

COMMODITY MARKET REVIEW 2003-2004

COMMODITIES AND TRADE DIVISION
FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
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FOREWORD

The present issue of the Commodity Market Review (CMR) marks a significant departure from past issues of the same named FAO publication. In the past the main focus of the CMR was a review of developments in agricultural commodity markets, a description of the current situation, and a short term outlook for these commodities. The CMR 2001-2002 departed somewhat from this format, by including some short analytical articles, that tried to explain in more detail the factors that shape commodity market developments.

In the past few years, the situation and outlook of food and agricultural commodities is being presented on the Commodities and Trade Division Web pages of the FAO Web site at www.fao.org (under "Departments" ES, Commodities and Trade Division) or directly at www.fao.org/ES/esc. This form of information provides greater scope for timely dissemination of detailed market information and more frequent updating than what is possible with conventional printed publications. The Web pages have undergone redesign that has made them more accessible and more user friendly. It is thus unnecessary to repeat the same information in printed form.

The present issue of the CMR, therefore, concentrates exclusively on in-depth analysis of some major issues that have been identified by FAO as crucial to world agricultural commodity market developments in the past two years. These include falling commodity prices, the changing experiences of food import bills for developing countries, the changing nature of food emergencies, issues of transmission of market signals from international to domestic markets, the impact of the Doha Development Round of the World Trade Organization (WTO) on developing countries, and tariff escalation in agricultural commodity markets. The research presented here in more technical form is intended to provide the analytical basis for FAO statements and recommendations on a variety of commodity and trade related issues. There are, of course, other issues that merit attention and research, and it is the intention of the Commodities and Trade Division to analyze in the future as many of these issues as possible within the resources available.

Alexander Sarris
Director
FAO Commodities and Trade Division
Rome, 2003

INTRODUCTION

Secular decline and variability in agricultural commodity prices continue to be matters of concern, not only for those developing countries dependent on commodity export earnings, especially from tropical crops, but also for those developing countries increasingly reliant on food imports for their food security. Secular relative decline in agricultural commodity prices is expected as technological progress reduces costs and induces supply expansion at a faster rate than population and income growth expand demand. However, unanticipated shifts in supply and demand lead to variability around commodity price trends, and the effects of these shifts are made more pronounced by the inherent economic and physical characteristics of agricultural commodities such as low demand and supply elasticities and perennial production. At a general level, all commodity prices are affected by the same basic factors, namely the market fundamentals of demand and supply, but these can change through time as a result of changes in technology, consumer preferences, market structures, policies or institutions. The articles in this *Commodity Market Review* describe analyses undertaken by the FAO Commodities and Trade Division relevant to a number of commodity market and policy issues.

The price inelastic demand for most agricultural commodities means that lower world prices lead to lower export earnings for developing country exporters. Many developing countries, and especially certain least developed countries, remain dependent for a significant share of their export earnings on one or a few agricultural exports. The first article explores the international coffee crisis which provides a graphic illustration of the difficulties faced by commodity exporters in recent years. It also illustrates some of the difficulties involved in industry coordinated responses to depressed commodity prices. The review of the recent unsuccessful coffee export retention scheme has topical relevance to the current discussions of commodity supply control schemes. It is apparent that attempts to control commodity supplies are fraught with difficulties. Attempts to stimulate demand through generic promotion may be more promising, but in the longer term demand-supply balance generally requires diversification out of commodity production.

Clearly, the implications of low agricultural commodity prices are different depending upon whether the perspective is that of a commodity exporter or a food importer, although declining export earnings will reduce a country's ability to pay for increasing food imports. Lower international prices for basic foodstuffs should slow the growth in the food import bills of the importing developing countries which include many of the poorest countries in the world. However, the trend towards increasing net imports exposes countries to risks of variability in food prices and hence food import bills. The second article in this review provides an analysis of trends in food import bills and the increasing vulnerability of least developed countries in particular to commodity price variability, including that which might be induced by international agricultural trade policy reform. Price fluctuations are not the only source of escalating food import bills. The third article in this review, on food emergencies, food security and economic progress in developing countries, examines the impact of disasters – natural and man-made – both of which appear to have increased in frequency in recent years.

The impact of world commodity price variability on producers and consumers and the effectiveness of price signals in bringing about adjustments in supply and demand depend on the extent to which world market prices are transmitted to domestic markets. It is only if falling prices, for example, are transmitted to domestic markets that producers have the incentive to reduce production and consumers have the incentive to increase their demand moving the market towards balance. The fourth article in this review on market integration and price transmission is concerned with these issues. It focuses particularly on empirical analysis of the extent of the degree of price transmission from world to domestic markets and presents some case study evidence of price transmission for various food and cash crops.

Recent discussions of international agricultural commodity markets have been dominated by the issue of trade liberalization and multilateral negotiations on improvement of market access and limitation of

export subsidies. The process of liberalization is generally seen as one which will lead to higher commodity prices at least in the short-run, although the effects of liberalization on commodity prices so far following the Uruguay Round have been apparently small. Progress in the negotiations of the current Doha Round is slow, with opinions apparently divided at the Cancun ministerial meeting on the appropriate scope and ambition of the liberalization envisaged. However, there remains keen interest in the likely outcomes of the negotiations. The next two articles consider policy issues and debates.

The first of these two policy articles presents a modelling analysis of the likely impact on world prices, producer and consumer welfare, trade and government revenues of various proposals put forward in the Doha Round - the Harbinson, US and EU proposed modalities. Since the Doha Round has been referred to as a "Development Round", the impacts on developing and least developed countries is the focus, and the article provides an assessment on the extent to which developing country concerns would be met under these various reform proposals.

While improving market access is important for food products, tariff levels for tropical products and raw materials at least in their less-processed forms are typically not high. More significant issues for these commodities are tariff escalation, where tariffs increase along value chains, and domestic support in developed countries which encourages excess production. Both of these issues were highlighted at the Doha Ministerial Conference. Reducing tariff escalation is considered a critical element of the development dimension of the Doha Round since it is seen as limiting the opportunity for developing country exporters to capture value-added through vertical diversification and hence achieve greater and less volatile growth in export earnings. The final article reviews the widespread incidence of tariff escalation and the extent to which different tariff-cutting formulae will reduce it.

David Hallam

Chief,

Raw Materials, Tropical and Horticultural Products Service

Editor, Commodity Market Review 2003-2004

FALLING COMMODITY PRICES AND INDUSTRY RESPONSES: SOME LESSONS FROM THE INTERNATIONAL COFFEE CRISIS

*David Hallam*¹

This paper examines the nature, origins and implications of the sharp decline in coffee prices since 1998. The decline is attributed to the significant expansion in global supplies against sluggish demand growth. Recent efforts on the part of producers and exporters to control supply growth or to promote demand growth are reviewed. It is argued that so-called “producer-only agreements” to restrict production or exports are unlikely to succeed because of the difficulties in maintaining the commitment of participants and policing such schemes. The organization of demand promotion is also problematic where stakeholders may see their interests as competing, and the experience with coffee indicates that there is a need to establish clear strategic aims to which all can subscribe. However, in the longer term the tendency towards oversupply in the coffee market can only be addressed by encouragement of diversification out of coffee production at least in marginal areas.

I. Introduction

Although depressed prices have been common to most commodities, much attention has focused on coffee. As the single most important tropical commodity accounting for almost half of total net exports of tropical products, coffee has become emblematic of the problems faced by all developing country agricultural commodity exports. Price falls for coffee have been particularly dramatic: after a brief recovery in the mid-1990s when buffer stocks were finally cleared, real coffee prices had fallen by 2001 to levels lower than ever recorded. In real terms coffee prices today are less than one third of their 1960 level, and for many producers less than the cost of production. According to the International Coffee Organization (ICO), this impacts directly upon an estimated 20-25 million households in coffee-producing countries, and indirectly upon up to a further 100 million engaged in upstream and downstream activities. The wider economic and political implications are clear: as James Wolfensohn, President of the World Bank, noted, “The reduction of coffee prices and also other commodities ... is undermining the economic sustainability of countries and millions of families in Latin America, Africa and Asia”.²

Many different explanations have been proposed for the precipitous decline in coffee prices. These include the emergence of Viet Nam as a major producer and exporter, the depreciation of the Brazilian real, “underconsumption”, exploitation of market power by roasters and retailers, technological change in roasting, domestic market liberalization and the abolition of parastatal marketing agencies. In its recent resolution, the European Parliament attributes the crisis to the dismantling of the international coffee agreement and the policies implemented by the World Bank, the International Monetary Fund (IMF) and the World Trade Organization (WTO). But basically the explanation lies in the market fundamentals of supply and demand. While it is tempting to assume that such a precipitous fall in prices must be due to some new factor or some change in market behaviour, according to FAO price determination models the operation of market fundamentals has not changed. Specifically it is the recent rapid growth in global supplies against sluggish demand growth which has led to falling prices, and the low price elasticity of demand means that these price falls are severe.

Suggested solutions to the crisis have been as various as the explanations. These have included supply control, demand promotion, guaranteed prices, product differentiation, support for diversification (and trade liberalization to provide opportunities for diversification), vertical coordination or integration

¹ David Hallam is Chief, Raw Materials, Tropical and Horticultural Products Service, Commodities and Trade Division, FAO.

² *El Pais*, 19 May 2003.

through the value chain, raising the profile of commodity problems in international fora, fair trade initiatives (including obliging the four main coffee roasters to pay a fair price to farmers and end “exploitation”), and even grower support funded by a windfall tax on roasters.

A tendency for expanding supplies to outstrip demand growth on world markets is not peculiar to coffee. The resulting market imbalances coupled with low price elasticities of demand led to the same downward pressure on prices across a broad spectrum of commodities, albeit less dramatically than for coffee. Some of the same solutions, notably demand promotion and supply control, have been implemented or are under active discussion in a variety of other international industry initiatives.

This paper examines the nature of the coffee crisis and discusses industry responses. Specifically, it focuses on the persistent decline in prices and its origins in the tendency for supply on world markets to grow ahead of demand. It considers experiences in internationally coordinated attempts on the part of producers and exporters to influence those market fundamentals by seeking to regulate supply or promote demand. It reviews recent efforts in these directions and examines what lessons can be learned for other commodities.

2. The nature of the international coffee crisis

The collapse in international coffee prices since 1998 is evident from Figures 1 and 2. The average ICO composite price fell by 21 percent in 1999, 25 percent in 2000, and 29 percent in 2001 to reach the lowest annual average since 1971. Apart from the upturn in the second half of the 1990s, prices have trended steadily downwards since the peak in 1977. Since mid 2001 prices appear to have levelled out a little but at very low levels, and this greater stability appears to have continued into the first three quarters of 2003.

Figure 1. Trends and variability in international coffee prices (annual averages)

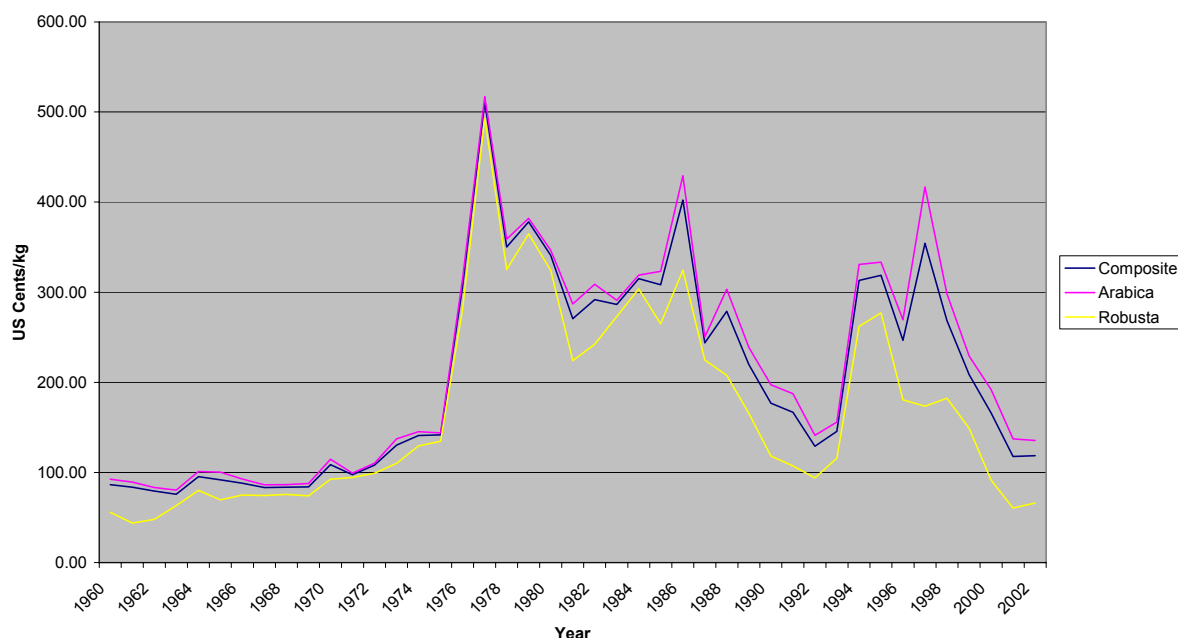
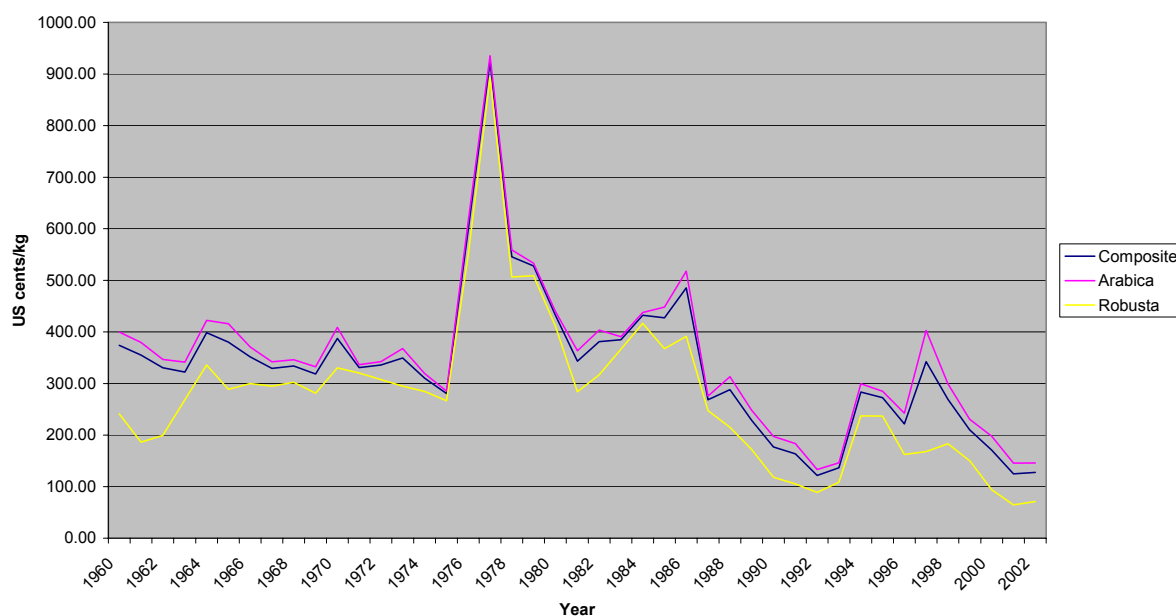


Figure 2. Trends and variability in real coffee prices (annual average prices deflated by MUV, 1999 = 100)



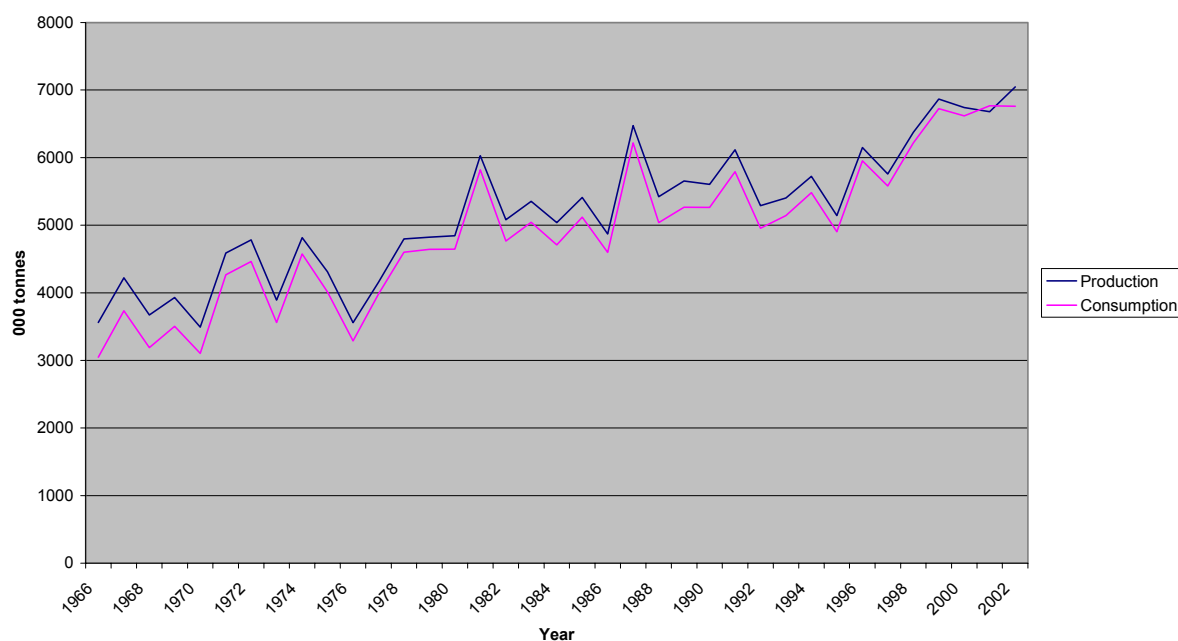
The recent variability of prices is also apparent in Figures 1 and 2 with the downward trend interrupted by periodic peaks on average every nine or ten years since the maximum in 1977 with the most recent peak in 1998. Variability is important since the duration and amplitude of price movements are relevant to the design of countermeasures to stabilize prices. If shocks are long-lived then the costs of stabilization in terms of storage and financing will probably outweigh any consumption or income benefits. The persistence of shocks in commodity prices has been explored in a recent IMF study³. This found that shocks to commodity prices are typically finite in duration but long-lived. For coffee, persistence (measured as the length of time until the effects of a shock decline to half the original magnitude) is at least nine years. This is also evident from Figures 1 and 2. In these circumstances the IMF study concluded that the costs of operating any kind of stabilization are likely to exceed any smoothing benefits. Ironically the International Coffee Agreement was regarded as relatively successful.⁴

Price movements reflect the evolving demand and supply situation. It is clear from Figure 3 that supplies of coffee on the world market have typically run ahead of the growth in demand. Since domestic consumption in producing countries did not expand sufficiently to absorb growing supplies, coffee exports increased. But as developed country markets became increasingly saturated growth in export earnings lagged behind growth in export volumes. The export earnings of coffee producing countries have fallen from US\$10-12 billion in the early 1990s to US\$5-6 billion currently. However the value of retail sales of coffee has increased over the same period from around US\$30 billion to around US\$70 billion.

³ Cashin, Liang and McDermott (1999). Interestingly, this study notes that persistence of shocks is very much less for tea than for coffee – less than one year in fact – with the implication that stabilization might feasibly have net benefits.

⁴ Palm and Vogelvang (1991).

Figure 3. International market balance for coffee



Imbalance in the world coffee market and the consequent low prices were exacerbated by new plantings in Viet Nam, and by an increase in Brazilian exports following expansion of plantings into frost-free areas, productivity improvements and devaluation of the real in early 1999. These supply side developments outweighed the steady increase in global coffee demand. In the ten years to 2000/01 the area under coffee in Viet Nam expanded from 60 578 hectares to 463 450 hectares and coffee bean output increased from 96 000 tonnes to 800 000 tonnes, making Viet Nam the largest robusta producer and second largest coffee producer in the world. The consequent increase in export revenues provided a boost to the country's overall rural economy with multiplier effects on incomes and employment in upstream and downstream activities and leading to significant declines in the incidence of poverty and hunger. However, the subsequent decline in robusta prices, by 39 percent in 2000 and 33 percent in 2001 had a "domino effect" on arabica prices which were already under pressure from the 30 percent increase in coffee exports from Brazil in 1999.

Over the last four years, consumption has remained virtually unchanged, and against this background of saturated markets coupled with low price elasticity of demand, prices tend to decline rapidly and sharply. However, falling prices do not necessarily prompt the expected supply response. The perennial nature of the crop means that adjustment to the scale of production through diversification and exit from the industry is slow: in the short run the price elasticity of supply appears to be very small, around 0.25. It may also be that, as is often argued for perennial crops, supply responses to price incentives are asymmetric: periods of rising prices stimulate new plantings and other fixed asset investments which are not scrapped when prices fall, but rather are simply not replaced when they reach the end of their productive life. Supply responses to falling prices have also been slowed in some cases by national efforts to assist producers, for example through price supports and debt relief. In the short-term adjustments can be made to reduce application of inputs including labour, but creating unemployment and stimulating migration. Reduced labour input through less care of trees and in harvesting also has adverse effects on quality which in turn leads to additional pressure on average price levels. This, together with the fact that much of the expansion in production from Viet Nam was of inferior quality has lowered average quality, posing a threat to the various product differentiation initiatives to develop markets for high-quality "specialist" coffees. However, there are signs that areas planted are being cut back, in Viet Nam and Brazil, for example, and it is partly this which is giving some strength to prices in the last few months of 2003. Elsewhere, the abandonment of farms by smallholders and increased migration to urban centres have been reported to the ICO by Cameroon, Central African Republic, Colombia, Costa Rica, Ecuador, Nicaragua, and Philippines. Colombia further reported coffee land

being used for illicit crops. Nevertheless, stocks remain at high levels with an apparent reduction in exporting country stocks being offset by further increases in importing country stocks.

The “coffee crisis” results not only from the price fall but also from the economic importance of coffee in many producing countries. The effects of the fall in coffee prices after 1998 were particularly severe in those countries where productivity growth has lagged behind, and coffee producers faced a tightening price-cost squeeze. However, such has been the extent of the fall in prices that the adverse economic and social impacts have become generalized with declining incomes, increasing unemployment and increasing rural poverty across all producing countries and all production systems. Any gains which might have derived from domestic market liberalization increasing the share of the export price going to farmers have been swamped.

While some traditional coffee exporters such as Brazil have diversified and reduced export dependency on coffee – from more than 40 percent in 1960 to less than 5 percent today - dependency remains a major problem, especially for poor African countries: Burundi derives nearly 80 percent of export earnings from coffee; Uganda and Ethiopia more than 50 percent; and Rwanda slightly less than 50 percent. A number of Latin American countries also have high dependency on coffee, notably Colombia and El Salvador where coffee has accounted for around 15 percent of export earnings, and Guatemala, Honduras and Nicaragua with around 20 percent of export earnings. Export dependency is also reflected in significant shares of employment related to coffee: in Colombia for example 30 percent of the rural population is directly dependent on coffee. Such dependency means that coffee price variations have significant multiplier effects on employment and incomes beyond production itself in related upstream and downstream industries, and across the economy in general.

The economic and social effects of falling coffee prices are documented by a recent ICO survey of producing countries.⁵ Nicaragua reported 122 000 job losses, Costa Rica 10 000. In Papua New Guinea employment in the estates sector has fallen by 40 percent. In Ecuador the coffee processing sector is operating at only one third capacity. Almost all countries reported falling incomes and expenditures among coffee-dependent households. An apparently common coping strategy is reduced spending on health and education. In Papua New Guinea 50 percent of parents in the Eastern Highlands had not paid school fees this year. Food security has inevitably been reduced. Increased incidence of malnutrition is documented in Colombia where the number of households in coffee growing areas living below the poverty line increased from 54 to 61 percent between 1997 and 2000. Malnutrition is also reported to be affecting 45 percent of children in the coffee growing areas of El Salvador, where the World Food Programme distributed emergency food supplies to some 10 000 coffee producing families. A March 2002 survey in Viet Nam showed 45 percent of coffee growing families lacking adequate nutrition. A similar picture of impacts on incomes and rural poverty emerges from case studies in Tanzania and Mexico reported earlier by Oxfam.⁶

Declining prices and export revenues also have macroeconomic consequences. Especially in the case of the highly dependent producers/exporters, declining prices and export revenues, and declining incomes in the coffee sector can have an impact on government revenues. Recent research shows this link continues to be particularly strong for African coffee exporting countries in spite of market liberalization, although there is apparently no significant statistical relationship in Latin America.⁷ Clearly, the strength of any such effect is likely to reflect the degree of dependency on commodity exports which is typically higher in Africa. However, more anecdotal evidence appears to indicate that the kind of extreme price falls observed for coffee over the last five years do have macroeconomic impacts elsewhere. In the ICO’s survey, Côte d’Ivoire, Ethiopia, Nicaragua and Philippines all reported fiscal constraints on the national investment budget. In the case of Nicaragua, the fall in foreign exchange earnings from coffee amounted to around US\$300 million between 2000/01 and 2002/03, while the reduction in income tax receipts from the coffee sector is estimated at around US\$13.2 million.

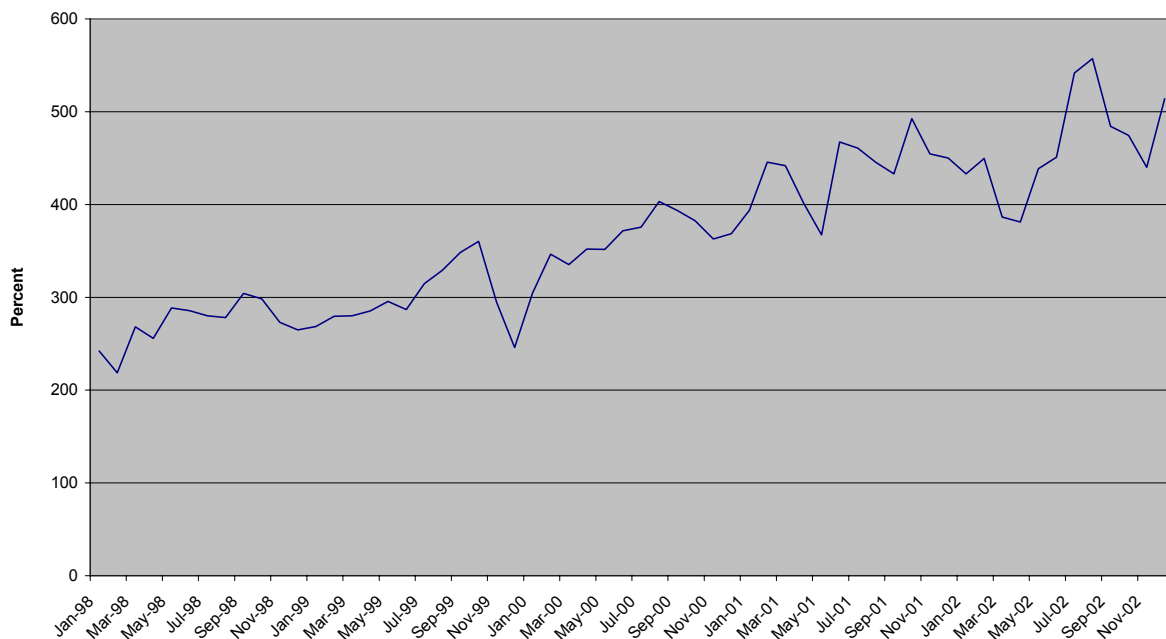
⁵ International Coffee Organization (2003a).

⁶ Oxfam (2001).

⁷ Gilbert (2003).

In the wide reporting of the coffee crisis, the media was quick to contrast the plight of coffee growers with the apparent buoyancy of sales and profits in the retail coffee markets in importing countries, prompting questions concerning the producers' share in retail prices. Figure 4 gives one illustrative example of marketing margin behaviour as producer prices fell. It does appear that margins were maintained as coffee prices received by growers fell and hence the share of growers in the final retail price diminished. The latter was already small – perhaps between 20 and 30 percent of the retail price of coffee, and only between one and two percent of the price of a cup of coffee sold in a coffee shop. Of course, the green coffee is only one element in the final retail product which includes costs of processing, transport, services and so on as well as the margins taken by firms at the various stages in the value chain. It would not be expected that transmission of prices through the value chain would be perfect in the sense that changes in grower or world prices would be mirrored by equivalent changes in final prices, especially in proportionate terms. The extent to which world price variations are transmitted depends *inter alia* on market structures at different stages in the value chain, the technology of processing, and the share of the basic commodity in final products. As noted above, the latter is reduced as processing, packaging and services increase in importance. Nevertheless much concern has been expressed at the “fairness” or otherwise of the small share of global coffee income accruing to growers.

Figure 4. Price spread between US retail price and Colombia producer price



The apparent tendency for falling international and producer prices not to be reflected in prices in final markets, and hence for consumer to world price spreads to widen has a further dimension which is that there is some evidence to suggest some asymmetry in price transmission with a tendency for falling world prices not to be passed on but rising prices to be passed on at least to some extent.⁸ The implication of this is that final demand does not rise as world prices fall because the price falls are not passed on into final markets. To the extent that retail demand responds to price changes, demand does not rise to absorb increasing levels of supply contributing further to supply-demand imbalance. At the same time, as noted earlier, the characteristics of the product and the production system are such that falling prices do not provoke significant reductions in supply at least in the short-run. The net result is persistence of falling prices.

⁸ Morriset (1998).

3. International action on coffee prices

3.1 Supply control

Depressed prices have prompted calls for international action to address problems of market imbalance with proposals both to control supply and to promote demand. For coffee, the Association of Coffee Producing Countries (ACPC) promoted a retention scheme from 1 October 2000 to retain 20 percent of exports to maintain prices above 95 cents/pound and release supplies onto the market when prices exceeded 105 cents/pound. While 19 countries joined, including non-members of ACPC such as Viet Nam, few actually retained any coffee at all: only Brazil, Colombia, Costa Rica and, temporarily, Viet Nam cooperated. Exports and stocks continued to rise, and prices continued to fall.

Analysis based on a simple partial equilibrium model of the world coffee market developed in the FAO Commodities and Trade Division⁹ indicates that if 20 percent of exports had actually been retained off the market in 2001, international prices would have been up to 32 percent higher, and the total export revenue accruing to all exporters would have been 5 - 6 percent higher. However, in spite of this apparently large increase in prices, the specified floor price of 95 cents per pound would still not have been reached, so low had prices fallen. In practice few exporters actually committed to retaining any exports. If Brazil, Colombia, Costa Rica and Viet Nam had actually implemented the 20 percent retention world prices would have risen by around 17 percent. However, this would not have compensated for the revenue loss due to the reduced volume of exports, and the revenue accruing to these countries would have fallen by about 6.5 percent. On the other hand, those countries not participating in the scheme and maintaining export volumes would have increased their revenues by 17 percent in line with the price increase. These results are summarized in Table 1.

Table 1. Estimated effects of coffee export retention scheme in 2001

Participation	Price effect	Revenue effect
All exporters	+32 percent	+5.5 percent
Brazil, Colombia, Costa Rica, Viet Nam	+17 percent	-6.5 percent
Non-participants	+17 percent	+17 percent

It appears from these results that prices could have been raised significantly in 2001, although not to the target level, even without full participation in the scheme. However, the most active supporters of the scheme would have lost revenues, while the free-riders would have gained. It is not surprising therefore that even those exporters initially declaring an intention to participate withdrew their support. The main difficulty with such schemes is to devise an appropriate institutional structure to maintain general support and compliance and control free-riders, especially where consuming-countries are not party to the agreement, and where financing is uncertain.

Such schemes hark back to the international commodity agreements (ICAs) with “economic clauses” which were widely seen in the 1970s as a solution to the problems of tropical commodities facing weak markets and variable prices. However, at that time support was forthcoming from the importing countries who wished to offset the threat of the use of the newly acquired producer power as revealed in the petroleum and food price peaks reached in 1972-74. Market interventions ended for sugar in 1984, for coffee in 1989 and for cocoa in 1993, while for jute and rubber the arrangements continued until 2000. The ICAs are not now widely regarded as a success, although the coffee agreement did succeed in keeping prices within the agreed range for some time. The coffee agreement also succeeded in raising prices above what they would otherwise have been,¹⁰ and its passing is seen by some as one reason for the coffee crisis. Today existing ICAs focus on measures to improve the functioning of markets, and there is little prospect of the resurrection of their economic clauses.

⁹ See Annex.

¹⁰ Palm and Vogelvang (1991).

Nevertheless, interest persists in supply management by producing countries to counter the long-run fall in international commodity prices.¹¹ The ACPC coffee export retention scheme has already been mentioned, but a similar scheme exists for rubber, and there has been active discussion of the need for such a scheme for tea. These “producer-only agreements” involve export retention or international stock management schemes, or diversion of low quality into alternative uses. However, as the ACPC scheme illustrates, the experience to date has not been encouraging. It seems difficult to maintain the continuing commitment of the parties to the discipline of the agreement, while free-rider problems persist with those suppliers outside. Even so, the issue of market interventions was seriously discussed again at the recent ICO/World Bank round table on the coffee crisis which recorded “A recognition that a totally free market entailed excessive social costs and that some forms of action with an impact on the market might be considered, notwithstanding the fact that finding such a form of action with an agreement between the various parties may be difficult”.¹²

In principle, the conditions for a successful – in the sense of raising prices or slowing their fall - producer-only agreement do not appear demanding. The basic requirements are:

- the parties to the agreement should control a high percentage of production
- price inelastic demand
- modest price objectives
- a high degree of commitment to a simple instrument.

The conditions are not prohibitive and the share of trade that a group needs to command (which depends on elasticities of import demand and export supply in non-members) need not be impossibly high to achieve gains in export earnings by withholding some supplies from the market in the short-run. In the longer-run the elasticities rise and with them the critical share required for the successful operation of an agreement, but this should not rule out modestly aimed agreements for a limited number of years. It is not a requirement for an international agreement that it should be designed to last for ever; periodic re-assessments of the membership and tactics make good sense. In any case market intervention cannot be sustained in a one-sided way to counter the tendency for relative commodity prices to decline in the long-run. This can only be achieved by bringing about a permanently improved balance between supply and demand.

The first two conditions are generally relatively easy to fulfil since production of many commodities, although not coffee, is geographically concentrated, and commodity demand is indeed typically inelastic. However, there is a tendency to be overambitious with respect to target prices and to be unwilling to recognize the need to adjust targets in line with changing market conditions, with politics rather than economics governing decisions. There are also difficulties in choosing the currency to denominate the target prices. If the target price is set in US dollars then devaluation of national currencies against this can offset falls in the dollar price. The devaluation of the Brazilian real is one factor which led to growth in world coffee output in spite of falling dollar prices, for example. Above all maintaining commitment, including financial support to establish and implement a scheme, is the most difficult as the experience with the ACPC coffee export retention scheme and the tripartite rubber agreement indicate. The higher the target prices set the greater the incentive for low-cost producers to cheat, and for those outside the agreement to increase their production and market share.

Control of cheating and free-riders is much easier if the agreement has full participation of importers, which, by definition, a producer only agreement presumably does not have. Consuming countries and the multinational trading companies which buy and process many commodities are not likely to favour higher prices, although under the old ICAs importers saw it in their interest to participate. Participation of consumers is not only desirable from the policing point of view, it may also be a legal requirement that importers are represented under WTO rules, although the constraints on WTO members forming

¹¹ Maizels, Bacon and Mavrotas (1997).

¹² International Coffee Organization. (2003b).

producer-only agreements are not entirely clear. Administration of an agreement has also become more difficult after market liberalization which reformed or removed institutional mechanisms for this.

In spite of the continuing interest in such arrangements, it is clear that market intervention of the producer-only agreement type is fraught with difficulties and unlikely to be successful. The ICO has recently launched a Quality Improvement Programme, which although portrayed as a demand enhancement scheme would also have supply side effects by eliminating a certain volume of inferior quality coffee from international markets. The programme was agreed in 2002 under Resolution 407 as the International Coffee Council proposed to prohibit from October 2002 the export of coffee failing to meet specified minimum standards in terms of numbers of defects and moisture content.¹³ Exporting member countries are expected to develop and implement national measures to implement the resolution.

If financing does not prove a problem, the scheme should have both demand and supply side benefits since higher quality might be expected to stimulate demand and command a higher price, while the elimination of low quality coffee would reduce overall supply. However, the burden of implementing the scheme will fall most heavily on those producers with the lowest quality at least in the short-run until their quality is improved. In terms of enforcement, coffee failing to meet the specified standards can be refused the ICO certificate of origin by exporting countries, but the cooperation of importers in policing the scheme and informing the ICO of shipments failing to meet the quality standards is purely voluntary. Furthermore, the participation of importers requires their agreement on the quality standards to be specified and a willingness to give up some flexibility in the range of quality entering their blends. More generally, if superior quality is to be demanded and to command a higher price, consumers must be able to recognize quality differences and be willing to pay for them. Quality improvement schemes may therefore need to be supported by educative information and promotion activities.

The impact of the coffee scheme on quality and prices and its costs is to be reviewed in late 2003. However, analysis using the world price determination model referred to above suggests that such a scheme could have beneficial effects. The impact on the demand side of the market is difficult to judge *a priori*, although estimates of the likely reduction in export volumes might be made. The extent of this reduction depends upon the percentage of production failing to achieve standards. The ICO estimates that around 600 000 tonnes would have fallen below the standard in 2002. However, perhaps 50 percent of this would not have been exported anyway. The model results suggest that withholding this quantity from the market in 2002 would mean that prices would be up to 8 percent higher than they otherwise would have been. This estimate seems in broad accord with the 4.7 percent increase in the average price for 2002 in spite of a 5.3 percent increase in global production. However, as noted above the burden of the scheme will fall most heavily on those producers with the lowest quality. In the case of Viet Nam it is estimated that as much as sixty percent of production in 2001/2002 was substandard.

A similar scheme is under active consideration by the world tea industry. Under this scheme, tea failing to meet ISO standard 3720 would be excluded from the world market. The details, and particularly the policing arrangements, remain to be worked out, and an international working group has been established to develop the proposal. There is some concern that the ISO standard involved may not be sufficiently stringent to be effectively constraining on volumes of inferior quality tea coming on to the world market and hence have little real impact. Most importantly, however, as with the coffee scheme, effective policing to ensure full cooperation is essential. The tea industry is less well-placed to ensure this in the absence of a relevant international body. Furthermore, it requires active participation of importers against a background that inferior quality does find a market.

¹³ Specifically, exporting members shall not export coffee that: for arabica has in excess of 86 defects per 300 g sample (New York green coffee classification/Brazilian method or equivalent); for robusta, has in excess of 150 defects per 300 g (Viet Nam, Indonesia or equivalent); for both arabica and robusta, has a moisture content below 8 percent or in excess of 12.5 percent measured using the ISO 6673 method.

3.2 Demand promotion

Difficulties in coordinating international action on the supply side have led to interest in demand side measures, and particularly demand promotion. However, from the outset it must be recognized that generic promotion is primarily a means of influencing longer-term trends in demand, not addressing short-run price variability. Nevertheless, there are certain common problems faced by internationally coordinated attempts to regulate supply or stimulate demand. Key amongst these is the need to secure continuing commitment to cooperative activities of participants who may see their interests as competitive. The current ICO promotional work emphasizes activities likely to command general support, and together with the arrangements for finance and organization, reflects a realistic response in the current depressed market conditions. In both respects, the lessons of past experience in coffee promotion are evident. Promotional messages are not the concern here, but rather how to organize and finance promotional programmes where there is not only the familiar free-rider problem, but also where there are conflicts of interest between participants and tensions between generic and “brand” interests. These controversies extend beyond coffee, of course, as evidenced by the current debates and legal challenges to various generic promotion schemes across a range of agricultural products in the United States. In particular the coffee experience offers some insights into how best to deal with the three challenges faced by all promotional programmes: obtaining agreement on programme objectives; generating financial backing for the programme; and sustaining promotional programmes long enough to generate the desired results.

The international coffee industry has a long history of promotional activity, through the Promotion Committee of the ICO which was charged under the terms of the various International Coffee Agreements with the responsibility for undertaking generic promotion for coffee without reference to brand, type or origin. The ICO was most active between 1976 and 1990. During this period over US\$43 million was spent on activities and campaigns specifically designed to build the market for coffee. Financial support for market building activities was internationally-based among virtually all coffee producing countries while activity implementation was typically national in conjunction with national coffee associations. The ICO was dominated by Brazil and Colombia, the two primary producers (and campaign financers as monies were raised *pro rata* by market share). Although monies were raised through a compulsory levy on coffee producing countries that were signatories to the ICO, expenditure was closely scrutinized and members focused on return for investment. Contributions were most difficult for the smaller countries. At the same time, Colombia’s contribution was in addition to the monies it was already spending on its national efforts, Café de Colombia. Tight budgets in the late 1980s and early 1990s combined with lack of unanimity among coffee roasters who typically proposed promotion campaign ideas and co-financed them led to the discontinuation of internationally backed generic promotion and emergence of campaigns for specific market segments or national interests.¹⁴

Stakeholders in the industry must be the primary source of funds for market development activities. There is therefore a close link between the fortunes of the industry, financial support for promotion and the scope and nature of promotional activities undertaken. Promotion has typically been funded primarily by producing/exporting countries, and generally on a *pro rata* basis relative to market share as in the case of ICO promotional activities. However, at times of protracted low prices the capacity and willingness of producers to fund such programmes may be limited. Consumers/importers may also cooperate in promotion activities in which case there will be a need for a financial formula for cost sharing. Budgetary limitations have led to a need for greater private sector contributions, and the need to attract private sector support is an explicit provision in the most recent ICO promotional plans. Generally speaking, the narrower the financial backing the more focused promotional efforts and greater likelihood of effectiveness. However, the narrower international participation the more limited the funding base and consequently the more limited the possible activity mix and geographical range. It

¹⁴ The cotton and wool industries show a similar experience. In each case there was a significant gap between the contributions of the largest backer and other programme participants, and the disparity between countries’ respective contributions led the dominant contributor (the United States in the case of cotton and Australia in the case of wool contributed 40-50 percent of the total budget) to believe that although the total market size may be increasing, other countries stood more to gain by their financial investment and to withdraw their support.

is an ongoing balancing challenge to secure financing and support (especially where each country perceives a commensurate return on expenditure) for promotion campaigns. In such cases high emphasis should be placed on clear targeted campaigns and routine feedback to all participants on campaign progress. Where possible, feedback should identify the return for each country to make it more meaningful to each participant. It also forms an essential tool for participating countries to justify expenditure on generic promotion to their trade and government.

The funding possibilities obviously constrain what can be done and there is little prospect that conventional advertising campaigns to compete with global brands could be mounted or would necessarily find favour with all participants. In the face of financial constraints, including those posed by depressed commodity prices and revenues, promotional activity needs to be carefully targeted and guided by market research. There appears to be much scope for the promotion of demand in producing countries: Brazil successfully raised coffee consumption during the 1990s from around 480 000 tonnes to 750 000 tonnes, and is now second to the United States as a consumer. However, even here, not all market segments offer the same prospects. Increasing consumption among younger age groups in particular poses a particular challenge where per capita consumption is low and heavily advertised soft drinks are the main competitive challenge. Market growth possibilities in the high income developed countries where most coffee has traditionally been consumed are relatively limited: only the specialist coffee markets have seen significant growth recently, again indicating product differentiation as a potentially successful marketing strategy. The same strategic priorities would be appropriate *mutatis mutandis* for tea. The emphasis must be on general information provision which all participants acknowledge to be of value, or campaigns targeted on specific market segments where those participants with most to gain contribute most. In the ICO's most recent promotional plans the priority is information provision, notably related to positive links between coffee consumption and health, and on targeted markets, especially in producing countries and emerging markets, for which generic programmes need to be developed on a country-by-country basis reflecting the unique characteristics of each market. The expectation is that counterpart funding would be forthcoming, especially for the latter. The basis for promotional activity of all kinds is research and studies related to coffee consumption for which the ICO Promotion Committee also has responsibility. Among producing and consuming countries alike there is common interest in the coordination of a programme of market research to generate an internationally comparable database of information on consumer attitudes and habits, and in the Promotion Committee acting as a clearinghouse for educational, informational and public relations material. Particular points of interest are the challenges of increasing sales to young people lured away from coffee in favour of ready-to-drink, cold beverages, and attacks on coffee on health grounds.

The scope of backing for generic promotion activities is an important determinant of the focus of activities and the marketing message or position. It serves as the basis for setting marketing objectives and targets. If the interests or priorities of backers differ one from another it becomes increasingly hard to secure collective ongoing support, whether that support is conceptual, political or financial. Every marketing proposition must have clear and commonly shared objectives. In the case of Cotton Council International (CCI) responsible for internal cotton promotion, the industry agrees to overall objectives and priorities. Once these are set specific country targets are developed internally as are the activities aimed to address those targets. This information is shared with the industry who agrees to them as a collective approach to promotion. The broader the financial and political support for a generic promotion campaign the bigger the task of gaining support for activity proposals; securing funding; and reporting on how monies were spent and what resulted from that expenditure. Accountability is paramount for generic promotion since all stakeholders need to receive clear, ongoing evidence that monies have been spent efficiently and generated the targeted results. Back-sell communication is essential on at least a semi-annual basis to maintain support for activities that likely take several years to generate significant results.

Regardless of campaign objectives generic promotion campaigns depend on a long-term commitment by backers to allow sufficient time for results to be generated. A minimum of three to five years is a realistic timeframe for most generic promotion activities. Defensive activities that are fundamentally issues management might achieve their objectives in a shorter period. Without exception the longer-

term the objectives of the project, the bigger the challenge to maintain political support and campaign funding. Maintaining support over the longer term is a clear challenge for all advertising and marketing campaigns. It can be even more difficult to convey the benefits derived from generic promotion to stakeholders when each has competitive and varied interests. Promotional campaigns need to include demonstrable effective use of funds; commonly agreed goals and realistic targets; specific measurable activities to track campaign effectiveness. In addition, generic promotion campaigns have the challenge of communicating to each stakeholder how those measured results impact the interests of that particular stakeholder to justify ongoing support. However, even the best conceived and managed campaign cannot always anticipate the effect of a changing market and the evolving consumer. For example, Café de Colombia did not expect that the emergence of a strong gourmet following for coffee in the 1990s would undermine its premium position, relegating Colombian coffee to “second best”. This single factor caused the Federación Nacional de Cafeteros de Colombia (FNC) to rethink its marketing strategy and the platform for its ongoing promotional efforts for the late 1990s and beyond – despite its success to date in developing a premium position for Colombian coffee over the previous 30 years. An alternative way to view this market development is that the FNC was so successful in its efforts that it set new standards for the industry as a whole which made its current market position redundant.

The experience of the development of ICO promotional campaigns provides some useful pointers to the design and implementation of promotional strategies for other commodities. The difficulty facing collaborative action on the demand side as with action on the supply side is to organize joint activities amongst stakeholders who may see their interests as competing. There is therefore a need to establish clear strategic aims to which all can subscribe, and clear targets based on rigorous market research. Activities in targeted markets need to be adapted to particular local needs in collaboration with local organizations and in these cases those with most to gain should provide the bulk of funding. In periods of declining prices and restricted public budgets it seems inevitable that the private sector must play a greater role in market development activities.

4. Some concluding comments

This paper has looked at the problems facing the international coffee market and specifically at two areas of industry level initiatives to help improve market balance. It is clear that industry level co-ordinated activities are not straightforward to organize, and attention has also focused on a more micro-level at options available to individual producers to secure better returns from the market.

Product differentiation into speciality varieties can achieve premium prices for coffee beans, although such product differentiation opportunities are not open to all. More generally, organic and fair trade products can also command a premium price. The International Trade Centre (ITC) has been active in researching market opportunities in these areas, through the Gourmet Coffee Project, for example.¹⁵ Coffee offers substantial scope for product differentiation in view of its quite different characteristics according to geographic origin. So-called speciality or gourmet coffees often associated with a particular producing region have continued to command a premium and enjoy market growth even when prices in general have been depressed. Of course, not all producers can enjoy the benefits of favoured locations, but alternative bases for differentiation are also possible – environmentally friendly production systems or organic or fair trade, for example. Exploiting such niche markets requires that segments offering higher returns must be identified and targeted, and quality maintained throughout the value chain. It may also be that the market needs to be educated to appreciate and be willing to pay for “speciality” coffees.

In these areas there may be a role for government and for international agencies, but basically they require investment. The problem is who will reap the benefits of any such differentiation – roasters, traders, retailers, governments or growers. A recent study¹⁶ shows that for coffee, while international prices have displayed increasing variability across coffee types as a result of increasing differentiation

¹⁵ International Trade Centre (2000).

¹⁶ Fitter and Kaplinsky (2001).

in final products markets this has not been reflected in prices paid to farmers – in fact variance of grower prices has actually declined. So a growing share of total incomes in the value chain has accrued to economic agents in the importing countries. Fitter and Kaplinsky attribute this to the imbalance in market power between the two ends of the value chain: while coffee growing is typically atomistic following abolition of marketing boards, importing is concentrated with the top five importers accounting for over 40 percent of total global trade, and roasting is even more highly concentrated with the top five roasters in Europe accounting for nearly 60 percent of coffee produced.

In the longer term the tendency towards oversupply in the coffee market can only be addressed by encouragement of diversification out of coffee production at least in marginal areas. Horizontal diversification into alternative crops is the obvious direction, but the important objective is to enhance income and employment opportunities, including outside agriculture. Vertical diversification can be a means of capturing a share of processing and distribution margins which have expanded even as prices of basic products have declined. Such vertical diversification faces tariff escalation and needs to overcome the barriers to entry which are a feature of the concentrated international market.

Ultimately, non-competitive producers must diversify out of coffee production. This will require public assistance to growers to identify market opportunities and to obtain the necessary knowledge, skills and resources to exploit them. Even for competitive producers, price variability and exposure to price risk will remain even if the protracted slumps seen in recent years resulting from global overproduction and stagnant demand may be limited. Attention can then increasingly focus on management of these risks.

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Annex

Partial Equilibrium Model of the world coffee market

Variables		Behavioural equation/identity
World		
- Production	WLDCOQP	$\sum(CTYCOQP_i)$
- Imports	WLDCOIM	..
- Ending stocks	WLDCOST	$\sum(CTYCOST_i)$
- Consumption	WLDCOQC	$\sum(CTYCOQC_i)$
- Exports	WLDCOEX	..
- Net trade	WLDCONT	$WLDCOQP-WLDCOQC-WLDCOVST=WLDCONT=0$
Each individual exporting country (20 major exporting countries or regions)		
- Production	CTYCOQP	$QP = f(RP(\text{lagged 5 or 3 years}), QP(-1), \text{trend}, \dots)$
- Imports	CTYCOIM	0
- Ending stocks	CTYCOST	$ST = f(RP, QC, QP, ST(-1), \dots)$
- Consumption	CTYCOQC	$QC_POP = f(GDPI_POP, RP, QC_POP(-1), \text{trend}, \dots)$
- Net exports	CTYCOEX	$NT = QP - QC - VST$
Each individual importing country (14 major importing countries or regions)		
- Production	CTYCOQP	0
- Net imports	CTYCOIM	$NT = QP - QC - VST$
- Ending stocks	CTYCOST	$ST = f(RP, QC, QP, ST(-1), \dots)$ or exogenous if minor
- Consumption	CTYCOQC	$QC_POP = f(GDPI_POP, RP, QC_POP(-1), \text{trend}, \dots)$
- Exports	CTYCOEX	0
Rest of World		
- Production	ROWCOQP	0
- imports	ROWCOIM	$ROWCONT = ROWCOQC - ROWCOVST$
- Ending stocks	ROWCOST	exogenous
- Consumption	ROWCOQC	exogenous
- Exports	ROWCOEX	0

Variables are defined according to the following mnemonics. The first three letters refer to the country name according to the code adopted by UNDP. CO stands for coffee. The last letters refer to the variable as follows: QP for production; QC for consumption; QC_POP for per capita consumption; ST for ending stocks; IM for imports; EX for exports; NT for net trade; VST for stock variations; WP for world price; RP for real price; GDPI for Gross Domestic Product Index; GDPI_POP for income per capita; XR for exchange rate; CPI for Consumer Price Index; POP for population.

FOOD IMPORT BILLS: EXPERIENCES, FACTORS UNDERPINNING CHANGES AND POLICY IMPLICATIONS FOR FOOD SECURITY OF LEAST DEVELOPED AND NET FOOD-IMPORTING DEVELOPING COUNTRIES

A. A. Gürkan, Kevin Balcombe and Adam Prakash¹

The study analyses in detail the historical developments observed during the period 1970-2001 in the food import bills of two groups of countries (i.e. least developed and net food-importing and developing countries, LDCs and NFIDCs, respectively). The first part of the study puts these developments into a broader economic perspective using data at the country level for all basic food commodities, while the second part of the study delves into the commodity aspects of food import bills at the country level by analyzing the sources of variation in the import bills of selected food commodities. Put briefly the study finds evidence that quantities and prices of food commodities tend to be affected by policy shifts, substantive changes in the behaviour of economic agents or other factors affecting the market fundamentals, the effects of which tend to be concentrated around certain important events, such as the 1974 world food crisis. Furthermore, the variances of prices, quantities and the total import bill were discovered not to be constant over time, with periods of high volatility, which tended to decline towards the end of the period. There is also evidence that prices tend to have a significant contemporaneous influence on quantities imported, with more income-elastic food commodities' changes in prices exerting a larger influence on quantities imported. In line with this, contribution of prices to variation import bills tends to be larger (close to over 50 percent) for those commodities that exhibit larger price effects on quantities. From a policy perspective the results indicate that it may be warranted to focus attention on the LDCs as they have been under relatively greater stress and exhibit greater vulnerability from the perspective of their national food security.

1. Introduction

Given the economic dependence of many vulnerable and food insecure developing countries on trade in agricultural commodities, in terms of ensuring both stable access to food and sufficient resources to maintain and enhance economic growth, it is important to understand the nature and causes of developments in global agricultural commodity markets. There have been periods when international prices of food commodities, for example, have spiked sharply, causing dismay among those poor developing countries that rely on imports to satisfy their food needs, though helping the producers who are able to benefit from the windfall. There have been other periods, prolonged at times, when food prices have remained at low levels, this time causing hardships among the producers, but helping the consumers to have easier access to food.²

Production of agricultural commodities is often subject to vagaries of weather and other natural stochastic events, such as pests and diseases, and tends to face inelastic market demand, which goes some way to explaining the observed volatility in those markets. The nature of institutional and policy settings and the changes in them also play a very important role in this process. The international community, however, has long recognized these problems and used different policy instruments at different times to deal with their unwanted consequences.

¹ The authors are, respectively, Chief, Basic Foodstuffs Service, Commodities and Trade Division, FAO; Lecturer, Imperial College at Wye and Commodity Specialist, Basic Foodstuffs Service, Commodities and Trade Division, FAO.

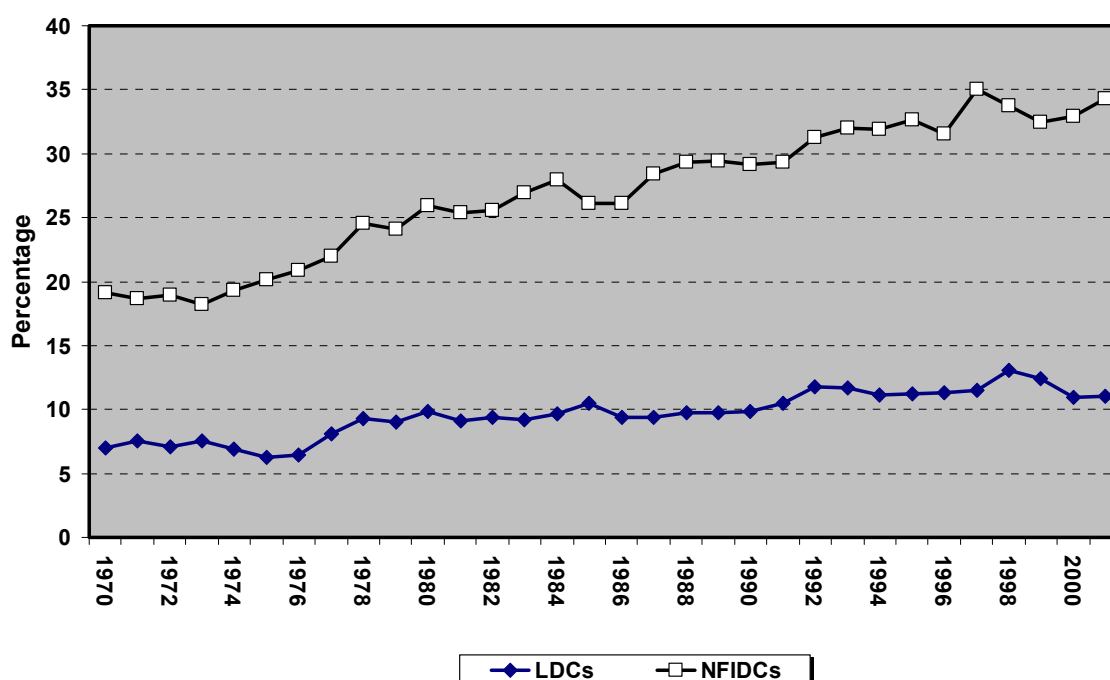
² A similar situation also holds true for non-food agricultural commodities that many poor developing countries rely on to earn much-needed foreign exchange when allows them to import their food needs. They suffer when prices are low, benefit when they are high; provided, of course, the movements of prices of food commodities that they have to import do not coincide.

With the beginning of the implementation of the Uruguay Round Agreement on Agriculture (UR AoA) in the mid-1990s, the trade of agricultural commodities has been brought under the discipline of almost universally accepted rules of behaviour; which has also meant gradual adjustment of domestic agricultural policies in order to make them consistent with those rules. The *ex ante* analyses of the possible impact of the reform programme in agriculture created concerns that this process may, on the one hand, reduce the availability of adequate supplies of basic foodstuffs from external sources on reasonable terms and conditions, and, on the other, put pressure on domestic markets that are more difficult to protect under the new arrangements, endangering the livelihoods of vulnerable producers.

The WTO's Marrakesh *Ministerial Decision on Measures Concerning the Possible Negative Effects of the Reform Programme on Least-Developed and Net Food-Importing Countries*³ was adopted in order to address the first of the issues; while the special safeguard clauses dealt with the second one. They are, however, continuing subjects of discussions within the current round of multilateral trade negotiations, i.e. the Doha Round⁴.

The aim of this study is to analyse the experience of the least developed countries (LDCs) and net food-importing countries (NFIDCs) with regard to their food import bills over the past three decades, with a

Chart 1. Share of food imports in total apparent food consumption - calorie equivalent



view to providing background information that could prove useful in enhancing the current international policy debate on the subject. The emphasis is on the LDCs and NFIDCs, as these are the countries most vulnerable, from a food security perspective, to unexpected developments in global agricultural commodity markets in the new international trade policy environment, as already recognized by the international community. The focus, moreover, is on the developments as observed at the country level rather than at the level of global markets.

³ The full text of the decision can be found at: http://www.wto.org/english/docs_e/legal_e/35-dag_e.htm

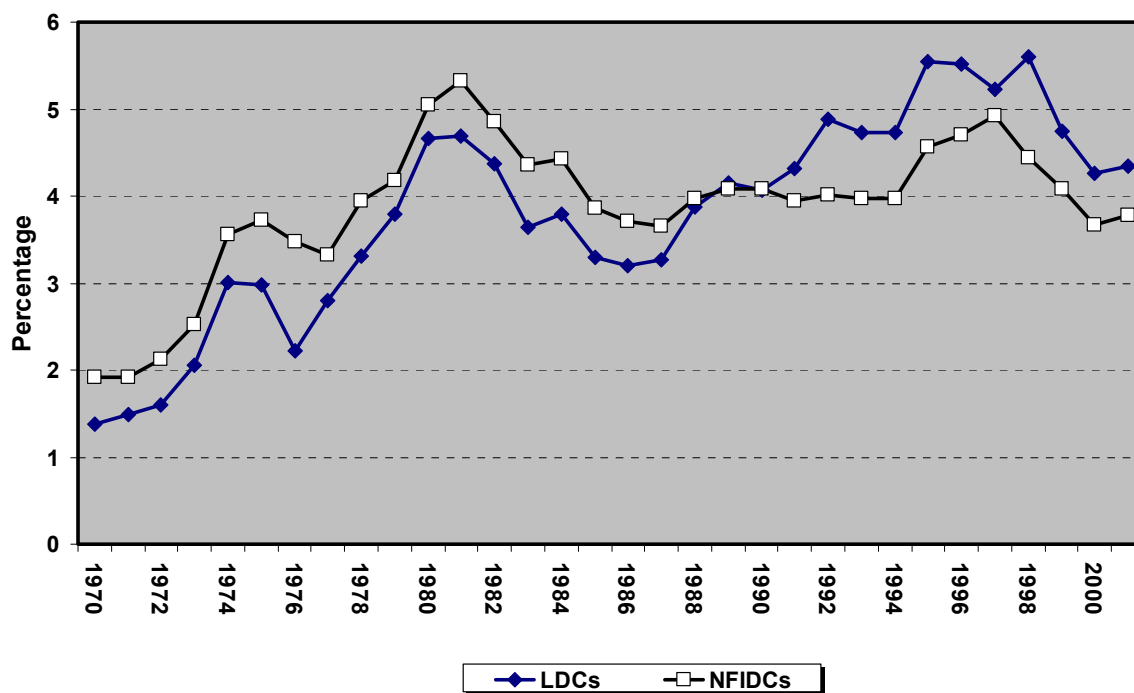
⁴ A Panel established at the World Trade Organization (WTO) has, for example, been assessing the effectiveness of various different instruments to deal with sharp increases in food prices from the perspective of least developed and net food importing countries, using their experiences during the mid-1990s, in line with the provisions of the Marrakesh Decision (see WTO 2002).

The study consists of three sections: The first contains a statistical overview analyzing the development of all the variables relevant for the *problematique* (i.e. value of commercial food imports, value of food aid, unit costs of imports, relative contributions of food imports to food availability at the country level, etc.); the second assesses the sources of variation in food import bills and determines the incidence of large, unanticipated changes in the value of food imports and its components; and the final section summarizes the analyses and notes policy lessons that could be inferred from the changes observed.

2. Experience with food import bills

Food imports of developing countries have been on the increase over the past decade⁵ (see Chart 1, for their importance also in relative terms⁶). For many, particularly the food insecure among the low income and net food importing ones, this situation could lead to increased stress if growth in income and export earnings to sustain food imports is not adequate and/or if growth in import growth undermines otherwise viable domestic production. In order to put these developments into a perspective which would allow such an assessment to be made, Charts 2 to 4 present average country shares of total food import bills (i.e. value of food commercially imported) in GDP (Gross Domestic Product), total merchandise exports and total merchandise imports, respectively.⁷

Chart 2. Share of food import bills in GDP



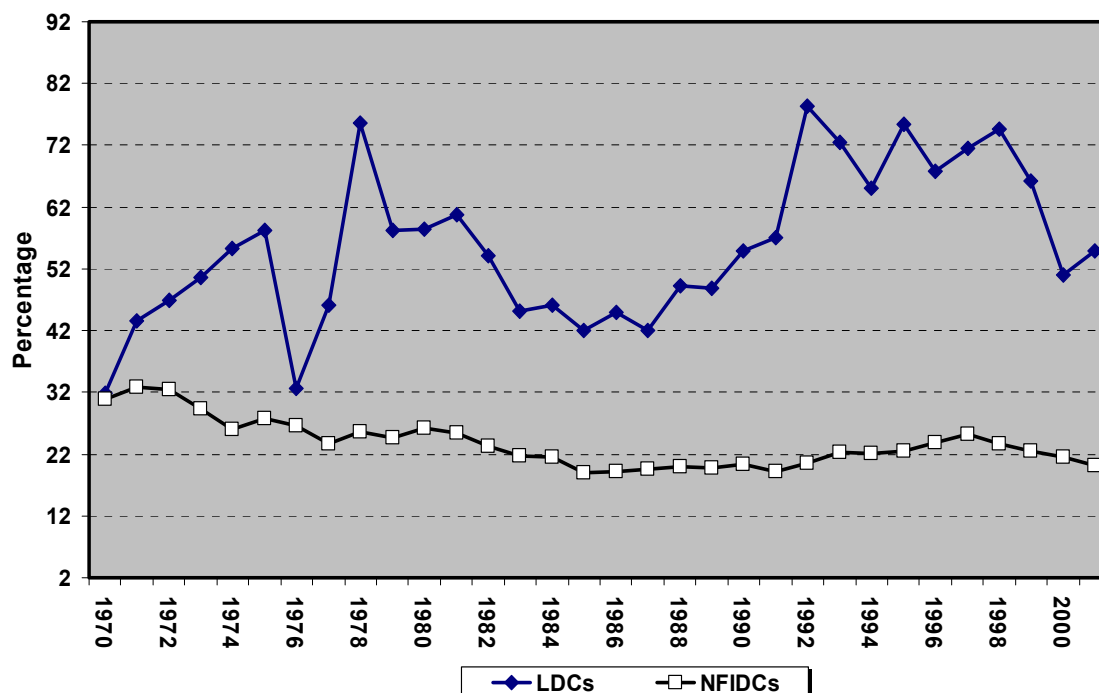
⁵ For all the developing countries the annual growth in volume of food imports has averaged around 5.6 percent and for the low-income food-deficit countries around 6.9 percent. For the developed countries, on the other hand, the annual average growth in food imports has been around only 1.9 percent (see FAO 2003, Table 3).

⁶ As expected, the NFIDCs import significantly more of their apparent consumption (nearly one-third more recently) than the LDCs (slightly above one-tenth over the past decade); and indeed the share of the former has also increased faster than that of the latter over the past three decades.

⁷ The averages for each category are simple averages calculated over the shares of the countries in each category. Before calculating the shares, the value of food aid deliveries on a calendar year basis has been subtracted from corresponding FAOSTAT estimates. Since food aid donations are not reported separately though included in official export statistics of the donor countries, and are assigned a "value" even when the food aid commodities are in grant form and in kind, the adjustments made to the recipient country imports to take this into account are to some extent arbitrary. The issue is complicated by the fact that it is not always clear that importing countries report food aid volumes and give them a value, and when they do what value they assign to aid especially when it contains some concessionality. Manual adjustments have been made to ensure consistency between reports by donor and recipient countries and to exclude food aid locally purchased.

- **Share of food import bills in GDP** (Chart 2). The shares over the past three decades have significantly⁸ increased from just about 1 to nearly 6 percent for the LDCs and from about 2 to 5 percent for the NFIDCs.⁹ This in effect means that, on average, the rate of growth in food import bills has been greater than that of the GDP for both groups of countries, putting a strain on their already meagre resources. Moreover, since the early 1990s, the share of the LDCs, which are by definition more vulnerable, has risen and remained above that of the NFIDCs. There have, however, been consecutive years during which the shares have declined for both groups of countries: the first period between 1981 and 1987; and the second, the last few years of the 1990s.

Chart 3. Share of total food import bills in total value of merchandise exports



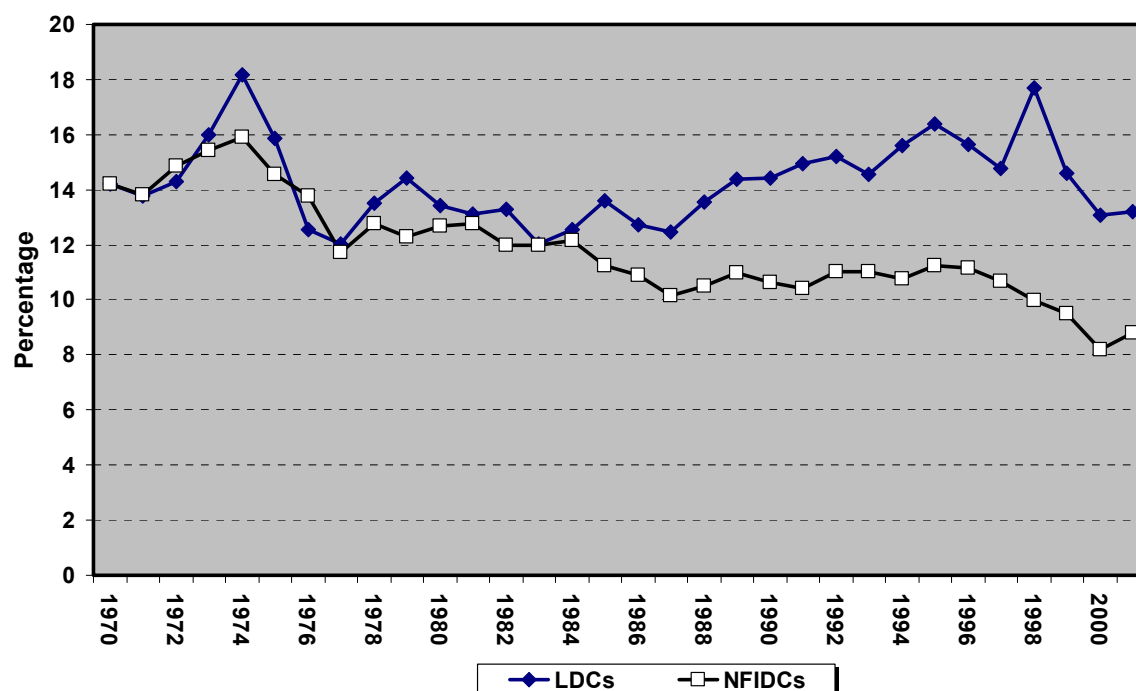
- **Share of food import bills in total value of merchandise exports** (Chart 3). More important than the differences in underlying trends in the shares for the two groups is the stark difference in their levels: starting from about the same level, at roughly 32 percent, the share for the LDCs has increased (though rather undecidedly) to and fluctuated around 72 percent between 1992 and 1997, while the share of the NFIDCs declined to and fluctuated around 22 percent during the same period.

As in the case for the shares in GDP, beginning in 1986-87, the shares in total merchandise exports increased significantly, at the rate of about 5 percent per annum for the LDCs and about 2.5 percent per annum for the NFIDCs, this time putting a strain on their scarce foreign exchange reserves. It is clear though that the LDCs are in a more vulnerable position than the NFIDCs, as a much smaller proportion of available foreign exchange reserves appears to be available for importing other goods and services that could, for example, be used for developing their infrastructure.

⁸ All statements in the rest of the paper claiming some “significant difference” are based on statistical tests to increase confidence that the observed differences are not likely to be due to some “error” variation.

⁹ The averages presented in Charts 2 to 4 have also been calculated by weighing each country by the relative importance of the food imports in apparent food consumption, both measured in terms of their calorie content. The values calculated in this manner are much higher than those reported here.

Chart 4. Share of total food import bills in total value of merchandise imports



- **Share of food import bills in total value of merchandise imports** (Chart 4). Indeed, as this chart illustrates, the share of food import bills of the NFIDCs in total merchandise imports has been almost continuously declining throughout the period; while that of the LDCs has increased significantly since, again, 1987.

Another aspect of vulnerability of these countries from the perspective of these three indicators is the variability in their values through time: tests indicate that volatility in these indicators for the LDCs is significantly greater than that for the NFIDCs. Although a part of the overall volatility is due to factors that the countries can anticipate, vulnerability of the former is likely to be greater than that of the latter, since their financial ability to cope with the negative consequences of such volatility tends to be relatively more limited even when they are expected. The situation does not change when similar tests are conducted on variability that is “unanticipated”¹⁰: they are still significantly larger for the LDCs.

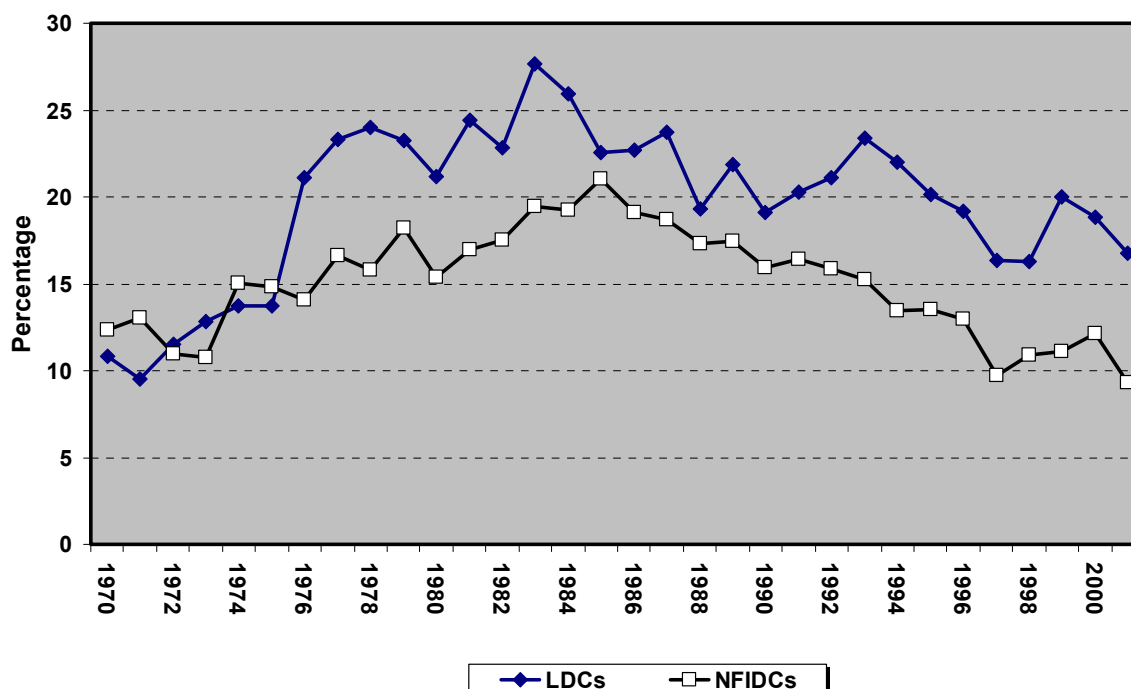
It must be remembered that the countries falling into these two categories are also the ones receiving substantial food aid shipments, which are deducted from the total food import bills in order to calculate the three indicators used in the analysis so far. It may well be that the developments in commercial food imports are related closely to developments in food aid flows: if, for example, more food aid was flowing into the NFIDCs in the 1990s, it may be expected that the share of their food import expenditures in GDP and total merchandise imports declined; or if less food aid was flowing into the LDCs, it may be expected that the value of all the three indicators increased, so as to maintain national food security. Chart 5 presents the developments in the ratio of the value of food aid to total value of food imported¹¹ by an average LDC and NFIDC. Apart from the fact that the LDCs have had greater (relative) dependence on food aid when compared to the NFIDCs since the time of the world food crisis in the early 1970s, it is clear that the fortunes of these two groups of countries have been diverging, especially since the late 1980s. It appears that the decreasing burden of commercial food imports of the NFIDCs during the 1990s is not likely to be due to increased food aid flows, as the ratio of value of food aid in total food imports started to decline in the mid-1980s, from about 20 percent to around 10

¹⁰ “Unanticipated” volatility is defined here as the residual variation derived from smoothing equations fitted through applications of non-parametric regression techniques to each series (see Härdle 1992); an approach similar to that used in the next section, yet different because of the econometric techniques used in identifying “anticipated” volatility.

¹¹ Please note that the official published estimates of the value of food imports include the value of food aid flows.

percent at the end of the 1990s.¹² Thus, not only the growth of GDP appear to have outstripped the growth of commercial imports, it did so when the importance of food aid was on the decline.¹³ This is quite the opposite situation to that of the LDCs: as, despite relatively higher annual variation, the significant decline in the share of value of food aid in total food imports over the past decade-and-a-half appears to have been compensated for by devoting relatively more domestic resources to meeting perceived national food needs.

Chart 5. Ratio of the value of food aid to total value of food imports



3. Determinants of food import bills

This section proposes and applies a methodology to decompose the variation in the value of commercial imports of countries falling into the LDC and NFIDC categories for a number of selected basic food commodities into its constituent components, import prices and quantities. (see Charts 6 and 7 for the appropriate indices as applied to the averages for the countries falling into the two groups).¹⁴ The principal aim here is to bring the analysis to the commodity level and to assess the incidence of sudden and unexpected increases in both import prices and quantities and the contributions of the variation in these two variables to the variation in import bills. Given the vulnerability of the countries under scrutiny, discovering the frequency and magnitude of the changes, especially at their border, is necessary to assess the need for policy instruments that could cope with possible negative consequences, and perhaps provide insight into the most appropriate form of these instruments if they were found to be needed.

¹² Indeed the decline was not only in relative terms but also in absolute terms, averaging 20 percent per year between 1986 and 1987 (measured in terms of calorie equivalents).

¹³ There was no clear decline in the absolute value of food aid flows (measured in calorie equivalents) for this group of countries during the same period.

¹⁴ The volume index is calculated using 1995 import unit values and the price index uses average import unit values per 1 000 units of kilocalories contained in food commodities imported.

Chart 6. Volume and price indices of food for LDCs – 1995=100

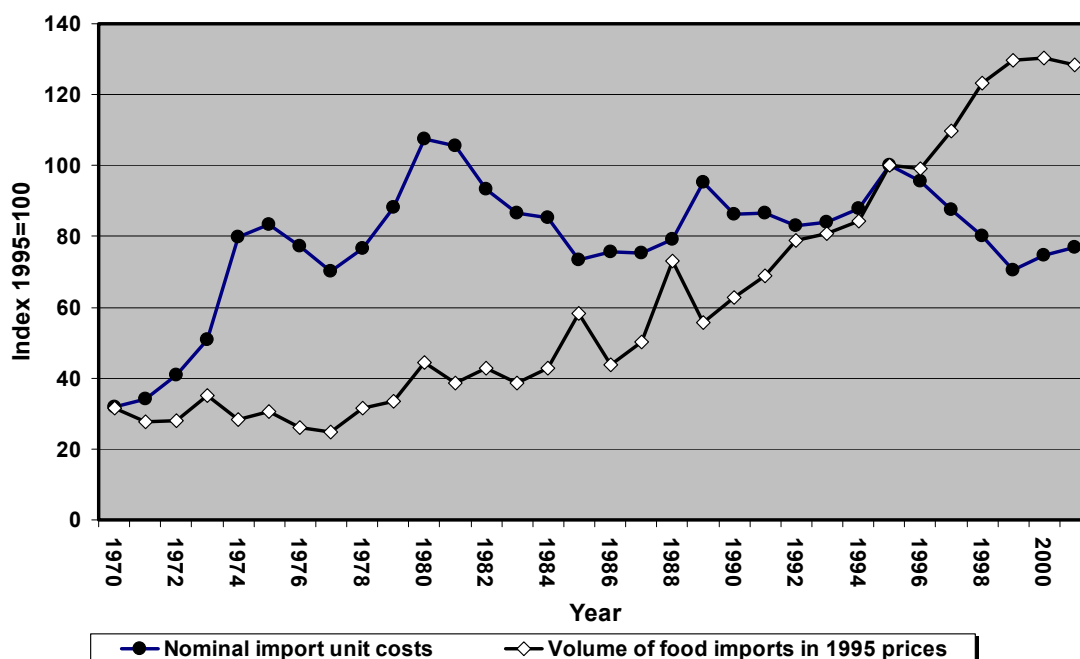
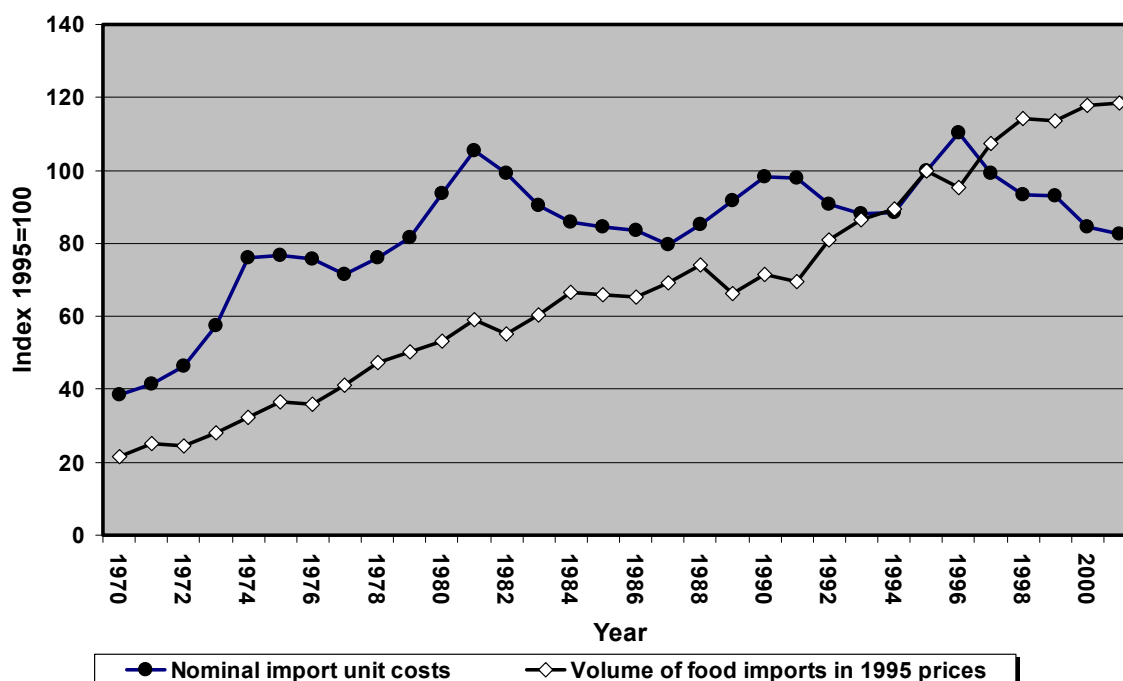


Chart 7. Volume and price indices of food for NFIDCs – 1995=100



3.1 The methodology¹⁵

The import bill, I_t , is the product of an aggregate price, (p_t), i.e. the unit import cost of the commodity in question, and a quantity aggregate (x_t), i.e. the volume of imports of the commodity.

$$I_t = p_t x_t \quad (1)$$

In order to analyze the impact of p_t and x_t on I_t , and of p_t on x_t , a joint framework is proposed. The trends in the data are likely to dominate any other source of variation as the sample grows. However, if the trends are of the type that can be removed by differencing, they can be split into a deterministic component and a stochastic component. The analysis, furthermore, can be facilitated by studying the natural logarithmic transformation of I_t rather I_t itself. This follows from the fact that:

$$\begin{aligned} \ln(I) &= \ln(p) + \ln(x) \\ \text{and} \\ \Delta \ln(I) &= \Delta \ln(p) + \Delta \ln(x) \end{aligned} \quad (2)$$

Thus, $\Delta \ln(I)$ can be linearly decomposed into the changes in the logarithmic transforms of prices and quantities, providing a basis for a fully coherent analysis. Moreover, the conclusions derived from such analysis would equally pertain to that using the untransformed series.

The variation of $\Delta \ln(p)$ and $\Delta \ln(x)$ can, of course, be analyzed separately and the component with the most variance could be argued to be the one which is driving the variation in the logarithmic transforms of the import bills. However, there are two important complications. First, the relationship between $\Delta \ln(p)$ and $\Delta \ln(x)$ needs to be accounted for, since we would expect import quantities to be, in part, driven by prices. Second, the serially correlated behaviours of $\Delta \ln(p)$ and $\Delta \ln(x)$ need to also be considered. The standard econometric approach to this type of problem is “Impulse Response Analysis” and “Forecast Variance Decomposition” (VAR) which is discussed next.

Vector Autoregressive Decomposition Analysis

The two variables can be expressed as a “Vector Autoregression” (VAR) as follows:

$$\begin{aligned} \Delta \ln(p_t) &= \mu_p(t) + \alpha_{11}(L) \Delta \ln(p_{t-1}) + \alpha_{12}(L) \Delta \ln(x_{t-1}) + e_{p,t} \\ \Delta \ln(x_t) &= \mu_x(t) + \alpha_{21}(L) \Delta \ln(p_{t-1}) + \alpha_{22}(L) \Delta \ln(x_{t-1}) + e_{x,t} \end{aligned} \quad (3)$$

where the $\alpha_{ij}(L)$ denote polynomial lag operators, that are a convenient notation for

$$\alpha_{ij}(L)y_t = \sum_{k=1}^K \alpha_{ij,k} y_{t-k} \quad (4)$$

Within this framework, the variables are driven by random “innovations” or “shocks”, $e_{p,t}$ and $e_{x,t}$, which represent sudden changes in the behaviour of economic producers and consumers and in the policy environment and/or stochastic events that affect the market fundamentals. These shocks are propagated in a way that is governed by the signs and magnitudes of the $\alpha_{ij}(L)$. The intercepts $\mu_i(t)$ may be treated as a variable over “regimes” that permanently alter the impact of prices and quantities on food import

¹⁵ This section is based on analysis undertaken by Kevin Balcombe.

bills (i.e. alter the mean rate of change in the variables, since the series are transformed into logarithms and then differenced).¹⁶

The parameters of interest are not only the values of $\mu_i(t)$ and $\alpha_{ij}(L)$, but also the innovation variances of $e_{j,t}$ as well as the covariance between $e_{p,t}$ and $e_{x,t}$. Together, these provide a basis on which to analyse the relative importance of shocks to quantity and prices, and their overall impact on the value food imports. The impact on the changes in import bills can then be studied because of the relationships expressed in equation (2).

Testing causality

If quantities do not cause prices (in the sense of Granger-causality), then one would expect $\alpha_{12}(L) = 0$ to hold. This hypothesis asserts that prices do not react to past changes in import quantities and would be expected to hold where the country was an import “price taker” (e.g. small relative to world demand) or where the effects of price changes on quantities were dissipated quickly enough so that there are no lagged effects. However, in circumstances where import quantities were forward looking (e.g. future price changes are correctly anticipated), a rejection of this hypothesis would not be unexpected. Consequently, this would be considered a subsidiary hypothesis.

The converse hypothesis that $\alpha_{21}(L) = 0$ would be rejected where price changes were driving current imports but the full impact of any price change did not happen within the year. In other words, if the hypothesis were to be rejected, the overall effect of a price spike would be larger since not only contemporaneous but also future import quantities would be affected by a price spike.

Variance decomposition

The above hypotheses (i.e. $\alpha_{12}(L) = 0$, $\alpha_{21}(L) = 0$) are commonly used to construct a “causal ordering”. This ordering can be justified when the importing country is relatively “small” in terms of impact on the global markets, as all the LDCs and NFIDCs tend to be. Consequently, changes in prices might be expected to impact on import demand, but not vice versa. The lag structures only partly capture the relationship between prices and quantities. In addition, the correlation between the shocks $e_{x,t}$ and $e_{p,t}$ are of interest. Under the “small country” hypothesis, while observed shocks to quantities and prices are likely to be correlated, part of the quantity shock will be due to a price shock. Consequently, it would be permissible to write:

$$e_{x,t} = \rho e_{p,t} + \hat{e}_{x,t}, \quad (5)$$

where $\hat{e}_{x,t}$ represents the innovation variance in x (orthogonal to $e_{p,t}$) that is not due to the innovations in import prices. The parameter ρ can be interpreted as a short run elasticity of import quantity with respect to import prices.

These innovations are assumed to have means and covariances equal to 0 and variances equal to σ_p^2 and σ_x^2 . The larger the variance σ_p^2 relative to σ_x^2 , then, *ceteris paribus*, the more important price variation is in determining the variation in overall import bill. However, the impact of price on quantity will also be determined by the parameters α_{21} in equation (3) and ρ in equation (5). In fact substituting equation (5) in (3) yields:

¹⁶ The existence and number of regime changes are determined using the statistical tests in Bai and Perron (1998) and Bai (1999) (see Annex A for details).

$$\begin{aligned}\Delta \ln(p_t) &= \mu_p(t) + \alpha_{11}(L) \Delta \ln(p_{t-1}) + \alpha_{12}(L) \Delta \ln(x_{t-1}) + e_{p,t} \\ \Delta \ln(x_t) &= \mu_x(t) + \alpha_{21}(L) \Delta \ln(p_{t-1}) + \alpha_{22}(L) \Delta \ln(x_{t-1}) + \rho e_{p,t} + \hat{e}_{x,t}\end{aligned}\quad (6)$$

Variance decomposition requires restating the autoregressive representation in equation (6) in terms of its “moving average” counterpart (see Annex B for details), which expresses changes in prices and quantities as the weighted sum of past “shocks” to prices and quantities. These then allow determining the contribution of the variances of prices, $R(I/P)$, and import quantities, $R(I/X)$, to that of the import bills and the second that of import quantities.

Moreover, given the assumed relationship between price innovations and import quantities, as expressed through equation (6), it is also possible to estimate the contribution of the variation in prices to that of quantities, $R(X/P)$ (see Annex B for details).

Identifying price spikes

The innovations driving prices and quantities are those represented by $e_{p,t}$ and $\hat{e}_{x,t}$. Large innovations will lead to large changes in prices and quantities contemporaneously and as they are propagated through time by the lags in the VAR. In econometric terms, these shocks are also often referred to as being “unanticipated” since their values at time t are not deducible from the historical data at time $t-1$. In this study, values that lie outside of two standard deviations above zero are defined as price spikes. Accordingly, about three price spikes would be expected every hundred years if the innovations were to behave in accordance with having a normal distribution.

3.2 Empirical analysis

Data

The data for this study are obtained from FAOSTAT and refer to values and quantities of imports by the LDCs and NFIDCs of wheat, rice, coarse grains, sugar, chicken meat, skim milk, soybeans and palm oil. As already noted in the previous section, published FAOSTAT estimates are adjusted to include estimates of food aid deliveries, in volume as well as value terms. For this study, however, estimates of both the volume and value of food aid flows to the individual LDCs and NFIDCs are deducted from the totals as reported in FAOSTAT. Since estimates of food aid flows at the country level are available only from 1970 onwards, the statistical analyses are conducted with at most only 32 observations, for the period 1970-2001. The import “prices” are computed implicitly by dividing the value series by the volume series; therefore they do not refer to prices paid of “homogeneous” commodities.¹⁷ Thus, changes in prices calculated in this manner also capture changes in the composition of the commodities (i.e. share of processed versus raw products etc.) imported by each country.

3.3 Summary of results

The following procedure is employed in the implementation of the vector auto-regression model as defined in equation (3):

- Structural break points are identified for import price and volume series for the j commodities, i.e. $\mu_{i,q,j}(t^q)$, for all the countries; these breaks represent a shift in the average rate of growth of the variables concerned;
- Appropriate dummy variables are created and each equation re-estimated;

¹⁷ However, estimated import volumes are expressed in their raw product equivalents.

- Granger-causality tests are conducted to assess empirically the direction of causation between prices and quantities;
- The coefficients of and moments derived from the estimated models are then used to determine the contribution of the price variations to variations in import bills and volumes of the commodities studied for each of the LDCs and NFIDCs, as well as to determine the years during which price and quantity spikes had occurred;

Structural breaks and spikes in the import prices and volumes

Breaks in the means (single and multiple) are found in several of the (country) series within each of the commodity groups.¹⁸ The most notable result with regard to price breaks¹⁹ is that for sugar and wheat more than a quarter of the countries exhibit at least one significant shift in the growth rate of import prices, with almost all occurring within the period 1974-1976, which roughly coincides with the occurrence of the “global food crisis”. Other crops have experienced fewer shifts (on average, about 7.5 percent of the countries for each commodity, which is fairly close to being within the error limits); moreover, there is little evidence that the breaks for these commodities coincide in terms of timing as they do in the case of sugar and wheat.

For quantity breaks, on the other hand, there is not much consistency. However, the number of countries experiencing significant shifts in the growth of rate of import volumes is greater than those experiencing shifts in growth of prices for coarse grains, chicken meat, skim milk and palm oil.

The picture changes, however, especially for prices, when spikes are also taken into account: over 50 percent of all the occurrences of such large, aberrant disturbances - the effects of which, though, do not last for more than a single period – for almost all the commodities studied here coincide with the period of the global food crisis as well²⁰ (see Chart 8).²¹ Moreover, similarly consistent picture emerges for the following two decades: nearly two-thirds of the observed price spikes experienced during the 1980s seem to have occurred in the latter part of that decade (with sugar being the only exception where the spikes occur at the beginning of the decade). This discovery is interesting because the period coincides with the occurrence of important policy changes in some major developed countries, especially in the United States (the implementation in 1985 of the US farm legislation) and the EC (significant increases in intervention stocks of wheat) (see WTO 2002, *ibid*). Similarly for the 1990s, when the spikes occur in greater frequency right after the mid-1990s, when there was a convergence of a number of different factors affecting market fundamentals: ranging from the widespread negative effects of El Niño on production of various agricultural products in many different parts of the world, changing public stock holding behaviour for cereals in some developing countries and continued domestic support in many developed countries to the beginning of implementation of the UR AoA²²(see also FAO 2002a, pp.33-39).²³

¹⁸ The tests are conducted at the 5 percent level of significance. Therefore, about one in twenty estimated breaks would be expected, even if there were no structural changes.

¹⁹ A tally of “shocks”, both positive and negative, beyond three standard deviations is also kept. Though one should hardly expect to find such extreme outliers, they do occur consistently, suggesting that the error terms of the VAR are not distributed normally as assumed.

²⁰ The exceptions are sugar, where all the structural breaks seem to have occurred during the same time, and skim milk, the product with the weakest links to the other commodity markets.

²¹ This also means that the incidence of unanticipated volatility was larger during the 1970s when compared to either the 1980s or the 1990s, providing support to the conclusions reached in an earlier FAO study that analyzed international representative commodity prices rather than country level data as used here (see FAO 2002b, pp. 134-136).

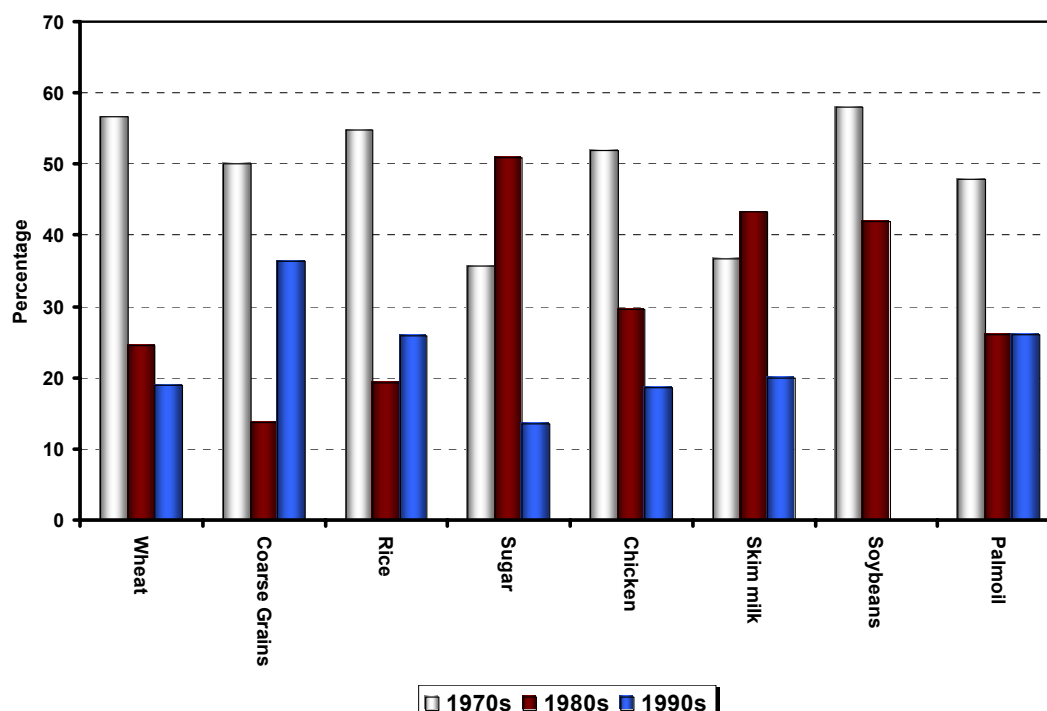
²² The timing of the import price peaks also coincides fairly closely with those discovered when similar structural break analyses were undertaken using representative international prices of some of the same commodities (FAO 2002b, pp.136-137; Prakash and Gürkan, 2002)

²³ Charts 2 to 5 illustrate the importance of the periods at end of the 1980s and mid-1990s in changing the trends in the indicators that are constructed using unrelated macroeconomic variables as well.

The tests conducted for structural breaks in the volatility of prices and quantities indicate significant changes in the variance in the innovations of the VAR as well: with on average one-third of the countries across all the commodities exhibiting at least one such break during the period under scrutiny. In the case of prices, the breaks in volatility, almost exclusively, coincide with the years in which of large shocks are identified; with volatility increasing at or very near a year in which there is a spike, decreasing when there is a sharp decrease.²⁴

Price and quantity causality

Chart 8. Distribution of the incidence of import price peaks through the past three decades for selected basic food commodities



A lack of causality, from prices to quantities and vice versa, in the Granger sense, is notable: with statistical tests failing to indicate causality in more than four-fifths of the countries across the commodities studied. This suggests that the impact of price changes on import quantities may take place relatively quickly.²⁵ “Non-causality” in the Granger sense, though, does not imply that the series are independent. In fact, estimates of ρ in equation (6) represent the contemporaneous impact of prices on import quantities. Nearly three-quarters of the estimates are found to be significantly negative, suggesting, as expected, that price “shocks” have an important negative contemporaneous impact on import quantities. Nevertheless, there are many instances of large shocks to import quantities that do not seem to be driven by price changes (i.e. similar shocks seem not to have taken place in prices).

²⁴ If tests for conditional heteroscedasticity (ARCH) were used, they would also undoubtedly commonly reject the hypothesis of constant variance. However, precisely how the variance should be modelled is an open question. ARCH or GARCH may be good ways of modelling the shifts in variance, but with such short series this is impossible to determine.

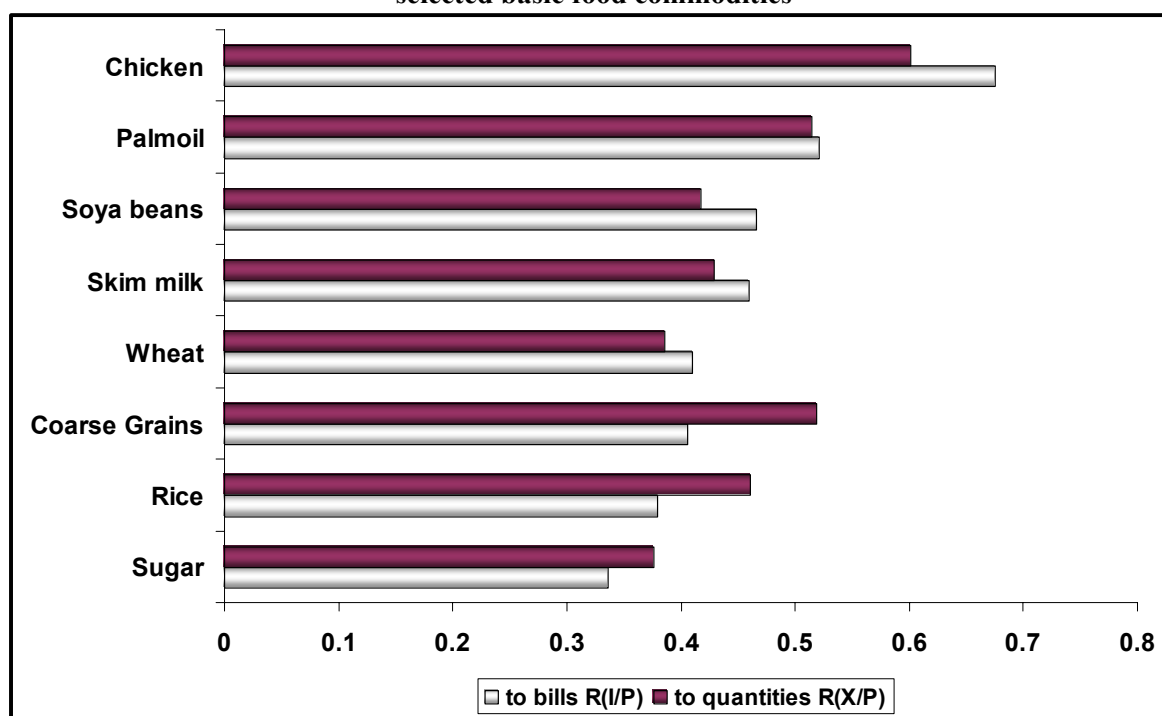
²⁵ However, the apparent non-causality between the series may also be due to small sample, numerous potential outliers in the series, inappropriateness of standard statistical tests when assumption of normality in the distribution of shocks, composite nature of the commodities considered in the analyses etc.. Non-causality from quantities to prices was imposed unless causality could not be rejected at the 5 percent level. However, for *a priori* reasons, non-causality of prices to quantities was not imposed.

Therefore, while the evidence suggests that price changes have an impact on quantities, it would be wrong to conclude that they are the only or dominant determinant of large changes in import quantities.

Impact of prices on food import bills and quantities

As noted above, shocks to prices lead to changes in import quantities in the expected direction and the estimates of ρ can be interpreted as the short run elasticity of import quantities with respect to import prices. The full impact of a given innovation will, however, be in part due to the dynamics of the system. The average elasticities (across countries) for the food groups range from -0.38, for wheat to -0.97, for chicken,²⁶ implying, for example for chicken, that, on average, a 1 percent rise in its import price could lead to a 0.97 percent decline in the quantity imported within one year. There is, however, large variation across countries for each commodity, so that these averages should be treated with caution when dealing with individual countries. Despite the large variation, as well as high standard errors for some individual country estimates, tests indicate that the averages for chicken, soybeans and palm oil tend to be significantly higher than for those other commodities; though no significant differences were detected between the LDCs and NFIDCs.

Chart 9. Estimated contribution of prices to import bills (R(I/P)) and quantities (R(X/P)) of selected basic food commodities



Turning to the contributions of prices to the variations in food import bills (R(I/P)) and quantities (R(X/P)), the averages (across countries) for each of the food groups are presented in Chart 9. For example, R(I/P) for chicken is 0.67, indicating that prices appear to be responsible for approximately 67 percent of the variation in its import bills. The value R(X/P) of 0.60 indicates that approximately 60 percent of the variation in import quantities of chicken is due to prices. Prices will have a direct impact on food import bills, and an indirect one through their impact on quantities. However, it is theoretically possible that price and quantity effects could cancel each other out leaving no impact on the import bill. Thus, R(I/P) may be higher or lower than R(X/P) from a theoretical point of view. The general findings

²⁶ The elasticities for the other commodity groups are: rice, -0.49; coarse grains, -0.53; skim milk, -0.55; sugar, -0.56; palm oil, -0.65; soybeans, -0.80.

indicate that import prices seem, on average, to contribute somewhere between a third and two thirds of the variation in import bills. The proportions are similar with regard to the variation in the overall import quantities explained by price variation. It should also be noted that the contribution of prices tends to be greater, the stronger is the contemporaneous influence of price innovations on quantity innovations. Again, an important proviso is that the within-group variation across countries is very wide. Therefore, it would be problematic to apply these numbers to individual countries.

4. Conclusions and policy implications

The study analysed in detail the historical developments observed during the period 1970-2001 in the food import bills of two groups of countries that are recognized as vulnerable from the perspective of their food security. These countries, identified as least developed and net food-importing and developing countries (LDCs and NFIDCs, respectively), have been the subject matter of existing multilateral trade agreements and current negotiations with a view to ensuring that the trade rules adopted do not endanger their food security status given their already vulnerable position. The first part of the study puts these developments into a broader economic perspective using data at the country level for all basic food commodities: the aim here being the facilitation, using data adjusted to address the specific demands of the analyses, of comparison between the two groups of countries and assessing the developments in the overall economic burden of their food import bills.

The analyses indicate that while there have been improvements in reducing the vulnerability of the NFIDCs, the situation for the LDCs has not been as promising, especially during the past decade. Although the share of food imports in total apparent consumption has nearly doubled over the past thirty years for both groups, the growth in food import bills for the latter has consistently outstripped those of GDP and total value of merchandise imports and exports up until very recently. This, together with much greater volatility experienced, is an indication that the least developed countries have been under stress to ensure their national food security. Although it may appear paradoxical that the situation in these countries has been alleviated somewhat after the implementation of the UR AoA, special conditions affecting the market fundamentals of the major food commodities, rather than the changes in the international policy environment itself, appear to have been more influential.

The second part of the study delves into the commodity aspects of food import bills at the country level by analyzing the sources of variation in the import bills of selected food commodities. The consistencies discovered provide convergence of support to analyses conducted elsewhere that, however, do not use data at the level of detail used in this study. Moreover, the underlying analyses are based on data properly adjusted to bear directly on the issues being addressed. The consistencies that are of relevance from a policy perspective can be summarised as follows:

- There is evidence of large “unanticipated” changes in import prices and import quantities (of all food commodities) that are indicative of either large policy shifts, substantive changes in the behaviour of economic agents or other factors affecting the market fundamentals.
- A significant proportion of large price spikes for most commodities, as well as the structural breaks for wheat and sugar, occur at or around periods that can be attributed to certain important events: for example, the 1974 world food crisis; policy changes in important developing countries after the mid-1980s; and around 1997-98 when many agricultural commodity markets tightened sharply and then subsequently reversed mainly as a result of policy responses. Around the time when such price spikes are observed, sharp dips in imported quantities occur as well. Furthermore, in years immediately after a sharp price increase, the volatility in prices increases too. A large proportion of the observed spikes experienced by the individual countries for most commodities is concentrated in the 1970s, implying declining volatility over the past three decades, and confirming findings based on analyses of representative international prices of more homogenous commodities.
- The variance of prices, quantities and the total import bill is not constant over time, and there appear to be periods of high volatility (for all food commodities). For most commodities, price

volatility appears to have declined over the past three decades, since a larger proportion of the observed spikes experienced by the individual countries for most commodities is concentrated in the 1970s. Moreover, these confirm findings elsewhere, which are based on analyses of representative international prices rather than unit import costs of composite commodities at the border. The volatility in quantities is distributed more uniformly across time, countries and commodities.

- There is little evidence of empirical causality, in the sense of Granger, between prices and quantities across all groups and most countries. Nevertheless, there is substantial evidence that prices tend to have a significant contemporaneous influence on quantities imported, with more income-elastic food commodities' changes in prices exerting a larger influence on quantities imported when compared to those less elastic. In line with this, it is also discovered that contribution of prices to variation import bills tends to be larger (close to over 50 percent) for those commodities that exhibit larger price effects on quantities. However, there is still a wide variation in these results across countries. Thus, while the evidence generally supports the contention that prices are an important determinant of total import values and import quantities, there are other important factors influencing these variables. The characteristics of countries which have relatively high and low responses may warrant further analysis.

From a policy perspective the results indicate that it may be warranted to focus attention on the LDCs as they have been under relatively greater stress and exhibit greater vulnerability from the perspective of their national food security. Indeed, both at a more macro level and at the commodity level, price, quantity and import bill variability faced by both groups of countries appears to be significant; though, incidence of especially price variability, at least in its more extreme forms, have been declining over the past three decades. For the more basic of the food commodities, there is some evidence to suggest that import quantity variation tends to be a larger contributor to the variation in import bills; while for those that tend to be more income-elastic, it is import price variation that tends to be more important. Moreover, some important policy landmarks appear to have been instrumental in causing sudden and substantial changes in the market fundamentals that have been transmitted to the border of these vulnerable countries. One relief, however, has been that such changes have not had lasting effects either on prices in subsequent periods or longer term effects on quantities imported; the effects usually dissipating within a single year. Overall, short term volatility appears to be an important policy issue that requires attention to reduce vulnerability, especially of the least developed countries, to an ensured continuous supply of food from the international markets.

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Annex A. Identifying structural breaks

All parameters in the VAR are potentially time dependent. However, using moderate-sized data sets, a more tractable approach is to allow and test for variation only in the deterministic components of the VAR. The type of structural change modelled within this study supposes that there may be up to K discrete shifts in some of the parameters. If the point of the structural break was known *a priori* then within a stationary framework (induced here by differencing the variables) inference concerning the structural breaks would be standard. However, if the breaks are unknown, then a search procedure must be adopted to choose the break points endogenously. Under such circumstances, the usual F -test or LR -test for the significance of these dummies where the breaks are chosen to give the best fit, are no longer applicable. This study uses an extension of tests developed in Bai and Perron (1998) and Bai (1999).

A full search for L structural breaks in sample size T , involves a number of regressions of the order of T^L . While more efficient algorithms can reduce the dimension of the search, efficient algorithms are not required in samples of less than one hundred, providing $L \leq 4$. For $T \leq 30$, or more, there are virtually no advantages in using efficient algorithms. Consequently a full search has been implemented here.

Bai (1999) outlines a maximum likelihood test for $l + 1$ breaks under the null of l breaks, where the deterministic components have up to Q polynomial trends. Here, a special case is analysed. In a regression of the form:

$$y_t = \sum_{q=1}^Q \mu_q(t^q) + \gamma' x_t + e_t \quad (\text{A.1})$$

where there are breaks in the values of μ_q . The critical values (c) for a given size α , are obtained by solving for c such that:

$$1 - \prod_{i=1}^{l+1} (1 - H_i(c)) = \alpha$$

$$r = Q + 1 \quad (\text{A.2})$$

$$H_i(c) = \frac{c^{\frac{r}{2}} \exp(-\frac{c}{2})}{2^{\frac{r}{2}-1} \Gamma(\frac{r}{2})} \left(\frac{1}{r} - \frac{1}{c} \right) [r^2] \ln \left(\frac{1 + \eta_i}{\eta_i} \right)$$

where the values of η_i are calculated using the estimated the proportions of sample between breaks λ_i $i=1, \dots, K$ and the minimum allowed proportional break $\varepsilon \eta_i = \varepsilon / \lambda_i$.

The equation (A.2) is a special case of equation (8) in Bai (1999).

In equation A.1 above, y and x could be replaced by logged prices and quantities:

$$\Delta \ln(p_t) = \sum_{q=1}^Q \mu_{p,q}(t^q) + \gamma_1' \Delta \ln(p_{t-1}) + \gamma_2' \Delta \ln(q_{t-1}) + e_{p,t}, \quad (\text{A.3})$$

which is the first equation of the VAR (e.g. equation 3 in the main text). Reversing the places of x and p gives the second equation. Therefore, this method is entirely appropriate for the estimation of the VAR as expounded in the text with time varying intercepts and time trends.

This study sets $Q=0$ (allow for time varying intercepts only). In order to select the correct number of breaks a sequential process was used. First 0 breaks against 1 break were tested. If 0 breaks were rejected then 1 break versus 2 was tested and so on. The maximum number of breaks used here was 4.

Breaks in volatility

The variance of the innovations within VARs might change through time. This would manifest itself in periods of high volatility for prices and quantities, and periods of comparative calm. Changes in the innovations variance may be conditional (known as ARCH or GARCH) or unconditional. While there are a range of tests for heteroscedasticity (conditional and unconditional), these tests will not generally identify break points, only whether the volatility tends to change in a systematic way. Consequently they are of limited use in analysing policy. This paper therefore extends the Bai and Perron tests by examining the absolute deviations of the innovations for structural changes in their means. This is equivalent to conducting a test for heteroscedasticity using a multiple break framework. An important caveat to these tests, however, is that the critical values applied to residuals derived from VARs may be misleading. The contention here would be that apparently significant breaks in volatility might be found, when in fact the evidence for this is weak. Nevertheless, this test is potentially useful and therefore employed in the analysis above.

Annex B. Decomposing variation in import bills

Expressing equation (6) in matrix notation:

$$\begin{pmatrix} \Delta \ln(p_t) \\ \Delta \ln(x_t) \end{pmatrix} = \begin{pmatrix} \mu_p(t) \\ \mu_x(t) \end{pmatrix} + \begin{pmatrix} \alpha_{11}(L) & \alpha_{12}(L) \\ \alpha_{21}(L) & \alpha_{22}(L) \end{pmatrix} \begin{pmatrix} \Delta \ln(p_{t-1}) \\ \Delta \ln(x_{t-1}) \end{pmatrix} + \begin{pmatrix} 1 & 0 \\ \rho & 1 \end{pmatrix} \begin{pmatrix} e_{p,t} \\ \hat{e}_{x,t} \end{pmatrix}. \quad (\text{B.1})$$

Variance decomposition requires restating the autoregressive representation above in terms of its “moving average” counterpart:

$$\begin{pmatrix} \Delta \ln(p_t) \\ \Delta \ln(x_t) \end{pmatrix} = \begin{pmatrix} \mu_p^*(t) \\ \mu_x^*(t) \end{pmatrix} + \sum \Theta_i \begin{pmatrix} e_{p,t-i} \\ \hat{e}_{x,t-i} \end{pmatrix}. \quad (\text{B.2})$$

The Θ_i parameters can be computed from the parameters in the VAR along with ρ .

Within this representation, prices and quantities have been decomposed into the sum of the “deterministic” terms $\begin{pmatrix} \mu_p^*(t) \\ \mu_x^*(t) \end{pmatrix}$ and “stochastic” terms $\sum \Theta_i \begin{pmatrix} e_{p,t-i} \\ \hat{e}_{x,t-i} \end{pmatrix}$. This representation is useful in that changes in prices and quantities can now be expressed as the weighted sum of past “shocks” to prices and quantities.

The contribution of the variances of prices and quantities to total import bills can then be calculated as:

$$\begin{aligned} \text{Var}(\Delta \ln(I_t)) &= \text{Var} \sum_{i=0}^{\infty} (1,1) \Theta_i \begin{pmatrix} e_{p,t-i} \\ \hat{e}_{x,t-i} \end{pmatrix} \\ &= (1,1) \left(\sum_{i=0}^{\infty} \Theta_i \Omega \Theta_i' \right) \begin{pmatrix} 1 \\ 1 \end{pmatrix} \text{ or alternatively} \\ \text{Var}(\Delta \ln(I_t)) &= \sum_{i=0}^{\infty} (\Theta_{11,i} + \Theta_{21,i})^2 \sigma_p^2 + \sum_{i=0}^{\infty} (\Theta_{12,i} + \Theta_{22,i})^2 \sigma_x^2. \end{aligned} \quad (\text{B.3})$$

The first term on the right-hand-side of the equation is the contribution of the variance of prices to that of the import bills and the second that of import quantities. Their relative importance can, respectively, be expressed as follows:

$$\begin{aligned} R(I/P) &= \frac{\sum_{i=0}^{\infty} (\Theta_{11,i} + \Theta_{21,i})^2 \sigma_p^2}{\text{Var}(\Delta \ln(I_t))} \quad \text{and/or} \\ R(I/X) &= \frac{\sum_{i=0}^{\infty} (\Theta_{12,i} + \Theta_{22,i})^2 \sigma_x^2}{\text{Var}(\Delta \ln(I_t))}. \end{aligned} \quad (\text{B.4})$$

For measuring the impact of price innovations on imported quantities, the total variation in $\Delta \ln(x_t)$ can be calculated as:

$$Var(\Delta \ln(x_t)) = Var\left(\sum_{i=0}^{\infty} (\Theta_{21,i} \Theta_{22,i}) \begin{pmatrix} e_{p,t-1} \\ \hat{e}_{x,t-1} \end{pmatrix}\right) \quad (\text{B.5})$$

or alternatively,

$$Var(\Delta \ln(x_t)) = \sum_{i=0}^{\infty} (\Theta_{21,i} \Theta_{22,i}) \Omega \begin{pmatrix} \Theta_{21,i} \\ \Theta_{22,i} \end{pmatrix},$$

(which is a standard decomposition formulae), with the proportion attributable to prices defined as follows:

$$R(X/P) = \frac{\sum_{i=0}^{\infty} (\Theta_{21,i}^2 \rho_p^2)}{Var(\Delta \ln(x_t))}. \quad (\text{B.6})$$

The quantities $R(I/P)$ and $R(X/P)$ can be estimated from the data and may therefore be used to summarise the importance of prices in determining the variation in the total food import bill and import volume respectively.²⁷

²⁷ The contributions of prices and quantities to the trend component can also be assessed in a similar manner. However, since the prices are being analysed in their nominal form and regime breaks in the trends will also be determined and incorporated into the analyses, no attempt has been made to estimate their contributions to the trend component of the food import bills.

FOOD EMERGENCIES, FOOD SECURITY AND ECONOMIC PROGRESS IN DEVELOPING COUNTRIES

Mwita Rukandema and A.A. Gürkan¹

The paper argues that frequent and often protracted disasters which lead to food emergencies in developing countries are a major threat to their economic and social progress and long-term food security. In Section 1 key concepts such as a disaster and a food emergency are defined, followed in Sections 2 and 3 by a review of the current food emergency situation and trends and causes over the past 20 years. This review indicates that Sub-Saharan Africa is the worst affected sub-region. In Section 4 potential impacts of various types of disasters on developing economies are discussed, along with some examples. Discriminant analysis is used to explore the inter-relationships between food security and a range of socio-economic variables. This analysis reveals that the more food insecure group of developing countries is characterised, inter alia, by low levels of socio-economic development and economic growth rates, high incidence of food emergencies and high food import bills relative to export earnings. Finally, levels of agricultural productivity across the developing regions are assessed and sub-Saharan Africa's debt burden is highlighted. Section 5 concludes and draws policy implications of the paper's various findings. Major policy implications are that developing countries, with the assistance of the international community, should implement measures to reduce vulnerability to disasters and to mitigate their impacts and enhance their economic performance. For the poorest and heavily indebted countries, creditors need to drastically reduce or write-off the debts in order to make more resources available for investment.

1. Introduction

FAO's Global Information and Early Warning System (GIEWS) classifies a country as facing a food emergency when a disaster-induced shortfall in its aggregate food supply relative to its consumption requirements in a given year cannot be fully covered by the country's own resources and, therefore, it needs external food assistance. In the absence of such assistance, the population or a significant proportion of it would be seriously undernourished or, in extreme cases, face famine.

The shortfall may be caused by a natural or man-made disaster, or a combination of both. A disaster is defined as a serious disruption of the functioning of a community or a society causing widespread human, material, economic, or environmental losses which exceed the ability of the affected population to cope on its own (UNISDR, 2002). Natural disasters are caused by events (or natural hazards) such as earthquakes, volcanic activity, drought, floods, landslides, tropical cyclones, pest and disease infestations, etc. On the other hand, man-made disasters are caused mainly by wars and financial/economic crises. However, what may appear to be a natural disaster may actually be the indirect result of human activities which harm the environment. For example, river flooding may be due to heavy soil sedimentation arising from serious soil erosion in the river's catchment area, which in turn is due to deforestation and land degradation. Human activities that harm the environment result in increased vulnerability of local communities to disasters. Furthermore, sometimes a natural disaster may strike a country already suffering from a man-made disaster. For example, over the past few years, Afghanistan has suffered simultaneously from serious droughts and civil war.

It is now widely acknowledged that natural disasters, particularly droughts and floods, are increasing both in frequency and severity. There is also evidence to show that man-made disasters, particularly armed conflicts, have increased steadily over the past two decades. Developing countries, mostly the poorest, bear the brunt of the world's disasters and suffer disproportionately from them because they lack the means both to prepare for them and to repair or rebuild shattered infrastructure afterwards.

¹ Mwita Rukandema is Senior Economist, Early Warning Group, Global Information and Early Warning Service and A.A. Gürkan, Chief, Basic Foodstuffs Service, Commodities and Trade Division, FAO.

Governments must divert scarce resources from much needed development programmes to reconstruction activities and to meet escalating food import bills, thereby compromising economic and social development and long-term food security. Coupled with the high costs of servicing external debts, the added cost of disasters is crippling for poor countries.

2. Current food emergency situation

Table 1 indicates that as of July 2003, some 36 countries around the world were affected by food emergencies, including 23 in Africa (64 percent), 7 in Asia (19.4 percent), 4 in Latin America (11.1 percent) and 2 in Europe (5.5 percent). In Africa, the dominant cause is civil war which affects 14 of the 23 countries or 61 percent, followed by drought (11 countries or 48 percent). In Asia, the main cause is drought, especially in Central Asia where the impact of the 2000 severe drought is still being felt and food assistance continues to be required. In Central America, the collapse of international coffee prices has left thousands of families without an income, as workers on coffee plantations have been laid off *en masse*. In Europe, many internally displaced families and refugees in Chechnya (Russian Federation) and in Serbia and Montenegro need food assistance to survive, following recent or ongoing civil wars. It should be noted that although a country may have recently emerged from a disaster (e.g. Afghanistan, Sierra Leone, Angola), a food emergency may persist for several years. Furthermore, several countries are affected by two or more disasters simultaneously (e.g. Somalia, Sudan, Zimbabwe, Afghanistan, Iraq), which makes the emergency quite complex.

Table 1. Countries facing food emergencies as of July 2003 (total: 36 countries)

Region/Country	Reason for Emergency	Region/Country	Reason for Emergency
AFRICA (23 countries)		ASIA (7 countries)	
Angola	Civil war	Afghanistan	Drought and war
Burundi	Civil war	Georgia	Recent drought
Cape Verde	Drought	Iraq	War, recent drought
Central African Republic	Civil war	Democratic People's	Economic constraints,
Democratic Republic of		Republic of Korea	recent floods
the Congo	Civil war	Mongolia	Drought, harsh winters
Côte d'Ivoire	Civil war	Tajikistan	Recent drought
Eritrea	Drought, recent war	Timor-Leste	Drought
Ethiopia	Drought, recent war	LATIN AMERICA (4 countries)	
Guinea	Refugees from	El Salvador	Coffee price crisis
	neighbouring countries	Guatemala	Coffee price crisis
Kenya	Drought	Honduras	Coffee price crisis
Lesotho	Drought, severe frost	Nicaragua	Coffee price crisis
Liberia	Civil war	EUROPE (2 countries)	
Madagascar	Drought, economic	Russian Federation	Civil war
	disruption	(Chechnya)	
Mauritania	Drought	Serbia & Montenegro	Recent war
Mozambique	Drought, recent floods		
Sierra Leone	Civil war		
Somalia	Civil war, drought		
Sudan	Civil war, drought		
Swaziland	Drought		
Tanzania	Drought, refugees		
Uganda	Civil war, drought		
Zimbabwe	Drought, economic		
	disruption		

FAO's latest (July 2003) estimates indicate that the number of people affected by food emergencies worldwide in need of food assistance stands at around 70 million, compared to an average of 64 million over the past three years.

3. Recent trends in food emergencies

Food emergencies all over the world have increased steadily since the mid 1980s (Figure 1). The figure, based on the FAO/GIEWS database, also shows that for some years (e.g. 1993, 1995, 1998 and thereafter), certain countries suffered more than one disaster in a single year.

Figure 1. Trends in food emergencies globally

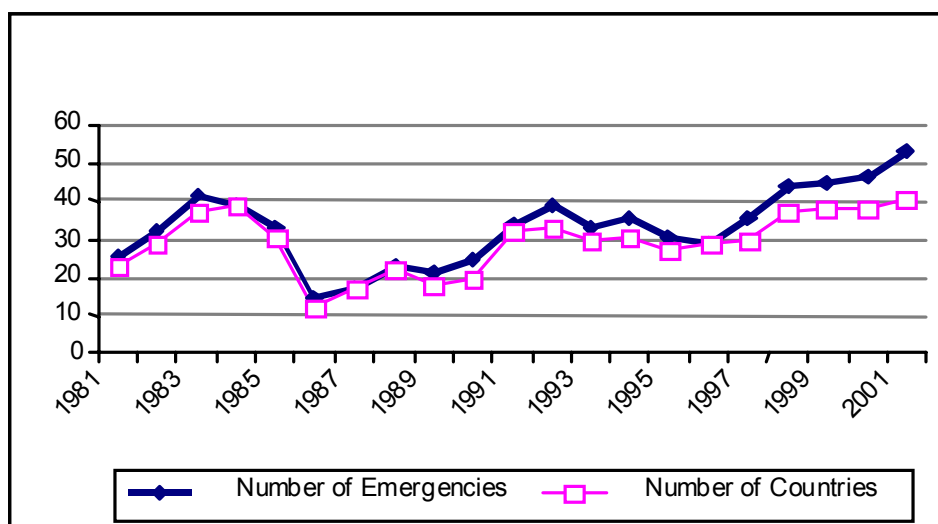
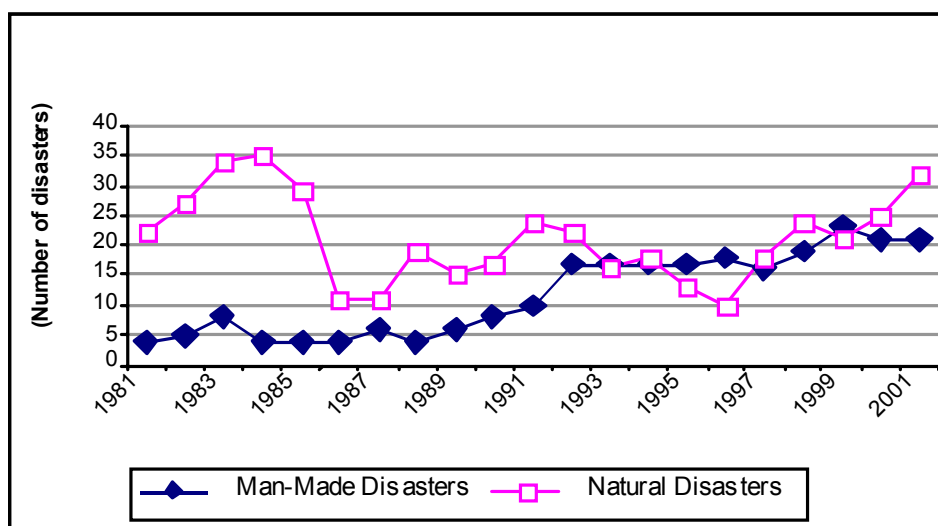


Figure 2 shows that man-made disasters have been on the increase since around 1990.

Figure 2. Trends in causes of food emergencies

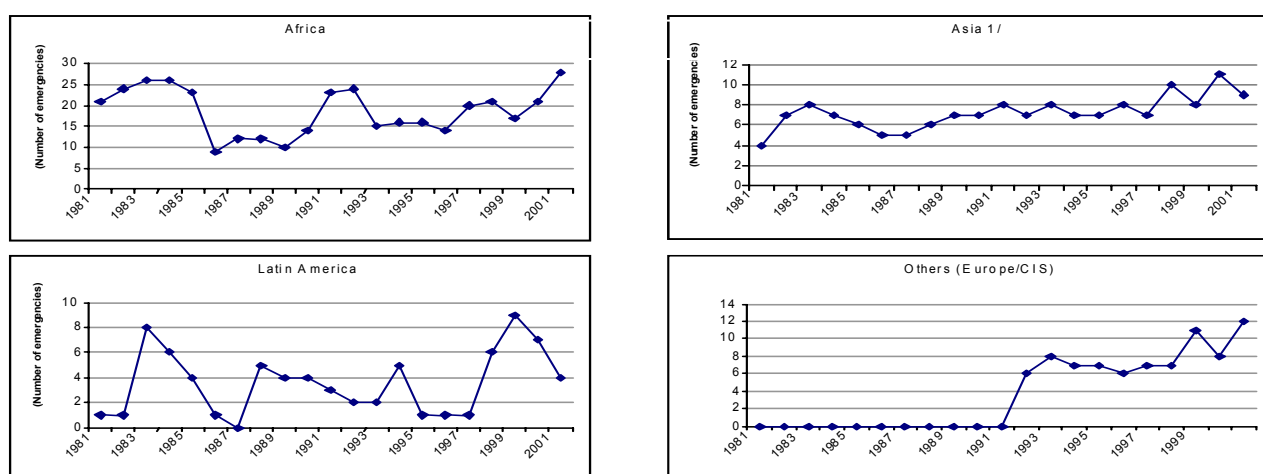


On the other hand, from a peak in 1984, natural disasters fluctuated considerably until around 1997 when they began to escalate. The main causes have been extreme hydro-meteorological events (mainly droughts, floods and cyclones/hurricanes).

Figure 3 shows trends in food emergencies by region. Sub-Saharan Africa has experienced the largest number over the past two decades, ranging from nine to 28. The number of people affected is currently

estimated at 40 million, compared to an average of 27 million over the previous three years. The main causes have been civil wars and droughts, followed by floods. An upward trend is evident since 1996, notwithstanding a small decline in 1999. In Asia, although the absolute numbers of emergencies are relatively small, the number of people affected is quite large, currently estimated at 32 million, more or less the same as the average of the past three years. The graph shows an upward but weak trend. The main causes have been floods and droughts, with the financial crisis of 1997/98, exceptionally harsh winters in Mongolia and over a decade of civil war in Afghanistan all playing a significant role. In Latin America, the pattern is less clear, but until 2002 emergencies were caused almost entirely by natural disasters, mainly hurricanes, floods and droughts. The peak in 1999 reflects “Hurricane Mitch”, which devastated several countries in Central America in October 1998. In Europe, the trend mainly reflects civil wars among Commonwealth of Independent States (CIS) countries following the break-up of the former Soviet Union, as well as the widespread drought in 1999/2000.

Figure 3. Trends in food emergencies by region



¹ Includes emergencies in the Near East

4. Impact of disasters on long-term food security and economic progress of developing countries

4.1 Natural disasters

There are two main types of natural disasters, those which develop relatively slowly such as droughts, and those with rapid onset such as floods, earthquakes, cyclones/hurricanes and landslides. The first type lends itself to sufficient early warning and preparedness, thus reducing the potential consequences, especially loss of human lives. On the other hand, sufficient early warning may be almost impossible for the second type and usually there are casualties in its wake. However, with recent advances in information technology including the use of satellites and computer-aided modelling, there is now more scope for early warning, even if still limited. For example, forecasting the timing and location of tropical cyclones has doubled warning time to 48 hours since 1990 (UNISDR 2002). From the perspective of food security and economic progress in developing countries, the following two paragraphs focus on disasters caused by three hydro-meteorological hazards, namely floods, cyclones/hurricanes and droughts, hazards that are becoming increasingly frequent and severe, with escalating economic, social and material costs.

Although the immediate physical impact of **floods** and **cyclones/hurricanes** may be confined to a relatively small part of a country such as a region or province, a large number of people may be killed, hundreds of thousands or even millions made homeless, and extensive damage or destruction inflicted on economic and social infrastructure and productive assets (roads, bridges, railways, schools, hospitals, public buildings, power lines, livestock, crops, factories, homes, etc). UNISDR (2002) concludes that in addition to the projected estimate of 100 000 lives lost annually due to natural disasters, the global cost is anticipated to exceed US\$300 billion annually by the year 2050, if the likely impact of climate change is not effectively countered. The lack of capacity to limit the impact of disasters remains a major weakness of developing countries, especially the poorest which also face higher levels of disaster risk because of adverse interactions between poverty-induced human activities and the environment.

The impact of **drought** tends to be more widespread, covering an entire country or even a whole region as exemplified by southern Africa recently and Central Asia in 2000. However, apart from losses in crop and livestock production and sometimes sharp reductions in hydro-electricity supply, the impact on infrastructure and other physical assets is minimal. Also, loss of human life is not great thanks to the slow onset of drought-induced disasters which allows sufficient time for early warning, usually followed by reasonably adequate and timely international response. Nevertheless, governments in developing countries are compelled to spend more of their scarce foreign exchange resources to finance increased food import bills. Furthermore, since agriculture is the backbone of manufacturing industries and the main employer in developing countries, economy-wide impacts of droughts seriously slow down or even reverse economic growth. The wide fluctuation of rainfed crop production in sub-Saharan African countries is one of the major causes of instability in overall economic growth rates. Thus the increasing frequency of droughts is a major threat to economic and social development and long-term food security in developing countries. At the household level, a succession of droughts deepens poverty and increases food insecurity and malnutrition, which in turn lead to human activities that damage natural ecosystems, thereby increasing the risk of further disasters.

4.2 Man-made disasters

Two major causes of man-made disasters in the world today are economic crises and civil wars. Recent examples of **economic crises** include the financial collapse in Indonesia in 1997/98 and in Argentina in 2002, and the current economic crisis in Central America following a ruinous crash of international coffee prices. In Indonesia, the sudden collapse of the rupiah sent shock waves throughout the economy, resulting in a sharp rise in unemployment to over 20 million and sending close to 100 million people below the poverty line within one year (FAO 1998). This episode coincided with an El Niño-induced drought that sharply cut paddy production and raised rice import requirements in 1998/99 by nearly 50 percent, at a time when foreign exchange was extremely scarce. In Central America, thousands of families are currently depending on international food assistance following abandonment of coffee plantations, a major source of livelihood in the sub-region.

Civil wars in many developing countries today, particularly in sub-Saharan Africa, are another major threat to long-term food security and economic progress for these countries. Section 2 indicates that food emergencies are concentrated in sub-Saharan Africa and that for the majority of the affected countries (61 percent) the dominant cause is civil wars. The human and economic cost of civil wars is always enormous. In the Democratic Republic of Congo, for example, an estimated 3 million people have died since the outbreak of civil war in 1998. The dead have been mostly civilians killed by the warring factions and by diseases affecting the internally displaced who are forced to live in subhuman conditions. Others have died of starvation. Angola, Afghanistan, Sierra Leone and Sudan have been in similar situations. In general, high military expenditures on civil wars and the incalculable direct and indirect costs to economies can reverse a country's economic progress by decades.

In order to explore in more detail the relationships between food emergencies and long-term food security and economic and social progress in developing countries, discriminant analysis is employed to determine whether there are characteristics that are consistently different in those developing countries

that are considered to be relatively more food insecure compared to those that are not. FAO's estimates of the proportion of undernourished in total population are used to divide the developing countries into two categories: those where the proportion is above 15 percent being considered as more food insecure than those below (FAO 2003a, forthcoming). The cut-off of 15 percent as a criterion for determining the membership into one or the other group is quite arbitrary. If "reasonable" consistencies in the differences in the characteristics of the two groups of countries are revealed by the statistical analysis, then the criterion would have proven its operational usefulness.

Studies undertaken elsewhere (World Bank 2002), suggest that conflict-related food emergencies are associated closely with economic performance, as well as with social and political factors, all of which in turn tend to be intimately linked to food security at both the national and household levels. In this study, a selection of such indicators for 92 developing countries for which estimates are available is used to explore the nature of these relationships. These are:

- the Human Development Index (2001), a composite variable representing many dimensions of the development process (see UNDP 2003);
- GDP per capita (US\$ - 1995) and growth rates of GDP per capita (during the 1990s), representing economic performance;
- various measures of food imports (averages for the 1990s), representing the ability of countries to access international food markets; and,
- total number of food emergencies experienced in each country (during the 1990s).

The estimates of the proportion of undernourished are the most recent available, using data for the period centred at 2000. Apart from the Human Development Index, which also uses the most recent data, all other variables are calculated using data pertaining to the decade of the 1990s. This has been done so that it may be possible to interpret some of the associations discovered in the analysis to imply causality in an empirical sense, since the indicators represent certain processes that occur chronologically prior to the state variables which are observed at the end of the period.

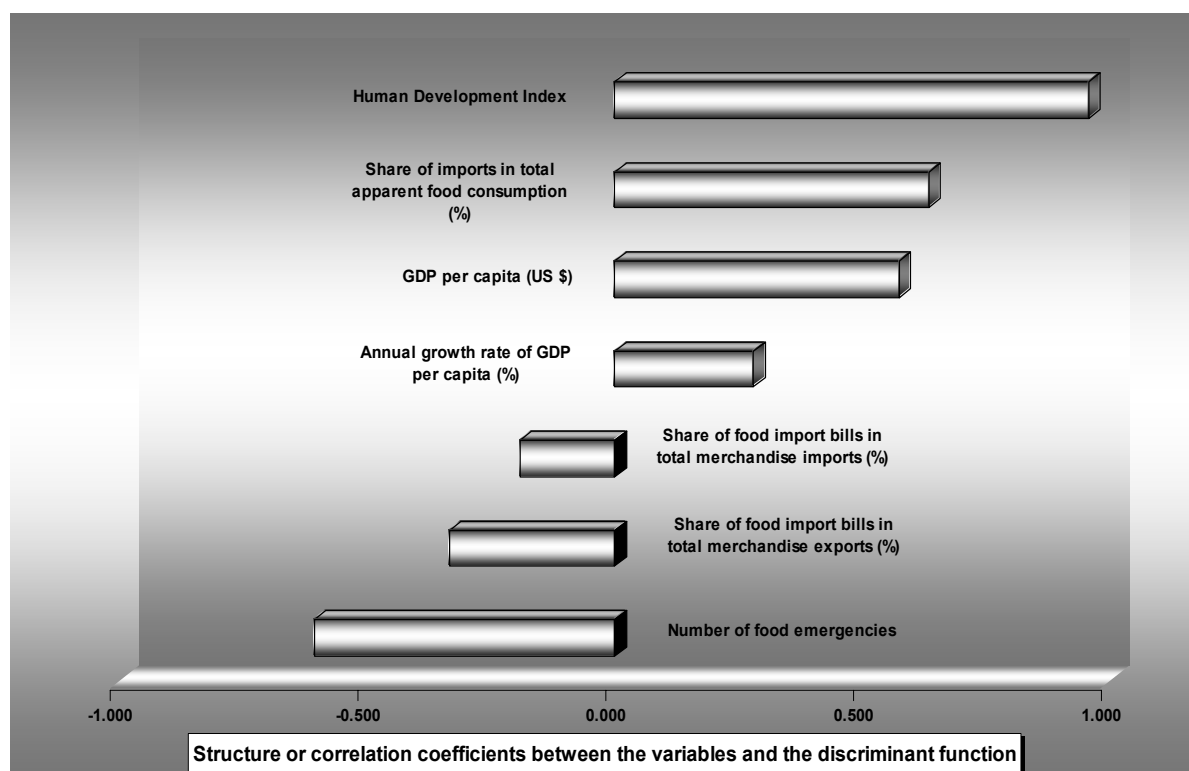
Discriminant analysis is a multivariate statistical technique that creates successive independent linear combinations of the variables in such a way that the means of the linear combinations (or discriminant functions) for each of the groups are as different as possible, after controlling for the effects of the preceding functions. With only two groups, as in our case, only a single discriminant function can be extracted; with, in this case, the coefficients of the function being estimated so that the mean values of the function in each of the two groups are farthest from each other. If, moreover, it is discovered that the variances of the function in each of the two groups are much smaller than the total variance of the function, then it becomes possible to assign a high level of (statistical) confidence to claims that the characteristics of the countries in the two groups, as measured by the underlying variables, are sufficiently different from one another.

These statistical tests indicate, with a level of confidence greater than 99.999 percent², that the differences between these two groups of countries are large. One way of understanding the nature of the differences is to look at the patterns of the structure coefficients or the correlations between the variables and the discriminant function itself, which Chart 1 visually displays. The variables have been ordered to reflect the nature of the relationship between them and the discriminant function. Positive structure or correlation coefficients indicate that larger values of the variables tend to be associated with larger discriminant scores, and vice versa and negative correlations indicate that smaller values of the variables are associated with larger discriminant scores, and vice versa. The signs of the coefficients, therefore, help group similar variables together, while the magnitudes determine the strength of the relationships between them. The largest positive coefficient is that of the Human Development Index (with a value of 0.96) and the largest negative coefficient belongs to the total number of food emergencies declared throughout the 1990s. Through the structure of the relationship of each variable

² The calculated value of Wilk's lambda is 0.413, with an associated Fisher's F-value of 17.084, indicating that a probability of finding a value as extreme as this is less than 0.0001, under the null hypothesis that of equality of mean vectors of the two groups. In other words, the difference between the group centroids is significant.

with the discriminant function, it is also possible to deduce the nature of the variables to one another along this discriminating dimension. This means, for example, that those countries that have a lower Human Development Index tend also to be ones that experience greater food emergencies, and vice versa.

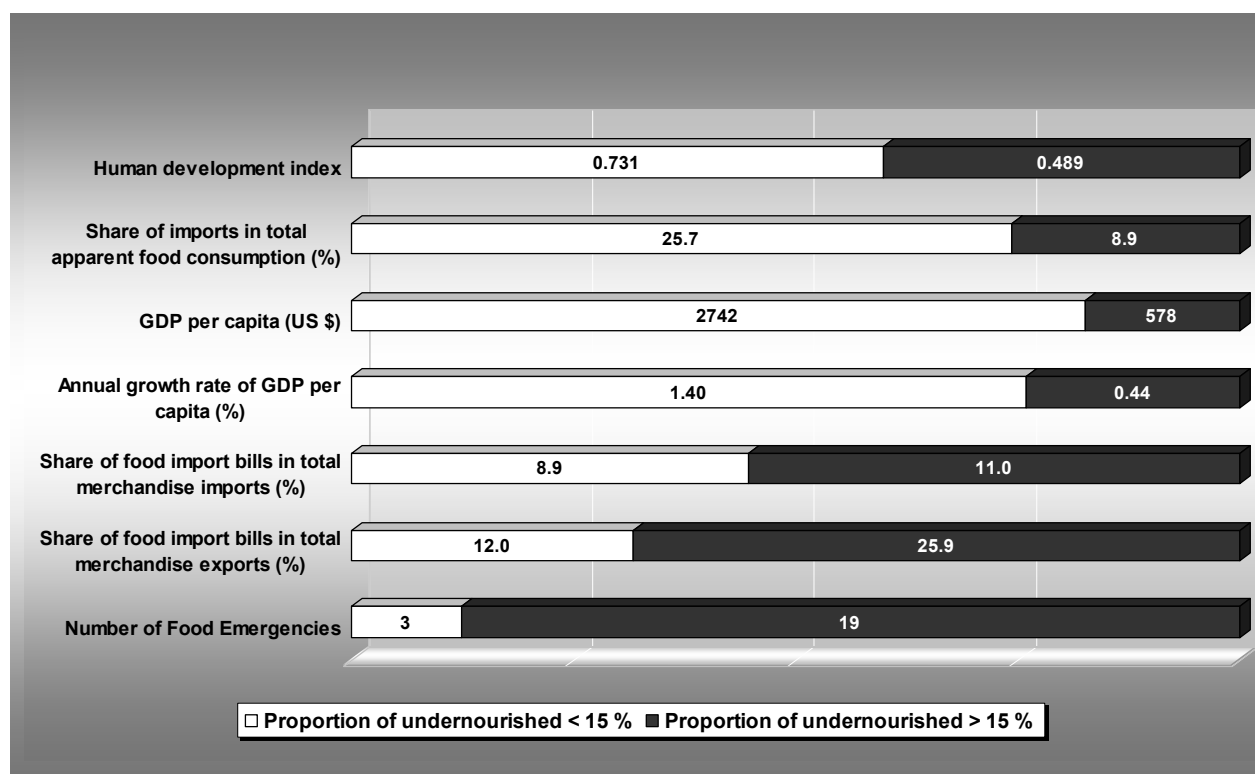
Chart 1. Structure of the discriminant function in terms of the underlying variables used to characterize the countries



A fuller and more meaningful discussion of the findings could be facilitated if we conducted the analysis using the vector of means of the seven variables as they apply to the two groups of countries categorized on the basis of the proportion of their population that is deemed to be undernourished. Chart 2 displays the group means of the variables in the same order as in Chart 1. It is obvious that those variables that have positive correlations with the discriminant function also exhibit larger means for the group of countries that are relatively more food secure (i.e. with lower a proportion of their population undernourished), and those that have negative correlations exhibit smaller means for the same group of countries. The substantive nature of the consistency in the differences is obvious:

- Countries in the food insecure and more vulnerable group have lower levels of economic and social development, smaller initial GDPs, have developed more slowly and depend less on international trade to provide for their food needs - the opposite applies for the more food secure group of countries;
- Countries in the food insecure group face a greater number of food emergencies and have a larger share of food import bills in total merchandise imports than the more food secure ones;
- Countries in the more food secure group have a larger share of imports in total apparent food consumption as they have access to larger resources for imports as evidenced by a smaller share of food imports in total merchandise exports.

Chart 2. Averages of the seven variables for the two groups of developing countries



Thus the general thrust of these findings is that the state of household food security at the national level (as measured by the proportion of population that is undernourished) at any moment appears to be crucially dependent on level of economic development and performance, on ability to access food imports to supplement what can be produced domestically and the degree to which falling into food emergencies can be avoided. Perhaps a new and significant insight that deserves reiteration is a reminder that self-sufficiency in food is not necessarily a good indicator of food security. The evidence provided here indicates that food self-sufficiency may indeed be the result of factors such as limited import capacity that constrain the ability of developing countries to obtain some of their food through international trade.

4.3 Other food security consequences of natural and man-made disasters

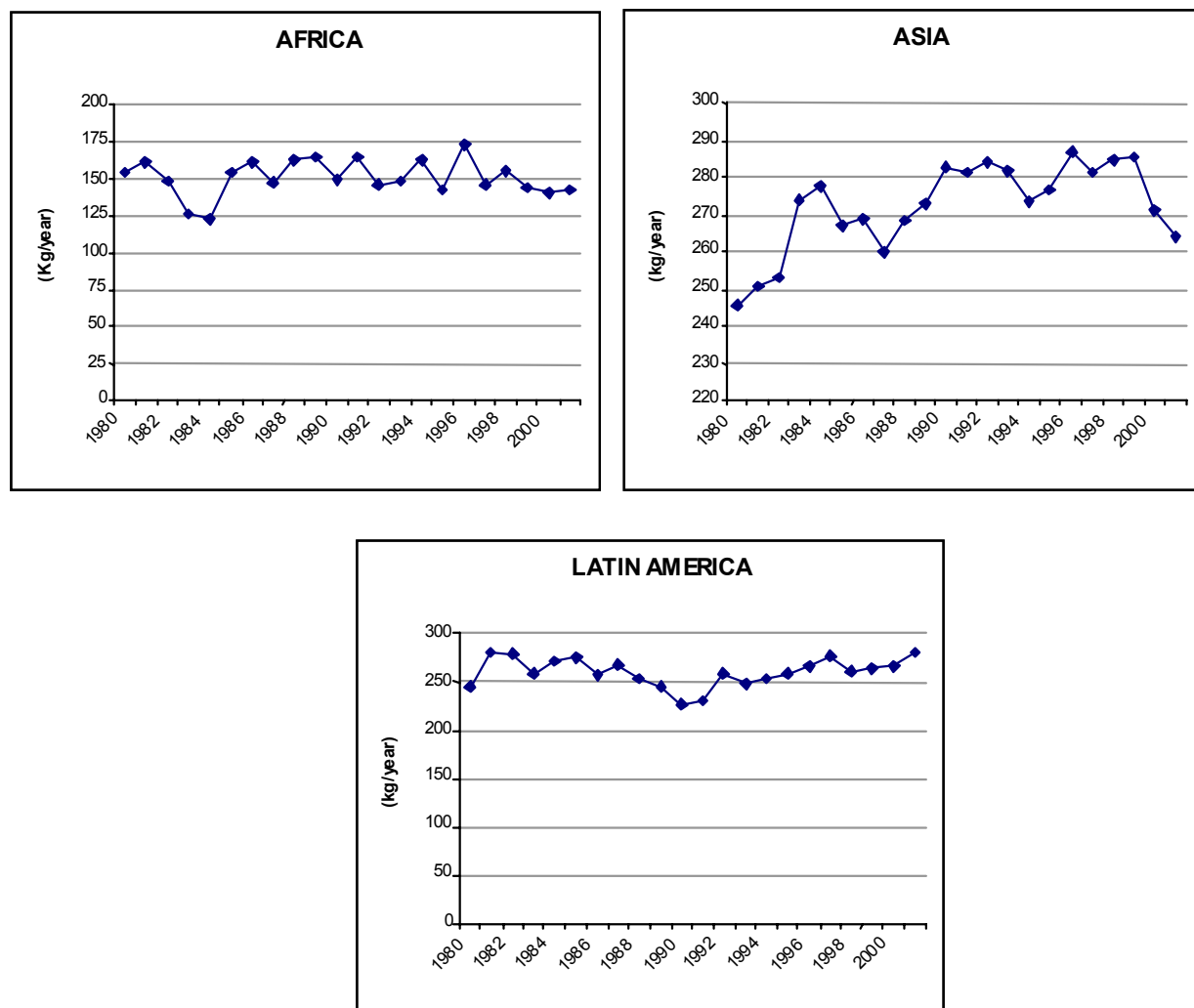
Repeated or protracted emergencies also lead to cumulative effects that deepen poverty and undermine development capacities. A diversion of resources from productive investment results, *inter alia*, in a stagnant agricultural sector, rising unemployment and increasing national indebtedness. The issues of low agricultural productivity and indebtedness are briefly highlighted below.

Low agricultural productivity

Figure 4 shows per capita cereal production in Africa, Asia and Latin America between 1980 and 2002. In Africa, per capita production has not only been very low (125-175 kg/year), but has also stagnated at around 150 kg/year. This mainly reflects limited use of productivity-increasing agricultural technologies (improved seeds, fertilizers, irrigation, tractors, etc.) but also the impact of frequent and often protracted disasters on the continent. In Asia, per capita production is relatively higher (245-288 kg/year) and shows an upward trend until 2000. Widespread use of improved agricultural technologies and intensification of production are the main determining factors. With relatively high levels of agricultural production and export earnings, Asian countries are generally better able to cope with or

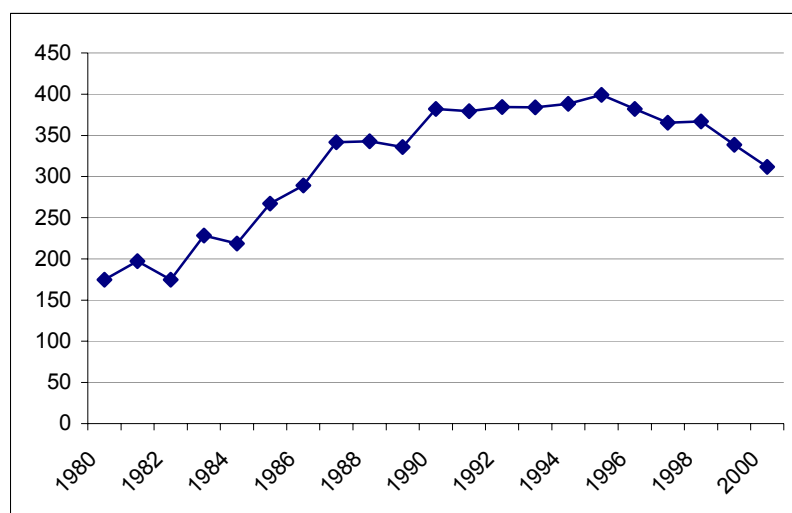
avoid food emergencies. In Latin America, per capita production is also relatively high (230-280 kg/year) and has trended upwards since 1993. Like Asia, Latin America generally has a capacity to cope with food emergencies, except for the poorer countries of Central America such as Guatemala, Nicaragua, Honduras and El Salvador which have suffered a succession of natural hazards (El Niño, Hurricane Mitch, Hurricane George, earthquakes) and are now gripped by the coffee crisis.

Figure 4. Trends in per capita cereal production, 1980-2002 by region



External debt burden

Balance-of-payments difficulties are particularly acute for sub-Saharan African countries, largely due to high external debts relative to their ability to repay. Figure 5 shows per capita external debt of sub-Saharan Africa from 1980 to 2000. The debt rose from US\$175 per person in 1980 to a peak of US\$400 in 1995, and stood at around US\$300 in 2000. The decline since 1996 probably reflects debt relief under the Highly Indebted Poor Countries (HIPC) initiative. Nevertheless, the debt burden is unsustainably high for countries whose per capita income averages less than US\$450 per annum, with the poorest at around US\$100 (Ethiopia, Burundi), and about 50 percent of their total population living below the poverty line (World Bank 2002, AfDB 2003). While a number of factors, including unfavourable terms of trade and high international interest rates, played a major role in raising the level of indebtedness, it is highly probable that repeated or protracted disasters contributed a significant part. Servicing these debts is a serious constraint to long-term food security and economic and social development of the sub-region.

Figure 5. Sub-Saharan Africa per capita external debt (US\$)

Source: World Bank, FAO.

5. Conclusion and policy implications

This paper argues that the increasing frequency and intensity of disasters is a major threat to long-term food security and economic progress of developing countries, particularly of the poorest which lack the capacity to cope with their impact. Scarce resources are diverted from development programmes to rehabilitation and reconstruction activities, military budgets and escalating food import bills. The worst affected sub-region is sub-Saharan Africa, which currently accounts for 64 percent of the total number of countries suffering from food emergencies globally. As regards natural disasters, developing countries need to be assisted to establish or run effective early warning systems that make use of advances in information technology, plus the necessary technical training. These countries themselves need to promote water management practices such as flood control, small-scale irrigation, water harvesting, watershed management and land-use planning to reduce vulnerability to droughts and floods and to mitigate their impacts. Civil wars are particularly concentrated in sub-Saharan Africa, which currently accounts for 82 percent of the global total. Enhanced economic performance is indicated in this paper to be a crucial requirement for prevention or mitigation of conflict-induced food emergencies. Therefore, poor countries need to be effectively assisted to achieve sustained economic growth, diversify their economies and achieve higher agricultural productivity. International assistance needs to target the poorest (and conflict-prone) countries. Moreover, it is essential that developed countries open up their markets to allow expansion and diversification of exports from developing countries. Furthermore, the crushing debts of the poorest countries need to be drastically reduced or cancelled to make more resources available for domestic investment.

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MARKET INTEGRATION AND PRICE TRANSMISSION IN SELECTED FOOD AND CASH CROP MARKETS OF DEVELOPING COUNTRIES: REVIEW AND APPLICATIONS

George Rapsomanikis, David Hallam and Piero Conforti¹

The article discusses time series applications to market integration. A number of important issues related to the definition of market integration and price transmission, the usefulness and limitations of time series econometrics and the interpretation of the estimated parameters are examined. The extent of price transmission is defined in terms of notional components such as completeness, dynamics and asymmetry of adjustment and a testing framework is applied with each component being tested individually. It is argued that, collectively, these tests can be utilized to assess market integration and the extent to which policies and other distortions affect price transmission. The testing framework is applied to selected food and cash crop markets of developing countries.

1. Introduction

A fundamental issue when analysing trade policy reform in global agricultural markets is the extent to which domestic agricultural commodity markets in developing countries respond to changes in international prices. Price transmission from the world to domestic markets is central in understanding the extent of the integration of economic agents into the market process.

Studies on the transmission of price signals are founded on concepts related to competitive pricing behaviour.² In spatial terms, the classical paradigm of the Law of One Price, as well as the predictions on market integration provided by the standard spatial price determination models (Enke, 1951; Samuelson, 1952; Takayama and Judge, 1972) postulate that price transmission is complete with equilibrium prices of a commodity sold on competitive foreign and domestic markets differing only by transfer costs, when converted to a common currency. These models predict that changes in supply and demand conditions in one market will affect trade and therefore prices in other markets as equilibrium is restored through spatial arbitrage.

The absence of market integration, or of complete pass-through of price changes from one market to another has important implications for economic welfare.³ Incomplete price transmission arising either due to trade and other policies, or due to transaction costs such as poor transport and communication infrastructure, results in a reduction in the price information available to economic agents and consequently may lead to decisions that contribute to inefficient outcomes. Agricultural and food trade policy reform, especially, is a priority issue in the next WTO negotiations, as trade liberalization is viewed as encouraging allocative efficiency and long run growth.

Price transmission studies are ostensibly an empirical exercise testing the predictions of economic theory and providing important insights as to how changes in one market are transmitted to another, thus reflecting the extent of market integration, as well as the extent to which markets function

¹ David Hallam is Chief, and George Rapsomanikis and Piero Conforti are Commodity Specialists, Raw Materials, Tropical and Horticultural Products Service, Commodities and Trade Division, FAO. The authors would like to thank Nanae Yabuki, Adam Prakash and Abdolreza Abbassian, Commodity Specialists, Commodities and Trade Division, FAO, Denis Sedieu, Senior Economist, ICO, and Kevin Balcombe, Imperial College, University of London for their helpful comments.

² Fackler and Goodwin (2001) provide a comprehensive review of market integration concepts and of the corresponding economic models of price determination.

³ Barrett (2001) and Barrett and Li (2002) distinguish between market integration and the efficiency purported by the Enke-Samuelson-Takayama-Judge model. They point out that tradability and nonzero trade flows is a sufficient condition establish market integration, whilst efficiency is established when prices in two different markets differ by transfer costs. In this paper, we follow the traditional definition of market integration that adheres to the satisfaction of the Law of One Price and to the equilibrium conditions of the Enke-Samuelson-Takayama-Judge model. In brief, we postulate that tradability on its own is not sufficient to ensure the "integration" of economic agents in the market process.

efficiently. In addition to the body of research and application that tests economic theory, price transmission mechanisms feature prominently in all global agricultural partial equilibrium models, such as the World Food Model of the UN Food and Agriculture Organization and other models such as the that developed by Tyers and Anderson (1992). In these models the price transmission parameter values consist of key building blocks and play an important role in determining the direction, magnitude and distribution of welfare effects of trade policy scenarios (for a review of price transmission mechanisms in partial equilibrium models see Sharma, 2002). Given the increasing use of these models to address sensitive policy issues, such as trade liberalization and the distribution of benefits and costs across countries and population groups, there is an urgency to review these mechanisms and fine-tune them for further applications.

The objective of this paper is to contribute to the body of research and applications on price transmission focusing on both food and cash crop markets in developing countries and to highlight a number of important issues related to the definition of price transmission, the various econometric methods utilized to examine its extent and the interpretation of the results within a policy perspective. Section 2 provides a brief review of the literature and highlights the main findings on the factors that impede complete price transmission and market integration. Section 3 discusses a definition of market integration and price transmission and examines the underlying issues. Section 4 draws a testing framework for the empirical work. Section 5 presents the case studies and section 6 concludes the paper.

2. Literature review and main findings

Several authors have studied price transmission within the context of the Law of One Price (*inter alia* Ardeni, 1989; Baffes, 1991) or within the context of market integration (Ravallion, 1986; Sexton *et al*, 1991; Palaskas and Harriss 1993; Zanias, 1993; Gardner and Brooks, 1994; Blauch 1997). The concept and the analytical techniques have also been used to evaluate policy reform, such as *ex post* assessment of market integration in the context of the implementation of the structural adjustment programmes (Goletti and Babu, 1994; Alexander and Wyeth, 1994; Dercon, 1995). Another vein of research focuses on vertical price transmission along the supply chain from the consumer to the producer level (see for example Brorsen *et al*, 1985; Wohlgenant, 1985; Kinnucan and Forker, 1987; Shroeter and Azzam, 1991; Goodwin and Holt, 1999; Prakash 1998; von Cramon-Taubadel, 1999).

The large body of research on market integration and price transmission, both spatially and vertically, has applied different quantitative techniques and has highlighted several factors that impede the pass-through of price signals. Distortions introduced by governments in the form of policies either at the border, or as price support mechanisms weaken the link between the international and domestic markets. Agricultural policy instruments such as import tariffs, tariff rate quotas, and export subsidies or taxes, intervention mechanisms, as well as exchange rate policies insulate the domestic markets and hinder the full transmission of international price signals by affecting the excess demand or supply schedules of domestic commodity markets (Gardner, 1975; Mundlak and Larson, 1992; Quiroz and Soto, 1996; Baffes and Ajwad, 2001; Abdulai, 2000; Sharma, 2002).

In theory, spatial price determination models suggest that, if two markets are linked by trade in a free market regime, excess demand or supply shocks in one market will have an equal impact on price in both markets. The implementation of import tariffs, in general, will allow international price changes to be fully transmitted to domestic markets in relative terms. Thus a proportional increase in the international price will result in an equal proportional increase in the domestic price, at all points in time provided that tariff levels remain unchanged. However, if the tariff level is prohibitively high, changes in the international price would be only partly, if at all, transmitted to the domestic market, as domestic prices may be close to the autarky price level, thus obliterating opportunities for spatial arbitrage and resulting in the two prices moving independently of each other, as if an import ban was implemented. Other policy instruments such as tariff rate quotas may result in international price changes not being at all points of time proportionately transmitted to domestic prices, as changes in the domestic price level will depend on two different tariff rates that are applied according to whether the

volume of imports falls within or outside the quota level. In the event that imports are equal to the quota level, changes in the international price may not affect the domestic price level at all, provided that these changes are relatively small, as compared to the difference between the within-the-quota and the out-of-the-quota tariff levels. The implementation of price support policies, such as intervention mechanisms and floor prices, may result in the international and the domestic price being completely unrelated or being related in a non linear manner, depending on the level of the intervention or floor price relative to the international price. Changes in the international price will have no effect on the domestic price level when the international price lies on a level lower than that to which the floor price has been set. However, any changes in the international price above the floor price level will be transmitted to the domestic market. Thus floor price policies may result in the domestic price being completely unrelated to the international market below a certain threshold determined by the floor price, or in the two prices being related in a non linear manner with increases in the international price being fully transmitted to the domestic level, whilst decreases are slowly and incompletely passed-through.

Apart from policies, domestic markets can also be partly insulated by large marketing margins that arise due to high transfer costs. Especially in developing countries, poor infrastructure, transport and communication services give rise to large marketing margins due to high costs of delivering the locally produced commodity to the border for export or the imported commodity to the domestic market for consumption. High transfer costs and marketing margins hinder the transmission of price signals, as they may prohibit arbitrage (Sexton, Kling and Carman, 1991; Badiane and Shively, 1998). As a consequence, changes in world market prices are not fully transmitted to domestic prices, resulting in economic agents adjusting (if at all) partly to shifts in world supply and demand.

Non-competitive behaviour such as that considered in pricing-to-market models (Dornbush, 1987; Froot and Klempeter, 1989; Krugman, 1986) can hinder market integration. Pricing-to-market models postulate that firms may absorb part of exchange rate movements by altering export prices measured in home currency in order to retain their market share. Alternatively, oligopolistic behaviour and collusion among domestic traders may retain price differences between international and domestic prices in levels higher than those determined by transfer costs.

Most of the studies utilize time series econometric analysis techniques that test for the co-movement of prices. The development of these techniques, which include cointegration and error correction models, has become the standard tool for analysing spatial market relationships, replacing earlier empirical tools, such as the bivariate correlation coefficient and regressions. Nevertheless, time series analysis has also been criticized as unreliable (Blauch, 1997; Barrett and Li, 2002) with recent research focussing on switching regime models that incorporate data on prices, volumes traded and transactions costs. The debate on the application methodology for testing for market integration and price transmission has a relatively long history starting with Harriss (1979). Blauch (1997) provides a review of the debate and examines the statistical performance of econometric tests for market integration. In essence, linear tests for market integration and price transmission are thought of as crude and inappropriate (Blauch, 1997; McNew, 1996; McNew and Fackler, 1997; Fackler and Goodwin, 2002 and Barrett and Li, 2002). Non linearities in market relationships that arise from arbitrage conditions, unsynchronized price cycles, discontinuous trade and non stationary transfer costs are thought of as rendering linear representations and models not useful and inaccurate.

In this paper, we argue that, although there is some merit in the above criticisms, especially as far as non stationary transfer costs are concerned, time series analysis can provide useful insights into the issue of market integration and price transmission if an appropriate testing framework is employed and the results are interpreted correctly. Market integration is formally testable, if one adheres to the definition implied by the standard spatial equilibrium model. However, the *extent* of price transmission is an inherently ambiguous concept. Cointegration and error correction models provide an analytical tool that can focus beyond the case of market integration or complete price transmission, in testing notions such as completeness, speed, and asymmetry of the relationship between prices. For example, discontinuities in trade, within a time series modelling framework, correspond to slow speed of convergence to a long run relationship, whilst non linearities may be modelled as asymmetric responses

to price changes. Time series models have small data requirements as compared to other methodologies, relying on price series only, which are more easily available for developing countries. In addition, time series applications perform a useful role in signalling potential failures in markets and in contributing to the assessment of the direction, magnitude and distribution of welfare effects of trade policy reforms. However, it is important to note that, in general, time series applications may also founder while attempting to achieve an unattainable goal, that of giving a universal measure of the extent of price transmission in terms of a single parameter or test.

3. Price transmission notions and components and the impact of food policies

Given prices for a commodity in two spatially separated markets p_{1t} and p_{2t} , the Law of One Price and the Enke-Samuelson-Takayama-Judge model postulate that at all points of time, allowing for transfer costs c , for transporting the commodity from market 1 to market 2, the relationship between the prices is as follows:

$$p_{1t} = p_{2t} + c \quad (1)$$

If a relationship between two prices, such as (1), holds, the markets can be said to be integrated. However, this extreme case may be unlikely to occur, especially in the short run. At the other end of the spectrum, if the joint distribution of two prices were found to be completely independent, then one might feel comfortable saying that there is no market integration and no price transmission. In general, spatial arbitrage is expected to ensure that prices of a commodity will differ by an amount that is at most equal to the transfer costs with the relationship between the prices being identified as the following inequality:

$$p_{2t} - p_{1t} \leq c \quad (2)$$

Fackler and Goodwin (2001) refer to the above relationship as the spatial arbitrage condition and postulate that it identifies a weak form of the Law of One Price, the strong form being characterized by equality (1). They also emphasize that relationship (2) represents an equilibrium condition. Observed prices may diverge from relationship (1), but spatial arbitrage will cause the difference between the two prices to move towards the transfer cost. The spatial arbitrage condition implies that market integration lends itself to a cointegration interpretation with its presence being evaluated by means of cointegration tests. Cointegration can be thought of as the empirical counterpart of the theoretical notion of a long run equilibrium relationship. If two spatially separated price series are cointegrated, there is a tendency for them to co-move in the long run according to a linear relationship. In the short run, the prices may drift apart, as shocks in one market may not be instantaneously transmitted to other markets or due to delays in transport, however, arbitrage opportunities ensure that these divergences from the underlying long run (equilibrium) relationship are transitory and not permanent.

The spatial arbitrage condition encompasses price relationships that lie between the two extreme cases of the strong form of the Law of One Price and the absence of market integration. Depending on market characteristics, or the distortions to which markets are subject, the two price series may behave in a plethora of ways, having quite complex relationships with prices adjusting less than completely, or slowly rather than instantaneously and according to various dynamic structures or being related in a non linear manner. Given the wide range of ways prices may be related, the concept of price transmission can be thought of as being based on three notions, or components (Prakash, 1998; Balcombe and Morisson, 2002). These are:

- co-movement and completeness of adjustment which implies that changes in prices in one market are fully transmitted to the other at all points of time;
- dynamics and speed of adjustment which implies the process by, and rate at which, changes in prices in one market are filtered to the other market or levels; and,

- asymmetry of response which implies that upward and downward movements in the price in one market are symmetrically or asymmetrically transmitted to the other. Both the extent of completeness and the speed of the adjustment can be asymmetric.

Within this context, complete price transmission between two spatially separated markets is defined as a situation where changes in one price are completely and instantaneously transmitted to the other price, as postulated by the Law of One Price presented by relationship (1). In this case, spatially separated markets are integrated. In addition, this definition implies that if price changes are not passed-through instantaneously, but after some time, price transmission is incomplete in the short run, but complete in the long run, as implied by the spatial arbitrage condition. The distinction between short run and long run price transmission is important and the speed by which prices adjust to their long run relationship is essential in understanding the extent to which markets are integrated in the short run. Changes in the price at one market may need some time to be transmitted to other markets for various reasons, such as policies, the number of stages in marketing and the corresponding contractual arrangements between economic agents, storage and inventory holding, delays caused in transportation or processing, or “price-levelling” practices.

Asymmetric response of one price to another implies non linear adjustment and deserves some further discussion. Many researchers have worked on the issue of asymmetric price responses utilizing the asymmetric error correction model developed by Granger and Lee (1989) or threshold cointegration models proposed by Enders and Granger (1998). Abdulai (2000) provides a comprehensive discussion on the rationale behind spatial asymmetric price response. In addition to policies, market power is often cited as a source of asymmetries (Scherer and Ross, 1990). Industry concentration and imperfectly competitive behaviour beyond the farm-gate implies that wholesalers, or middlemen with power over price, may exercise pricing strategies that result in a slow and incomplete pass-through of increases in the international price and a fast and complete transmission of decreases in the international price to prices upstream, as their margins are squeezed.

However, in the short run, asymmetric price transmission may also occur for reasons other than policies and market power. In spatial markets, inventory holding behaviour in domestic markets may lead to asymmetries, as high international price expectations lead to stock accumulation. The subsequent release of stocks, *post* the realization of high international price expectations, may exert downward pressure on the domestic market and cause the domestic price not to rise as much as it would in the absence of inventories (Maccini, 1978; Blinder, 1982). Other reasons for asymmetric price adjustment include different reaction to increases and decreases of input costs, depending on whether prices are rising or falling, as competition between wholesalers with high fixed costs and excess capacity may result in producer prices that increase rapidly when demand for processed product is high, but decrease at a slower rate when demand is low (Bailey and Brorsen, 1989; Kovenock and Widows, 1998). Therefore, it is important to note that although most researchers agree that asymmetric price response may be due to concentration and non competitive pricing behaviour, the theoretical underpinnings of this hypothesis (see for example Wohlgenant, 1999), as well as the related empirical evidence are inconclusive. For example, Griffith and Piggot (1994) detected asymmetries in the Australian lamb and beef markets, but not in the pork market in spite of the fact that the Australian pork market is more concentrated than the other meat markets.

4. A price transmission testing framework

As mentioned in section 2, the extent of price transmission lacks a direct unambiguous empirical counterpart in the form of single formal testing. The definition of price transmission provided in the section above encompasses the case of perfect market integration, the inherent dynamic market relationships that arise due to inertia or discontinuities in trade, as well as non linearities that may arise due to policies and other distortions in arbitrage. More importantly, it implies hypotheses, through its components, that are testable within a cointegration–error correction model framework. A number of

time series techniques can be used to test each of the components of price transmission and thus ultimately assess the extent of price transmission. These are as follows:

- cointegration;
- causality;
- error correction mechanism; and,
- symmetry.

Each of the above tests are taken to present evidence about the components of transmission thus providing particular insights into its nature. Collectively, these techniques offer a framework for the assessment of price transmission and market integration.

The concept of cointegration (Granger, 1981) and the methods for estimating a cointegrated relation or system (*inter alia* Engle and Granger, 1987; Johansen, 1988, 1991, 1995) provide a framework for estimating and testing for long run equilibrium relationships between non stationary integrated variables.⁴ Cointegration has been extensively discussed and applied in the literature and thus a detailed examination is beyond the scope of this paper (Maddala and Kim, 1998 provide a thorough and extensive review of cointegration). However, a brief description of the concept and the estimation methods in the context of the present analysis is provided.

If two prices in spatially separated markets (or different levels of the supply chain) p_{1t} and p_{2t} contain stochastic trends and are integrated of the same order, say $I(d)$, the prices are said to be cointegrated if:

$$p_{1t} - \beta p_{2t} = u_t \quad (3)$$

is $I(0)$.

β is referred to as the cointegrating vector (in the case of two variables a scalar), whilst equation (3) is said to be the cointegrating regression. The above relationship can be estimated utilizing *inter alia* Ordinary Least Squares OLS (Engle and Granger, 1987), or a Full Information Maximum Likelihood method developed by Johansen (1988, 1991) that is most commonly encountered in the literature. More specifically, p_{1t} and p_{2t} are cointegrated, if there is a linear combination between them that does not have a stochastic trend even though the individual series contain stochastic trends (see Stock and Watson, 1988, for the stochastic trend representation of cointegrated systems). Cointegration implies that these prices move closely together in the long run, although in the short run they may drift apart, and thus is consistent with the concept of market integration. Engle and Granger test the null of no cointegration by applying unit root tests on \hat{u}_t . Johansen derived the distribution of two test statistics for the null of no cointegration referred to as the Trace and the Eigenvalue tests.⁵

As u_t is stationary, the prices contain stochastic trends that have a long-run proportionality, with the cointegrating parameter β measuring the long-run equilibrium relationship between them. This parameter has sometimes been interpreted as the “elasticity of price transmission”, when the price series are converted into logarithms. However, this cointegrating parameter does not identify this elasticity, or in other words, the completeness of transmission, particularly well, as recognized by Balcombe and

⁴ Statistical properties of series can be summarised by the concept of stationarity. A stationary series has a constant mean and a constant finite covariance structure. Such a series does not vary systematically with time, but tends to return frequently to its mean value and to fluctuate around it within a more or less constant range. Alternatively, a non stationary series has time-dependent statistical properties. Non stationary series may contain stochastic or deterministic trends. Variables that contain stochastic trends are called “integrated” and exhibit systematic, but unpredictable variation, as compared to series that contain deterministic trends and display completely predictable variation. A stochastic trend in a series can be removed by differencing. The differenced series has statistical properties which are invariant with respect to time, whilst inferences about the similarity of the statistical properties of different economic series can be made by comparing the number of times the series have to be differenced in order to achieve stationarity. More formally, a variable is integrated of order d , written $I(d)$, if it must be differenced d times to achieve stationarity.

⁵ Comprehensive presentations of both the Engle and Granger, and the Johansen tests can be found in Hamilton (1994). A brief description of the Johansen test is provided in the Annex.

Morrison (2002) and Barrett and Li (2002). Cointegration is a statistical concept and thus “atheoretical”, whilst the cointegrating parameter may not have any economic interpretation, in the way a parameter of a structural model has. For example, if prices in spatially separated markets have a common stochastic trend reflecting inflation, the cointegrating parameter will be equal to one mirroring a proportionality of unity and implying that price transmission is complete.

Nevertheless, failure to reject the null of non cointegration implies that the two prices drift apart in the long run, as they are driven by stochastic trends that are not proportional. In this case, some changes in one price, say the international market price, may to a certain extent be transmitted to the domestic market price, however, other factors, such as policies or deviations from marginal cost pricing determine the movements of the domestic market price, thus resulting in absence of market integration. A potential shortcoming of cointegration in testing for market integration is the implicit assumption that transfer costs are stationary (Fackler and Goodwin, 2001; Barret and Li, 2002). Non stationary transfer costs will result in cointegration tests suggesting the absence of market integration, as the international and domestic prices drift apart, in spite of the fact that price signals are transmitted from one market to another. Nevertheless, non stationary transfer costs cause domestic prices to move independently from international prices, thus limiting the information that is available to producers.

In addition to formally testing market integration, the concept of cointegration has an important implication, purported by the Granger Representation Theorem (Engle and Granger, 1987). According to this theorem, if two trending, say I(1), variables are cointegrated, their relationship may be validly described by an Error Correction Model (ECM), and vice versa (see also brief description in the Annex). In the case that prices from two spatially separated markets, p_{1t} and p_{2t} , are cointegrated, the Vector Error Correction (or VECM) representation is as follows:

$$\begin{pmatrix} \Delta p_{1t} \\ \Delta p_{2t} \end{pmatrix} = \begin{pmatrix} \mu_1 \\ \mu_2 \end{pmatrix} + \begin{pmatrix} \alpha_1 \\ \alpha_2 \end{pmatrix} (p_{1t-1} - \beta p_{2t-1}) + A_2 \begin{pmatrix} \Delta p_{1t-1} \\ \Delta p_{2t-1} \end{pmatrix} + \dots + A_k \begin{pmatrix} \Delta p_{1t-k} \\ \Delta p_{2t-k} \end{pmatrix} + \begin{pmatrix} v_{1t} \\ v_{2t} \end{pmatrix} \quad (4)$$

where v_{1t} and v_{2t} are *iid* disturbances with zero mean and constant finite variance, whilst the operator Δ denotes that the I(1) variables have been differenced in order to achieve stationarity.

The inclusion of the levels of the variables, p_{1t} and p_{2t} alongside their differenced terms Δp_{1t} and Δp_{2t} is central to the concept of the ECM. Parameters contained in matrices $A_2 \dots A_k$, measure the short run effects, while β is the cointegrating parameter that characterizes the long run equilibrium relationship between the two prices. The levels of the variables enter the ECM combined as the single entity $(p_{1t-1} - \beta p_{2t-1})$ which reflects the errors or any divergence from this equilibrium, and correspond to the

lagged error term of equation (3). The vector $\begin{pmatrix} \alpha_1 \\ \alpha_2 \end{pmatrix}$ contains parameters, usually $0 < |\alpha_i| < 1$, $i=1,2$,

commonly called error correction coefficients, that measure the extent of corrections of the errors that the market initiates by adjusting p_{1t} and p_{2t} towards restoring the long run equilibrium relationship. The speed with which the market returns to its equilibrium depends on the proximity of α_i to one. Within this context, short run adjustments are directed by, and consistent with, the long run equilibrium relationship, allowing the researcher to assess the speed of adjustment that shapes the relationship between the two prices.

In the context of market integration and price transmission studies, the ECM, as well as its further applications discussed below, is perhaps the most useful tool as it provides a stylized picture of the relationship between two prices. The model provides a structure within which gradual, rather than instantaneous price transmission can be tested, thus taking into account discontinuities in trade and other factors that may impede market integration over time. Most importantly, the proximity of the error correction coefficient to -1 can be used to assess the extent to which policies, transaction costs and other distortions delay full adjustment to the long run equilibrium. Sharma (2002) in a paper aiming to assess market integration between several Asian wheat markets and the world market, estimated ECMs

and conducted an extensive policy review. His findings suggest that in countries such as Pakistan, India, Sri Lanka and Indonesia, where government intervenes in the domestic market through various policy instruments, the error correction coefficients were estimated to lie between -0.01 and -0.07 indicating a slow adjustment to the long run relationship.

Another important implication of cointegration and the error correction representation is that cointegration between two variables implies the existence of causality (in the Granger sense) between them in at least one direction (Granger, 1988). The definition of causality and its relevance in the context of market integration and price transmission warrants some discussion. Cointegration itself cannot be used to make inferences about the direction of causation between the variables, and thus causality tests are necessary. Granger (1969) proposed an empirical definition of causality based only on its forecasting content: if x_t causes y_t then y_{t+1} is better forecast if the information in x_t is used, since there will be a smaller variance of forecast error. This definition has caused considerable controversy in the literature (see for example Pagan, 1989) as it really indicates precedence, rather than instantaneous causality that most economists profess. Nevertheless, if two markets are integrated, the price in one market, p_1 , would commonly be found to Granger-cause the price in the other market, p_2 and/or vice versa. Therefore, Granger causality provides additional evidence as to whether, and in which direction, price transmission is occurring between two series.

The hypothesis that p_1 Granger-causes p_2 and vice versa can be assessed within a Vector Autoregression (VAR) framework (see Annex) by testing the null that the coefficients of a subset of these jointly determined variables, the lagged p_1 terms, are equal to zero. In addition, Granger (1988) proposed a test for long run Granger causality within the context of the error correction representation of a cointegrated system of variables. The presence and direction of Granger causality in the long run can be assessed by testing the null that the error correction coefficients α_1 and α_2 in the VECM presented by (3) are equal to zero, a test that also reveals weak exogeneity in the econometric sense. In more detail, under $\alpha_1 = 0$, $\alpha_2 \neq 0$, p_2 Granger-causes p_1 in the long run, under $\alpha_2 = 0$, $\alpha_1 \neq 0$, p_1 Granger-causes p_2 in the long run, whilst under $\alpha_1 \neq 0$, $\alpha_2 \neq 0$, both series Granger-cause each other in the long run.

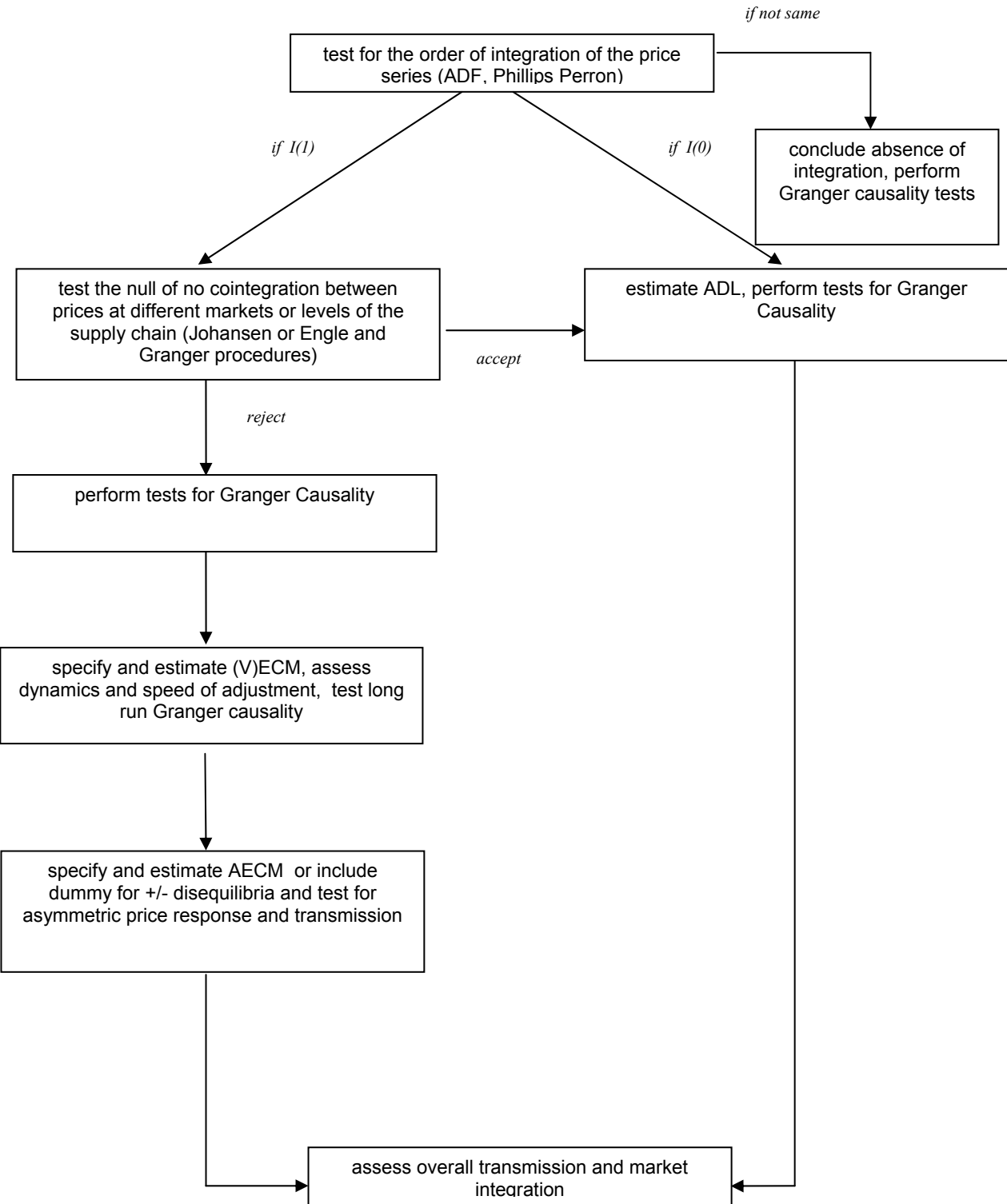
It is important to note that although cointegration between two price series implies Granger causality in at least one direction, the opposite is not necessarily true. In this case, as noted above in the discussion on cointegration, lack of cointegration between the two trending price series may indicate that market integration is absent, as other factors such as transaction costs determine the movements of one of the price series. However, Granger causality may exist, indicating that, although the two price series drift apart due to other factors such as non stationary transaction costs, some price signals are passing through from one market to another. On the other hand, lack of Granger causality may not imply an absence of transmission, as price signals may be transmitted instantaneously under special circumstances. However, given the inherent dynamics of markets, we believe that this is highly unlikely.

The error correction representation also provides a framework for testing for asymmetric and non linear adjustment to a long run equilibrium. Granger and Lee (1989) proposed an asymmetric ECM (AECM) where the speed of the adjustment of the endogenous variable depends on whether the deviation from the long run equilibrium is positive or negative. The single asymmetric ECM is specified as follows:

$$\Delta p_{1t} = \mu_1 + \alpha_1^+ (p_{1t-1} - \beta p_{2t-1})^+ + \alpha_1^- (p_{1t-1} - \beta p_{2t-1})^- + \sum_{i=0}^k \delta_i \Delta p_{2t-i} + \sum_{i=1}^n \gamma_i \Delta p_{1t-i} + v_{1t} \quad (5)$$

The errors or divergences from this equilibrium are decomposed in two parts, $(p_{1t-1} - \beta p_{2t-1})^+$ and $(p_{1t-1} - \beta p_{2t-1})^-$ reflecting positive and negative disequilibria respectively. Within this context, asymmetry occurs in the event when positive and negative divergences from the long run equilibrium between p_{1t} and p_{2t} result in changes in p_{1t} that have different magnitude. Therefore, asymmetric transmission implies that α_1^+ is not equal to α_1^- . The null of symmetry against the alternative hypothesis

Diagram 1



that adjustment is asymmetric is tested by imposing the equality restriction $\alpha_1^+ = \alpha_1^-$. In addition to the above, short run asymmetric transmission can also be tested by decomposing ΔP_{2t} in two parts reflecting price rises and price falls, and testing for equality of the corresponding short run coefficients. Asymmetric adjustment can be also tested by following Prakash *et al* (2001). This method involves the assignment of a dummy variable, $d=0$ to all the parameters of the underlying Autoregressive Distributed Lag (ADL) if there is positive disequilibrium and $d=1$ if there is negative disequilibrium. Asymmetric adjustment to the long run equilibrium is then tested by imposing and testing zero restrictions on the dummies' parameters.

In view of the above discussion on the empirical tools that can be used to assess the notional components of market integration and price transmission, we proceed to apply the proposed time series techniques on selected commodity markets in a sequence depicted in Diagram 1. The way in which the tests for the components of transmission have been ordered is to some extent *ad hoc*. The sequence of the tests is as follows:

- (i) For each pair of prices, we start by testing for the order of integration for each price utilizing the Augmented Dickey-Fuller (Dickey and Fuller, 1979) and the Phillips and Perron tests (Phillips and Perron, 1988). In the event that the series have a different order of integration, we conclude that the markets are not integrated. In the case that the series are found to be $I(0)$, we resort to assessing the dynamics of the relationship by means of Autoregressive Distributed Lag (ADL) models. We test for Granger Causality within a Vector Autoregression (VAR) framework to assess price transmission between the markets or along the supply chain.
- (ii) In the event that the tests indicate that the series are integrated of the same order (say $I(1)$), we proceed by testing the null of non cointegration against the alternative hypothesis of one cointegrating vector using the Johansen procedure (Johansen 1988, 1991), or we test for the null of non cointegration following Engle and Granger (1987). Evidence against the null of no cointegration is taken to indicate that prices co-move and that markets are integrated. We do not impose and test for any restrictions on the cointegrating parameter estimate $\hat{\beta}$. As noted earlier in this section, inference on the extent of price transmission based on the size of the parameter may be misleading. In the event that the null of non cointegration is not rejected, we conclude that the markets are not integrated, and/or that we are unable to conclude that price transmission along the supply chain is complete.
- (iii) In the event that tests indicate that the price series are cointegrated, we proceed by focusing on the error correction representation, in the form of a (V)ECM and on examining the short run dynamics, the speed of adjustment and the direction of Granger causality in the short or the long run following Granger (1969, 1988).
- (iv) At the next stage, based on our results on the direction of causality, we specify AECMs and test for the null of symmetry following Granger and Lee (1989) or Prakash, Oliver and Balcombe (2001). Finally, we discuss the results and comment on the nature of price transmission and market integration.

It is important to note that the above testing framework does not identify the factors that affect market integration and price transmission. In other words, we are not able to distinguish whether price transmission and market integration is shaped by transaction costs, policy intervention that insulates the domestic markets, or by the degree of market power exerted by agents in the supply chain. For this reason, an attempt is made to complement the results with some qualitative information on the major factors that may determine the extent of transmission.

5. Application to markets in developing countries

We apply the testing framework to a number of cash and food crop markets. We test for market integration between the coffee markets of Ethiopia, Rwanda and Uganda and the international market. Coffee is an important cash crop for these African countries and our objective is to assess the extent to which coffee producers in these countries are integrated into the market process, given that Ethiopia,

unlike Uganda, exports coffee through an auction system, whilst in Rwanda the price of coffee is fixed. We also test for market integration between the wheat market of Egypt and the international market. Egypt intervenes in the wheat market through a variety of policy instruments and our objective is to assess the extent of market integration and price transmission and discuss the impact of policies.

For analysing the coffee markets, we use the logarithmic transformation of monthly domestic prices measured in US\$ per lb at the producer level, from January 1990 to December 2001 and the Composite Indicator Price (CIP) of the International Coffee Organization (ICO), as a world market reference price.⁶ The CIP is a weighted average of import prices of different types of coffee in the main import markets (United States, France and Germany). A detailed description of the calculation of the ICO Composite Indicator Price can be found in International Coffee Organization (2002). All data series are published by the ICO⁷.

We first test for the order of integration. We apply a number of tests, namely the Augmented Dickey Fuller (ADF) test (Dickey and Fuller, 1979) and the Z_t and Z_ρ tests by Phillips (1987) and Phillips and Perron (1988). The ADF is the most commonly used test, but sometimes it behaves poorly, especially in the presence of serial correlation. Dickey and Fuller correct for serial correlation by including lagged differenced terms in the regression, however, the size and power of the ADF has been found to be sensitive to the number of these terms. The Phillips and Perron tests are non parametric tests of the null of the unit root and are considered more powerful, as they use consistent estimators of the variance.

Table 1. Unit root tests for coffee market prices

	Levels		Differences	
	with drift	with drift and trend		
ICO Composite Indicator Price				
ADF test	-1.192	-1.135	-9.220	
Phillips Perron test Z_t	-1.015	-0.938	-9.226	
Phillips Perron test Z_ρ	-2.886	-2.620	-107.151	
Producer price, Ethiopia				
ADF test	-2.036	-2.146	-12.455	
Phillips Perron test Z_t	-2.033	-2.149	-12.455	
Phillips Perron test Z_ρ	-10.352	-10.971	-149.882	
Producer price, Rwanda				
ADF test	-10.910	-1.690	-13.377	
Phillips Perron test Z_t	-1.092	-1.702	-13.766	
Phillips Perron test Z_ρ	-3.472	-7.016	-159.370	
Producer price, Uganda				
ADF test	-2.027	-1.395	-10.595	
Phillips Perron test Z_t	-2.049	-1.425	-10.595	
Phillips Perron test Z_ρ	-6.167	-4.783	-126.494	
	with drift		with drift and trend	
Critical values	5 percent	10 percent	5 percent	10 percent
ADF and Phillips Perron Z_t	-2.88	-2.57	-3.43	-3.13
Phillips Perron test Z_ρ	-13.7	-11.0	-20.7	-17.5

Table 1 presents the unit root test statistics. The ADF test is performed by including up to 12 lagged terms of the differenced terms in the regression and we use the Akaike Information Criterion (AIC) to choose the appropriate lag length by trading off parsimony against reduction in the sum of squares. The ADF test statistics presented in Table 1 correspond to the regression that has maximized the AIC. On the basis of both the ADF and Phillips and Perron tests, both with and without a deterministic trend, we

⁶ The use of logarithmic transformations implies that transfer costs are proportional to prices. For example insurance costs may be expressed as a percentage of the value. See Fackler and Goodwin (2001) for a relevant discussion.

⁷ The data series was collected from <http://www.ico.org/frameset/traset.htm>

conclude that there is insufficient evidence to reject the null hypothesis of non stationarity for all price series. When applied to the differenced series, both tests reject the null, indicating that all price series are $I(1)$.

We proceed by following the sequence of tests depicted in Diagram 1. For each of the African coffee markets we test for cointegration using the Johansen approach, test for Granger causality and formulate an ECM in order to assess the dynamics and the speed of adjustment. Asymmetric adjustment is then tested following Granger and Lee (1989). In all markets we select the lag length in the underlying VAR and the ECM by means of the AIC.

The results for Ethiopia are summarized in Table 2. There is strong evidence that the producer price and the CIP are cointegrated, with the Johansen test rejecting the null of no cointegration, but failing to reject the null of one cointegrating vector. Cointegration indicates that producers in Ethiopia are integrated to the market process and that there is Granger Causality in at least one direction. The Granger causality tests indicate that the CIP Granger-causes the producer price. The estimated ECM suggests that the adjustment process is relatively fast with about 27 percent of divergence from the notional long run equilibrium being corrected each month. The short run dynamics indicate that changes in the CIP are transmitted to the producer price contemporaneously, although not fully. This indicates that the markets are well integrated in the short run, with changes in the international prices being partly transmitted to the domestic market. Moreover, the parameter on ΔWPt is estimated to be 0.77, suggesting that international market shocks affect the Ethiopian market. However, lagged differenced terms are also estimated to be negative, reflecting somewhat complex short run dynamics. Tests for long run Granger causality indicate that the CIP Granger causes the Ethiopian producer price but not vice versa. Finally, asymmetric adjustments to the long run equilibrium appear to be unlikely, with the F-test failing to reject the null hypothesis of symmetry, suggesting that increases and decreases in the international price are passed-through in a similar and symmetric manner to the domestic market.

Overall, there is sufficient evidence to conclude that the Ethiopian market is well integrated with the world market in the long run, whilst price signals are also being transmitted in the short run. The result indicates that the supply chain from the producer to the exporter functions well with the government administered auction system and quality control facilitating price transmission. Coffee growers in Ethiopia sell the produce in dry form to cooperatives, private collectors and to the Coffee Purchase and Sales Enterprise who in turn deliver it at two auction centres (in Addis Ababa and in Dire Dawa), run by the country's Coffee and Tea Authority (CTA). The system allows for the auction to take place each weekday throughout the year, whilst from February to April, at the peak of the season, auctions are held twice a day. Samples are being taken and cup tasting is conducted by the CTA in order ensure quality control and grading of each lot before sale and exportation. Occasionally, shocks in domestic demand may help to increase the auction prices but only temporarily as a large part of domestic consumption is supplied through trade that takes place out of the auction system.

In Rwanda, the Johansen test (Table 3) provides insufficient evidence against the alternative of one cointegrating relationship between the domestic producer price and the CIP, thus suggesting absence of integration between the Rwandan and the international market. The result is not surprising, as the government, over the period under examination, implemented policies that isolated the Rwandan coffee market from the world economy. Up to 1994, the Rwandan Government intervened in the coffee market by offering a fixed price to producers. The grower price for parchment was fixed by OCIR Café, a parastatal organization, at the beginning of the season, and was held at that level (generally lower than the world market level) throughout the period of the crop. From 1994 to 1997, the government imposed an export tax. Given that the domestic and international coffee prices do not co-move, we proceed by testing for Granger causality and by specifying and estimating an ADL. The tests suggest that there is strong evidence for Granger causality from the international price to the domestic producer price. It appears that over time, changes or shocks in the CIP pass through into the domestic market, but these are not adequate to drive the domestic prices. The ADL coefficients reveal that produces prices in Rwanda follow an autoregressive pattern. The lagged terms of the international price also appear to

Table 2. Market integration tests for the Ethiopian coffee market

Johansen test for cointegration						
No. of cointegrating vectors						
Null	Alternative	Rank test	Critical values			
			5 percent		10 percent	
0	1	21.211	14.880		12.980	
1	2	1.796	8.070		6.500	
Cointegrating vector						
	Parameter	Standard Error				
DP	1.00	0.00				
WP	-0.76	0.08				
Granger Causality						
No. of lagged WPt terms	F-Test	Probability value				
0	8.73	0.00				
1	4.82	0.01				
2	5.43	0.00				
3	3.68	0.01				
4	3.34	0.01				
5	3.29	0.00				
6	2.76	0.01				
7	3.38	0.00				
8	3.43	0.00				
9	2.87	0.00				
10	3.87	0.00				
11	3.11	0.00				
12	2.76	0.00				
Error Correction Models						
	Symmetric			Asymmetric		
	Parameter	t ratio		Parameter	t ratio	
intercept	0.00	-0.29		intercept	-0.01 -0.33	
ECM(-1)	-0.27	-3.52		ECM(-1)+	-0.29 -2.11	
Δ WPt	0.77	5.56		Δ WPt	0.88 4.96	
Δ DP(-1)	0.03	0.36		Δ DP(-1)	0.00 0.03	
Δ WPt(-1)	-0.01	-0.04		Δ WPt(-1)	-0.21 -1.00	
+DPt(-2)#	0.19	2.14		+DPt(-2)#	0.24 2.02	
Δ WPt(-2)	-0.43	-2.89		Δ WPt(-2)	-0.49 -2.45	
Δ DPt(-3)	-0.16	-1.75		Δ DPt(-3)	-0.05 -0.40	
Δ WPt(-3)	0.22	1.46		Δ WPt(-3)	0.51 2.57	
				ECM(-1)-	-0.23 -1.90	
				Δ WPt	0.75 3.18	
				Δ DP(-1)	0.04 0.29	
				Δ WPt(-1)	0.10 0.45	
				+DPt(-2)#	0.15 1.02	
				Δ WPt(-2)	-0.50 -2.13	
				Δ DPt(-3)	-0.28 -2.12	
				Δ WPt(-3)	-0.13 -0.59	
Test for long run Granger Causality*			Tests for symmetry versus asymmetry			
	Parameter	t ratio		F-value	Prob.	
ECM(-1)	0.033	0.79		1.488	0.169	
				Wald test		
				0.069	0.792	

WPt and DPt are the ICO CIP and the domestic producer prices respectively.

* ECM with Δ WPt as dependent variable.

influence the movements of the producer price, to a certain extent. However, it is difficult to assess the relationship with the CIP term lagged once being positive and that lagged twice being negative. Nevertheless, it appears that there is some transmission, a finding also supported by the Granger causality tests, albeit not enough to determine domestic prices throughout the sample.⁸ Granger causality from the international to the domestic price indicates that policy makers in Rwanda take the international price level into consideration when fixing the domestic price.

Table 3. Market integration tests for the Rwandan coffee market

Johansen test for cointegration					
Number of cointegrating vectors					
Null	Alternative	Rank test	Critical values		
			5 percent	10 percent	
0	1	5.892	14.880	12.980	
1	2	0.051	8.070	6.500	
Cointegrating vector					
	Parameter	Standard Error			
DP	1.000	0.000			
WP	-0.842	0.521			
Granger Causality					
No. of lagged WPt terms	F-Test	Probability value			
1	9.35	0.00			
2	4.79	0.01			
3	4.25	0.01			
4	3.29	0.01			
Autoregressive Distributed Lag					
	Parameter	t ratio			
intercept	-0.130	-0.139			
DPt(-1)	0.815	9.849			
DPt(-2)	0.137	1.663			
WPt	0.055	0.692			
WPt(-1)	0.192	1.526			
WPt(-2)	-0.204	-2.533			

WPt and DPt are the ICO CIP and the domestic producer prices respectively.

For Uganda, where growers sell their produce directly to traders and exporters, the Johansen test provides sufficient evidence for the alternative of one cointegrating relationship, indicating that the domestic and international markets are integrated (see Table 4). The Granger causality tests suggest that the CIP Granger-causes the domestic producer price, whilst in the estimated ECM, the error correction coefficient (-.18) suggests that the adjustment to the long run relationship is relatively fast, with the producer price adjusting fully to changes in the CIP after approximately five months. In the ECM, the AIC selected to include only the differenced term ΔWP_t . Its coefficient is estimated to be equal to 0.58, suggesting that shocks in the international price are instantaneously, although not fully, passed through to the domestic market. Using the error correction coefficients from the VECM to test for Granger causality in the long run, it is noted the CIP Granger-causes the producer price in Uganda, but not vice versa. Finally, there is sufficient evidence that the adjustment to the long run equilibrium is not asymmetric. Overall, the tests suggest that the Ugandan market is integrated with the international market, whilst adjustments to this long run equilibrium take place fast.

⁸ As the null of no cointegration was not rejected, Granger causality tests were performed by specifying VARs of the differenced terms following Toda and Phillips (1993).

Table 4. Market integration tests for the Ugandan coffee market

Johansen test for cointegration					
Number of cointegrating vectors					
Null	Alternative	Rank test	Critical values		
			5 percent	10 percent	
0	1	18.147	14.880	12.980	
1	2	2.268	8.070	6.500	
Cointegrating vector					
	Parameter	Standard Error			
DP	1.000	0.000			
WP	-1.298	0.172			
Granger Causality					
No. of lagged WPt terms	F-Test	Probability value			
	14.70	0.00			
1	7.83	0.00			
2	7.58	0.00			
3	6.13	0.00			
4	5.93	0.00			
5	5.47	0.00			
Error Correction Models					
Symmetric ECM			Asymmetric ECM		
	Parameter	t ratio	Parameter	t ratio	
intercept	0.007	0.635	intercept	0.001	0.080
ECM(-1)	-0.182	-4.968	ECM(-1)	-0.148	-1.705
Δ WPt	0.585	4.419	Δ WPt	0.562	2.514
			ECM(-1)	-0.199	-3.747
#			Δ WPt	0.596	3.586
Test for long run Granger Causality*			Tests for symmetry versus asymmetry		
	Parameter	t ratio	F-value	Prob.	
ECM(-1)	0.01614	0.8279	0.1082634	0.8974702	
			Wald test		
			0.1925044	0.6608403	

WPt and DPt are the ICO CIP and the domestic producer prices respectively.

* ECM with Δ WPt as dependent variable.

In analysing the wheat market in Egypt, we use logarithmic transformations of monthly commodity wholesale and world reference prices, in logarithms, from January 1969 to May 2001. The domestic price series have been collected from the *Consumer & Wholesale Price Bulletin* published by the Central Agency for Public Mobilization & Statistics, the *Agricultural Statistic Bulletin* published by the Ministry of Agriculture & Land Reclamation, and with data of the Ministry of Supply. All prices were converted into US dollars, using the nominal average exchange rates. World reference prices for the four commodities over the same period, together with relevant exchange rates with the US\$, were collected from the *International Financial Statistics* database of the International Monetary Fund.⁹

We test for the order of integration by applying the ADF and the Phillips-Perron Z_p tests. Both tests were performed with and without a time trend and a constant term, including a maximum of 12 lagged differenced terms. The results indicate that all the series involved are $I(1)$, i.e. they are difference stationary processes as, when in levels, there is insufficient evidence to reject the null hypothesis of

⁹ The world reference price used is that of US n. 2 Hard Red Winter at Gulf Port. Other world prices (Australian and Argentine export prices) were also tested.

stationarity,¹⁰ whilst, when in differences, both tests reject the null (Table 5). We proceed by following the testing framework and testing for cointegration following the Engle and Granger approach, estimating the corresponding ECMs and assessing the dynamics and the speed of adjustment. We then test for Granger-causality and asymmetric response by including a dummy variable, as in Prakash *et al.* (2001). In all markets we select the lag length in the ECM by means of the AIC.

Table 5. Unit root tests for wheat market prices

	Levels	Differences
Wholesale price, Egypt		
ADF test	-0.45	-8.36
Phillips-Perron test Z_p	-1.76	-20.37
World reference price		
ADF test	-3.54	-4.18
Phillips-Perron test Z_p	-2.05	-14.65
Critical values	5 percent	10 percent
ADF	-2.88	-2.57
Phillips Perron test Z_p	-13.7	-11.0

Table 6 presents the results for wheat. The ADF and Phillips-Perron tests provide evidence for the null of no cointegration, thus suggesting that the Egyptian and world wheat markets are not integrated. However, casual inspection of the series and a test for the stability of parameters based on the cumulative sum of recursive residuals (not reported) suggests the presence of a structural break in August 1989. This break corresponds to the beginning of a process of restructuring of the Egyptian economy which included, among other measures, the liberalization of the exchange rate regime that was previously set at different levels for different transactions.¹¹ a significant reduction in trade barriers and the liberalization of marketing channels for several commodities, that were previously operated solely under State control (FAO, 1999). In order to take the structural break into account we separated the sample into two periods 1969-1989 and 1990-2001, and estimated two separate models.¹²

The unit root tests for the 1969–1989 period (not reported) suggest that the Egyptian and world price of wheat are not cointegrated, whilst those for the period 1989–2001 provide evidence against the null of no cointegration (Table 6). This appears broadly consistent with the notion that price transmission and market integration has arisen after economic reform and the liberalization of the exchange rate regime. The error correction coefficient suggests that adjustment is relatively slow with about 7 percent of the divergence from the long run equilibrium being corrected each month. The coefficients of the lagged differenced terms suggest that a proportion of shocks in the world reference price is transmitted to the wholesale price instantaneously, suggesting that the markets are linked reasonably well in the short run. It is worth noting that the wheat market in Egypt is still a relatively administered one: the Government operates a floor price both at the producer and at the consumer level (for bread). The evidence for market integration from the late 1980s onwards indicates that price signals are transmitted and markets are integrated despite the presence of floor prices. This may suggest that the floor price affects only the level of risk for producers and consumers, by truncating the probability distribution of price outcomes, rather than directly affecting market price formation. The finding that the Egyptian wholesale and the world wheat prices are cointegrated provides an interesting insight for policy analysis. Usually, the implementation of a floor price policy is modelled by equating the domestic market price with the floor price. Nevertheless, our findings suggest that such a specification may imply a significant overvaluation

¹⁰ The ADF test for the wheat world reference price in levels rejects the null at 5 percent, however, this rejection is not supported by the Z_t which does not provide evidence against the null at 1 percent.

¹¹ For example, products imported by the Public Authority for Commodities Supply, including wheat, were denominated in a specific exchange rate, which was lower than the one prevailing in the free market (in local currency for US \$).

¹² Quintos (1995) also takes the presence of a structural break into account by separating the sample assuming that the break point is known.

of the distortionary impact of a floor price.¹³ The test for asymmetric adjustment suggests that there is sufficient evidence against the null of symmetry, as the dummy variable that allows for positive and negative disequilibria is different from zero, whilst the error correction coefficient is larger in magnitude than that of the symmetric model. This result indicates that the domestic wholesale price reacts differently to changes in the world price depending on whether these are increases or decreases. The evidence suggests that decreases in the world price are incompletely and slowly passed-through to the domestic market, as compared to increases. This asymmetric adjustment may be due to the floor price policy that is implemented at the producer and consumer levels and may result in smoothening the downward changes in the world reference price. Nevertheless, other reasons may include market power exerted by the distribution levels of the supply chain or high fixed costs in the distribution industry. However, whatever the true reason behind this asymmetry, subsidization of bread consumption suggests that its costs are borne by the taxpayers rather than the consumers.

Table 6. Market integration for Egyptian wheat

Engle and Granger two-step procedure						
Cointegrating regression						
Sample: Jan 1969 – May 2001			Sample: Aug 1989 – May 2001			
Variable	Parameter	t-ratio	Variable	Parameter	t-ratio	
DPt			DPt			
intercept	-1.07	-0.41	intercept	-5.26	-1.40	
WPt	0.77	1.36	WPt	1.24	2.10	
T	0.00	0.67	T	0.01	1.94	
Test for cointegration						
ADF	-2.01		ADF	-3.47		
Phillips Perron Zt	-1.93		Phillips Perron Zt	-3.06		
Error Correction Models						
		Symmetric		Asymmetric		
	Variable	Parameter	t-ratio	Variable	Parameter	t-ratio
	ΔDPt			ΔDPt		
	intercept	-0.38	-1.82	intercept	0.69	2.73
	ECM(-1)	-0.07	-3.45	ECM(-1)	-0.24	-4.00
	ΔDPt(-1)	-0.21	-2.50	ΔDPt(-1)	-0.02	-0.27
	ΔDPt(-2)	-0.09	-1.07	ΔDPt(-2)	0.00	-0.05
	ΔDPt(-3)	-0.05	-0.59	ΔDPt(-3)	0.05	1.05
#	ΔDPt(-4)	-0.17	-2.13	ΔDPt(-4)	-0.09	-1.69
	ΔDPt(-5)	-0.11	-1.37	ΔDPt(-5)	0.04	0.77
	ΔDPt(-6)	-0.23	-3.05	ΔDPt(-6)	-0.14	-2.85
	ΔDPt(-7)	-0.08	-1.07	ΔDPt(-7)	0.04	0.72
	ΔDPt(-8)	0.20	2.67	ΔDPt(-8)	0.15	2.82
	ΔWPt	0.09	2.81	ΔDPt(-9)	0.16	3.08
	Trend	0.0004	2.64	ΔWPt	0.00	-1.25
				Dummy	0.20	6.42
				Dummy t(-1)	-0.05	-1.50
				Trend	0.00	-1.25

6. Some policy implications and suggestions for future research

This article focuses on time series techniques to test for spatial price transmission in a number of cash and food crop markets in developing countries. The objective of the article was to provide a review of

¹³ In fact, to avoid this type of errors, policy-oriented models like e.g. the AGLINK model of OECD have introduced an explicit modelling of floor price policies, based on inequality constraints.

the application of time series techniques in testing market integration and to contribute to the body of research on this subject by highlighting a number of important issues. Our applied work also drew attention to the impact of agricultural policies in weakening the link between domestic and international markets by examining commodities that are subject to different levels of intervention.

We stressed that although market integration, in the Enke-Samuelson-Takayama-Judge sense, and complete price transmission can be formally tested in the long run, the extent to which price signals are transmitted from one market to another is an ambiguous concept. In order to assess its extent, we decomposed the concept of price transmission into notional components: co-movement and completeness, dynamics and speed of adjustment and asymmetric response. The above definition of price transmission encompasses the case of market integration, the inherent dynamic market relationships that arise due to inertia or discontinuities in trade, as well as non linearities that may arise due to distortions in arbitrage. More importantly, it implies hypotheses, through its components, that are testable within a cointegration – error correction model framework. The testing framework was applied to a number of cash and food crop markets in developing countries. In general, given that the cointegrating parameter does not reflect the “elasticity of price transmission” well, we proposed that the assessment of the extent of market integration and price transmission should be based on ECMs with both symmetric and asymmetric adjustment.

Agricultural policies may or may not hinder market integration, depending on the nature of the policy instruments employed. For example, the Rwandan coffee market was found not to be integrated with the international coffee market, being subject to prices that were fixed by the government to a predetermined level. On the other hand, floor price policies implemented in the Egyptian wheat market were found not to impede market integration, but to result in relatively slow and asymmetric adjustment to international price changes. In general, for markets that are subject to policies, the speed of adjustment, as reflected by the error correction coefficients, was estimated to be relatively low. Although several authors stress that policies impede the extent of price transmission (see for example Mundlak and Larson, 1992; Quiroz and Soto, 1996; Baffes and Ajwad, 2001; Abdulai, 2000; Sharma, 2002), it should be noted that other reasons such as high transaction costs and other distortions may also be the cause for slow adjustment.

Non linearities and asymmetric adjustment remain an important issue to be explored especially when the objective of the research is to provide a price transmission mechanism that can be incorporated in a structural partial equilibrium model. Although asymmetric adjustment may also be the outcome of market imperfections, it is plausible that price support policies result in positive and negative changes in the international price affecting the domestic market in different ways. More importantly, such policies may imply a “threshold” or a minimum price, above which, transmission of price signals take place. Such a discrete adjustment process implies that movements towards a long run equilibrium do not take place at all points in time, but only when the divergence from equilibrium exceeds a certain threshold. For example, policies such as price support mechanisms and tariff rate quotas may result in such an adjustment process. In the former case, governments may intervene in the market when market prices fall below a floor level, whilst in the latter, international price signals pass-through when import volumes are sufficiently within, or out of the quota. Thus, future research may focus on two-regime threshold cointegration, which may be beneficial, as it provides additional information in the form of the threshold, if the objective of the analysis is the development of price transmission mechanisms for structural models.

Apart from assessing the effect of food and trade policies on market integration, threshold cointegration applied in commodity markets of developing countries may also provide a rough indication of transfer costs. Transfer costs in developing country markets may give rise to a threshold over which arbitrage possibilities are obliterated, resulting in an absence of market integration. Thus, a threshold cointegration framework can encompass the possibility of non stationary transfer costs and provide valuable information that can lead to policy prescriptions.

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Annex

Tests for cointegration

Engle and Granger (1987)

Consider the following single equation:

$$p_{1t} = \beta p_{2t} + u_t \quad (\text{a.1})$$

If u_t is non stationary, then $p_{1t} - \beta p_{2t}$ is not a cointegrating relationship. Engle and Granger suggest estimating the above by OLS and applying unit root tests, such as the ADF and Phillips-Perron Z_t or Z_p to the estimated residuals \hat{u}_t , in order to test the null of no cointegration.

The Engle and Granger approach is a single equation method of testing for cointegration, where the cointegrating relationship has to be “normalized” with respect to one of the two variables. For a discussion on the issues related to the Engle and Granger method see Maddala and Kim (1998), Section 5.3.

Johansen (1988, 1991)

Consider a Vector Autoregression (or VAR) of two variables p_{1t} and p_{2t} . A VAR expresses a vector of variables as a linear sum of a set of lags of itself. A simple case of a VAR between two variables is:

$$\begin{pmatrix} p_{1t} \\ p_{2t} \end{pmatrix} = \begin{pmatrix} \mu_1 \\ \mu_2 \end{pmatrix} + \begin{pmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{pmatrix} \begin{pmatrix} p_{1t-1} \\ p_{2t-1} \end{pmatrix} + \begin{pmatrix} v_{1t} \\ v_{2t} \end{pmatrix} \quad (\text{a.2})$$

The issue of cointegration can once again be addressed by looking at the VAR, but extending it to contain a second lag. An example of a VAR(2) would be

$$\begin{pmatrix} p_{1t} \\ p_{2t} \end{pmatrix} = \begin{pmatrix} \mu_1 \\ \mu_2 \end{pmatrix} + A_1 \begin{pmatrix} p_{1t-1} \\ p_{2t-1} \end{pmatrix} + A_2 \begin{pmatrix} p_{1t-2} \\ p_{2t-2} \end{pmatrix} + \begin{pmatrix} v_{1t} \\ v_{2t} \end{pmatrix} \quad (\text{a.3})$$

This has the Vector Error Correction (VECM) representation:

$$\begin{pmatrix} \Delta p_{1t} \\ \Delta p_{2t} \end{pmatrix} = \begin{pmatrix} \mu_1 \\ \mu_2 \end{pmatrix} + (A_1 + A_2 - I) \begin{pmatrix} p_{1t-1} \\ p_{2t-1} \end{pmatrix} + \begin{pmatrix} v_{1t} \\ v_{2t} \end{pmatrix} \quad (\text{a.4})$$

The rank of the matrix $(A_1 + A_2 - I)$ is equal to the number of cointegrating vectors. If the rank of $(A_1 + A_2 - I)$ is equal to two, then both variables can be shown to be stationary. If the rank of $(A_1 + A_2 - I)$ is zero then the series are not cointegrated, whilst if the rank of $(A_1 + A_2 - I)$ is one then the variables are cointegrated.

Therefore, in the case of two variables, cointegration can be tested by testing the significance of the characteristic roots or eigenvalues of $(A_1 + A_2 - I)$. If the variables are not cointegrated the characteristic roots λ_1, λ_2 are equal to zero. Similarly if the rank of $(A_1 + A_2 - I)$ is equal to one, $0 < \lambda_1 < 1$ and λ_2 is equal to zero. Johansen (1988, 1991) derived the distribution of two test statistics for the null of no cointegration referred to as the Trace and the Maximum Eigenvalue test.:

$$\lambda_{\text{trace}} = -T \sum_{i=1}^2 \ln(1 - \hat{\lambda}_i) \quad (\text{a.5})$$

$$\lambda_{\text{max}} = -T \ln(1 - \hat{\lambda}_{n_2}) \quad (\text{a.6})$$

The first statistic tests the null hypothesis that the number of independent cointegrating parameters is less than or equal to two, whilst the second statistic tests the null hypothesis that the number of cointegrating parameters is one against an alternative of two cointegrating parameters.

Error Correction Representation of cointegrated equation or systems

Johansen derived an Error Correction Representation of a cointegrating system. He defined two ($n \times r$) matrices α and β , where n is the number of variables (in the case of price transmission exercise n equals 2) and r the rank of $(A_1 + A_2 - I)$. The properties of these matrices are:

$$(A_1 + A_2 - I) = \alpha\beta' \quad (\text{a.7})$$

The matrix β is the matrix of cointegrating parameters, whilst the matrix α represents the adjustment of the variables towards the long run equilibrium, if it exists. In the case of two variables such as p_{1t} and p_{2t} , the error correction representation or Vector Error Correction Model (VECM) is as follows:

$$\begin{pmatrix} \Delta p_{1t} \\ \Delta p_{2t} \end{pmatrix} = \begin{pmatrix} \mu_1 \\ \mu_2 \end{pmatrix} + \begin{pmatrix} \alpha_1 \\ \alpha_2 \end{pmatrix} (p_{1t-1} - \beta p_{t-2}) - A_2 \begin{pmatrix} \Delta p_{1t-1} \\ \Delta p_{2t-1} \end{pmatrix} + \begin{pmatrix} v_{1t} \\ v_{2t} \end{pmatrix} \quad (\text{a.8})$$

β represents the long run multipliers where a rank restriction has been imposed:

$$\frac{a_{12}}{1 - a_{11}} = \frac{a_{21}}{1 - a_{22}} = \beta \quad (\text{a.9})$$

In this case the lack of a cointegrating relationship would also imply no Granger causality between the series, but only if $A_2 = 0$. More generally, Granger causality does not require cointegration. However, cointegration does imply causality in at least one direction.

Autoregressive Distributed Lag (ADL) Models and Cointegration

An ADL model can be written as:

$$p_{it} = a + \sum_{j=1}^J \beta_j p_{i,t-j} + \sum_{k=0}^K \gamma_k p_{2,t-k} + \varphi T + \varepsilon_i \quad (\text{a.10})$$

where p_{it} , $i=1,2$, are price series, a is an intercept, T is a time trend, and ε_i is the error term.

A key issue in estimating ADLs is the identification of the correct number lag length. Under-parameterization can lead to misspecification, whilst over-parameterization limits the degrees of freedom and increases forecast variance. Normally, the relevant J and K are selected by means for information criteria such as the Akaike, Schwartz-Bayes, the Hannan Quinn, and Log Likelihood.

In the long run equilibrium $p_{1t} = p_{1t-k}, \forall j$ and $p_{2t} = p_{2t-k}, \forall k$ and therefore the long run response of p_{1t} to a change in p_{2t} is given by:

$$\delta_1 = \frac{\sum_k \gamma_k}{1 - \sum_j \beta_j} \quad (\text{a.11})$$

Consequently, the long run equilibrium relationship can be written as follows:

$$p_{1t} = \delta_0 + \delta_1 p_{2t} + u_t \quad (\text{a.12})$$

where

$$\delta_0 = \frac{a}{1 - \sum_j \beta_j} + \frac{\varphi}{1 - \sum_j \beta_j} \quad (\text{a.13})$$

As from (a.13) $1 - \sum_j \beta_j = \frac{\sum_k \gamma_k}{\delta_1}$, the ECM representation of the ADL (a.10) can be written as:

$$\Delta p_{1t} = a - \left(1 - \sum_j \beta_j\right) (p_{1t-1} - \delta_0 - \delta_1 p_{2t-1}) + \sum_{j=1}^J \beta_j^* \Delta p_{1t-j} + \sum_{k=0}^K \gamma_k^* \Delta p_{2t-k} + \varepsilon_t \quad (\text{a.14})$$

where $\left(1 - \sum_j \beta_j\right)$ is the error correction coefficient.

THE IMPACT OF THE DOHA DEVELOPMENT ROUND OF TRADE NEGOTIATIONS ON DEVELOPING COUNTRIES: RESULTS FROM ATPSM¹

Daneswar Poonyth and Ramesh Sharma²

This paper assesses the likely impact of the draft Harbinson modalities, along with the EU and US proposals, for the ongoing agricultural negotiations. The impact is assessed on three country groups: developed, least-developed (LDCs) and rest of the developing countries. A number of indicators are used for the assessment, notably welfare and trade outcomes. Many of the results, simulated with the ATPSM model, are standard and relatively straightforward to explain, e.g. further trade liberalization raises world prices of farm products, lowers producer surpluses in developed countries while consumers gain. The impact on the two developing country groups is mixed, particularly on the LDCs. The US proposal appeared to be most attractive for all three country groups in terms of total welfare, dominated by consumer surpluses. However, the ranking of the modalities varies according to impact indicator, with other modalities appearing more attractive for other indicators. The key result of the study – that total welfare is high due to consumer surplus and not because of producer gains – raises some important questions about the choice of the right impact indicator, and of the trade-offs involved, especially for low-income agrarian economies like the LDCs that must first develop their agricultural sector. For them, agricultural development is the need of the day and this requires sustained gains in producer surpluses. A different ranking of the modalities flows when producer gain is the main impact indicator. The paper presents a range of results and discusses the trade-offs, with the hope that trade negotiators and policy makers find these to be useful as they negotiate for the final form of the modalities.

1. Introduction

The first half of 2003 was a crucial period for the ongoing agricultural trade negotiations in the WTO. End-March was set as the deadline for finalizing modalities for commitments, which would determine the final shape and details of the new agricultural agreement. The Chairman of the WTO General Council, Mr Stuart Harbinson, released draft negotiating modalities in February 2003 and a revised version in March 2003. No agreement was reached on the modalities by end-March and the next deadline for agreement was September 2003 when Ministers met in Cancún. However, for various reasons, this also did not materialize. Some negotiators complained that the agricultural trade liberalization was too ambitious while others said that it was not ambitious enough. Hence it seems that the modalities for further commitment as drafted and revised by Chairman Harbinson is still the basis for further negotiations.

In view of this, there is a heightened interest among all those involved in the negotiations, directly or indirectly, in likely impacts of the modalities, i.e., on questions such as who will lose and by how much, and who will gain and by how much. Of particular concern is the impact of the negotiated outcomes on developing countries, specially the least developed among them, as this round of negotiations is also called a “development” round. The participation of developing countries in the current round of agricultural trade negotiations should be grounded in analytical and empirical understanding of the effects of the current proposals.

¹ ATPSM: Agricultural Trade Policy Simulation Model.

² Daneswar Poonyth and Ramesh Sharma are Economist and Senior Economist, Commodity Policy and Projections Service, Commodities and Trade Division, FAO. The authors would like to thank Alexander Sarris, Director, Commodities and Trade Division, FAO for his support, and Hansdeep Khaira of the Commodity Policy and Projections Service for his contribution to this paper.

This paper has two main objectives. First, it provides quantitative assessments of the likely impacts of the negotiating modalities, in particular the Harbinson draft of March 2003, but also of the European Union (EU) and United States (US) proposals as alternative scenarios. The EU and the US proposals are seen as representing modest and deeper reforms, respectively, relative to the draft proposal of Harbinson. The second objective is to evaluate how the modalities impact on economies, in particular the developing and least-developed countries. Such assessment should indicate, albeit indirectly, whether, or to what extent, the concerns of these countries have been addressed in the modalities. It is hoped that these assessments will provide a sound basis for all parties concerned to ascertain priorities for negotiating efforts.

The paper is also a contribution to the new literature on the assessment of the impact of the proposals and modalities for negotiations in the context of the Doha Round of the WTO, focusing on the three main pillars of the Agreement on Agriculture (AoA), namely domestic support, export competition and market access. Recent model-based assessments of the WTO reform process are Freeman *et al.* (2000), Diao *et al.*, (2001), FAO (2002), FAPRI (2002), OECD (2002), Vanzetti and Sharma (2002) and Vanzetti and Peters (2003).

The paper consists of six sections. Following this introduction, Section 2 presents an overview of the trade concerns of developing and least developed countries in the post-UR AoA period. Section 3 introduces the ATPSM model, including sources of the data and parameters, and the coverage of countries and commodities. Next, Section 4 summarizes negotiating modalities and presents the three scenarios simulated. Section 5 presents simulation results while section 6 concludes with some remarks.

2. Developing country concerns in the post Uruguay Round period

The UR was a milestone in bringing agricultural trade closer to the disciplines of the GATT. All tariffs were bound and rules were developed to govern agricultural trade policies, and quantitative limits were placed on various subsidies. Notwithstanding this achievement, it is also widely held that the immediate trade impact of the disciplines has been minimal, although it is next to impossible to verify this on an *ex post* basis (OECD 2001; Diaz-Bonilla *et al.*, 2001). One major reason for this is that the quantitative limits were set too high for these to be binding on actual policies. This has been the case with domestic and export subsidies, while tariffs on many major commodities were bound at high levels. It is for these reasons that the ongoing round of negotiations is critical for genuine trade reforms that benefit low-cost, non-subsidizing countries.

Although developing countries are not a homogenous group, they share some common features. One is that they provide few trade-distorting subsidies and so would stand to gain from reductions in trade distortions. They are also natural low-cost producers of farm products. Not surprisingly, they have participated intensely during this round of negotiations, and on the whole have called for sharp reductions or even elimination of trade-distorting domestic and export subsidies, as well as improved market access terms.

The international community also feels the challenge. The community has not only expressed concerns over the distribution of gains from farm trade but has also made strong statements calling for measures that ensure that the developing countries gain significantly from trade, especially agricultural trade, in the new round. There are compelling reasons for developing countries to develop their agriculture. Development history shows that very few of the current developed countries reached that status without developing the agricultural sector. The development of this sector is also essential in order to reduce poverty and food insecurity and thus to meet the millennium goals. This would require not only the elimination of present imbalances and inequities in the trade rules but also some effective proactive provisions in favour of these countries. The current Doha Round is called a “development” round, and it is important to ensure that it is truly so.

Improving market access terms is the key objective for all developing countries. The post-UR tariff profile of many developed countries in particular is characterized by relatively high tariffs on temperate-zone food products and lower rates on tropical products. In the UR, tariffs on the former products were cut only modestly compared with the latter products.³ Developing countries also produce and many also export temperate-zone products. These are also the products where markets are still expanding. Bound tariffs are also high in many developing country markets which will affect negatively other developing countries as intra-developing country trade is high and growing. Many developing countries rely on a narrow range of primary products and so it is critical for them to diversify towards processed exports. This requires *inter alia* sharp reductions in tariff escalations, the phenomenon whereby tariffs on processed products rise as the degree of processing increases. The UR did not reduce tariffs significantly (Lindland, 1977; OECD, 1997). There are also many issues relating to Tariff Rate Quotas (TRQs) including access to quotas and rules of administration. Last but not least, tariffs have to be simplified as the UR reforms left many complex tariffs, especially in several developed countries.

Despite these common interests, it is also useful to note that in some areas developing country interests are not so similar. In WTO, some country groups were defined formally (e.g. Net Food Importing Developing Countries, NFIDCs) while in other cases alliances developed sharing common interests (e.g. the Cairns Group, Friends of multi-functionality, Small Island Developing States (SIDS) etc.). The NFIDCs, for example, are concerned about the possibility of negative effects in terms of the access to food in global markets on reasonable terms following trade liberalization. Several others are concerned about deteriorations in market access terms and loss of export earnings as MFN (most-favoured nation) tariffs are reduced in preference-giving countries. Loss of tariff revenue, following tariff reductions, is also a common concern for many.

For all these reasons, there is much at stake for these countries in the Doha Round. This is called a “development” round and so it is important that developing country concerns are fully taken into account and that they stand to gain from further reforms. Hopes are pinned in the Harbinson modalities. As the modalities are being debated in order to reach a negotiated agreement, questions are asked whether this package satisfies the “development” criterion. It is not straightforward to answer those questions, for both technical and other reasons. For one thing, the package includes many trade policy instruments and it is often not a simple task to quantify their impacts as there are important interactions among them. It is for this reason that models are essential for such an assessment. Model results are often criticized for not being accurate to the extent desired, but they have been very useful and there is no alternative.

3. The ATPSM model

Developed jointly by UNCTAD and FAO, the Agricultural Trade Policy Simulation Model (ATPSM) is a global trade model designed primarily for simulating agricultural trade policies, notably in the context of the UR Agreement on Agriculture. The primary objective is thus to assist trade negotiators, policy analysts and others interested in the assessment of the effects of various negotiating proposals and of the Agreement itself once negotiated. An unique advantage of this model over other models of this type is that it covers virtually all countries, including LDCs. It can simulate the effects of a range of trade policy instruments, notably:

- Reduction of out-of-quota (or MFN) tariffs, either by a certain percentage, or with the tariff harmonizing Swiss formula
- Reduction of in-quota tariffs
- Expansion of TRQ volumes

³ See Table III.2 in WTO (1999) for reduction rates. Some of the reduction rates could be misleading. For example, tariffs on tropical products were reduced the most but from a very low base (e.g. 5 – 10 percent). The effect on trade would be much less than, say, 26 percent reduction from a very high base.

- Reduction of domestic subsidies
- Reduction of export subsidies.

The model is also flexible in that a user can define his/her own groups of countries and commodities (e.g. cereals). Different reduction rates can be applied to selected countries and commodities, individually or to groups. This is a very useful advantage for analyzing the impact of, for example, special treatment to some countries and/or commodities.

3.1 Model characteristics

The ATPSM is a comparative-static, synthetic, multi-commodity, multi-region, partial-equilibrium world trade model for agricultural products. It also accounts for the distribution of quota rents, solves for equilibrium world market prices and their impact on domestic production and trade flows. It explicitly covers 161 countries (160 individual countries and the EU-15, treated as one country). For the purpose of this paper, all countries are grouped into three categories, namely LDCs, the rest of the developing countries (RDC) and developed countries (DD), using per caput income levels from the World Bank. Of the 161 countries, 42 are LDCs, 99 RDCs and 20 DDs (Annex 1). The model is also fairly comprehensive in its commodity coverage, a total of 36 commodities (Annex 2).

All policy instruments are defined in ad valorem equivalents terms. Thus, specific tariffs are converted to ad valorem rates and both domestic and export subsidies are similarly expressed in their respective ad valorem equivalents.

Production (domestic supply) and demand depend linearly on domestic prices. Imports clear the market. The world prices are linked to domestic prices by price transmission equations. The price transmissions are assumed to be complete. Both demand and supply specifications account for cross-effects. The demand function for country r and commodity i is expressed as:

$$\hat{D}_{i,r} = \eta_{i,j,r} [\hat{P}_{wt} + (1 + \hat{t}_{ci,r})] + \sum_{\substack{j=1 \\ j \neq i}}^J \eta_{i,j,r} [\hat{P}_{wj} + (1 + \hat{t}_{cj,r})] \quad (1)$$

Domestic supply for country r and commodity i is similarly expressed as

$$\hat{S}_{i,r} = \varepsilon_{i,j,r} [\hat{P}_{wt} + (1 + \hat{t}_{pi,r})] + \sum_{\substack{j=1 \\ j \neq i}}^J \varepsilon_{i,j,r} [\hat{P}_{wj} + (1 + \hat{t}_{pj,r})] \quad (2)$$

The import and export functions are expressed as

$$\Delta M_{i,r} = D_{i,r} \hat{D}_{i,r} - S_{i,r} \hat{S}_{i,r} + \Delta X_i$$

$$\text{and } \Delta X_{i,r} = \gamma_{i,r} \Delta S_{i,r}$$

where: D , S , X , and M denote demand, supply, exports and imports, respectively: $\hat{}$ denotes a relative change and Δ absolute changes, P_w denotes world price, t_c denotes the domestic consumption tariff and t_p denotes the domestic production tariff, ε denotes supply elasticity, η denotes demand elasticity, γ the ratio of exports to production, i, j are commodities indexes and r is a country index.

Thus there are four equations for each country. The export equation implies that the change in export in each market is some proportion of the change in production. This proportion is determined by the ratio of exports to production. For example, if half of the initial production is exported, half of the change in production is also exported, i.e. the proportion of exports to production is maintained. Finally, imports clear the market, i.e., production plus imports equals domestic consumption plus exports. Domestic prices are determined as a function of the world market prices and policy variables, e.g. support

measures, tariffs, subsidies and quotas. Model parameters are assembled from several sources, but mainly from the FAO World Food Model (WFM).

Trade revenue and welfare effects are computed based on volume responses (i.e., ΔX , ΔM , ΔS , and ΔP) and price changes. The trade revenue effect of a policy change is computed for each country and commodity as follows:

$$\Delta R = (P_w + \Delta P_w)[(X + \Delta X) - (M + \Delta M)] - P_w((X - M))$$

Total welfare is the sum of producer surplus, consumer surplus and government revenue, i.e. $\Delta W = \Delta PS + \Delta CS + \Delta NGR$. Following a simulation, a change in total welfare consists of the changes in these three components.⁴ The changes in producer and consumer surpluses depend on changes in domestic market prices and changes in production and consumption quantities. The former also takes into account the change in the quota-rent received. Quota rents, U , are computed for each country and commodity as follows - the volume of imports times the world price times the difference between the in-quota and out-quota tariffs, i.e.

$$U = QP_w(t_{m2} - t_{m1})$$

where Q denotes the import quota, P_w the world price, t_{m1} and t_{m2} the in-quota and out-quota or applied tariff rates. Rent accrues only if the importing country is applying the out quota tariff rate. The capture rate, c , is the proportion of the rent captured by exporting producers as opposed to the proportion, $1-c$, going to the importing country. The change in quota rent received, $c\Delta U$, is added to producer surplus. For each country and commodity, producer and consumer surpluses are defined as:

$$\Delta PS = \Delta P_p [S + 0.5(\Delta S_d)] + c\Delta U$$

$$\Delta CS = -\Delta P_c [D + 0.5(\Delta D_d)]$$

Change in net government revenue (ΔNGR) includes a change in tariff revenue, change in export subsidy expenditure, change in domestic support expenditure and change in quota rent not received by exporters. For each country and commodity, $\Delta NGR = \Delta TR - \Delta ES - \Delta DS + (1-c)\Delta U$, where TR is tariff revenue, ES is export subsidy expenditure, DS is domestic support expenditure and $(1-c)\Delta U$ is change in quota rent foregone.

The model generates outputs in terms of both changes in quantities and percentage changes from the base period for the following variables.

- Quantities - production, consumption, imports and exports (X , M , S , and D)
- Trade values - export, import, and net trade balance
- Welfare effects - producer surplus, consumer surplus, government revenue and total welfare
- Prices - world market prices, and wholesale (consumer) and farm prices.

3.2 Data sources

The model is based on data from various sources. The quantities of production, consumption, export and imports (in metric tonnes) are from FAOSTAT (Supply and Utilization Accounts and Trade Domain data). All prices are expressed in US dollars and are assembled from various sources. The base period for the model is 1998-2000 for production, imports, exports, etc. while tariffs and other policy parameters are based on the final year of implementation of the UR AoA (2000 for developed and 2004 for developing countries). In-quota tariffs, out-quota tariffs and global quotas are from the AMAD⁵

⁴ A change in net government revenue, ΔNGR , is measured as within-quota and out-quota tariff revenue less export subsidy and domestic support expenditures and quota-rent foregone.

⁵ AMAD: Agricultural Market Access Data Base, <http://www.amad.org/files/index.htm>

database and were aggregated to the ATPSM commodity levels. UNCTAD COMTRADE⁶ is the main source for bilateral trade flows, while applied tariffs are from the TRAINS⁷ database.

3.3 Model limitations

All commodities are assumed to be tradable, i.e. there is no independent behaviour for domestic prices. There are no other domestic policies besides the Amber Box subsidies. All agricultural commodities are assumed to be homogeneous and so there is perfect substitution among goods produced in different countries, an assumption that may not always hold.

Similarly, the model does not account for the possibility of countries exerting market power, though it is well known that international trade of several agricultural products is often concentrated in a small number of companies. Being a comparative static model, all non-price developments in supply and demand are not captured. Finally, there is no income variable in the model.

An important assumption is that within-quota tariffs are not relevant even where quotas are unfilled. This means that the higher out-quota tariffs or applied rates, whichever is operative in a particular situation, are the key determinants of domestic prices. This assumption tends to overstate the benefits of liberalization, as there may be cases where in-quota rates are the relevant determinants of domestic prices. ATPSM does not account for preferential access and trade diversion. Bilateral quotas are allocated by a complex procedure based on each country's import and export shares. Quota rents are distributed in proportion to trade flows.

4. Negotiating modalities and simulation scenarios

During 1999-2002, the so-called “proposal harvesting phase” in the WTO negotiations on agriculture, a total of 44 negotiating proposals were submitted by individual countries or country groups. As the process entered the “modalities” phase in the second half of 2002, some countries submitted modalities.⁸ In December 2002, Chairman Harbinson released an overview of the negotiating modalities,⁹ and subsequently in February 2003 a draft negotiating modality. This was further revised and released in March 2003. This Harbinson text takes into account various proposals and modalities, and has been the subject of much debate. This text was expected to be modified further in Cancún, but failure to reach a consensus there left many negotiators wondering about the outcome of the next round of trade talks in Geneva.

Although the focus of this study is on the Harbinson modalities, the EU and US modalities are also analyzed in view of *inter alia* these being among the few modalities on the table, the weights these two proposals carry in these negotiations and also because they represent to a large extent both modest and deeper reforms, relative to the Harbinson text, and so are interesting for comparing results.

The final modalities for further commitment which were expected to be an outcome of the negotiations in Cancún did not materialize, and it was not expected that much would be on the table in the following months. However the basis of the negotiating modalities for further commitment would remain substantially the same as the revised version of March 2003. In what follows, the main elements of these modalities are introduced in brief, followed by the three scenarios constructed for simulations based on the three proposals.

⁶ COMTRADE: <http://unstats.un.org/unsd/comtrade/>

⁷ TRAINS: <http://r0.unctad.org/trains/>

⁸ Unlike the proposals, which express positions and reform measures in a broad manner, the modalities are much more specific, for example in matters such as reduction rates and formulae.

⁹ WTO Document TN/AG/6, 18 Dec 2002.

4.1 *The modalities*¹⁰

Market access. The key US proposal on tariffs was the use of a harmonization formula that would reduce higher tariffs more deeply than lower tariffs. For this, the Swiss formula was proposed, with a parameter of 25. This means that all tariffs are reduced to below 25 percent. For example, an initial tariff of 100 percent would fall to 20 percent and a tariff of 10 percent to 7 percent. The other key proposal was to apply the formula to applied tariffs. The EU proposal was for the continuation of the UR approach, i.e., 36 percent average reduction with a minimum 15 percent cut for each tariff line. The reductions are to be applied to bound tariffs. The Harbinson draft proposed three different reduction rates for developed countries depending on the level of the initial tariff (and four bands for developing countries). Box 1 shows these bands and reduction rates in detail. This proposal also leads to harmonization of tariffs to some extent because higher rates are reduced proportionally more than lower rates. It also has the average-minimum feature of the EU proposal. The US proposal does not say anything about special and differential treatment for developing countries.

As regards TRQs, the Harbinson proposal called for expanding volumes up to 10 percent of current domestic consumption (6.6 percent for developing countries). Some proposals have been made for in-quota tariffs also. The US proposed elimination of the in-quota rate and a 20 percent expansion of the TRQ volumes. The EU modalities did not propose any increase in the TRQ volume.

Domestic support. The US proposal is for the reduction of total non-exempt domestic support (which includes in the US definition both the Amber Box and the production-limited Blue Box support) to at most 5 percent of the average value of agricultural production in the base period 1996-98, to be implemented over a five-year period. It further proposed maintaining the current de minimis threshold (5 percent of the value of agricultural production). The EU proposed maintaining all the three Boxes (Amber, Blue and Green). The Amber Box aggregate measure of support (AMS) to be reduced by 55 percent, while eliminating the de minimis provision for developed countries. Harbinson's proposal is for reducing the AMS by 60 percent over five years for developed countries and by 40 percent over ten years for developing countries. It also proposes reducing de minimis by 50 percent over five years for developed countries but maintaining it for developing countries.

Export subsidies. The US proposal is for complete elimination of export subsidies over a five-year period. Export taxes are to be phased out in developed countries and if export taxes are used in a developing country, it should be applied uniformly across all agricultural commodities. Furthermore, United States proposed that export credits need to be further disciplined. The EU proposed a "substantial" but unspecified cut in the volume of subsidized exports and 45 percent reduction in subsidy outlays. Harbinson's proposal is to reduce export subsidies using the following formulae:

$$\text{Budgetary outlay, } B_j = B_{j-1} - C * B_{j-1}$$

$$\text{Volumes subsidized, } Q_j = Q_{j-1} - C * Q_{j-1}$$

where j is the implementation year. The value of C is 0.3 for developed countries (to be reduced over a five year period and then eliminated) and 0.25 for developing countries (reduced over 10 years and eliminated in the eleventh).

Other proposals. As said earlier, the modalities contain proposals in several other areas that are not easy to quantify and so are not discussed in this paper. These include, for example, rules on TRQ administration, state trading enterprises, non-direct forms of export subsidies, Green Box measures, "non-trade" concerns, and so on. These are obviously important provisions and could have significant impact on outcomes, but are not as easy to study within a quantitative framework.

¹⁰ The presentation of modalities in this section is not comprehensive, interested readers should refer to the original WTO modalities documents.

4.2 Scenarios simulated

Box 1 summarizes the parameters selected for simulations. For obvious reason, these are those proposals in the modalities that are amenable to quantitative analysis with the ATPSM. Thus, some elements of the modalities are not included in the model simulations, and it is not clear to what extent this will bias the results. However, the scenarios cover all the most important parameters and so the bias should be small. Some of the elements not currently included could be modelled with further technical improvement of the model, but that is left for the future. It is important to note that the EU scenario includes its preferential market access package for the LDCs, called “Everything But Arms” (duty-free and quota-free imports).

Box 1 Modalities parameters used in simulations¹	
HARBINSON PROPOSAL	
Tariff:	<p>Developed countries 3 band reduction formula</p> <p>tariff > 90 reduction of 60 percent with a minimum 45 percent</p> <p>15 < tariff ≤ 90 reduction of 50 percent with a minimum 35 percent</p> <p>tariff < 15 reduction of 40 percent with a minimum 25 percent</p> <p>Developing countries 4 band reduction formula</p> <p>tariff > 120 reduction of 40 percent with a minimum 30 percent</p> <p>60 < tariff ≤ 120 reduction of 35 percent with a minimum 25 percent</p> <p>20 < tariff ≤ 60 reduction of 30 percent with a minimum 20 percent</p> <p>tariff < 20 reduction of 25 percent with a minimum 15 percent</p>
TRQ:	No change in in-quota rates, Expand TRQ up to 10 percent of the current domestic consumption for developed countries and 6.6 percent for developing country. LDCs exempted.
Domestic support:	60 percent cut in Amber Box for developed country, 40 percent for developing country. No reduction for LDCs
Export subsidies:	Eliminate
US PROPOSAL	
Tariff:	Swiss formula with parameter 25 on applied tariffs
TRQ:	No cuts in in-quota rates, 20 percent in expansion TRQ volume
Domestic support:	Reduce to 5 percent of the value of agricultural production
Export subsidies:	Eliminate
EU PROPOSAL	
Tariff:	15 percent minimum cut, 36 percent on average
TRQ:	No cuts in in-quota rates, No expansion in TRQ volume
LDC:	Duty and quota free access for LDCs
Domestic support:	55 percent cut in Amber box, (two thirds for developing countries, no cut for LDCs)
Export subsidies:	45 percent reduction (two third for developing and LDCs)
<p>¹ The full text of the Harbinson proposal can be found at http://www.wto.org, document number TN/AG/W/1/Rev., dated 18th March 2003, for the EU proposal, and the US proposal.</p>	

The ATPSM is designed to simulate the effects of the Swiss formula, and so this is not an issue. There are, however, some areas where incorporating the scenario parameters is not as simple. For example, simulating tariff reductions in the Harbinson proposal requires first the grouping of commodities into the three and four tariff bands as per tariff rates. Even then, it is not possible to implement the “minimum-average” reduction rule, because it cannot be known in advance how individual countries will select tariff lines for the minimum reduction. This limitation also applies to the EU proposal. In case of export subsidies, the EU proposal merely says a “substantial” reduction in export volumes without specifying the exact number. In the simulation, the same 45 percent as for budgetary outlay is also assumed for quantities. Finally, additional work was needed to incorporate the duty-free and quota-free market access terms to the LDCs in the EU scenario.

5. Simulation results

This section reports assessments of the likely impacts of the three scenarios, representing the Harbinson, the US and the EU proposals. Most of the main results are expressed as percentage change from the base levels. Also reported is the information on “winners and losers”, i.e. the number of individual countries that gain or lose in various ways.

It is useful at this stage to take note of the commonly stated scepticism about model-based results. The sceptics argue that global trade models often give different assessments, and messages, at times widely different for even seemingly similar reform. This is true to some extent, but not entirely so. For example, most studies of this type point to the same direction for changes in world market prices, at times even to similar magnitudes, e.g. the impacts on temperate-zone food products versus those on tropical products. But differences do also occur. There are several reasons for this, which are worth noting in reviewing the results.¹¹ For example, models differ with respect to structure, specification and parameters. Models also differ greatly in terms of aggregation, both of countries and commodities, which tend to cancel out some effects that would be evident in more disaggregated models. The elements of a simulated reform package could also be different, and even weights attached to particular instruments could vary. Nevertheless, there is no alternative to model-based assessments.

5.1 Impact on world market prices

Often, it is changes in world market prices that drive other results, and so this has to be the starting point. Table 1 shows the impact on world market prices, measured as percentage change from the base period levels. There are three main messages here. First, on the whole, the impact is large on most temperate-zone commodities such as beef, sheepmeat, dairy products, sugar, wheat and vegetable oils, in all three scenarios. This is an expected result, as these are the commodities receiving high levels of protection and support. Other studies do also point to similar impacts. For example, the USDA study (Diao *et al.*, 2001) showed large increases in world prices under full policy reform (18 percent for wheat, 15 percent for other grains, 22 percent for butter and 12 percent for beef). The impact was small (e.g. 3.4 and 1.4 percent for wheat and other grains) under slight reductions in domestic support and tariffs. The study of Diao *et al.*, (2001) full policy reform scenario is closer to the US scenario in this paper. Similar effects were noted in a recent FAPRI study analyzing the impact of the Doha Round reforms (FAPRI, 2002). By contrast, impacts on tropical product prices were modest, which was expected result.¹²

Second, looking at the results across the three scenarios, the impact is most pronounced under the US scenario, also expected in view of the sharp reductions in tariffs in particular but also elimination of domestic support and exports subsidies. Unlike the other two proposals, the US one is based on cuts in applied rates, which are much lower already for developing countries. These price rises are on average twice the levels under the EU proposal, while those under the Harbinson proposal lie in between the two scenarios. There are some cases where this pattern does not hold strictly.

Third, it is already possible to guess, based on the extent of the changes in world prices, the direction of the impact on some of the national level indicators, like trade and welfare. Thus, the change in the terms of trade would be unfavourable for developing countries to the extent they import basic foods and export tropical products.

All elements of the reform package contribute to the price change, but tariffs play a dominant role, especially the sharp reduction for developing countries resulting from the US scenario.

¹¹ Sharma *et al.* (1996) identify a number of factors in their review of models and results in the context of assessing the impact of the UR AoA.

¹² It is also remarkable that the direction and even the extent of these impacts are not very different from those assessed in the context of the impact of the UR Agreement back in 1995 and 1996. See Sharma (1996) for that review.

Table 1. Impact on world market prices (percent change from base levels)

	US Proposal	EU Proposal	Harbinson Proposal
Bovine meat	7.8	3.2	6.0
Sheep meat	9.6	4.2	6.0
Pig meat	3.4	1.8	2.6
Poultry	5.8	1.9	2.5
Milk, fresh	10.3	4.4	6.0
Milk, concentrated	18.1	7.0	13.7
Butter	24.3	10.6	20.2
Cheese	16.0	7.3	13.0
Wheat	11.9	5.4	10.8
Rice	2.5	1.0	1.6
Barley	2.8	0.8	1.5
Maize	4.4	1.6	2.7
Sorghum	0.8	0.3	0.6
Pulses	3.2	0.7	2.7
Tomatoes	3.1	1.6	2.1
Roots & tubers	3.5	1.0	0.9
Apples	3.6	1.9	2.3
Citrus fruits	1.5	0.8	1.1
Bananas	1.2	0.7	0.9
Other tropical fruits	2.5	1.1	2.3
Sugar	9.2	3.3	4.7
Coffee green	1.2	0.5	0.8
Coffee roasted	0.5	0.2	0.3
Coffee extracts	6.8	0.3	3.7
Cocoa beans	0.3	0.1	0.2
Cocoa powder	1.3	0.7	1.0
Cocoa butter	0.5	0.7	0.7
Chocolate	6.1	3.4	4.7
Oilseeds	1.2	0.8	1.0
Cotton linters	1.5	0.8	1.4
Vegetable oils	7.2	1.3	3.4

Source: Simulation results.

5.2 Impact on total welfare

As explained in Section 3.1, total welfare or surplus (TS) in the ATPSM is the sum of producer and consumer surpluses (PS and CS respectively) and government revenue. This sub-section summarizes the overall impact of trade liberalization on country groups in terms of the TS; impacts on the three individual components of the TS are discussed separately in some detail in the following sub-sections and so these should be read for further insights. Table 2 shows the results, whereas Annex 3, Table 1 gives the results by country groups and commodities.

Table 2. Change in total welfare by country groups (billion US\$)

	US Proposal	EU Proposal	Harbinson Proposal
World	24.17	12.14	18.82
DD	21.73	12.97	19.51
RDC	1.54	-0.80	-0.37
LDC	0.89	-0.03	-0.32

Source: Simulation results. All monetary values are in US dollar terms. DD= Developed countries, RDC = Rest of developing countries, LDC =Least developed countries.

Results for both the Harbinson and EU scenarios show a similar pattern in terms of the direction of change (positive or negative), while this is somewhat different in the US scenario. Focusing on the developing countries and the former two scenarios, the results show both groups of countries losing in TS term although the magnitude of the loss is small. The loss in TS is the result of the sum of the losses in CS and government revenues exceeding the PS gain. In case of the LDCs, the main reason for the CS loss is that since they are not required to reduce tariffs, the high world prices are transmitted to consumers in full; had tariffs been lowered, these would have offset some of the effects of higher world prices.

In the case of the rest of the developing countries,¹³ the expectation would be that the effect of the higher world prices on CS would be moderate as these countries reduce import tariffs. But the CS still turned out to be negative for them, which is somewhat surprising. This means that the reduction in the operative tariff in the model (that is, the lower of the applied or bound tariffs) was not large enough to more than offset the effect of the higher world price. Producer surpluses for the two developing country groups are positive. This is easier to explain – as tariffs did not decline or did not fall sufficiently, the higher world prices were transmitted to domestic markets almost entirely, leading to positive PS. As for government revenues, the negative effect was because imports declined as world prices rose (while tariffs remained the same or fell only slightly).

The results under the US scenario for the two developing country groups are interesting in that TS is positive. Importantly, the positive TS gain for the LDC is due to CS gain since the impact on PS is negative, which is in contrast to the other scenarios (see Table 4 below). This is explained by the fact that the LDC do reduce tariff in the US scenario. As a result, domestic prices do not rise by as much, and so the CS is positive while PS is negative.

It is relatively straightforward to explain the impact on developed countries. They experience TS gains in all three scenarios, due to gains in both CS and government revenues which together more than offset the large PS losses. These are all expected results, and are explained further below. Briefly, the PS loss is due to the sharp reduction in tariffs which lowered domestic prices despite the increased world prices. The significant increases in government revenues reflect reduced expenditures on domestic and export subsidies. The bulk of the welfare gains to developed countries come from commodities receiving high support and protection such as wheat, rice, and livestock products see Table 4. The much larger impacts in the US scenario are due to both elimination of subsidies and steep reduction in tariffs.¹⁴

Table 3 shows the number of countries experiencing TS gain and loss. Among the three scenarios, the Harbinson proposal shows the highest number of losers, a total of 114 countries out of 161, 73 of them being rest of the developing countries. However, the magnitude of the loss itself is small, as PS and CS typically tend to cancel out. For example, the TS loss is only US\$0.32 billion for Mexico and US\$0.3 billion for China. The EU scenario results in the lowest number of losers, only 97 countries, of which 69 are from the rest of the developing countries group, 21 LDCs and 7 developed countries.

Table 3. Winners and losers: total welfare

US proposal		EU proposal		Harbinson proposal	
Losers	Winners	Losers	Winners	Losers	Winners
7 DD	13 DD	7 DD	13 DD	8 DD	12 DD
71 RDC	28 RDC	69 RDC	30 RDC	73 RDC	26 RDC
23 LDC	19 LDC	21 LDC	21 LDC	33 LDC	9 LDC

Source: Simulation results. DD= Developed countries, RDC =Rest of developing countries, LDC = Least-developed countries.

¹³ Note that this group is the “rest” of the developing countries, i.e. excluding the LDCs.

¹⁴ It is worth noting that applied tariffs are similar to bound rates for developed countries in general while applied rates are lower than bound rates for developing countries - hence the asymmetry in some of the results.

5.3 Consumer and producer surpluses

Consumer and producer surpluses are useful welfare indicators on their own. These are also interesting from the standpoint of the political economy. Governments often attach different importance to these gains. In general, producer gains are preferred in practice. Although agriculture is at times found to be taxed, many developing country policy makers would like to support the sector in view of its importance for economic growth and poverty reduction. Most developed countries also attach greater weight to the PS gain, perhaps for other reasons.

Table 4 shows estimated PS and CS values for the three scenarios. The developed countries are seen to experience losses in PS terms and gains in CS terms in all three proposals. The gains more or less offset the losses, with one exception in the US scenario where the CS gain is markedly higher than the PS loss. It is straightforward to explain this outcome. With liberalization, the high level of support and protection currently accorded to agriculture in these countries declines, leading to massive PS losses (lower producer prices and reduced production). This is also obvious from the estimates of the gains and losses associated with individual commodities.

Table 4. Change in consumer and producer surplus (in billion US\$)

Group of countries	US Proposal		EU Proposal		Harbinson Proposal	
	Consumer subsidy	Producer subsidy	Consumer subsidy	Producer subsidy	Consumer subsidy	Producer subsidy
DD	82.0	-66.8	33.8	-29.7	61.6	-55.0
RDC	-14.0	21.4	-9.5	9.2	-20.3	21.2
LDC	4.5	-3.1	-1.5	1.5	-2.0	-1.8

Source: Simulation results.

The opposite is the case for rest of the developing countries – they lose in CS but gain in PS in all three scenarios. Both the Harbinson and US results show similar PS gains, about US\$21 billion, but only half that amount in the EU scenario. For LDCs, there is an outlier to this pattern – they lose in PS term in the US scenario, and significantly so, about US\$3 billion, but gain (about US\$1.6 billion) in the other two scenarios. The main reason for this loss, as noted before, is that in the US scenario the LDCs also reduce tariffs and so farm prices decline. By contrast, in the other two scenarios, although tariffs decline they do not fall so far as to lower domestic prices much given the rise in world prices.

Thus, overall, if developing countries were to place greater importance on the PS gain, the Harbinson and US proposals appear attractive, as these gains are about twice the levels under the EU proposal. For the LDC on the other hand, the best outcome from the PS standpoint seems to be the Harbinson proposal, as they lose in the US proposal. Tables 2 and 3 in Annex 3 show the results for producer and consumer surplus by country group and commodity.

Table 5 shows the number of winners and losers. Considering the case of the two developing country groups, the results show that an overwhelming majority of them (about 115 countries) gain in PS term under the EU and Harbinson scenarios, versus only 88 gainers under the US proposal. Out of 42 LDCs, 39 gain under the EU and Harbinson proposals. The opposite result holds somewhat in the case of the CS gain – 56 developing countries combined gain on this account under the US proposal and only half as many under the EU and Harbinson scenarios.

Table 5. Winners and losers: consumer and producer surplus

	US proposal		EU proposal		Harbinson proposal	
	Losers	Winners	Losers	Winners	Losers	Winners
Consumer surplus (CS)	8 DD 60 RDC 25 LDC	12 DD 39 RDC 17 LDC	7 DD 80 RDC 39 LDC	13 DD 19 RDC 3 LDC	8 DD 71 DG 39 LDC	12 DD 28 RDC 3 LDC
Total	93	68	126	35	118	43
Producer surplus (PS)	38 RDC 15 LDC 11 DD	61 RDC 27 LDC 9 DD	25 RDC 1 LDC 12 DD	74 RDC 41 LDC 8 DD	26 RDC 1 LDC 12 DD	73 RDC 41 LDC 8 DD
Total	68	97	38	123	39	122

Source: Simulation results.

In summary, two points may be noted. First, the results show differing gains and losses under the three proposals, at times markedly so, and mostly in opposite directions. This is useful information for trade negotiators and policy makers to assess the outcomes, as they often attach different weights to the two sources of welfare gains. Second, the results raise the issue of compensation, as is well known in welfare economics. There are two dimensions to this issue. One is compensating winners and losers within a country (i.e. between the PS and CS gainers and losers). The other is compensation at the world level. Given the results, it is clear that governments need to take into account the issue of social cost to particular population groups during the reform process. At the world level, the framework for compensation is not as developed. Nevertheless, this is one area worth pursuing within the WTO framework.¹⁵

5.4 Government revenue

In the ATPSM, a change in government revenue results from changes in tariff revenues, expenditures (namely, domestic and export subsidies) and the part of the quota rent not received by exporters. For a large number of developing countries, tariff revenue accounts for a large share of total revenue - in the 10-20 percent range for many, and considerably more in several cases (Weisbrot and Baker, 2002). The impact on revenue of reduced domestic support and export subsidies is obvious - these show up in the model in the form of increased revenue. Reduced import tariffs (export taxes) typically lower border revenues but it may also be the case that these reductions could actually lead to higher border revenues if lower tariffs lead to higher imports (or more exports) to the extent that the overall revenue is higher. In the model, changes in trade flow also depend upon world prices, and thus there are some interesting interactions at play.

Table 6 reports impacts on government revenues. Turning first to the simpler case of developed countries, revenues increase substantially under all three scenarios. The explanation is simple - most of this is due to reductions in government expenditures on domestic and export subsidies. This is also clear from Annex 3, Table 4, which shows that most of the increases in government revenues came from products that received large subsidies in the base period. Reduced import tariffs also play some role, but a relatively small one for these countries. Increased revenue is about US\$13 billion under the Harbinson proposal, and US\$9 and US\$6 billion under the EU and the US scenarios respectively.

¹⁵ The WTO Marrakesh Ministerial Decision on Measures Concerning the Possible Negative Effects of the Reform Programme on Least-Developed and Net Food-Importing Developing Countries (the *Decision*) is seen by many as a form of compensation, a response to some countries losing during the process of liberalization. Unfortunately, progress towards its effective implementation has been mired by controversies ever since the *Decision* was taken.

Table 6. Impact on government revenue (in billion US\$)

Country groups	US Proposal	EU Proposal	Harbinson Proposal
DD	6.49	8.92	12.90
RDC	-5.84	-0.47	-1.30
LDC	-0.44	-0.03	-0.105

Source: Simulation results

In the case of the two developing country groups, the impact of all three proposals is negative, i.e. there are revenue losses, although magnitudes differ for obvious reasons. Since these countries grant few domestic and export subsidies (none in the case of the LDCs), almost all of the observed effects are due to changes in border revenues, notably tariff revenues. As said earlier, the net effect is the outcome of two factors, average tariff rate and trade volume. The former is obviously lower after liberalization. As for the second, while higher world prices discourage imports, lower tariffs typically have the opposite effect. Given that the revenues declined, it is obvious that import volumes did not rise enough to more than offset the effect of the lower tariffs. In particular, it seems that the substantively reduced revenues for the rest of the developing countries (US\$5.8 billion) under the US scenario was due to both marked declines in import volumes (as import prices rose sharply) and much lower tariff rates after the reform. In general, the decline in government revenue is least under the EU proposal, i.e. one-third less than in the Harbinson proposal and several times less under the US scenario.

These results show the possibility of significant negative effects that many developing countries have been expressing as a matter of concern for them in the context of trade liberalization. Faced with these prospects, they are often advised to diversify into other forms of taxation. But this is often more easily said than done for a majority of these countries if one takes into account administrative and other costs involved in raising these taxes. In any case, the results show that it is important that this aspect is taken into account in considering alternative proposals for trade liberalization.

Table 7 provides further information in terms of the number of countries that lose or gain on this account. It shows that 81 percent, 74 percent and 71 percent of the developing country group face reduced government revenues under all three proposals, while a majority of developed countries show gains.

Table 7. Winners and losers: government revenue

US proposal		EU proposal		Harbinson proposal	
Losers	Winners	Losers	Winners	Losers	Winners
9 DD	12 DD	7 DD	14 DD	9 DD	12 DD
86 RDC	13 RDC	77 RDC	22 RDC	73 RDC	26 RDC
28 LDC	13 LDC	26 LDC	15 LDC	27 LDC	14 LDC

Source: Simulation results.

5.5 Impact on export earnings, import cost and trade balance

In the model, the two key factors that determine changes in export earnings and import bills following a policy reform are changes in world market prices and tariff rates, which influence trade flows. Table 8 shows the results. With the exception of two cases for LDCs, both export earnings and import costs increased for all country groups and scenarios. Although the changes in world prices are common to all country groups, the impact on trade flows varies according to changes in tariff rates and to differences in commodity composition. The developed country group experiences deteriorations in trade balance in all three scenarios, significantly so in the Harbinson and US proposals, as import bills rise markedly

over export earnings. This is explained mainly by generalized contractions in export volumes as production shrinks when farm support is lowered and the market is opened. Import bills would have increased even if import volumes did not increase much, due to the effect of the world price.

Table 8. Change in export revenues, import costs and trade balance(billion US\$)

	Change in export revenue (a)	Change in import cost (b)	Change in trade balance (a -b)
US proposal			
DD	11.4	26.8	-15.4
RDC	28.7	12.0	16.7
LDC	1.2	2.5	-1.3
EU proposal			
DD	4.3	13.1	-8.8
RDC	9.8	1.8	8.0
LDC	0.6	-0.1	0.7
Harbinson proposal			
DD	7.3	23.5	-16.2
RDC	17.2	2.0	15.2
LDC	0.9	-0.1	1.0

Source: Simulation results.

As for the rest of the developing countries, they too experience increases in both export revenues and import bills in all three scenarios, as above. However, and in contrast, for them the increase in export revenue more than offsets the rise in import bills and, as a result, the trade balance improves. As above, the increases are significantly higher under the Harbinson and US scenarios. The main reason for the modest rises in import bills is contraction in consumption and hence in imports, due to higher prices.¹⁶ By contrast, export earnings rose because both exports and world prices increased.

In the case of the LDCs, the direction of the impact differs in three places relative to the case of the rest of the developing countries (negative signs in the table). The underlying reasons behind these effects on LDCs have been discussed throughout this section. Since the LDCs do not reduce tariffs, higher world prices raise domestic prices fully. This causes consumption, and thus imports, to contract. Despite the high world price, the net effect was reduced food import bill in the two scenarios. In the case of the US proposal, as said earlier, even the LDCs reduce tariffs and hence the effect is similar to that seen for other countries. The reason for higher export earnings is obvious.

Table 9 reports the number of winners and losers under the three scenarios. These show 75 winners in the rest of the developing country group under the US proposal, 76 under the EU proposal and 75 under the Harbinson proposal. Overall, thus, there are significantly more winners than losers.

¹⁶ This is also reflected in the significant losses in consumer surplus for developing countries, as discussed earlier in the section on consumer and producer surplus above.

Table 9. Winners and losers in terms of trade balance

US proposal		EU proposal		Harbinson proposal	
Losers	Winners	Losers	Winners	Losers	Winners
15 DD	5 DD	15 DD	5 DD	12 DD	8 DD
24 RDC	75 RDC	23 RDC	76 RDC	24RDC	75 RDC
19 LDC	23 LDC	5 LDC	37 LDC	5 LDC	37 LDC

Source: Simulation results

6. Concluding remarks

This paper uses the ATPSM model to assess the likely impact of the modalities for the ongoing agricultural negotiations on three country groups: developed countries, LDCs and the rest of the developing countries. Three scenarios were analyzed, the draft Harbinson modalities of March 2003 and those of the EU and US, as alternative scenarios. Impacts were assessed on a number of indicators, notably world market prices, various welfare measures and trade and government revenues. For each indicator, information was also presented on the number of countries that gain or lose. Thus, the paper provides a range of information that should be useful for trade negotiators and policy makers as they negotiate to finalize the negotiating modalities. The assessment of the likely impact of the reform package as a whole is also a contribution to this literature.

Many of the results are standard and relatively straightforward to explain. Thus, further trade liberalization raises world prices of farm products, much more so for temperate-zone products, which received large support and protection in the base period, than for tropical products. Price rises are more pronounced under the US scenario than the under other two, reflecting the depth of the reform proposed. Similarly, in all scenarios, the developed country group experiences producer surplus losses while consumers gain.

The extent of the change in domestic prices, following a simulation, determines many of the outcomes. The domestic prices are influenced by the interaction between changes in world prices and tariffs. While all countries face the same change in world prices, both applied and bound tariffs are country-specific. Depending on the formula used and operative tariffs in the base period, different scenarios result in different depths of tariff cuts for individual countries and commodities. So, the impact cannot be predicted in advance and herein lies the value of an empirical model. Thus, for example, for given (simulated) increases in world prices, the LDCs were affected differently from the other two country groups in scenarios where they were not required to reduce tariffs (the EU and Harbinson proposals) but not in the US proposal where even the LDCs reduce tariffs. Where an LDC does not reduce tariffs, domestic prices rise to the full extent of the change in world markets. This reduces consumer surpluses while producer surpluses increase. The net impact, i.e. on total welfare, for LDCs was negative in both the EU and Harbinson scenarios. By contrast, in the US scenario, reduced tariffs moderated the transmission of higher world prices and so the LDCs gain in consumer surplus but lose in producer surplus, with positive net impact in total welfare terms. Government revenues are also affected by these forces and play some role in determining the size of the total welfare.

To state the results on total welfare gains in one sentence, the US scenario appeared to be most attractive for all three country groups. While developed countries experienced positive gains in all three scenarios (with the largest value in the US proposal), it was only in the US scenario that both the LDC and rest of the developing countries experienced positive gains.

This ranking of the modalities in terms of “gains” varies according to impact indicator. For example, the impact on government revenue for both developing country groups was negative in all three scenarios, the least negative impact being under the EU proposal. As for trade revenues, the impact on LDCs was positive under both the EU and Harbinson scenarios but higher in the latter, which was also

more or less the case for the rest of the developing countries. Finally, the LDCs experienced increased producer surplus only in the EU proposal, while this was the case under both the US and Harbinson proposals for the rest of the developing countries.

Thus, there are important trade-offs involved in the ranking of the modalities depending on the indicator used. Very often, published impact studies report only one or other indicator, the typical ones being total welfare and trade flow. While economists tend to like the former, trade negotiators seem to be mainly interested in the latter. This study demonstrates the value of considering a range of impact indicators and the trade-offs involved. Hopefully, this is appreciated by both economists and trade negotiators.

Finally, it seems useful at this stage to raise an issue for further debate. The question is what would it really mean in practice to gain in consumer surplus terms (and lose in producer surplus) in lower-income economies with large populations engaged in agriculture? One issue is that in models where income gains are not generated endogenously (as in the ATPSM) or even injected exogenously, it is not clear if consumers are able to express effective demand to the extent estimated by the model. The problem is that consumer surpluses invariably show up with producer losses. But in these economies, farm production itself is a major source of income (for consumers) and so producer losses also imply income losses for consumers. Moreover, agricultural development requires producer surplus gains on a sustained basis. For such economies, it would thus seem that producer surpluses are much more valuable than consumer gains. If this is so, assessments based on total welfare could also be misleading because this indicator attaches equal importance to both the surpluses (i.e. one dollar of producer surplus is valued similarly to one dollar of consumer surplus). Thus, it makes sense for policy makers in such economies in particular to review the impact of policy reforms on both surpluses, alongside total welfare.

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Annex 3 Tables

Table 1. Change in total welfare (million US\$)

	US PROPOSAL			EU PROPOSAL			HARBINSON PROPOSAL		
	Developed Countries	Developing Countries	LDC	Developed Countries	Developing Countries	LDC	Developed Countries	Developing Countries	LDC
Bovine meat	3 797	-394	42	2 498	-218	70	4 251	-323	5
Sheepmeat	614	-69	20	365	16	16	504	-66	6
Pigmeat	471	295	111	221	60	-1	566	114	-2
Poultry	532	1461	115	369	-3	-11	554	-24	-13
Milk, fresh	1 446	243	8	1 071	74	30	1 243	206	1
Milk, conc.	1 016	-632	-51	517	-276	-20	789	-439	-40
Butter	829	-77	-2	456	-75	0	762	-107	-2
Cheese	953	-113	-5	412	-109	-1	1 091	-162	-5
Wheat	3 871	-1351	-177	1 672	-437	-87	3 930	-1 106	-177
Rice	3 200	-647	5	1 892	-247	-12	2 608	-406	-18
Barley	389	-54	0	212	3	0	281	18	0
Maize	636	-30	23	373	-73	-3	-147	647	-5
Sorghum	14	-3	3	8	-2	0	11	-2	0
Pulses	52	-4	15	25	-3	-1	36	12	-2
Tomatoes	468	288	16	391	102	5	454	124	0
Roots & tubers	64	134	596	74	86	8	94	49	5
Apples	700	842	3	503	359	0	656	480	-1
Citrus fruits	140	75	70	113	73	1	132	15	7
Bananas	375	-138	1	243	-74	1	240	-47	1
Other tropical fruits	19	484	23	33	32	-2	19	316	-2
Sugar	911	-318	-55	496	-187	-27	741	-278	-37
Coffee green	-94	92	10	-54	37	21	-60	57	6
Coffee roasted	0	3	0	0	0	0	0	1	0
Cocoa beans	-8	9	0	-2	3	0	-4	5	0
Cocoa butter	-3	5	0	-4	6	0	-4	7	0
Chocolate	53	-17	-1	38	-15	-1	49	-19	-2
Oilseeds	200	82	-1	295	-1	4	190	9	-1
Cotton lint	43	-8	8	52	-23	12	40	-8	6
Vegetable oils	-49	249	-57	-185	1 261	-41	-2	-45	-18
Others	1 091	1 133	80	886	-1 169	9	486	598	-32
Total	21 730	1 540	800	12 970	-800	-30	19 510	-374	-320

Table 2. Change in producer surplus (million US\$)

	US PROPOSAL			EU PROPOSAL			HARBINSON PROPOSAL		
	Developed Countries	Developing Countries	LDC	Developed Countries	Developing Countries	LDC	Developed Countries	Developing Countries	LDC
Bovine meat	-12 841	3 009	162	-5 669	1 465	267	-10 870	3 059	135
Sheepmeat	-1 980	963	97	-870	268	75	-1 234	969	94
Pigmeat	-3 536	1 676	-428	-1 368	15	38	-3 987	1 944	-434
Poultry	187	-1 735	-517	-268	-83	54	-1 160	-1 657	-504
Milk, fresh	-13 686	3 370	222	-5 996	2 094	192	-7 964	3 249	213
Milk, conc.	-1 763	491	0	-691	244	0	-1 555	511	0
Butter	-3 471	485	30	-1 291	347	24	-2 804	451	30
Cheese	-3 765	784	16	-1 491	562	15	-3 101	758	17
Wheat	-8 749	7 352	118	-2 870	1 445	72	-7 516	7 261	118
Rice	-9 665	1 528	214	-3 964	286	167	-6 507	1 543	201
Barley	-641	-326	5	-322	-95	2	-493	-318	5
Maize	-260	-186	-31	-428	236	51	-1 197	-197	-51
Sorghum	-16	-4	-7	-12	9	4	-14	1	-12
Pulses	1	-366	-24	-37	50	18	5	-361	-29
Tomatoes	-1 146	773	-19	-722	513	18	-975	797	-25
Roots & tubers	-288	1 375	-2563	-330	66	170	-402	1 365	-2 564
Apples	-1 380	155	1	-918	411	2	-1 328	236	1
Citrus fruits	-289	298	-99	-255	198	10	-387	301	-102
Bananas	-116	43	41	-67	-19	27	-92	45	39
Other tropical fruits	-100	-131	-51	-121	100	29	-76	-127	-57
Sugar	-2 849	-132	10	-1 239	20	20	-2 441	-112	15
Coffee green	4	94	16	2	35	24	3	90	20
Coffee roasted	52	-47	1	9	-3	0	12	-43	1
Cocoa beans	0	4	0	0	3	0	0	4	1
Cocoa butter	0	4	0	-4	9	0	-4	4	0
Chocolate	176	78	0	76	44	0	110	74	0
Oilseeds	192	390	4	158	58	16	88	387	2
Cotton lint	-357	109	9	-198	56	12	-357	109	9
Vegetable oils	59	439	-112	-410	417	26	-637	457	-110
Others	-563	907	-215	-434	429	-2 803	-97	380	1 177
Total	-66 790	21 400	-3 120	-29 730	9 180	-1 470	-54 980	21 180	-1 810

Table 3. Change in consumer surplus (million US\$)

	US PROPOSAL			EU PROPOSAL			HARBINSON PROPOSAL		
	Developed Countries	Developing Countries	LDC	Developed Countries	Developing Countries	LDC	Developed Countries	Developing Countries	LDC
Bovine meat	15 391	-3 094	-110	6 271	-1 590	-190	11 950	-2 919	-322
Sheepmeat	2 492	-981	-73	998	-301	-58	1 522	-522	-79
Pigmeat	3 573	-1 384	511	1 298	21	-37	3 993	-2 173	-50
Poultry	382	3 674	663	511	144	-63	1 545	-473	-75
Milk, fresh	13 911	-3 183	-212	5 848	-2 070	-162	7 700	-2 846	-207
Milk, conc.	2 558	-841	-27	915	-454	-23	1 871	-818	-43
Butter	3 934	-491	-30	1 355	-397	-23	2 943	-732	-42
Cheese	4 137	-735	-17	1 481	-609	-17	3 339	-1 140	-30
Wheat	10 117	-8 480	-229	2 865	-1 886	-160	8 293	-7 012	-310
Rice	11 905	-2 233	-125	4 418	-574	-178	7 470	-1 353	-240
Barley	1 041	297	-5	411	66	-2	638	142	-3
Maize	986	591	85	823	-323	-53	1 125	881	-76
Sorghum	37	5	9	21	-13	-4	28	-12	-7
Pulses	95	435	45	62	-45	-17	11	284	-60
Tomatoes	1 312	-557	32	774	-482	-13	1 065	-677	-17
Roots & tubers	334	-1 294	2 936	354	-73	-160	432	-251	-103
Apples	2 168	660	17	1 203	-309	-2	1 833	-434	-2
Citrus fruits	264	-193	144	256	-160	-9	349	-284	6
Bananas	639	-86	-38	305	-46	-26	342	-32	-32
Other tropical fruits	140	376	62	162	-75	-29	115	254	-49
Sugar	3 663	-41	20	1 339	-188	-48	2 718	-662	-57
Coffee green	-31	103	-5	79	34	-3	64	16	-3
Coffee roasted	-50	55	-1	-7	6	0	-11	10	0
Cocoa beans	-8	20	0	-2	9	0	-4	12	0
Cocoa butter	4	5	0	11	-1	0	12	0	0
Chocolate	505	45	4	261	-22	-1	393	-31	-2
Oilseeds	931	-165	-3	382	67	-16	633	43	-19
Cotton lint	-104	-61	6	-49	-51	-6	-95	-76	-11
Vegetable oils	-291	1740	145	375	-326	-39	366	14	-82
Others	1 995	1793	556	1 060	128	2 809	950	541	3 515
Total	82 030	-14 020	4 360	33 780	-9 520	1 470	61 590	-20 250	1 600

Table 4. Change in government revenue (million US\$)

	US PROPOSAL			EU PROPOSAL			HARBINSON PROPOSAL		
	Developed Countries	Developing Countries	LDC	Developed Countries	Developing Countries	LDC	Developed Countries	Developing Countries	LDC
Bovine meat	1 247	-309	-10	1 896	-93	-7	3 246	-132	-12
Sheepmeat	102	-51	-4	237	48	-1	232	-30	-1
Pigmeat	434	3	28	291	25	-2	573	73	-2
Poultry	-37	-478	-31	126	-64	-2	207	-32	-2
Milk, fresh	1 221	56	-2	1 219	50	-1	1 539	155	-1
Milk, conc.	221	-282	-24	293	-67	2	472	-44	3
Butter	366	-71	-2	391	-26	-1	621	-44	-1
Cheese	581	-162	-4	421	-62	0	859	-77	0
Wheat	2 503	-223	-66	1 677	4	1	3 304	-164	-3
Rice	960	58	-84	1 437	41	-1	1 734	95	-8
Barley	-11	-25	0	123	33	0	151	35	0
Maize	-90	-435	-31	-22	13	-1	-71	-374	-2
Sorghum	-7	-4	1	-1	3	0	-3	0	0
Pulses	-44	-73	-6	0	-8	-1	22	-38	-3
Tomatoes	302	72	3	339	71	0	373	73	0
Roots & tubers	18	53	223	50	93	-2	63	84	4
Apples	-88	27	-15	218	257	0	160	279	0
Citrus fruits	165	-30	25	112	35	0	184	-33	5
Bananas	-148	-95	-2	5	-10	0	5	-18	0
Other tropical fruits	-21	239	12	-8	7	-2	-13	215	-2
Sugar	97	-145	-85	397	-18	1	468	-90	-3
Coffee green	-67	-105	-1	-135	-32	0	-126	-27	0
Coffee roasted	-2	-5	0	-2	-3	0	-2	-1	0
Cocoa beans	0	-15	0	0	-9	0	0	-9	0
Cocoa butter	-7	-4	0	-11	-3	0	-12	-3	0
Chocolate	-628	-140	-5	-299	-37	0	-454	-51	0
Oilseeds	-923	-143	-2	-350	-116	-1	-507	-158	-1
Cotton lint	504	-56	-7	287	-13	0	505	-42	0
Vegetable oils	183	-1930	-90	33	-135	-5	222	-332	-14
Others	-341	-1567	-261	196	-454	-7	-852	-610	-62
Total	6 490	-5840	-440	8 920	-470	-30	12 900	-1 300	-105

Table 5. Change in trade balance (million US\$)

	US PROPOSAL			EU PROPOSAL			HARBINSON PROPOSAL		
	Developed Countries	Developing Countries	LDC	Developed Countries	Developing Countries	LDC	Developed Countries	Developing Countries	LDC
Bovine meat	-3 009	2 814	157	-1 403	1 262	126	-2 556	2 285	242
Sheepmeat	-590	517	78	-267	229	40	-375	321	58
Pigmeat	-527	636	-144	34	-71	18	-1 235	1 186	22
Poultry	973	-780	-196	-2	-22	23	-474	453	20
Milk, fresh	-1 970	1 863	104	-971	912	58	-1 291	1 212	77
Milk, conc.	59	-61	-39	2	-4	-13	1	-6	-26
Butter	-616	606	26	-277	270	14	-587	571	30
Cheese	-729	781	6	-420	441	6	-814	850	11
Wheat	-3 100	3 125	-10	-1 002	1 001	7	-2 795	2 783	25
Rice	-1 181	1 090	90	-477	390	87	-805	683	122
Barley	158	-158	2	46	-46	1	83	-83	1
Maize	333	-354	20	-8	-7	14	103	-129	26
Sorghum	2	-1	-2	-3	2	2	-1	-2	2
Pulses	47	-47	5	-8	-3	12	41	-81	44
Tomatoes	-1 580	1 595	-17	-999	977	21	-1 387	1 357	28
Roots & tubers	-190	1 305	-1 115	-239	144	95	-293	241	52
Apples	-1 248	1 245	-5	-950	944	1	-1 378	1 372	1
Citrus fruits	-457	607	-145	-438	426	14	-649	657	-5
Bananas	-370	315	56	-193	156	37	-223	177	46
Other tropical fruits	-139	190	-50	-188	148	40	-117	43	76
Sugar	-703	698	-28	-294	277	4	-557	537	3
Coffee green	-112	99	14	-44	39	6	-77	69	9
Coffee roasted	14	-14	0	1	-2	0	2	-2	0
Cocoa beans	-6	6	0	-1	1	0	-3	3	0
Cocoa butter	-3	4	0	-9	10	0	-9	11	0
Chocolate	-46	10	-3	-43	21	0	-60	30	-1
Oilseeds	-229	226	9	12	-23	15	-47	36	16
Cotton lint	-36	24	14	-21	13	9	-37	21	17
Vegetable oils	123	31	-143	-372	358	16	-496	466	34

TARIFF ESCALATION IN AGRICULTURAL COMMODITY MARKETS

Nasredin Elamin and Hansdeep Khaira¹

Tariff escalation biases protection in both developed and developing countries against agricultural and labour-intensive products. This holds back export-led growth and greater diversification in developing countries. The findings of the study suggest that tariff escalation prevails in a large number of agricultural commodity chains in both developed and developing countries. It is more pronounced in commodity sectors such as meat, sugar, fruit, coffee, cocoa, and hides and skins most of which are of export interest to many of the poor developing countries. On average, tariff escalation is lower in the case of applied than bound tariffs, particularly when tariff preferences are taken into account.

Reducing tariff escalation is considered a critical element of the development dimension of the current round of multilateral trade negotiations, as it is seen to add considerably to the export potential of commodity-exporting developing countries. Comparing the impact of three tariff reduction methods - linear, Swiss formula (25 percent), and the Harbinson proposal formula- on tariff escalation, the Harbinson formula appears to produce the lowest tariff wedges, but it will erode much of the preferential tariff margins for developing countries. Several issues of escalating tariff structure must be addressed when evaluating tariff reduction proposals in the context of the WTO negotiations on agriculture: i) measurement of tariff escalation; ii) the actual bias tariff escalation poses for processed commodity trade; and iii) their interaction with tariff preferences for developing countries.

1. Introduction

Tariff escalation refers to a situation where tariffs rise along processing chains. This practice can afford significant protection to processed products in importing countries, depending on the share of value-added in final output. Thus, tariff escalation effectively limits the scope for processing of agriculture and labour-intensive products in exporting countries. The issue of tariff escalation in agricultural products is gaining more importance given the fact that growth in agricultural trade is shifting more to processed products. Countries with high dependence on commodity exports have a strong interest in this matter as they are trying to escape from the circle of producing and exporting primary products.

The existence of tariff escalation in agricultural markets is regarded as one of the major factors that hinder export growth and diversification and sustainable development in the exporting countries. Two aspects of this effect are seen as critical. First, tariff escalation has the potential of hindering the growth of agricultural processing in the exporting countries. It reduces demand for more processed imports from exporting countries, and hence the expansion of their processing industries, the means of accumulating skills and capital, and export diversification. In addition, the concentration of exports in less processed commodities often results in slower export growth and greater exposure to the risk of commodity price volatility.

Second, tariff escalation is perceived as a source of environmental damage to exporting countries – a tax on sustainability. There are many possible ways in which tariff escalation may hurt the environment. The excessive reliance on primary product exports is likely to cause over-depletion of natural resources and disturb the ecological balance of the country. The increased stress on the production and export of raw materials will lead to "excessive" extraction of natural resources, with the consequent degradation of the resource base.² In addition, the slower rate of growth of income as a result of over-exploitation of resources will leave fewer resources available for efficient environmental management in exporting countries.

¹ Nasredin Elamin is Economist, and Hansdeep Khaira, Consultant, Commodity Policy and Projections Service, Commodities and Trade Division, FAO.

² OECD (1996).

Reducing tariff escalation figured out as an important issue in the on-going WTO negotiations on agriculture. This article examines tariff escalation in agricultural commodity markets. Section 2 examines the evolution of trade in processed agricultural products during 1981-2000 and highlights major constraints for its expansion in developing countries. Section 3 provides a brief description of the measurement of tariff escalation and section 4 reviews some recent empirical work assessing tariff escalation in the post-Uruguay Round period. Section 5 assesses the magnitude of escalation in both bound and applied tariffs in selected major agricultural commodity chains and Section 4 highlights possible changes in their structure under different methods of tariff reduction, and section 6 concludes and raises some policy issues.

2. Evolution of trade in processed agricultural products

Over the last 20 years, world trade in processed agricultural products grew faster than in primary agricultural products. As a group, exports of processed agricultural products grew at 6 percent annually during the period 1981-2000 (compared to 3.3 percent for primary products), raising their world market shares in total agricultural trade from 60 percent in 1981-1990 to 66 percent in 1991-2000 (Table 1). Growth rates have been exceptionally high (above the average 6 percent) for the processed forms of cereals, fruit, vegetables, pulses, tropical beverages and poultry products (Figure 1).

Table 1. Value of world agricultural exports, all commodities (crops and livestock)

	Value of world agricultural exports ^a (million US\$)		Share in total world agricultural exports (percent)	
	Primary	Processed	Primary	Processed
1981 - 1990	111 805	160 996	40	60
1991 - 2000	1662 49	310 019	34	66

^a Includes intra-EU trade.

Source: Computed from FAOSTAT (2003)

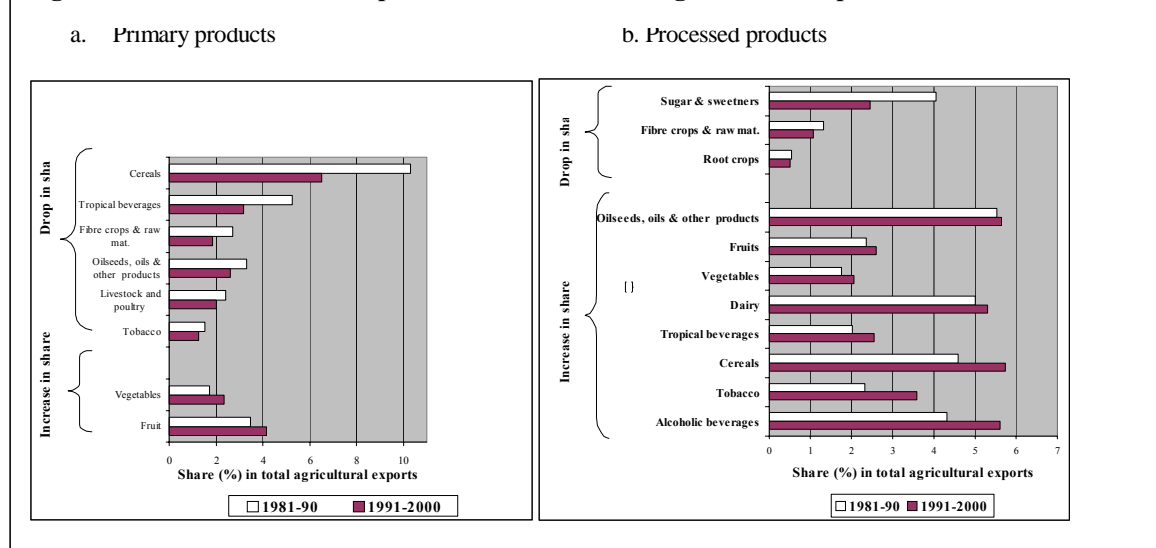
Low income elasticity of demand for primary commodities and declining intensity of raw materials use in economic activities have been shown to be the major factors that led to the decline in the share of primary commodity trade (World Bank, 1994). Several studies have also shown that changes in the organizational structure of commodity markets may have contributed to the decline in the share of primary commodities in total trade. The high costs associated with processing, packaging, advertising, marketing and distribution mean that the cost of primary commodities as a share of the processed product price is usually small (OECD, 2001).

Although some of the developing countries have increased their share in world exports of processed agricultural products, ³ the developed countries captured the bulk of the rapidly growing trade in this sector. High dependence on exports of primary agricultural products continued to be a prominent feature in many developing countries, particularly the least developed countries (LDCs).⁴ The share of developing countries in world exports of processed agricultural products decreased from 27 percent in 1981-1990 to 25 percent in 1991-2000 (Table 2). For LDCs as a group, the share in processed agricultural exports fell sharply from 0.7 percent to 0.3 percent.

³ Malaysia and Chile are examples of developing countries that have succeeded in diversifying their agricultural exports.

⁴ For a detailed description of dependence on agricultural commodity exports, see FAO (2002).

Figure 1: Share of individual products in total world agricultural exports, 1981-90, 1991-2000



Source: FAO (2003).

Table 2. Share in world agricultural exports, all commodities (crops and livestock)

	Primary products			Processed products		
	Developed	Developing	LDCs	Developed	Developing	LDCs
1981 – 1990	66.2	33.8	3.1	73.0	27	0.7
1991 - 2000	67.4	32.6	2.2	75.0	25	0.3

Source: Computed from FAOSTAT (2003)

The decline of the share of developing countries in world exports of processed products was more evident in such products as cocoa and coffee. The share of the top ten cocoa-producing developing countries in world exports declined as the stage of processing increased. In 1996-99, the shares of these countries in world exports of cocoa beans, cocoa butter, cocoa powder and chocolate were 83 percent, 30 percent, 18 percent and 1 percent respectively. While the share of chocolate exports in total cocoa trade rose from 20 percent in 1970-75 to 56 percent in 1996-99, the share of these countries in chocolate exports declined from 1.3 percent to only 1 percent during the same period. Similarly, the share of the top 10 coffee-producing developing countries in green coffee remained unchanged at about 67 percent between 1970-75 and 1996-99, but their share in roasted coffee declined from 10 to 2 percent during the same period.

The declining shares of developing countries in world processed agricultural exports have been attributed to several factors. Market access and market entry barriers in importing countries have limited the ability of developing countries to expand exports of their processed products. Tariff escalation, in particular, is often considered to be the major market access barrier for most of the processed agricultural exports of the developing countries.

Several studies have shown that agricultural commodity chains, particularly those of high value crops and processed products, are increasingly dominated by a few multinational enterprises (MNEs) and

distribution companies.⁵ Growing concentration may affect access to markets and returns to developing countries for their primary products.

Other major challenges facing many developing countries, particularly LDCs, are internal supply constraints that limit the ability of these countries to take advantage of the trading opportunities in processed agricultural products. These include weak technology; insufficient transport, storage and marketing infrastructure; inadequate legal and regulatory arrangements; and policy-induced disadvantages resulting from trade and macroeconomic policies that are biased against agriculture and exports.

3. Measurement of tariff escalation: nominal tariff wedges and effective rate of protection (ERP)

Tariff escalation is measured by tariff wedges, the difference in nominal tariffs between the output commodity and the input commodity. Tariff wedge can be expressed as:

$$TW = T - t \quad (1)$$

Where,

$$\begin{aligned} TW &= \text{Nominal tariff wedge} \\ T &= \text{Tariff in ad valorem equivalent of the output commodity} \\ t &= \text{Tariff in ad valorem equivalent of the input commodity} \end{aligned}$$

Thus, tariff escalation occurs when $TW > 0$, tariff de-escalation takes place when $TW < 0$ and tariff parity is defined as $TW = 0$.

While the nominal tariff wedge (TW) is simple and easy to calculate, it has a major limitation in that it does not fully measure the intensity of protection accorded to the final product. First, the nominal tariff wedge measure does not provide information about the impact of the tariff structure on the value added of the final product. Second, it compares nominal tariffs of final output and only one input. As explained by Lindland (1997), TW can hardly be applied to fabrication processes involving multiple inputs and/or multiple outputs.

The intensity of protection for a product can best be measured by the effective rate of protection (ERP),⁶ which assesses how tariffs affect the value-added of the processed commodity and takes into account tariffs on multiple inputs. The ERP is defined as the change in value added, made possible by the tariff structure, as a percentage of the free trade value added:

$$ERP = \frac{VA_d - VA_f}{VA_f} \times 100, \quad VA_f \text{ and } VA_d > 0 \quad (2)$$

where,

$$\begin{aligned} VA_f &= \text{value added per unit of final output at free trade prices;} \\ VA_d &= \text{value added per unit of output in presence of tariffs} \end{aligned}$$

⁵ In 1996, for example, four companies accounted for 50 percent of roasted coffee. and the number of cocoa trading houses in London decreased from 30 in 1980 to about ten in 1999. Similarly, the six largest chocolate manufacturers account for half of world chocolate sales. For vegetable oils, following mergers and acquisitions in the 1990s, a small number of MNEs now dominate the production, distribution and trade in oilseeds and oils. For grains, a few big companies have become vertically integrated businesses in trading, storage, processing and milling (see FAO 2003).

⁶ ERP was first articulated by Corden (1966).

With m inputs used the production of final output j , VA_f and VA_d can be written as:

$$VA_f = P_j - \sum_{i=1}^m a_{ij} \quad (3)$$

and

$$VA_d = P_j(1 + T_j) - \sum_{i=1}^m a_{ij}(1 + t_i) \quad (4)$$

where,

P_j	=	nominal price per unit of j at free trade prices;
P_i	=	nominal price per unit of input i at free trade prices;
a_{ij}	=	share of input i in cost of j at free trade prices;
T_j	=	nominal tariff in ad valorem equivalent of output j ;
t_i	=	nominal tariff in ad valorem equivalent of input i .

With only one input and one output, equation [2] can be simplified as follows:

$$ERP = \frac{T - a_{ij}t}{1 - a_{ij}} \quad \text{where } 0 < a_{ij} < 1 \quad (5)$$

Equation (5) shows the relationship between nominal tariff wedge (TW) and ERP:

If:

$T > t$ (tariff escalation)	→	$ERP > T > t$, and ERP increases with the increase in a_{ij}
$T < t$ (tariff de-escalation)	→	$ERP < T < t$, and ERP decreases with the increase in a_{ij}
$T = t$ (tariff parity)	→	$ERP = T = t$, and ERP is not affected by changes in a_{ij}

Thus the higher the degree of tariff escalation, the greater is the effective rate of protection enjoyed by the final-good industry, i.e. for TW greater than zero ($T > t$), the ERP will be positive and greater than the nominal tariffs on output. This can be illustrated by examples of green coffee (denoted by A) and roasted coffee (denoted by B). Assuming a_{ij} of 0.6, a tariff of 20 percent on product B and 10 percent on A will result in ERP of 30 percent. However, a 20 percent tariff on product B and a zero tariff on A will result in ERP of 50 percent.

Thus, comparing nominal tariffs on inputs and output-product within production chains gives a good indication of the sign of the effective rate of protection, but obviously not the intensity of protection. A major problem with the ERP measure, compared to the nominal tariff wedge measure, however is that it requires accurate data on prices and technical input-output coefficients, which are generally not available. While the ERP is relatively more comprehensive in measuring protection resulting from tariff structure, it has several limitations. Greenaway and Milner (2003) have summarized the theoretical critique of the concept. Despite these limitations ERP remains one of the major indicators to evaluate trade policy.

4. Tariff escalation and the Uruguay Round – review of evidence

The reduction in overall tariff rates for agricultural products during the Uruguay Round (UR) is considered a significant move in reducing distortions in world agricultural markets and improving market access conditions for agricultural exporters, including through reducing tariff escalation.

Several studies have been conducted to assess the impact of the Uruguay Round on tariff escalations in agricultural commodity markets. These studies differ widely in terms of country and commodity coverage, type of measures used (nominal wedges or effective rate of protection), level of tariff aggregation used in the analysis and the stages of processing considered (first, intermediate and final stages of processing). The studies reveal many results and observations, but the major finding reached is the persistence of tariff escalation, post-UR, in markets of both developed and developing countries.

Almost all the studies have shown that while MFN tariffs have, on average, been reduced post-UR, problems of high tariffs and tariff escalation are still widespread. Lindland (1997) assessed the changes in tariff escalation resulting from the UR tariff concessions, examining the agricultural import markets of the EU, Japan and the United States. After a detailed comparison of base bound tariffs resulting from commitments under the WTO Agreement on Agriculture (AoA) for an extensive range of commodity pairs, it was concluded that more than 80 percent of the bound tariff wedges between processed and primary products had decreased as a result of the UR, creating thus additional opportunities for developing countries to diversify their exports into higher value-added processed products. However, after full implementation of the UR commitments more than 50 percent of the commodity pairs examined would still have escalating bound tariffs, with an average nominal tariff wedge of 17 percent. The study shows that the highest post-UR bound tariff escalation was present in the dairy, sugar, fruit, tobacco and hides and skins sectors (See Table 3).

Table 3. Selected commodity groups with highest bound tariff escalation (nominal tariff wedges)

	Tariff wedges ^a	
	Base tariffs	UR bound tariffs
European Union		
Fruit products	102.5	84.8
Sugar products and sweeteners	39.8	37.2
Dairy and egg products	51.6	34.4
Root and tuber products	31.0	19.8
Tobacco and pyrethrum	37.3	14.1
Japan		
Sugar products and sweeteners	96.9	82.2
Root and tuber products	61.1	50.3
Hides and skins	60.0	30.0
Dairy and egg products	36.9	29.1
United States		
Cassava starch	40.1	38.0
Malt of barley	38.1	36.9
Dairy and egg products	39.7	33.6
Sugar products and sweeteners	36.1	31.2

^a Tariff wedge measures the difference between tariffs in primary and processed stages, calculated as $T-t$, where t stands for tariff at the primary stage and T for tariff at the processed stage.

Source: Lindland (1997).

Similar results were obtained in a study conducted by the OECD in 1996. The study pointed out that in the OECD countries in general tariffs are not reduced more for processed than for basic agricultural products. A recent UNCTAD study (UNCTAD, 2003) evaluated tariff escalation for 12 agricultural commodity groups by averaging nominal tariffs by major groups and by processing stage in the Quad (Canada, the EU, Japan, and the US) markets. It was noticed that, with a few exceptions, post-UR tariffs escalate not only between raw and semi-finished but also, where appropriate, between semi-finished and finished products. On average, the escalation in Canada and Japan and the EU is higher between raw and finished, while in the United States the highest average escalation is found between semi-finished and finished goods.

Some of the studies have examined tariff escalation in markets of both developing and developed countries. A recent USDA study, calculating simple average of bound MFN tariffs for a number of agricultural commodity groupings by region, has shown that tariff escalation in agricultural markets exists in both developed and developing countries.⁷ UNCTAD (2003) reached similar results.

Notwithstanding the progress that has been made in assessing tariff escalation across commodities and countries, much scope for improvement remains. There are several areas where more improvements may be particularly useful.

First, most of the past studies assessing the impact of the Uruguay Round on tariff escalation have used bound tariffs. This has the advantage of providing a measure of tariff escalation WTO members have negotiated. However, actual applied tariffs are often much below the bound rates. In addition, tariff preferences, which operate for various groups of countries, are often ignored. This is mostly because such data have not been available in a form that analysts could readily use. A recent study by Chevassus-Lozza and Gallezot (2003) shows that tariff escalation in the EU is lower when tariff preferences are taken into account. Therefore, analysing escalation in applied tariffs would be necessary, particularly in view of the presence of tariff preferences from which a large number of developing countries benefit.

Second, findings on incidence of tariff escalation differ significantly between studies employing different levels of commodity and country aggregations. Averages of tariffs by major commodity groups and/or by importing region or country groups provide, however, an incomplete picture of level of protection accorded by existing tariff structure. Such averages conceal significant tariff escalation at the product-by-product pairs. A more disaggregated analysis is required to arrive at representative indicators of tariff escalation.

Furthermore, there is a need to assess impact of tariff escalation on trade of processed products. Most of the studies focus on assessing the magnitude and change in tariff escalation and less on what the impact of the escalating tariffs would be on the structure of trade. OECD (1996), UNCTAD (2003) and Rae and Josling (2003) are among the few studies that assess the effect of changes in tariff structures on exports of processed products from developing countries. Simulation results in these studies have shown that developing countries would accrue significant benefits from liberalization of processed products compared with primary products. Overall, what matters is the magnitude of the effect of tariff escalation on production and trade flows: this would require not only assessing the protection it accorded to processing but also the impact it may have on trade structure.

5. Tariff escalation in selected agricultural commodity chains – applied and bound tariff wedges

To complement analyses of previous studies, this article examines escalation in bound as well as applied tariffs for selected agricultural commodity chains in the major developed and developing country markets. The previous studies have focused almost exclusively on bound tariffs. A simple approach has been adopted by measuring nominal tariff wedges for selected commodity chains, at a highly disaggregated level and mostly at the first stage of processing. Lack of detailed data precludes the estimation of the effective rate of protection for the selected commodities.

The choice of countries reflects the major importers of agricultural products, i.e. the Quad countries. In addition, the major four or five developing country importers are included when information on relevant product chains is readily available.⁸ The selected commodity chains include both basic food products, which are predominantly temperate-zone products, and tropical and horticultural products. Specific tariffs are converted to ad valorem rates using Agricultural Market Access Database (AMAD) data on world unit values and exchange rates.

⁷ USDA (2001).

⁸ See Box 2 for lists of developing countries selected for each commodity chain.

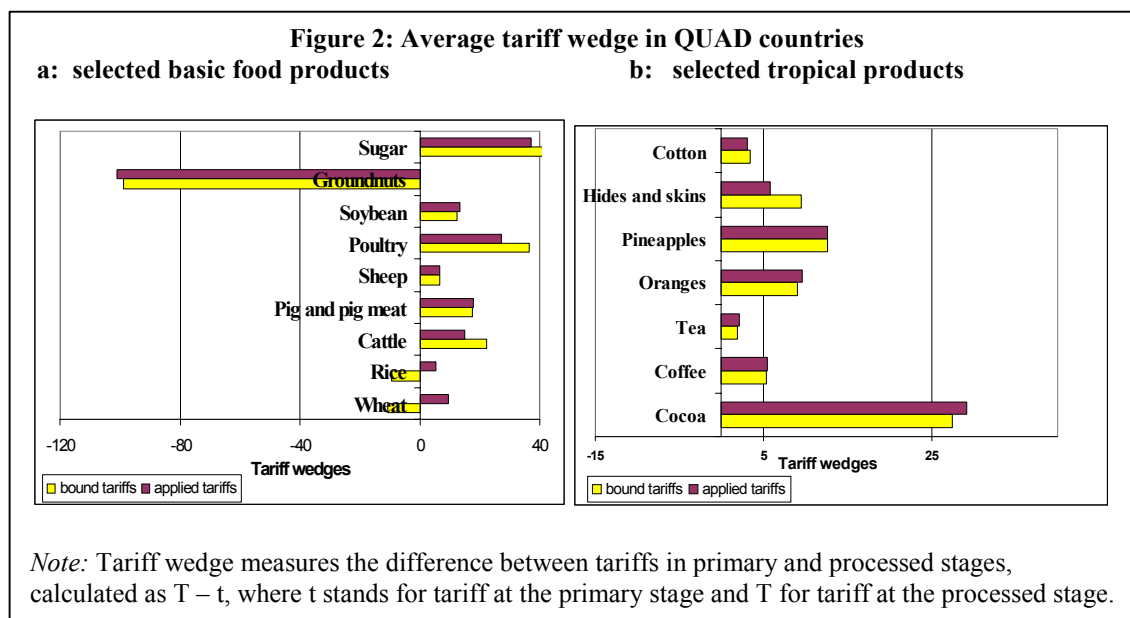
Annex tables 1 and 2 draw on data from AMAD and WITS database. The tables report simple averages of applied and final bound MFN tariffs countries apply to primary and processed forms of the selected commodities. It should be noted that data on applied tariffs are for the year 1999 or before, while final bound MFN tariffs represent the rates that should be reached by the end of the implementation period of tariff reduction commitment under the Uruguay Round Agreement on Agriculture – 2000 for developed countries and 2004 for developing countries. This may explain the few cases where applied MFN rates were higher than the bound rates as, for example, in the case of raw sugar in Japan.

Three broad observations can be drawn from tariff data in Annex tables 1 and 2.

Tariff escalation prevails in a large number of commodity chains. Comparing tariffs of the selected commodities at the different stages, it is clear that nominal tariff escalation affects many commodities, and this is true for both bound and applied tariffs. Of the 16 commodity chains examined, 12 suffer from tariff escalation, mostly at the first stage of processing, across the selected countries. The majority (nearly 60 percent) of tariff escalation pairs have tariff wedges between 1 and 10 percent, while about 10 percent have tariff wedges exceeding 50 percent.

Tariff escalation is higher in the case of bound than applied tariffs. As expected applied tariffs in almost all countries are, on average, lower than bound tariffs, and in several cases this difference is very large. As a result nominal wedges of applied tariffs for all the examined commodity chains in the Quad group, apart from a few exceptions, are low compared with bound rates (Figure 2).

Tariff escalation exists in both basic food commodities and tropical and horticultural products. Of the nine basic food commodities included in the study, wheat, groundnuts and rice are the only commodities where the existence of escalating tariffs is fairly limited in the Quad countries (Annex Table 1). When escalation exists in these products, it tends to be relatively weak and in most cases, tariff de-escalation, i.e. tariff protection declining with processing, is observed. As for livestock and meat (cattle, sheep and pigs), sugar and soybeans, tariffs vary greatly between countries and tariff escalation is common.



Tariff escalation is more visible in agricultural raw materials and horticultural products (Annex Table 2). It is worth noting that while tropical products generally face lower tariffs compared with basic food commodities, the wedge between tariffs at their primary and processed stages tend to be higher than in basic food commodities. In cocoa, while the average tariffs on cocoa beans is zero in the Quad

countries, the bound rates on chocolate are considerably higher, above 20 percent in the EU, Japan and Canada. Coffee, hides and skins and cotton exhibit similar high tariff escalation. In oranges, tariff escalation is more pronounced in the EU, while for the rest of the countries tariffs are generally high but with relatively weak escalation along the processing chain. In the case of tea tariff escalation does not seem to exist in almost all countries apart from Japan.

Applied tariffs show escalation in some developing countries. As Annex tables 1 and 2 show, tariff escalation exists in both developed and developing countries. In developing countries, represented by 4-5 major importers of the particular commodity for which data were available, tariffs vary greatly between countries and applied tariffs are much lower than bound rates. Tariff escalation in these countries is more apparent in applied than bound rates and, on average, occurred in 15 out of the 16 commodity chains examined. These tariffs are often imposed for development or revenue-raising reasons.⁹

Import tariffs decline significantly once account has been taken of the preferences that developing countries receive. Average applied tariffs as presented in Annex tables 1 and 2 are based on applied MFN rates only. Drawing on available data from the World Integrated Trade Solution (WITS) database, average applied tariffs for the EU were estimated taking into account tariff preferences under Generalized System of Preferences (GSP) and African, Caribbean and Pacific Group (ACP) preference regimes (Annex tables 3 and 4).

Annex tables 3 and 4 provide snapshot of the structure of EU agricultural tariffs taking into account the GSP and ACP preference regimes. The results show that in 11 out of the 16 examined product categories, tariff wedges are relatively lower under GSP and ACP regimes. This suggests that, compared with countries whose products face MFN tariffs in the EU market, preference-receiving developing countries are in a better competitive position in view of the relatively lower tariff wedges.

6. Tariff escalation and the new WTO negotiations on agriculture

Tariff escalation has been raised as one of the important market access issues in the current WTO negotiations on agriculture. Thirteen out of the 45 country negotiating proposals asked for substantial reduction in tariff escalation, particularly in the developed country markets.¹⁰ In these proposals, tariff escalation is considered a key market access problem faced by commodity exporters, and should thus be eliminated in order to help placing agricultural commodities on the same footing as other products in the international trading system.

The impact of further reduction of agricultural tariffs on tariff escalation will depend a great deal on the method to be used in reducing tariffs. Most of the country proposals addressing tariff escalation are suggesting the adoption of a harmonizing reduction formula that reduces higher tariffs by greater amounts, including tariff peaks, and eliminates tariff escalation.

Two points are critical when assessing the implications of tariff reduction proposals for tariff escalation: i) the change in the level of tariff escalation in importing countries as a result of tariff reduction; and ii) the influence this change may have on the structure of trade.

⁹ Article XVIII of GATT 1947 recognizes the need of countries in the early stages of development to maintain sufficient flexibility in their tariff structure to be able to grant tariff protection required for the support of their infant industries.

¹⁰ See, for example, the negotiating proposals of the African group (G/AG/NG/W/142); ASEAN (G/AG/NG/W/55); Cairns Group (G/AG/NG/W/54 and 93); US (G/AG/NG/W/15); CARICOM (G/AG/NG/W/100); Canada (G/AG/NG/W/12); Developing country grouping (G/AG/NG/W/13).

6.1 *Impact on tariff escalation*

The Draft of Modalities for the Further Commitments in the context of the ongoing WTO negotiations on agriculture (Harbinson proposal)¹¹ proposes a three-band reduction formula (four-band for developing countries).¹² This formula requires steeper cuts in higher tariffs, with the condition that where the tariff on a processed product is higher than the tariff for the product in its primary form, the rate of tariff reduction for the processed product shall be equivalent to that for the product in its primary form multiplied, at a minimum, by a factor of 1.3.

For comparison purposes, three different tariff reduction methods - linear, Swiss formula (25 percent) and Harbinson proposal formula - have been applied to the average bound MFN tariffs of selected products in the Quad countries. As shown in Figure 3 (see Annex), the adoption of Harbinson proposal and the “Swiss formula” appear to produce relatively more harmonized tariff levels than the linear formula, with the Harbinson formula producing the lowest tariff wedges. While the Harbinson proposal produces a significant reduction in tariff escalation, it appears to erode much of the preferential margins for developing countries. For instance, in the case of the EU’s ACP regime the average preferential margin for 13 of the selected commodity groups will shrink from 8 percent to only 2.1 percent.

The Swiss formula seems to be more effective in reducing tariff escalation when the level of tariffs is generally high, as in the case of pineapples and poultry, more so than in the case of coffee and hides and skins (tropical products), where tariffs are relatively low but tariff escalation is high. It is very unlikely that the Swiss formula will achieve substantial reduction in tariff escalation in all commodities of export interest to developing countries, particularly tropical products, unless it involves some additional criteria for capping tariff wedges along the processing chain.

6.2 *Implications for trade in processed products*

The existence of escalating tariffs is neither a necessary nor a sufficient condition to establish a bias against processed goods (Yeats, 1984). The actual economic effects of tariff escalation on trade are affected by import demand elasticities for the goods in question. To account properly for the influence of escalating tariffs on the structure of trade, one must analyse changing conditions of demand at different levels of processing along the commodity chain. Since empirical studies show import demand elasticities normally increase with fabrication, constant tariffs will have relatively larger trade effects on fabricated commodities than on unprocessed commodities. Thus the higher the demand elasticity along the commodity processing chain, the higher would be the effect of escalating tariffs on processed commodity trade.

Using the UNCTAD-FAO Agricultural Trade Policy Simulation Model (ATPSM)¹³ a simple exercise has been undertaken to simulate the effects of changes in tariff escalation, under the Harbinson proposal, on selected processed products. The model includes only a few processed products, namely, roasted coffee, cocoa butter, cocoa powder, chocolate and vegetable oils. Apart from oilseeds, existing tariffs on primary and processed forms of these products show a clear pattern of escalation. The model results for these products (Table 4) show a reduction in tariff wedges for coffee and cocoa products with

¹¹ WTO (2003).

¹² The Harbinson Draft proposed reducing tariff in equal annual instalments over a period of [five] years, applying the following formula:

- (i) For all agricultural tariffs greater than [90 percent ad valorem] the simple average reduction rate shall be [60] percent subject to a minimum cut of [45] percent per tariff line.
- (ii) For all agricultural tariffs lower than or equal to [90 percent ad valorem] and greater than [15 percent ad valorem] the simple average reduction rate shall be [50] percent subject to a minimum cut of [35] percent per tariff line.
- (iii) For all agricultural tariffs lower than or equal to [15 percent ad valorem] the simple average reduction rate shall be [40] percent subject to a minimum cut of [25] percent per tariff line.
- (iv) For developing countries, a four-band formula, with less reduction rates was also suggested (see WTO (2003) TN/AG/W/1/Rev.1), p. 4.

¹³ For a brief description of the specifications and policy parameters of the ATPSM see Poonyth and Sharma (2003).

sizeable increases in global exports of their processed forms, with gains in exports being relatively higher for developing countries and LDCs.

Table 4. ATPSM model results: impact of the Harbinson proposal on tariff wedges and export values of selected processed commodity products

	Base tariff wedge	Tariff wedge ^a under Harbinson proposal	Percentage change in export value			
			World	Developed countries	Developing countries	LDCs
Coffee - green			1.0	0.9	1.0	1.1
Coffee - roasted	2.7	1.6	0.4	0.3	0.6	0.4
Cocoa beans			0.3	0.3	0.3	0.3
Cocoa powder	7.3	4.4	1.4	1.2	1.6	7.3
Cocoa butter	-4.7	-5.7	1.1	0.6	1.3	n.a.
Chocolate	24.7	11.0	6.5	6.3	6.8	6.7
Oilseeds			1.8	1.2	2.4	28.1
Vegetable oils	-21.3	-8.4	4.6	2.2	5.0	6.1

^a Tariff wedge measures the difference between tariffs in primary and processed stages, calculated as $T-t$, where t stands for tariff at the primary stage and T for tariff at the processed stage.

Source: ATPSM simulation results.

More elaborate analysis by expanding the number of processed products included in the ATPSM model would certainly help in providing a better perspective on the impact of tariff structure on processed agricultural trade.

7. Conclusions and policy issues

Tariff escalation biases protection in both developed and developing countries against agricultural and labour-intensive products. This holds back export-led growth and greater diversification in developing countries and the poverty reduction that is associated with increased demand for unskilled labour.

Available evidence suggests that tariff escalation prevails in a large number of agricultural commodity chains in both developed and developing countries. It is more pronounced in commodity sectors such as meat, sugar, fruit, coffee, cocoa and hides and skins, most of which are of export interest to many of the poor developing countries.

Reducing tariff escalation is considered a critical element of the development dimension of the current round of multilateral trade negotiations, as it is seen to add considerably to the export potential of commodity exporting developing countries. Several issues of escalating tariff structure must be addressed when evaluating tariff reduction in the context of the multilateral reform of agriculture.

First, it should be noted that the economic significance of tariff escalation lies more in accurate assessment of the protection they create along the commodity chains, which depends not only on nominal tariffs imposed but also on the share of inputs in the value of final product. Assessing tariff escalation on the basis of tariff wedges only, particularly at higher levels of commodity aggregation, is not a reliable indicator of tariff escalation, as it may conceal considerable tariff wedge in certain product lines of export interest to many exporters of agricultural products.

Second, a distinction must be drawn between the level of tariff escalation and the bias that tariff escalation poses for processed commodity trade.¹⁴ Though useful, the tariff wedge and ERP indicators, do not provide policy makers and trade negotiators very reliable information on the trade and welfare effects of tariff escalation. The mere comparison of nominal tariffs or effective tariffs at different stages of processing does not convey sufficient information on the relative importance of existing trade barriers. The optimal approach would be to assess the effects of the tariff structure on trade of the particular products. Thus, to account properly for the effect of tariff escalation, one must analyse changing conditions of demand at different levels of processing.

Third, efforts to reduce tariff escalation should take into account the implications for tariff preferences. The analysis of this article suggests that while the adoption of a harmonizing method such as that incorporated in the Harbinson proposal would result in greater reduction in tariff escalation than linear methods, it may lead to considerable erosion of tariff preferences like those under the GSP and ACP preference regimes.

In addition, tariff escalation will have to be evaluated in conjunction with other trade barriers, not captured by the tariff data, like tariff rate quota and special safeguards.

¹⁴ For detailed discussion on the link between tariff escalation and the bias in trade protection, see Yeats (1984).

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Annex

Table 1. Average bound and applied tariffs and nominal tariff wedges (TW) in the major importing developed and developing countries: selected basic food commodities

Product ^a	Average final bound MFN tariffs ^b					Average applied MFN tariffs ^c				
	US	EU	Japan	Canada	Major 4 - 5 importing developing countries ^d	US 1999	EU 2000	Japan 1999	Canada 1998	Major 4 - 5 importing developing countries ^d
Wheat										
Durum	4.2	69.5	321.9	31.7	48.2	4.0	69.5	32.3	33.5	2.5
Meal/flour	1.5	74.6	291.3	16.5	77.8	1.8	74.6	83.2	17.6	11.5
- TW	-2.7	5.1	-30.6	-15.2	29.6	-2.2	5.1	50.9	-15.9	9
Rice										
Husk/husked	5.1	61.9	1069.2	0	96.0	5.7	61.9	92.7	0	10.7
Glazed/polished	5.6	89.7	1003.4	0.8	96.0	6.1	89.7	87.0	0	12.8
- TW	0.5	27.8	-65.8	0.8	0	0.4	27.8	-5.7	0	2.1
Cattle										
Live	0.5	35.9	119.0	0	18.1	0.3	35.9	81.7	0	4.0
Fresh/frozen meat	13.5	128.6	50.0	13.2	39.6	8.8	128.6	40.0	0	15.0
- TW	13	92.7	-69.0	13.2	21.5	8.5	92.7	-41.7	0	11
Pig & Pig meat										
Live swine	0	20.0	40.5	0	20.0	0	20.0	41.8	0	12.3
Fresh/frozen pork	0.3	28.0	83.6	0	30.0	0.3	28.0	86.3	0	27.5
- TW	0.3	8.0	43.1	0	10.0	0.3	8.0	45.5	0	15.2
Sheep and sheep meat										
Live sheep	0	42.8	0	0.2	15.0	0	42.8	0	0	7.6
Fresh/frozen mutton	0.9	88.7	0	1.3	15.0	0.9	88.7	0	1.1	9.0
- TW	0.9	45.9	0	1.1	0	0.9	45.9	0	1.1	1.4
Poultry										
Live poultry	1.0	10.4	0	96.3	22.0	1.0	10.4	0	51.2	7.2
Fresh/frozen poultry	10.0	39.5	8.2	123.0	41.8	10.2	39.5	7.9	88.2	22.5
- TW	9	29.1	8.2	26.7	19.8	9.2	29.1	7.9	37.0	15.3
Soybeans										
Seeds	0	0	0	0	88.3	0	0	0	0	18.9
Crude oil	19.1	4.8	20.7	4.8	81.1	19.7	4.8	22.7	5.5	29.9
- TW	19.1	4.8	20.7	4.8	-7.2	19.7	4.8	22.7	5.5	11
Groundnuts										
Seeds	56.8	0	366.0	0	47.5	57.8	0	377.0	0	25.2
Crude Oil	8.8	4.8	9.8	4.8	98.0	9.0	4.8	11.4	5.5	14.3
- TW	-48	4.8	-356.2	4.8	50.5	-48.8	4.8	-365.6	5.5	-10.9
Sugar										
Raw	32.8	134.7	224.9	6.5	62.1	33.8	134.7	231.5	5.9	24.7
Refined	42.5	161.1	328.1	8.6	66.0	43.8	161.1	242.5	7.5	29.5
- TW	9.7	26.4	103.2	2.1	3.9	10	26.4	11	1.6	4.8

Source: FAO staff calculations, based on Agricultural Market Access Database (AMAD); WTO country schedules of commitments in goods; *the International Customs Journal*, EU - 1999-2000, 22nd edition; and *World Integrated Trade Solution (WITS)*, General Database Information, World Bank/UNCTAD

Table 2. Average bound and applied tariffs in the major importing developed and developing countries: selected raw material and horticultural products

Product ^a	Average final bound MFN tariffs ^b					Average applied MFN tariffs ^c				
	US	EU	Japan	Canada	Major 4 - 5 importing developing countries ^d	US 1999	EU 2000	Japan 1999	Canada 1998	Major 4 - 5 importing developing countries ^d
Cocoa										
Beans	0	0	0	0	32.0	0	0	0	0	9.5
Paste	0.1	9.6	7.5	0	33.3	0.1	10.0	9.0	0	10.6
- TW ^e	0.1	9.6	7.5	0	1.3	0.1	10.0	9.0	0	1.1
Chocolate	14.7	21.1	21.3	52.8	44.3	17.7	21.1	23.6	54.2	16.6
- TW	14.6	11.5	13.8	52.8	11.0	17.6	11.1	14.6	54.2	6.0
Coffee										
Green	0	0	0	0	39.8	0	0	0	0	24.8
Roasted	0	9.0	12.0	0.4	32.7	0	9.0	13.0	0	29.3
- TW	0	9.0	12.0	0.4	-7.1	0	9.0	13.0	0	4.5
Black Tea										
Bulk	0	0	6.7	0	81.8	0	0	7.0	0	25.5
Other	0	0	14.5	0	83.8	0	0	15.5	0	26.6
- TW	0	0	7.8	0	2.0	0	0	8.5	0	1.1
Oranges										
Fresh	3.5	16.7	24.0	0	41.0	3.7	16.7	25.0	0	23.7
Juice	6.8	44.1	28.1	1.0	41.0	6.9	44.1	31.9	1.0	25.7
- TW	3.3	27.4	4.1	1.0	0	3.2	27.4	6.9	1.0	2.0
Pineapple										
Fresh	1.2	5.8	12.1	0	38.2	1.3	5.8	13.0	0	19.8
Juice	4.1	33.0	32.3	0	42.2	4.4	33.0	32.3	0	25.4
- TW	2.9	27.2	20.2	0	4.0	3.1	27.2	20.2	0	5.6
Hides & skins										
Raw	0	0	0	0	20.9	0	0	0	0	4.1
Tanned	3.0	5.4	23.5	6.3	30.3	2.9	5.4	14.9	0	6.7
- TW	3.0	5.4	23.5	6.3	9.4	2.9	5.4	14.9	0	2.6
Cotton										
Lint	11.3	0	0	0	41.0	8.7	0	0	0	4.3
Yarn	8.3	4.0	4.7	8.0	52.7	6.8	4.8	4.1	5.3	12.9
- TW	-3.0	4.0	4.7	8.0	11.7	-1.9	4.8	4.1	5.3	8.6

Notes:

^a For the Harmonized System (HS) levels covered, see Box 1.

^b The bound and applied rates are simple averages, mostly at the 6-digit of the Harmonized System (HS), after excluding tariff lines that are not corresponding between bound and applied schedules. Specific rates are converted to ad valorem rates using AMAD's data on world unit values and exchange rates. The world import unit values were defined at the 6-digit HS level.

^c Applied rates are taken from AMAD – 1999 for Japan and the US; 1998 for Canada; and various years from 1995 to 1999 for the developing countries. For the EU, however, applied rates are for the year 2000 and are estimated from The International Customs Journal, EU - 1999-2000, 22nd edition.

^d For developing countries included in the analysis, see Box 2.

^e Only ad valorem tariffs are considered.

^e Tariff wedge measures the difference between tariffs in primary and processed stages, calculated as $T-t$, where t stands for tariff at the primary stage and T for tariff at the processed stage.

Source: FAO staff calculations, based on *Agricultural Market Access Database* (AMAD); WTO country schedules of commitments in goods; *the International Customs Journal*, EU - 1999-2000, 22nd edition; and *World Integrated Trade Solution* (WITS), General Database Information, World Bank/UNCTAD.

Table 3. EU: average MFN tariffs and average tariffs under GSP and ACP preference regimes, 2000

Product	MFN	GSP	ACP (out of quota)
Wheat			
Durum	69.5	69.5	69.5
Meal/flour	74.6	74.6	60.8
- TW ^a	5.1	5.1	-8.7
Rice			
Husk/husked	300.7	300.7	298.1
Glazed/polished	136.0	136.0	136.0
- TW	-164.7	-164.7	-162.1
Cattle			
Live	35.9	35.9	31.7
Fresh/frozen meat	128.6	128.6	97.1
- TW	92.7	92.7	65.4
Pig & Pig meat			
Live swine	16.0	16.0	13.6
Fresh/frozen pork	32.0	32.0	32.0
- TW	16.0	16.0	18.4
Sheep and sheep meat			
Live sheep	63.8	63.8	0
Fresh/frozen mutton	88.7	88.7	67.9
- TW	24.9	24.9	67.9
Poultry			
Live poultry	10.4	10.4	8.8
Fresh/frozen poultry	39.5	39.5	39.5
- TW	29.1	29.1	30.7
Soybeans			
Seeds	0	0	0
Crude oil	4.8	4.1	0
- TW	4.8	4.1	0
Groundnuts			
Seeds	0	0	0
Crude oil	4.8	4.4	0
- TW	4.8	4.4	0
Sugar			
Raw	134.7	134.7	134.7
Refined	161.1	161.1	161.1
- TW	26.4	26.4	26.4

^a Tariff wedge measures the difference between tariffs in primary and processed stages, calculated as $T-t$, where t stands for tariff at the primary stage and T for tariff at the processed stage.

Source: WITS, 2003.

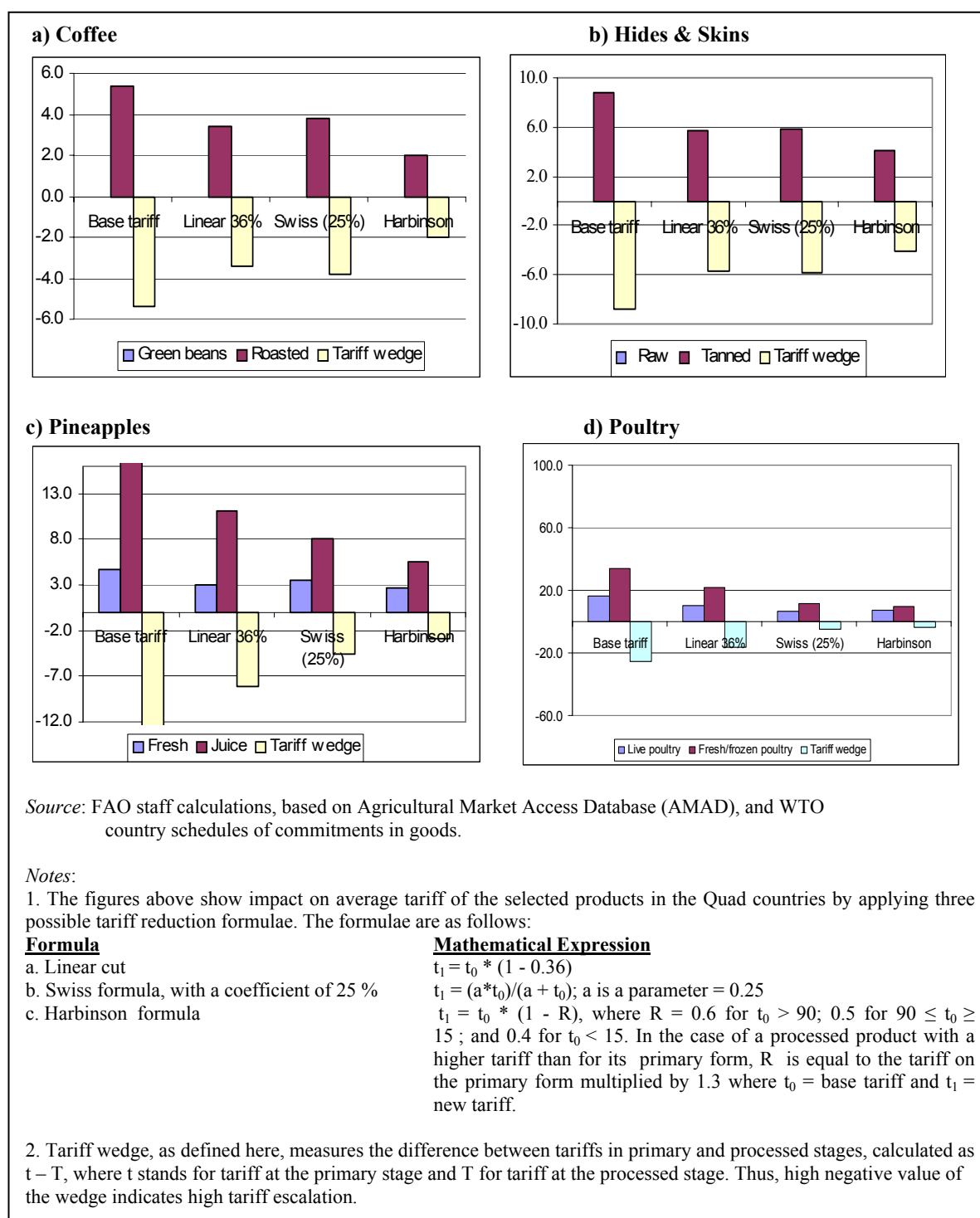
Table 4. EU: average MFN tariffs and average tariffs under GSP and ACP preference regimes, 2000

Product	MFN	GSP	ACP (out of quota)
Cocoa			
Beans	0	0	0
Chocolate	43.0	40.0	10.0
- TW ^a	43.0	40.0	10.0
Coffee			
Green	0	0	0
Roasted	9.0	3.1	0
- TW	9.0	3.1	0
Black Tea			
Bulk	0	0	0
Other	0	0	0
- TW	0	0	0
Oranges			
Fresh	16.7	16.7	3.1
Juice	34.9	24.7	13.6
- TW	18.2	8	10.5
Pineapple			
Fresh	5.8	4.9	0
Juice	34.9	23.2	0
- TW	29.1	18.3	0
Hides & skins			
Raw	0	0	0
Tanned	5.4	4.4	0
- TW	5.4	4.4	0
Cotton			
Lint	0	0	0
Yarn	4.0	3.9	0
- TW	4.0	3.9	0

^a Tariff wedge measures the difference between tariffs in primary and processed stages, calculated as $T-t$, where t stands for tariff at the primary stage and T for tariff at the processed stage.

Source: WITS, 2003.

Figure 3. Changes in average tariffs in Quad countries under different tariff reduction methods



Box 1 : Product coverage, by HS code**Wheat**

Durum: 100110, 100190
Meal/flour: 110100, 110311, 110321
Bread / biscuits: 190510, 190540, 190590

Rice

In husk / husked: 100610, 100620
Glazed / polished: 100630, 100640

Cattle

Live: 010210, 010290
Fresh / frozen meat: 020110, 020120, 020130, 020210, 020220, 020230

Pig & pig meat

Live swine: 010310, 010391, 010392
Fresh / frozen meat: 020311, 020312, 020319, 020321, 020322, 020329

Sheep & sheep meat

Live sheep: 010410
Fresh / frozen mutton: 020410, 020421, 020422, 020423, 020430, 020441, 020442, 020443, 020450

Poultry

Live poultry: 010511, 010512, 010519, 010592, 010593, 010599
Fresh/frozen poultry: 020711, 020712, 020713, 020714, 020724, 020725, 020726, 020727, 020732, 020733, 020735, 020736

Soybeans

Seeds: 120100
Crude oil : 150710

Groundnuts

Seeds: 120200, 120220
Crude oil: 150810

Cocoa

Beans: 1801
Powder: 1803
Paste: 1805
Chocolate: 1806

Coffee

Green: 090111
Roasted: 090122

Black Tea

Bulk: 090240
Other: 090230

Oranges

Fresh: 080510
Juice: 200919

Pineapples

Fresh: 080430
Juice: 200940

Hides & skins

Raw: 4101, 4102, 4103
Tanned: 4104

Cotton

Lint: 5201
Carded/combed: 5203
Yarn: 5205, 5206, 5207

Sugar

Raw: 170111, 170112
Refined: 170199

Box 2. Developing country coverage

The major 4-5 importing developing countries of each of the commodity chains considered by the study, and for which data were available, include:

Cattle:	Mexico, Indonesia, Philippines, Egypt, Brazil	Sugar:	Indonesia, India, Philippines, Republic of Korea, Morocco
Pigs:	Singapore, Mexico, Philippines, Republic of Korea, Thailand	Pineapples:	Republic of Korea, Argentina, Philippines, Mexico, Brazil
Sheep:	Nigeria, Bahrain, Mexico, Côte d'Ivoire	Oranges:	Morocco, Egypt, Argentina, Brazil, Uruguay
Poultry:	Singapore, Brazil, Indonesia, Thailand, Turkey	Cocoa:	Mexico, Brazil, Republic of Korea, Philippines, Argentina
Wheat:	Brazil, Egypt, Indonesia, Republic of Korea, Pakistan, Philippines	Coffee:	Republic of Korea, Argentina, Morocco, Mexico
Rice:	Indonesia, Brazil, Republic of Korea, Jamaica, Peru	Tea:	Morocco, India, Indonesia, Argentina, Pakistan
Soybeans:	Pakistan, India, Brazil, Morocco	Hides & skins:	Mexico, Indonesia, Republic of Korea, Brazil
Groundnuts:	Thailand, India, Brazil, Singapore	Cotton:	Indonesia, Mexico, India, Thailand, Republic of Korea
Dairy:	Brazil, Mexico, Singapore, Philippines		