1}{2} (g - h') = e_1 \]

1. \[ G_{pw} = G_{py} + G_{ppn} \]
2. \[ G_{cw} = G_{cy} + G_{Cppw} \]
3. \[ G_{ww} = G_{cppw} + G_{cpp} \]
A. Expected value of "welfare" gains from stabilization (Massell's results):

\[ G_{cw} = \frac{1}{2} \left\{ (p_2^*p_{2MR}) - (p_1^*p_{1EN}) \right\} = \frac{1}{2} (e_1' + e_1^' + e_2^' - e_1 - e_1^' - e_2) \]

\[ G_{pw} = \frac{1}{2} \left\{ (p_1^*p_{1ZM}) - (p_2^*p_{2MN}) \right\} = \frac{1}{2} (e_1^' + e_2^' - e_1 - e_2) \]

\[ G_{ww} = G_{cw} - G_{pw} = e_1 + e_2 \]

B. Expected value of income (revenue/expenditure) from stabilization:

\[ G_{cy} = \frac{1}{2} \left\{ 2(p_0^*q_0^*) - (p_2^*m_{2q_2} + p_1^*m_{1q_1}) \right\} = (e_1^' + e_2^') = 2e_1 \]

\[ G_{py} = -2e_1 \]

C. Expected value of pure welfare gains from stabilization:

\[ G_{ppw} = \frac{1}{2} \left\{ 2(ov_{q}) - (ov_{q_1} + ov_{q_2}) \right\} = \frac{1}{2} (e_1^' + e_2^') = e_1 \]

\[ G_{wpw} = \frac{1}{2} \left\{ (ot_{r_3} + uf_{q_4}) - (ot_{m_2} + un_{q_1}) \right\} = \frac{1}{2} (m_{q_2} - f_{q_4} + q_4) = (e_2^' + e_2^') = e_2 \]

\[ G_{pw} = G_{py} + G_{ppw} \]

\[ G_{cw} = G_{cy} + G_{cpw} \]

\[ G_{ww} = G_{ppw} + G_{cpw} \]
whole. The second point brought clearly into focus by this analysis is that in a demand shift market producers (exporters) would lose from price stabilization in terms of revenue, while consumers (importers) would gain from price stabilization in terms of expenditure (their import expenditure would be lower than in an unstable market). Consumers (importers), therefore, would necessarily gain from price stabilization in a demand shift market in terms of both pure welfare and income, while the impact of price stabilization on producers (exporters) would be uncertain in such a market; $G_{ppw} < G_{cy}$, pure welfare gains could be greater or smaller than income losses for producers.

Finally, joint net producer-consumer gains from price stabilization—if one assumes compensation—can again be seen to be positive.

29. In terms of criteria for choice, if the objective of commodity price stabilization is that of helping developing countries, the integration of the income and welfare aspects of price stabilization shows how important is the knowledge of the prevalent source of commodity price instability. As a "first approximation" criterion for choice, developing countries as a group can be seen to be clear gainers from price stabilization via buffer stocks only in those commodities whose prices fluctuate mostly as a consequence of supply disturbances and where developing countries are net exporters of the commodity in question (which is the normal case). Price stabilization would increase both their export revenue and pure welfare (i.e. reduce the resource costs of producing the commodity). Developing countries as a group would only stand to gain from price stabilization in those few commodities where instability is mostly caused by demand disturbances and they are net importers. In general, however, the impact of price stabilization on developing countries as net exporters of those commodities whose price fluctuations are mostly demand-induced is uncertain: developing countries would gain in terms of pure welfare (assuming zero storage costs), but lose in terms of export revenue. The balance between gains and losses in these commodities can only be empirically estimated and no certain answer can be given from a simple analysis of the sources of price instability.
VI. THE IMPACT OF PRICE STABILIZATION: EMPIRICAL ANALYSIS

A. The Choice of the Sample

30. The impact of price stabilization was examined in 17 primary commodities traded by developing countries over the 1954-73 period. In conducting the empirical investigation, two preliminary choices had to be made. The first concerned the specific commodities to be included in the sample. Two criteria guided this choice: suitability of commodities for buffer stock operations and relative importance of commodities to developing countries. Bananas, meat, and citrus products, for example, were excluded from the sample on the ground of their poor storability. Oils and fats were excluded because of the extreme complexity of any buffer stock operation involving a large number of interrelated products. Commodities sold on the basis of long-term contracts—such as fertilizers and iron ore—were also left out. To choose among the remaining commodities, the criterion of importance in developing countries’ trade was used. In essence, the commodities whose trade value to developing countries—either from the point of view of exports or imports—was below a certain minimum (US$100 million per year) were excluded from the sample. An exception to this criterion was made for hard fibers, because of their importance to some of the poorest developing countries. Table 1 shows the commodities included in the sample, their respective export and import values to developing countries, and developing countries’ percentage share in total world trade in those commodities.

31. The second choice—that of the time period during which to examine the impact of price stabilization for the sample commodities—was made largely on grounds of convenience. On the one hand, there was the need to have a long enough time series to allow the necessary degree of freedom to perform statistical analysis. On the other hand, reliable and consistent data—particularly on world export volumes—are available only from the mid-1950s onwards. Sufficiently uniform and reliable statistics for 12 agricultural commodities included in the sample could only be assembled for the period 1954 to 1973. Because international market price quotations for some commodities may not accurately reflect the unit prices realized by exporters, 1/ it was decided to use world export unit values wherever available as an alternative to market price quotations. In order to do so, without changing the length of the time series used in the statistical analysis, it was necessary to take 1973 as the terminal year for all the time series used. Reliable data on

1/ The divergence may be caused by the existence of separate markets for the same product, or bilateral import arrangements that take up a substantial share of the market, or by differences in marketing seasons for the same product. Trends between market prices and export unit values are known to diverge quite substantially, particularly during commodity peaks and troughs.
<table>
<thead>
<tr>
<th>Commodity</th>
<th>Value of Developing Countries' Exports</th>
<th>% Share of World Exports</th>
<th>Value of Developing Countries' Imports</th>
<th>% Share of World Imports</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat</td>
<td>160</td>
<td>4</td>
<td>1,778</td>
<td>39</td>
</tr>
<tr>
<td>Maize</td>
<td>331</td>
<td>14</td>
<td>215</td>
<td>9</td>
</tr>
<tr>
<td>Rice</td>
<td>440</td>
<td>37</td>
<td>974</td>
<td>79</td>
</tr>
<tr>
<td>Sugar</td>
<td>2,235</td>
<td>67</td>
<td>614</td>
<td>18</td>
</tr>
<tr>
<td>Coffee</td>
<td>3,049</td>
<td>100</td>
<td>141</td>
<td>4</td>
</tr>
<tr>
<td>Cocoa Beans</td>
<td>723</td>
<td>100</td>
<td>26</td>
<td>4</td>
</tr>
<tr>
<td>Tea</td>
<td>609</td>
<td>82</td>
<td>242</td>
<td>31</td>
</tr>
<tr>
<td>Cotton</td>
<td>1,757</td>
<td>62</td>
<td>549</td>
<td>18</td>
</tr>
<tr>
<td>Jute</td>
<td>670</td>
<td>80</td>
<td>200</td>
<td>24</td>
</tr>
<tr>
<td>Wool</td>
<td>161</td>
<td>12</td>
<td>105</td>
<td>6</td>
</tr>
<tr>
<td>Hard Fibers</td>
<td>84</td>
<td>97</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Rubber</td>
<td>904</td>
<td>100</td>
<td>101</td>
<td>9</td>
</tr>
<tr>
<td>Copper</td>
<td>2,395</td>
<td>58</td>
<td>214</td>
<td>5</td>
</tr>
<tr>
<td>Lead</td>
<td>116</td>
<td>28</td>
<td>31</td>
<td>7</td>
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<tr>
<td>Zinc</td>
<td>194</td>
<td>23</td>
<td>125</td>
<td>13</td>
</tr>
<tr>
<td>Tin</td>
<td>632</td>
<td>87</td>
<td>92</td>
<td>12</td>
</tr>
<tr>
<td>Bauxite</td>
<td>218</td>
<td>71</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>14,678</strong></td>
<td></td>
<td><strong>5,416</strong></td>
<td></td>
</tr>
</tbody>
</table>

world export unit values were not available even for agricultural products beyond 1973 \(^1\).

32. Data on minerals and metals posed a more serious problem. Consistent and uniform world statistics are generally available only for production. Export statistics are available from the late 1960s onward, but depending on the source both country coverage and commodity specifications vary a great deal. In the case of lead and zinc where trade in ores is very important, it is impossible to aggregate ore and metal statistics since the former refer to gross weight and the metal content of ores cannot be gauged with any degree of precision. In all cases, however, world production statistics for the 1954-73 period were assembled. World export statistics for tin and bauxite were also compiled for the same 20 years, while for copper (blister and refined metal) and zinc (unwrought metal) reliable and consistent world export data could only be assembled for shorter periods (from 1960 to 1975 and 1959 to 1975 respectively). \(^2\)

B. The Methodology

33. To ascertain the impact of price stabilization on producers and consumers a third choice had to be made: a single commodity vs. a cross commodity approach. The pure welfare and income effects of price stabilization can be determined through detailed case studies of individual commodity markets where demand and supply functions for a particular commodity are fully specified and estimated. The advantage of such an approach is that it permits one to determine not only who is likely to gain or lose from price stabilization, but also to quantify pure welfare as well as income gains or losses. The main disadvantage lies in the formidable difficulties that are involved in trying to specify and estimate full models for a large number of commodities.

34. Knowledge of model structures, however, is not necessary to ascertain the income effect of price stabilization. The income effect depends on observable variables and it can be ascertained directly from them. The conclusions that can be derived are qualitative in nature, but nonetheless significant in terms of providing preliminary answers to the question at stake:

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1/ Production and export data for the agricultural commodities were taken from FAO Production and Trade Yearbooks except in the case of rubber and jute for which International Rubber Study Group (IRSG) and national statistics were used.

2/ All production statistics were taken from the Metalgesellschaft Yearbooks. Export statistics for copper were taken from the World Bureau of Metal Statistics publications, for tin from the International Tin Council Yearbooks, for lead and zinc from the Lead and Zinc Study Group Statistical Bulletins and Yearbooks.
in which commodities is the income effect of price stabilization likely to be favorable to developing countries as producers (exporters) or consumers (importers)? On grounds of convenience as well as economy it was therefore decided to use a simple cross-commodity approach.

35. It was assumed that for each commodity:

\( q = s = \alpha p + x \) \((\alpha > 0)\)

\( q = d = -\beta p + y \) \((\beta \geq 0)\)

where: \( s \) = quantity supplied, \( d \) = quantity demanded, \( q \) = quantity traded, \( p \) = price, \( \alpha \) and \( \beta \) are positive constants and \( x \) and \( y \) are random variables with contemporaneous moment matrix \( \sigma_{xx}, \sigma_{yy}, \) and \( \sigma_{xy} \); all the variables are expressed in terms of deviations from their means which are themselves functions of time \( (\mu_x = \mu_y = \mu_q = \mu_s = \mu_d = \mu_p = 0) \). Now, since equations (1) and (2) imply that:

\( p = \frac{y - x}{\alpha + \beta} \) and

\( q = \frac{\alpha y + \beta x}{\alpha + \beta} \)

the income effect of market price stabilization, i.e. the difference between the mean value of revenue in a non-stabilized and a stabilized market is:

\[ \sigma_{pq} = \frac{\beta \sigma_{xx} + (\beta - \alpha) \sigma_{xy} + \alpha \sigma_{yy}}{(\alpha + \beta)^2} \theta \sigma_{pp} \]

Since \( \sigma_{pp} > 0 \), from the sign of \( \theta \) (the regression coefficient of observed quantity deviations from trend on price deviations from trend) it is possible to determine whether \( \sigma_{pq} \geq 0 \). If \( \theta > 0 \) the income effect is favorable to consumers (importers) since their expenditure in a stabilized market is smaller than in an unstable market and unfavorable to producers (exporters) since their revenue is lower with stable prices than with unstable prices.

Vice versa if \( \theta < 0 \), the income effect is favorable to producers (exporters)
and unfavorable to consumers (importers). 1/

36. For each agricultural commodity the trend in world exports and prices was calculated for the 1954-73 period. Linear and semilog trends were computed for both exports and price (or unit values of exports). 2/ Quantity deviations from trends were then regressed against price (or export unit value) deviations from trends. Four regressions of quantity deviations from trends against price deviations were conducted for each commodity: (a) quantity deviations against price deviations from linear trend, (b) quantity deviations against price deviations from log trend, (c) quantity deviations from log trend against price deviations from linear trend and (d) quantity deviations from linear trend against price deviations from log trend. From the sign of the regression coefficients the income effect of price stabilization on exporters and importers was then ascertained. 3/ It is worth emphasizing that price stabilization is defined here as an operation aimed at smoothing out fluctuations around the price trend set by market forces.

37. The same procedure was used in the case of minerals and metals, but because of the data limitations mentioned in the previous section, production data for the 1954-73 period were first used. The results concerning the sign and statistical significance of the coefficients obtained by regressing production deviations from trends against price deviations from trends were subsequently compared to and checked whenever possible, against those obtained regressing export deviations from trends on price deviations from trends during the same (bauxite and tin) or different time periods (copper and zinc). 4/

1/ It may be helpful to quantitatively oriented readers to point out that (1) and (2) can be thought of as derived from complete econometric demand and supply equations which are linear in all variables except time. Annex III provides this derivation.

2/ Prices and export unit values were expressed in current US$ terms.

3/ Originally, in order to ascertain the income effect of price stabilization on commodity producers, production deviations from trends were also regressed against price deviations from trends. In the case of agricultural commodities, however, the correspondence between world prices and producers' prices is often dubious. Since conclusions pertaining to the possible benefits of domestic price stabilization that can be inferred from the sign of the regressions' coefficient are open to serious questions, the world production-price regression results for agricultural commodities were excluded from the final version of the paper.

4/ As mentioned in the previous section, reliable and consistent world export statistics could not be assembled. Tin ore and metal export statistics, on the other hand, are available but, because of the export controls imposed by the International Tin Councils under the authority of various International Tin Agreements that were in force during the 1950s and 1960s, they are of dubious value for the type of analysis conducted here. Since tin production was less affected by ITC actions than tin exports and practically all tin produced in the world is exported, only world production series were used to perform the statistical analysis.
C. The Statistical Results

38. The results of the time series regressions of world export deviations from trends against world price deviations from trends for the 12 agricultural commodities included in the sample are given in Table 2. The corresponding results obtained for 11 agricultural commodities using world export unit value deviations from their trends instead of world prices are given in Table 3. The two sets of results are broadly consistent. There are sign reversals in two cases—tea and sisal—but the statistical significance of the regression coefficients is very low for both these commodities.

39. The regression coefficient has a positive sign and is statistically significant 1/ in the case of wheat, maize and rubber. Importers are likely to gain from price stabilization in these commodities in terms of reduced import expenditure (and exporters correspondingly likely to lose). Developing countries as a group are net exporters of all these commodities except for wheat. It follows, therefore, that the income effect of price stabilization would be positive to developing countries only in wheat: as importers developing countries would have a smaller expenditure with stable, rather than unstable prices. The income effect would be negative for developing countries in maize and rubber (their export revenue will be smaller with, rather than without, price stabilization).

40. The regression coefficient has a negative sign in the case of rice, coffee, cocoa, jute, wool, cotton and sugar. Exporters would stand to gain from price stabilization in these commodities in increased export revenue (and importers correspondingly lose). The regression coefficients, however, are statistically significant for the first five commodities but statistically insignificant for the latter two. Developing countries as a group are net exporters of all these commodities except rice. It follows, therefore, that the income effect of price stabilization would be positive for developing countries in all these products except rice. However, because of the statistical insignificance of the regression coefficient in the cases of sugar and cotton, only in cocoa, coffee, jute 2/ and wool would developing countries' export revenue be likely to be greater with than without price stabilization. The income effect of rice price stabilization would be negative for developing countries as a group.

41. The results of the time series regressions of world production and export deviations from trends against price deviations from trends for the five minerals and metals included in the sample are given in Table 4. The results obtained using world production over the 1954–73 period and world

1/ At the 90% level or above.

2/ In the case of jute reliable export series exist only for Bangladesh. This country, however, accounts for over 85 percent of world exports of true jute. Historically the market share of Bangladesh was even higher. Bangladesh exports were used as a proxy for world exports.
exports over shorter periods appear to be broadly consistent with each other: there are no sign reversals, even though the statistical significance of the regression coefficients varies somewhat from one set of regressions to the other. The regression coefficients of all five commodities have positive signs. Those of copper, bauxite, zinc, and lead are statistically significant. 1/ Developing countries as a group are net exporters of all these five commodities. The income effect of price stabilization in the minerals and metals included in the sample, with the possible exception of tin, would seem to be negative to developing countries.

42. On the whole, the results concerning the income effect of price stabilization reached here seem to conform broadly with a priori expectations about the prevalent source of commodity price instability (demand for minerals and metals and supply for most agricultural products) and with those of the only previous empirical study on the source of price instability that has come to our attention. 2/

1/ At the 90% level or above.

<table>
<thead>
<tr>
<th>COMMODITY</th>
<th>LINEAR FORM</th>
<th>LOG-LINEAR FORM</th>
<th>LINEAR-LOG FORM</th>
<th>LOG-LOG FORM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat</td>
<td>Intercept: -0.7561, t=8</td>
<td>Regression Coefficient: 0.263</td>
<td>Intercept: 0.00437, t=17</td>
<td>Intercept: 0.296, t=17</td>
</tr>
<tr>
<td></td>
<td>195.2699e- (7.58)</td>
<td>5.4666, t=17</td>
<td>6.4666, t=17</td>
<td>-1.4119, t=17</td>
</tr>
<tr>
<td></td>
<td>195.2699e- (7.58)</td>
<td>0.263</td>
<td>0.00437 (0.658)</td>
<td>0.296 (0.753)</td>
</tr>
<tr>
<td></td>
<td>190.8279e- (6.86)</td>
<td>1.0152, t=12</td>
<td>1.0152, t=12</td>
<td>-1.3993, t=12</td>
</tr>
<tr>
<td></td>
<td>190.8279e- (6.86)</td>
<td>0.568</td>
<td>-0.00952 (-1.295)</td>
<td>0.678 (-1.686)</td>
</tr>
<tr>
<td>Rice</td>
<td>Intercept: 3.5357, t=10</td>
<td>Regression Coefficient: 0.166</td>
<td>Intercept: 1.7556, t=8</td>
<td>Intercept: 3.7711, t=10</td>
</tr>
<tr>
<td></td>
<td>195.2699e- (7.58)</td>
<td>3.4682, t=11</td>
<td>3.4682, t=11</td>
<td>-1.3993, t=12</td>
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<tr>
<td></td>
<td>195.2699e- (7.58)</td>
<td>0.166</td>
<td>-0.00952 (-1.295)</td>
<td>0.678 (-1.686)</td>
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<tr>
<td>Sugar</td>
<td>Intercept: 6.6116, t=10</td>
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<td>Intercept: 1.0118, t=10</td>
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<tr>
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<td>-3.4052, t=10</td>
<td>-1.3993, t=12</td>
</tr>
<tr>
<td></td>
<td>195.2699e- (7.58)</td>
<td>-0.6217 (-0.567)</td>
<td>-0.6217 (-0.567)</td>
<td>-1.3993, t=12</td>
</tr>
<tr>
<td>Coffee</td>
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<td>Intercept: 3.7711, t=10</td>
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<td>195.2699e- (7.58)</td>
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<td>1.9615, t=10</td>
<td>-1.3993, t=12</td>
</tr>
<tr>
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<td>195.2699e- (7.58)</td>
<td>0.207</td>
<td>-0.00952 (-1.295)</td>
<td>0.678 (-1.686)</td>
</tr>
<tr>
<td>Cocoa</td>
<td>Intercept: 4.5995, t=10</td>
<td>Regression Coefficient: 0.586</td>
<td>Intercept: 3.4692, t=9</td>
<td>Intercept: 3.7711, t=10</td>
</tr>
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<td>195.2699e- (7.58)</td>
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<td>3.6139, t=11</td>
<td>3.7711, t=10</td>
</tr>
<tr>
<td></td>
<td>195.2699e- (7.58)</td>
<td>0.586</td>
<td>-0.00952 (-1.295)</td>
<td>0.678 (-1.686)</td>
</tr>
<tr>
<td>Tea</td>
<td>Intercept: -2.0107, t=10</td>
<td>Regression Coefficient: 0.019</td>
<td>Intercept: -1.9830, t=9</td>
<td>Intercept: 1.0118, t=10</td>
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<td>195.2699e- (7.58)</td>
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<td>0.0579, t=14</td>
<td>1.0118, t=10</td>
</tr>
<tr>
<td></td>
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<td>-0.00952 (-1.295)</td>
<td>0.678 (-1.686)</td>
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<tr>
<td>Cotton</td>
<td>Intercept: -4.4730, t=9</td>
<td>Regression Coefficient: 0.000</td>
<td>Intercept: 1.3886, t=11</td>
<td>Intercept: 1.0118, t=10</td>
</tr>
<tr>
<td></td>
<td>195.2699e- (7.58)</td>
<td>1.3886, t=11</td>
<td>1.3886, t=11</td>
<td>1.0118, t=10</td>
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<tr>
<td>Jute</td>
<td>Intercept: 8.3117, t=10</td>
<td>Regression Coefficient: 0.363</td>
<td>Intercept: 2.1619, t=9</td>
<td>Intercept: 1.0118, t=10</td>
</tr>
<tr>
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<td>195.2699e- (7.58)</td>
<td>3.2804, t=11</td>
<td>3.2804, t=11</td>
<td>1.0118, t=10</td>
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<tr>
<td>Wool</td>
<td>Intercept: 2.3517, t=9</td>
<td>Regression Coefficient: 0.173</td>
<td>Intercept: 5.2139, t=9</td>
<td>Intercept: 1.0118, t=10</td>
</tr>
<tr>
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<td>195.2699e- (7.58)</td>
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<td>Steel</td>
<td>Intercept: 9.3333, t=10</td>
<td>Regression Coefficient: 0.000</td>
<td>Intercept: -7.8067, t=11</td>
<td>Intercept: 1.0118, t=10</td>
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<td>195.2699e- (7.58)</td>
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<td>-7.8067, t=11</td>
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<td>0.678 (-1.686)</td>
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<tr>
<td>Rubber</td>
<td>Intercept: -7.5406, t=10</td>
<td>Regression Coefficient: 0.169</td>
<td>Intercept: -1.6968, t=8</td>
<td>Intercept: 1.0118, t=10</td>
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<tr>
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<td>195.2699e- (7.58)</td>
<td>b.1021, t=12</td>
<td>b.1021, t=12</td>
<td>-1.6968, t=8</td>
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<td>195.2699e- (7.58)</td>
<td>0.169</td>
<td>-0.00952 (-1.295)</td>
<td>0.678 (-1.686)</td>
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Notes: 1. Data in parentheses.
2. Significant at the 90% level.
3. ** Significant at the 95% level.
4. *** Significant at the 99% level.
5. Bangladesh exports for jute.
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<th>COMMODITY</th>
<th>LINEAR FORM</th>
<th>100-LINEAR FORM</th>
<th>LINEAR-100 FORM</th>
<th>100-100 FORM</th>
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<td>Regression Coefficient</td>
<td>Intercept</td>
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<td>3.873 .10</td>
<td>296.905e(1.98s)</td>
<td>0.268</td>
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<td>Maize</td>
<td>-1.9011 .10</td>
<td>317.82e(5.267)</td>
<td>0.265</td>
<td>-3.597 .10</td>
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<tr>
<td>Rice</td>
<td>3.0969 .10</td>
<td>-8.16e(1.366)</td>
<td>0.228</td>
<td>3.4993 .10</td>
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<td>Sugar</td>
<td>6.6199 .10</td>
<td>-5.45231 .006</td>
<td>-0.006</td>
<td>1.7160 .10</td>
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<td>Coffee</td>
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<td>-3.613e(-2.247)</td>
<td>0.233</td>
<td>1.9065 .10</td>
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<td>Cocoa</td>
<td>7.4050 .10</td>
<td>-0.6415e(-4.372)</td>
<td>0.573</td>
<td>3.6379 .10</td>
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<td>Tea</td>
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<td>0.003</td>
<td>6.2965 .10</td>
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<td>Cotton</td>
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<td>-0.5605e(-0.818)</td>
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<td>Silk</td>
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<td>0.004</td>
<td>2.6023 .10</td>
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<td>/ Rubber</td>
<td>3.3350 .10</td>
<td>0.075e(2.801)</td>
<td>0.475</td>
<td>4.923 .10</td>
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Notes: t ratio in parentheses.
* significant at the 95% level.
** significant at the 99% level.
1/ 1959-73.
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<th>Significance</th>
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<th>Intercept</th>
<th>Regression Coefficient</th>
<th>R²</th>
<th>Intercept</th>
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<th>Regression Coefficient</th>
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<td>1.0627</td>
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<td>0.000025</td>
<td>0.2756</td>
<td>2.4655</td>
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<td>0.075275</td>
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<td>0.075275</td>
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<td>0.000025</td>
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<td>0.009737</td>
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<td>0.4973</td>
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<td>0.075275</td>
<td>0.033</td>
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<td>Imports</td>
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<td>0.000025</td>
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<td>1.1212</td>
<td>0.0040</td>
<td>0.000025</td>
<td>0.075275</td>
<td>0.033</td>
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<td>Production</td>
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<td>0.033</td>
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<tr>
<td>Tin</td>
<td>Production</td>
<td>0.000202</td>
<td>0.000025</td>
<td>0.00900</td>
<td>0.9970</td>
<td>0.0050</td>
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<td>Barite</td>
<td>Production</td>
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<td>0.00900</td>
<td>0.9970</td>
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<td>0.075275</td>
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<td>Iron-ore</td>
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</table>

Notes: t-ratios are in parentheses.
* significant at the 95% level.
** significant at the 99% level.
*** significant at the 99.9% level.
VII. CONCLUSIONS AND QUALIFICATIONS

43. The analysis of Chapters III, IV and V points to the need to distinguish clearly between the goals that commodity price stabilization is intended to reach for the developing countries, whether:

(1) stabilization of their export revenue;

(2) maximization of their export revenue and welfare as commodity exporting countries; or

(3) minimization of their import expenditure and maximization of their welfare as commodity importing countries.

The simultaneous attainment of more than one of these desirable targets is in no way assured.

44. If attention is focused on price stabilization—defined as an operation intended to smooth out commodity price fluctuations around the trend set by market forces—then the welfare and income effects of price stabilization on exporters and importers should be carefully considered. Since the pure welfare effects of price stabilization are always positive for both producers and consumers—at least when demand and supply are linear in price and the stochastic disturbances, whose effect on price one wants to eliminate (or reduce, to be more realistic), are additive in nature—the income effect of price stabilization becomes the critical criterion for determining at first approximation in which commodities exporters or importers would gain most from price stability.

45. Our empirical analysis on the income effect of price stabilization suggests that in cocoa, coffee, wool and jute developing countries as a group would gain in terms of greater export revenue and in wheat they would gain in terms of lower import expenditure. In these commodities both the income and the pure welfare impact of price stability are positive to developing countries. In two other commodities—cotton and sugar—where the income effect would also be positive to developing countries as exporters and the pure welfare effect would be equally positive, the direction of the income effect is statistically inconclusive and falls outside the probabilistic range of acceptance. In maize, rice, rubber, lead, copper, zinc, and bauxite, the income effect would be negative to developing countries, while the pure welfare effect would be positive. Therefore, no answer concerning the desirability of price stabilization for developing countries can be given until the size of the income and pure welfare effect is quantified to determine whether positive pure welfare gains are larger than income losses. It should be noted, however, that in quantifying the size of the welfare effect of stabilization, the costs of buffer stocking should be explicitly considered. It would seem doubtful that in the presence of an income loss, the size of the pure welfare gains could be enough to make price stabilization worthwhile for developing countries if they were also required to bear the burden of the
financial costs of buffer stocking. In all other commodities—tea, tin and sisal—the income effects of price stabilization are statistically uncertain. The results of our analysis are summarized in Table 5.

**Table 5: PURE WELFARE AND INCOME EFFECTS OF PRICE STABILIZATION FOR DEVELOPING COUNTRIES: SUMMARY OF RESULTS**

<table>
<thead>
<tr>
<th>Commodity</th>
<th>Trade Position</th>
<th>Sign of Regression Coefficient</th>
<th>Income Effect</th>
<th>Pure Welfare Effect</th>
<th>Total Effect</th>
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<tbody>
<tr>
<td>Wheat</td>
<td>NM</td>
<td>+</td>
<td>POSITIVE</td>
<td>POSITIVE</td>
<td>POSITIVE</td>
</tr>
<tr>
<td>Maize</td>
<td>NX</td>
<td>+</td>
<td>NEGATIVE</td>
<td>POSITIVE</td>
<td>UNCERTAIN</td>
</tr>
<tr>
<td>Rice</td>
<td>NM</td>
<td>-</td>
<td>NEGATIVE</td>
<td>POSITIVE</td>
<td>UNCERTAIN</td>
</tr>
<tr>
<td>Sugar</td>
<td>NX</td>
<td>-1/</td>
<td>UNCERTAIN</td>
<td>POSITIVE</td>
<td>UNCERTAIN</td>
</tr>
<tr>
<td>Coffee</td>
<td>NX</td>
<td>-</td>
<td>POSITIVE</td>
<td>POSITIVE</td>
<td>POSITIVE</td>
</tr>
<tr>
<td>Cocoa</td>
<td>NX</td>
<td>-</td>
<td>POSITIVE</td>
<td>POSITIVE</td>
<td>POSITIVE</td>
</tr>
<tr>
<td>Tea</td>
<td>NX</td>
<td>+*</td>
<td>UNCERTAIN</td>
<td>POSITIVE</td>
<td>UNCERTAIN</td>
</tr>
<tr>
<td>Cotton</td>
<td>NX</td>
<td>-1/</td>
<td>UNCERTAIN</td>
<td>POSITIVE</td>
<td>UNCERTAIN</td>
</tr>
<tr>
<td>Jute</td>
<td>NX</td>
<td>-1/</td>
<td>POSITIVE</td>
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<tr>
<td>Wool</td>
<td>NX</td>
<td>-</td>
<td>POSITIVE</td>
<td>POSITIVE</td>
<td>POSITIVE</td>
</tr>
<tr>
<td>Sisal</td>
<td>NX</td>
<td>+*</td>
<td>UNCERTAIN</td>
<td>POSITIVE</td>
<td>UNCERTAIN</td>
</tr>
<tr>
<td>Rubber</td>
<td>NX</td>
<td>+</td>
<td>NEGATIVE</td>
<td>POSITIVE</td>
<td>UNCERTAIN</td>
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<tr>
<td>Copper</td>
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<td>NEGATIVE</td>
<td>POSITIVE</td>
<td>UNCERTAIN</td>
</tr>
<tr>
<td>Lead</td>
<td>NX</td>
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<td>NEGATIVE</td>
<td>POSITIVE</td>
<td>UNCERTAIN</td>
</tr>
<tr>
<td>Zinc</td>
<td>NX</td>
<td>+</td>
<td>NEGATIVE</td>
<td>POSITIVE</td>
<td>UNCERTAIN</td>
</tr>
<tr>
<td>Tin</td>
<td>NX</td>
<td>-1/</td>
<td>UNCERTAIN</td>
<td>POSITIVE</td>
<td>UNCERTAIN</td>
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<tr>
<td>Bauxite</td>
<td>NX</td>
<td>+</td>
<td>NEGATIVE</td>
<td>POSITIVE</td>
<td>UNCERTAIN</td>
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</table>

Note: NM = Developing countries as a group are net importers of the commodity.

NX = Developing countries as a group are net exporters of the commodity.

1/ Sign of regression coefficient is statistically insignificant.

* Sign of regression coefficient alternates from the first set of regressions using prices to the second set of regressions using export unit values and is statistically insignificant.

Source: (1) From Table 1.
(2) From Tables 2, 3 and 4.
46. Some preliminary yet important conclusions can be drawn from the analysis of the likely distribution of income and pure welfare gains of international price stabilization. First, the number of primary commodities for which price stabilization can be assumed to be clearly beneficial to developing countries appears to be quite limited, i.e. cocoa, coffee, jute, wool and wheat. Coffee, cocoa, jute and wool accounted in 1973 for about 12 percent of the total primary commodity export earnings of developing countries (excluding oil), and wheat accounted for about 15 percent of developing countries’ total import expenditures on primary commodities (excluding oil). Only coffee— as an export commodity— has general importance to developing countries. Cocoa, wool and jute have only regional importance as an export commodity respectively for West Africa, Asian sub-continent and Latin America. However, cocoa and jute are a very important source of income, employment and foreign exchange for some of the poorest developing countries. Only if sugar and cotton could be included— on stronger empirical grounds than those found in our research— among the group of commodities for which international price stabilization can be assumed to be beneficial to developing countries, would the scope of international action in this field broaden enough to become more worthwhile for developing countries. 1/

47. The second conclusion is that international price stabilization in minerals and metals is not likely to benefit developing countries in terms of income. 2/ The empirical findings on the source of price instability for these products are largely in conformity with a priori expectations: demand fluctuations— induced by changes in economic activity in developed countries— are the main cause of price fluctuations. International price stabilization in these commodities would benefit the developed countries that consume most of the minerals and metals exported by developing countries. To mitigate the adverse macroeconomic impact of fluctuations in the prices of minerals and metals on the economies of developing countries’ producers, compensatory financing schemes appear to be the most appropriate policy avenue that should be followed. Developing countries— particularly if freed from stringent BOP constraints— could resort to domestic policy instruments to alleviate some of the most undesirable micro effects of price fluctuations in their mineral-metal industries.

48. Some specific qualifications apply to these two conclusions drawn from the analysis presented in this paper. This type of analysis of the benefits of price stabilization is based on a partial equilibrium model

1/ In 1973, the total value of developing countries’ exports was $108.8 billion, of which oil was $43.3 billion, all primary commodities $41.7 billion, manufactures $22.7 billion, and miscellaneous products $1.1 billion. Exports of coffee (raw) and cocoa (beans) amounted to $5 billion. Exports of wool (raw) and jute (raw) amounted to $0.5 billion. Exports of cotton (raw) and sugar amounted to $5.0 billion.

2/ The developing countries’ income (revenue) losses from international price stabilization in minerals and metals are likely to be relatively small, since the short-term price elasticities of supply for these products are small.
and focuses on income and pure welfare gains and losses. The use of partial
equilibrium analysis for problems of this kind presents the usual drawback
that it neglects the possible indirect effects of commodity price stabilization.
One potentially serious drawback is that, by considering commodity price
stabilization of individual commodities, one could overlook the indirect
market price stabilizing effects on related commodities. The available
empirical evidence on the nature of intercommodity price movements, however,
points to the conclusion that these indirect benefits are likely to be quite
small. 1/

49. A more important drawback on this type of analysis is perhaps the
exclusive concentration on income and pure welfare effects. There are other
benefits that can accrue to exporter developing countries from international
price stabilization. These include possible improvements in the long-term
demand prospects for their products, reduction of the incentive to develop
man-made substitutes, and greater bargaining strength of commodity sellers in
international markets. These benefits could in some commodities be quite
important and sufficient to justify price stabilization even when the income
effects are likely to be negative for the developing exporting countries. 2/
While this possibility should be clearly acknowledged, whether price stabili-
ization can be justified on these grounds is a question that can only be
answered after in-depth analysis of the specific market conditions of the
commodities in question. For the products that compete with man-made substi-
tutes, price stability is a necessary condition for improving their long-term
demand prospects, but price competitiveness must also be present. How much
a buffer stock could improve the bargaining strength of commodity sellers
is open to some question. If the objective of international assistance
in commodities is that of avoiding distress sales by financially weak sellers
in times of low market demand in order to avoid both the seller's loss of
potential revenue and the ripple effect of such sales on market price, some
form of international foreign exchange reserve assistance would prima facie
appear to be the most efficient method of coping with this problem.

50. The question of how general the conclusions reached in this paper
are, deserves some final comments. The welfare and income results that con-
stitute the basic criteria for the choice of the commodities whose price sta-
bilization at the international level would benefit the developing countries
follows from the market form that was assumed as the basis of the analysis.
The assumption of linear demand and supply curves in variables other than
time and of additive stochastic disturbances are quite critical. Changing
the assumption of linearity of demand and supply would change the welfare and

1/ Intercommodity covariance analysis shows that apart from the oils and
fats group (which was excluded from our sample on the basis of the
enormous technical difficulties implicit in its price stabilization),
other within-group price correlations are low and limited in extent.
See Walter C. Labys and Yves Perrin, "Optimal Portfolio Analysis of

2/ This consideration applies in particular to rubber.
income results. The linearity issue, however, is well understood and the theoretical limitations implied by this assumption are quite clear. On the other hand, the critical importance of the assumption about the nature of the stochastic disturbance has emerged only recently in economic literature.

51. It can be shown, in fact, that if stochastic disturbances are multiplicative in nature, and thus affect also the slopes of the demand and supply curves, the desirability of price stabilization for either exporters or importers no longer depends on the source of market price instability, but only upon the shapes of the deterministic component of the demand and supply curves. 1/ The critical question is, therefore, whether the assumption of multiplicative disturbances is more realistic than that of additive disturbances. While the answer is to a large extent dependent on empirical evidence of producers' behavior (which to date is not available to any sufficient extent), some a priori consideration can put this issue into perspective. Multiplicative disturbances on the supply side are a justifiable hypothesis for annual crops, 2/ but not for perennial crops (cocoa, coffee, tea, rubber, hard fibers, wool, and cane sugar) and minerals—metals (copper, lead, zinc, tin and bauxite). Across the sample of the 17 commodities considered in this study, uncertainty about the distributional impact of price stabilization on exporters' or importers' welfare would remain in the case of rice, wheat, maize, cotton, and jute, if a multiplicative form of stochasticity were to affect the supply of these commodities. The assumption of multiplicative stochastic disturbances could change only two of the strong conclusions reached in this study: that developing countries would stand to gain from price stabilization in wheat as consumers and in jute as producers. The basic inference of this study—that prima facie the scope for commodity price stabilization which is clearly beneficial to developing countries in welfare and income terms appears to be quite limited, pending possibly more conclusive evidence from in-depth commodity-specific studies—remains virtually intact.


2/ In the case of annual crops, while areas planted can be thought to depend on prices, yields are certainly dependent on random factors such as weather. Since production is area x realized yields, the stochastic error term affect the slope of the supply function in addition to its location. A simple example well illustrates this point. Assume that: A (area) = ap + b and Y (yield) = y + u. Since S (supply) = AY, we have: S = (ap + b) (y + u) = a(y + u) p + b(y + u), from which it is apparent that the stochastic disturbance (u) influences the location as well as the slope of the supply curve.
ANNEX I: PRICE STABILIZATION AND REVENUE STABILIZATION

A. Demand Shift Market
(Refer to Figures 1 and 2 in the text.)

CONDITIONS:

(a) \[
\frac{(O_{p1}^* \times OQ^*)}{(O_{p1}^* \times OQ^*_1)} < \frac{(O_{p2} \times Oq_2)}{(O_{p1} \times Oq_1)}
\]

Price stabilization at \( p^* \) is revenue stabilizing.

(b) \[
\frac{(O_{p1}^* \times OQ^*_2)}{(O_{p1}^* \times OQ^*_1)} > \frac{(O_{p2} \times Oq_2)}{(O_{p1} \times Oq_1)}
\]

Price stabilization at \( p^* \) is revenue destabilizing.

**Case 1:** If \( |\varepsilon dp| < 1 \)

\[
(O_{p1}^* \times OQ^*_2) < (O_{p2} \times Oq_2)
\]

(1) and

\[
(O_{p1}^* \times OQ^*_1) > (O_{p1} \times Oq_1)
\]

(2)

\( \therefore \) Condition (a) attains.

**Case 2:** If \( |\varepsilon dp| > 1 \)

\[
(O_{p1}^* \times OQ^*_2) > (O_{p2} \times Oq_2)
\]

(3) and

\[
(O_{p1}^* \times OQ^*_1) < (O_{p1} \times Oq_1)
\]

(4)

\( \therefore \) Condition (b) attains.
B. Supply Shift Market
(Refer to Figures 3 and 4 in the text.)

In a supply shift market (as long as the linear demand curve is negatively sloped and the linear supply curve is positively sloped) \((O\bar{p}^* \times OQ_2^*) > (O\bar{p}^* \times OQ_1^*)\) but \((O_2 \times Oq_2) > (O_1 \times Oq_1)\) depending on whether \(|\varepsilon dp| \geq 1\). Therefore:

I. Where demand is price elastic \((|\varepsilon dp| > 1)\)

\[
\frac{(O\bar{p}^* \times OQ_2^*)}{(O\bar{p}^* \times OQ_1^*)} > \frac{(O_2 \times Oq_2)}{(O_1 \times Oq_1)} \quad \text{Price stabilization at } p^* \text{ is revenue destabilizing.}
\]

\[
\frac{(O\bar{p}^* \times OQ_2^*)}{(O\bar{p}^* \times OQ_1^*)} < \frac{(O_2 \times Oq_2)}{(O_1 \times Oq_1)} \quad \text{Price stabilization at } p^* \text{ is revenue stabilizing.}
\]

For any rightward shift of the supply curve:

\[
(O\bar{p}^* \times OQ_2^*) > (O_2 \times Oq_2) \quad \text{while always}
\]

\[
(O\bar{p}^* \times OQ_1^*) < (O_1 \times Oq_1)
\]

Consequently, Condition (c) will attain, irrespective of the value of \(|\varepsilon p|\).

II. Where demand is price inelastic \((|\varepsilon dp| < 1)\) Conditions (c) and (d) become:

\[
\frac{(O\bar{p}^* \times OQ_2^*)}{(O\bar{p}^* \times OQ_1^*)} > \frac{(O_1 \times Oq_1)}{(O_2 \times Oq_2)} \quad \text{Price stabilization at } p^* \text{ is revenue destabilizing.}
\]

\[
\frac{(O\bar{p}^* \times OQ_2^*)}{(O\bar{p}^* \times OQ_1^*)} < \frac{(O_1 \times Oq_1)}{(O_2 \times Oq_2)} \quad \text{Price stabilization at } p^* \text{ is revenue stabilizing.}
\]

Under these conditions, whether \((O\bar{p}^* \times OQ_2^*) > (O_1 \times Oq_1)\) and \((O\bar{p}^* \times OQ_1^*) > (O_2 \times Oq_2)\) depends on both \(|\varepsilon dp|\) and \(|\varepsilon ds|\).
Only when demand and supply are price inelastic over the relevant range $|ed_p| < 1$ and $|esp| < 1$, can Condition (d') be satisfied. The specific condition under which (d') is satisfied is that $2|ed_p| + |esp| < 1$.

This can be proven by letting:

**PERIOD 1 (NO PRICE STABILIZATION)**

(1) $\log Q_s_1 = s \log p + x$ \hspace{1cm} *(supply curve in Period 1)*

(2) $\log Q_d = d \log p + y$ \hspace{1cm} *(demand curve, stationary over the two periods)*

(3) $\log Q_s_1 = \log Q_d$ \hspace{1cm} *(equilibrium condition)*

From which we can derive by solving the system of equations (1) and (2):

(4) $\log p_1 = \frac{y-x}{s-d}$ \hspace{1cm} *(price in Period 1)*

(5) $\log q_1 = \frac{sy-dx}{s-d}$ \hspace{1cm} *(quantity in Period 1)*

From which:

(6) $\log R_1 = \log p_1 + \log q_1 = \frac{y-x-dx+sy}{s-d}$ \hspace{1cm} *(revenue in Period 1)*

**PERIOD 2 (NO PRICE STABILIZATION)**

(7) $\log Q_s_2 = s \log p + x + \alpha$ \hspace{1cm} *(supply curve in Period 2)*

(8) $\log Q_d = d \log p + y$ \hspace{1cm} *(demand curve, stationary over the two periods)*

(9) $\log Q_s_2 = Q_d$ \hspace{1cm} *(equilibrium conditions)*

From which:

(10) $\log p_2 = \frac{y-x-\alpha}{s-d}$ \hspace{1cm} *(price in Period 2)*

(11) $\log q_2 = \frac{sy-da-dx}{s-d}$ \hspace{1cm} *(quantity in Period 2)*

(12) $\log R_2 = \log p_2 + \log q_2 = \frac{y-x+sy-dx-da}{s-d}$ \hspace{1cm} *(revenue in Period 2)*
PERIOD 1 (PRICE STABILIZED AT $p^* = \sqrt{p_1p_2}$)

(13) $\log p^* = \frac{1}{2} (\log p_1 + \log p_2) = \frac{a}{2(s-d)}$ (stabilized price)

(14) $\log Q_1^* = s \log p^* + x = \frac{sa+2(s-d)x}{2(s-d)}$ (quantity in Period 1 with price stabilization)

(15) $\log R_1^* = \log p^* + \log Q_1^* = \frac{a+sa+2sx-2dx}{2(s-d)}$ (revenue in Period 2 with price stabilization)

PERIOD 2 (PRICE STABILIZED AT $p^* = \sqrt{p_1p_2}$)

(16) $\log Q_2^* = s \log p^* + x + a = \frac{sa+2sx-2dx+2sa-2da}{2(s-d)}$ (quantity in Period 2 with price stabilization)

(17) $\log R_2^* = \log p^* + \log Q_2^* = \frac{a+sa+2sx-2dx+2sa-2da}{2(s-d)}$ (revenue in Period 2 with price stabilization)

Condition (d') can be expressed as (d''): $\log \frac{R_2^*}{R_1^*} < \log \frac{R_1}{R_2}$

Now:

(18) $\log R_2^* - \log R_1^* = \log \frac{R_2^*}{R_1^*} = a$ and

(19) $\log R_1 - \log R_2 = \log \frac{R_1}{R_2} = \frac{a(1+d)}{s-d}$

The fulfillment of Condition (d'') requires that:

(20) $\frac{a(1+d)}{s-d} > a$ or

(20') $\frac{1+d}{s-d} > 1$
Now: \( d = \varepsilon dp \) and \( S = \varepsilon sp \), therefore (20') becomes:

\[
\frac{1+\varepsilon dp}{\varepsilon sp-\varepsilon dp} > 1 \quad \text{or}
\]

\[
1 > \varepsilon sp - 2\varepsilon dp
\]

when \( |\varepsilon dp| < 1 \) and \( |\varepsilon sp| < 1 \) then:

(20'') will hold if \( 2|\varepsilon dp| + |\varepsilon sp| < 1 \)
ANNEX II: EFFECT OF PRICE STABILIZATION VIA BUFFER STOCK 
ON EXPORT EARNINGS OF PRODUCING COUNTRIES

A. Demand Shift Market

Let: $D_1 = a_1 + f(p)$  linear demand curve in Period 1  \( \frac{dD_1}{dp} < 0 \)

$D_2 = a_2 + f(p)$  linear demand curve in Period 2

$S = b + g(p)$  linear supply curve (stationary)  \( \frac{dS}{dp} > 0 \)

$p_1 =$ market equilibrium price in Period 1 (without buffer stock)

$p_2 =$ market equilibrium price in Period 2 (without buffer stock)

$p^* = \frac{p_1 + p_2}{2} =$ stabilized market price (with buffer stock)

Under these assumptions, we will have:

$p_1 = p^* - \Delta p^*$

$p_2 = p^* + \Delta p^*$

Total export revenue (over the two periods) without buffer stock will be:

(1) \[ [b+g(p^*-\Delta p^*)] (p^*-\Delta p^*) + [b+g(p^*+\Delta p^*)] (p^*+\Delta p^*) (p^*+\Delta p^*) = \alpha \]

Total export revenue (over the two periods) with buffer stock will be:

(2) \[ 2(b+gp^*)p^* = \beta \]

\(/1/ \text{This is Grubel's proof.}\)
We want to ascertain whether (1) $\frac{\Delta}{\Delta} \leq \frac{\Delta}{\Delta}$ or

(3) $[b+g(p^* - \Delta p^*)] (p^* - \Delta p^*) + [b+g(p^* + \Delta p^*)] (p^* + \Delta p^*) > \frac{\Delta}{\Delta} 2(b+gp^*)p^*$

By performing the appropriate algebraic manipulations, we can reduce (3) to:

(3') $2g(p^*)^2 + 2g\Delta p^* \leq 2g(p^*)^2$ or

(3'') $2g\Delta p^* > 0$

Since by model specification $g$ (the slope of the supply curve) is positive and $\Delta p^*$ is always positive, $2g\Delta p^* > 0$, which proves that in a demand shift market price stabilization via buffer stock reduces export earnings over the two periods as long as the supply curve is positively sloped.
B. Supply Shift Market

Let: \[ S^1 = b_1 + g(p) \] linear supply curve in Period 1 \[ \frac{dS^1}{dp} > 0 \]

\[ S^2 = b_2 + g(p) \] linear supply curve in Period 2

\[ D = a + f(p) \] linear demand curve (stationary) \[ \frac{dD}{dp} < 0 \]

\[ p^1 = \text{market equilibrium price in Period 1 (without buffer stock)} \]

\[ p^2 = \text{market equilibrium price in Period 2 (without buffer stock)} \]

\[ p^* = \frac{p^1 + p^2}{2} = \text{stabilized market price (with buffer stock)} \]

Under these assumptions, we will have:

\[ p_1 = p^* - \Delta p^* \]

\[ p_2 = p^* + \Delta p \]

Total export revenue (over the two periods) without buffer stock will be:

(1) \[ [a+f(p^* - \Delta p^*)] (p^* - \Delta p^*) + [a+f(p^* + \Delta p^*)] (p^* + \Delta p^*) = \alpha \]

Total export revenue (over the two periods) with buffer stock will be:

(2) \[ 2(a+fp^*)p^* = \beta \]
Again we want to ascertain whether $(1) > (2)$ or

$$(3) \ [a+f(p^* - \Delta p^*)] (p^* - \Delta p^*) + [a+f(p^* + \Delta p^*)] (p^* + \Delta p^*) > (a+fp^*)p^*$$

Again (3) reduces to:

$$(3') \ 2f \Delta p^* > 0$$

Since by model specification $f$ (the slope of the demand function) is negative and $\Delta p^* > 0$ is always positive, $2f \Delta p^* > 0$, which proves that in a supply shift market price stabilization via buffer stock increases total export earnings over the two periods as long as the demand curve is negatively sloped.

Note: A backward sloping supply curve will reverse the result of Case 1, while an upward sloping demand curve will reverse the result of Case 2.
The Model

Assume that for each commodity supply and demand are

(1) \( Q = S = \alpha P + \gamma X + u \) (supply)

(2) \( Q = D = \beta P + \delta Y + v \) (demand)

where: \( P \) = price

\( S, D \) = quantities

\( X, Y \) = other independent variables

\( u, v \) = random disturbances

Equilibrium price and quantity are

(3) \( \bar{P} = \frac{\gamma}{\alpha + \beta} + \frac{\delta}{\alpha + \beta} + \frac{v - u}{\alpha + \beta} \)

(4) \( \bar{Q} = \frac{\beta \gamma}{\alpha + \beta} + \frac{\alpha \delta}{\alpha + \beta} + \frac{\alpha v + \beta u}{\alpha + \beta} \)

If \( \mu u = \mu v = 0 \), \( \mu x = g(t) \) and \( \mu y = h(t) \), then

(5) \( \mu t \frac{h(t) \delta - g(t) \gamma}{\alpha + \beta} \)

(6) \( \mu t \frac{\delta g(t) \gamma + \alpha h(t) \delta}{\alpha + \beta} = \mu s = \mu d \)
where:

\[
\begin{align*}
  t & \quad \mu = \text{trend of } P \\
  t & \quad \mu = \text{trend of } Q \\
  t & \quad \mu = \text{trend of } D \\
  t & \quad \mu = \text{trend of } S \\

g(t).Y \text{ and } h(t).\delta \text{ are scalar products, (denoting the fact that } X \text{ and } Y \text{ may be vectors of variables in the demand and supply equations).}
\end{align*}
\]

By substituting

\[
\begin{align*}
  Q &= S = D = t \mu + q \\
  P &= t \mu + p \\
  X.Y &= g(t).Y + x \\
  Y.\delta &= h(t).\delta + y
\end{align*}
\]

into (1) and (2) and using (4) and (5) to cancel out the trends on both sides, one obtains

\[
\begin{align*}
  (6) & \quad q = s = \alpha p + x \\
  (7) & \quad q = d = -\beta p + y
\end{align*}
\]
where: \( x = (X - g(t)) \cdot \gamma + u \)
\( y = (Y - h(t)) \cdot \delta + v \)

and

\( \sigma, \sigma, \sigma, \sigma \) are defined on pg. 21 of text.

It is assumed that \( x \) and \( y \) have moment matrices that converge in probability to:

\[
\text{Plim } \begin{bmatrix} m_{xy} & \circ_{xy} \\ m_{xx} & \circ_{xx} \\ m_{yy} & \circ_{yy} \end{bmatrix}
\]

Since this does not imply that the shift factors in the demand and supply equations are distinct, the equations need not be identified.
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