

**Vulnerability of Artisanal and
Small-Scale Mining to Commodity
Price Fluctuation**

**PAPER 3: Price and Other Risks in the
Artisanal and Small-Scale Mining
Industry**

Bannock Consulting Ltd

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Summary

This paper surveys price variability and other risk issues with specific reference to the artisanal and small-scale mining sector (ASM) industry and discusses international and nationally-based policies to mitigate price volatility. The main conclusion is that price is not the most important risk for the ASM sector and there appears to be little reason to give priority to policies aimed at the alleviation of levels of price risk. It is recommended that risk management in the ASM sector should focus on non-price risk including weather risk, yield risk and risk from pollution in some cases.

The analysis here looks at the limitations of price stabilisation schemes which are found not to offer producers any protection against quantity variations. To the extent that quantity shocks are common, there will be an inverse relation between these and price shocks, with the result that price stabilisation will actually increase revenue variability. Price stabilisation should therefore not be seen as a priority for policy. This is fortunate because the history of price intervention schemes, particularly in the agricultural sector, is not encouraging.

International commodity agreements can have a reasonable prospect of effectiveness when they have wide consumer government as well as producer government support, and, in the case of buffer stock schemes, they are adequately financed. However, the only ASM industry with a dominant producer is diamonds where the De Beers cartel has delivered high and stable prices. Elsewhere, there is neither a dominant producer nor likely consumer government support for a stabilisation agreement. Neither the commodity agreement nor the producer only agreement route appear very promising for the ASM sector.

Compensatory finance is only indirectly relevant to the ASM sector since its point of reference is primarily government export revenues and not producer revenues. More generally, the purposes of compensatory finance schemes are either primarily macroeconomic, or are intended to complement other stabilisation measures. A compensatory mechanism may be preferable, such as a shock facility, designed primarily for macroeconomic stabilisation purposes, to provide the finance for an intervention in favour of miners in the ASM sector.

Producer-only stabilisation schemes appear to give the producers the power to achieve the twin objectives of stable and high prices without the requirement to take consumer government pressures into account. However, these schemes have been even less successful than international schemes including both producer and consumer governments. Agricultural experience suggests that nationally-based stabilisation schemes can be effective, but only if governments can find an institutional structure which precommits them to keeping stabilisation surpluses for price support at times of low prices.

Risk management instruments aimed at assisting commodity producers in coping with market risks, which are currently being employed in smallholder agriculture, may have potential in the ASM sector and have the added benefit of increasing access to credit. Nevertheless, there is a fundamental problem in devising a low cost means of intermediating the instruments to the producers. However, there is merit in actively considering the use of weather insurance for small-scale mining operations.

More generally, policy towards the ASM sector should be seen as part of an overall rural development strategy. The paper concludes that one general lesson is that major improvements to the livelihoods of those working in the sector will also come from improving the opportunities to work outside the sector.

Table of Contents

1	Introduction	1
2	The Artisanal and Small-Scale Mining Industry	1
2.1	Characterisation	1
	2.1.1 <i>Extension – Which Metals and Minerals?</i>	2
	2.1.2 <i>Parallels with Smallholder Agriculture</i>	2
2.2	Price Variability	3
	2.2.1 <i>Stockholding</i>	3
	2.2.2 <i>Investment Cycles</i>	4
	2.2.3 <i>Price Variability Across Commodities</i>	5
	2.2.4 <i>Pass-Through</i>	7
	2.2.5 <i>Figure 1: Pass-Through in Ghanaian Diamonds</i>	8
	2.2.6 <i>Figure 2: Pass-Through in Ghanaian Gold</i>	9
2.3	Summary	10
3	Types of Commodity Intervention	10
3.1	International Schemes	11
	3.1.1 <i>International Commodity Agreements</i>	11
	3.1.2 <i>Producer-only Agreements</i>	16
	3.1.3 <i>Monopolies and Cartels</i>	20
	3.1.4 <i>Relevance to the ASM Sector</i>	22
3.2	National Schemes.....	23
	3.2.1 <i>National Buffer Stock Schemes</i>	23
	3.2.2 <i>Marketing Boards</i>	24
	3.2.3 <i>Caisses de Stabilisation</i>	26
	3.2.4 <i>Variable Export Taxes</i>	26
	3.2.5 <i>Nation Stabilisation Schemes - Summary</i>	27
3.3	Compensatory Finance Schemes.....	28
	3.3.1 <i>Stabex, Sysmin and Flex</i>	28
	3.3.2 <i>The IMF Compensatory Finance Scheme</i>	29
	3.3.3 <i>A Possible "Shocks" Facility</i>	30
	3.3.4 <i>Application to the ASM Sector</i>	31
3.4	Summary of the Historical Stabilisation Experience.....	31
4	Market-Based Schemes	32
4.1	Macroeconomic Aspects of Commodity Price Volatility	33
	4.1.1 <i>Government Revenues</i>	33
	4.1.2 <i>The Exchange Rate</i>	33
4.2	Microeconomic Aspects of Commodity Price Volatility	34
	4.2.1 <i>Diversification</i>	35
	4.2.2 <i>Risk-Sharing Markets</i>	36
	4.2.3 <i>The International Task Force on Commodity Risk Management</i>	37
	4.2.4 <i>Quantity Risk and Weather Insurance</i>	38
	4.2.5 <i>Risk Management and Credit</i>	38
	4.2.6 <i>Application to the ASM Sector</i>	38
5	Risk in the Artisanal and Small-Scale Mining Sector	39
5.1	Risk Dimensions	39

5.1.1	<i>Price Risk</i>	39
5.1.2	<i>Quantity Risk</i>	40
5.1.3	<i>Credit</i>	41
5.2	ASM Policy by Industry.....	41
5.2.1	<i>Copper</i>	41
5.2.2	<i>Tin</i>	42
5.2.3	<i>Gold</i>	43
5.2.4	<i>Diamonds</i>	43
5.2.5	<i>Coloured Gemstones</i>	45
6	Conclusions: The Directions for Policy	46
	Appendix: Estimated Price Trends	48
7	References	49

1 Introduction

The objective of this paper is to survey price variability and other risk issues with specific reference to the artisanal and small-scale mining (ASM) industry. In particular, international and nationally-based policies to mitigate price variability are discussed.

ASM is important in only a subset of extractive industries, and there is relatively little history of intervention in those industries. However, the principles of intervention are common across a much wider range of industries, and it is possible to learn from the wider experience. It would be foolish to adopt policies in the ASM sector which have failed to work in other sectors, and, at the same time, the positive experiences in other sectors might usefully be transferred to the ASM sector. The paper therefore discusses the entire set of commodity-producing industries, both extractive and agricultural, in the hope of benefiting from as wide an experience as possible.

The structure of the paper is as follows: section 2 discusses the price variability and ASM sector; section 3 looks at commodity market intervention schemes; in section 4, schemes which assist producers in coping with price and revenue variability are analysed; section 5 attempts to apply these lessons to the ASM sector; and section 6 concludes.

2 The artisanal and small-scale mining industry

In this introductory section, small-scale mining is characterised, discussing its extension, and looking briefly at parallels with smallholder agriculture.

2.1 Characterisation

Artisanal mining is any mining activity undertaken by individuals or small groups of workers (often family groups or neighbours) (see paper one). Typically, these groups have no formal association. They may also be fluid in the sense of lacking fixed membership. Lacking formal structure, they are almost inevitably in the informal sector of the economy. They may also be itinerant, either within the area in which the group resides or over a much wider area. In many cases, including most of the itinerant cases, the miners lack documented title to the land they mine.

Given these characteristics, it is almost inevitable that artisanal mining exhibits very low levels of mechanisation. Significant capital expenditures pre-suppose an ownership structure, or, in the case of leasing, a legal identity. The term small-scale mining refers to organisation which do have some formal structure but which operate with relatively low levels of capital. Because there are often relatively limited opportunities for substituting labour for capital, limited capitalisation typically implies low output. However, the existence of a formal structure implies that these organisations are more likely to be integrated into the formal economy (e.g. through payment of tax and social security contributions) and are more likely to have title to their land.

In practice, not a lot is gained by attempting a fine distinction either between artisanal and small-scale mining or between small and larger-scale mining. Informal artisanal and more formal small-scale mines operate on the same deposits, and where this is the case, individuals often shift between artisanal mining and employment in a more formal small-scale mine in the same vicinity. In certain cases, operators of small-scale mines may sub-contract extraction to individual miners or groups of miners so that the mine is effectively operated on an artisanal basis despite its formal structure. In what follows, I will refer simply to the small-scale sector. Although one can formulate a long list of characteristics of the artisanal and small-scale sector (see, for example, Hentschel et al.,

2002), it follows from this characterisation that the dominant characteristic is the low capital stock. But that implies that the distinction between small- and medium-scale mining is simply one of degree.

2.1.1 Extension – Which metals and minerals?

The viability of small-scale mining depends on both geological and technological features – how the mineral or ore crops, and, in the case of metals, how easy it is to separate the metal from the ore. These factors differ across metals and minerals, and also across geographical locations.

There are three principal mining technologies: shallow or opencast mining, deep mining and alluvial mining. Economies of scale are most pronounced in opencast mining and least important in alluvial mining (with the exception of sea-bed mining). Capital costs tend to be highest in opencast and deep mining. It is difficult for small-scale mines to compete effectively in industries in which economies of scale are pronounced and capital requirements high. For these reasons, small-scale mining is now the exception in most base metal industries despite the fact that some of these metals have been mined on a small-scale for many centuries. Alluvial extraction of gold, and to a lesser extent of tin, remains an important sphere of small-scale mining.¹

Gemstones form an important category of minerals in which small-scale extraction is important. They differ from most metals in that the rough gems are obtained without intermediate processing (smelting, refining etc.), although the same is also true of gold. Diamonds occur alluvially again facilitating small-scale operations, as well as in pipes, which require deep mining and will typically be undertaken by medium or large scale enterprises. Many coloured gemstones, such as emeralds, rubies, sapphires and tanzanite, crop in insufficient abundance to justify large scale exploitation.

An important distinction is between metals and minerals mined for the international market, and those mined for domestic consumption. Trade barriers and transport costs allow prices to differ across and (in the case of transport costs) within countries. These price differences imply that small-scale activities which may be economically viable in one country or region are not viable in another. Transport costs are particularly important for low value products such as aggregates, but also to a lesser extent for coal and iron ore. These industries can be very important, despite the small-scale of enterprises.² They have been relatively lightly documented and researched. Despite this, the main focus of this paper is metals and minerals which enter international trade.

2.1.2 Parallels with smallholder agriculture

There are a number of parallels between small-scale mining and smallholder agriculture, although there are also important differences. The most obvious parallel is that both activities are undertaken on a small-scale and with limited capital. Smallholder farmers, like small-scale miners, have no or only very limited access to credit as the consequence of their lack of collateralisable assets. In some cases smallholder farmers may also be small-scale miners, varying the family's time allocation between the two activities depending on the season and the weather. In other cases, miners may be members of smallholder families who are diversifying family income across activities. In these cases, it is clear that the same set of constraints apply across the agricultural and mining activities.

¹ Some tin dredgers may stretch the distinction between small and medium scale operations.

² Hertschel et al. (2000) report that 90% of miners in China are employed in small-scale mines for aggregates and coal.

Just as there are geological and technological differences between mining different metals or minerals, there are agronomic differences across crops. Some crops, like cocoa, which permit intercropping, are better suited to smallholder than estate production. There are few benefits to scale. A second group of crops, like natural rubber, are well-suited to estate production and demonstrate scale economies – intercropping is not desirable and one rubber tapper can cover a large area. Finally, there are crops which are intermediate, like coffee, where smallholders and estates can compete on broadly equal terms. One is therefore able to observe the same sorts of variation of enterprise size and organisational structure in developing country agriculture as in mining, except that there are no agricultural plantations of comparable size to the largest mines.

The parallels between smallholder agriculture and small-scale mining are important in the discussion that follows because they allow us to draw on a much larger range of experience than would be available had attention been confined solely to the small-scale mining sector.³ Important as small-scale mining is, agriculture remains much more important to developing country economies, and there have therefore been many more policy initiatives in the agricultural sphere. That experience is important since otherwise there is a danger that mistakes made in agricultural policy might be repeated in relation to mining.

2.2 Price variability

Commodity prices are variable because short-term production and consumption elasticities are low. Production responsiveness is low in metals because there is a lag of several months between mine production decisions and the sale of refined metal. Similarly, planting decisions in agriculture are made before new crop prices are known. In both cases, production decisions depend on expected prices, and not realised prices. Short-term demand elasticities are low because the actual commodity price may not be a large component of the overall value of the final product (aluminium in the price of an automobile or cocoa in chocolate, to take two examples). Further, for those metals and agricultural products which are used in industrial applications, input choices and proportions are embodied in product designs and the specifications of the production processes.

Those factors determine the amplitude of fluctuations in commodity prices. Two types of shocks must be distinguished. Shocks to demand originating in the industrial business cycle predominantly affect industrial commodities, such as metals. Shocks to supply predominantly affect agricultural commodities. Low elasticities imply that small shocks to production or consumption can have a large impact on price.

2.2.1 Stockholding

The impact of shocks on commodity prices is moderated by stockholding. Low prices, caused either by positive supply shocks, negative demand shocks, or both, imply probable positive returns to stockholding. Consumption demand is therefore augmented by stock demand until such point as the expected return from holding stocks is equal to rate of interest on comparably risky investments. The fall in prices is moderated to the extent that excess supply is absorbed in stocks. Because of stockholding, the impact of a negative shock in one year is extended into the following year or years (Samuelson, 1957). The consequence is that, even with shocks that are uncorrelated over time, stockholding induces positive autocorrelation in the resulting prices.

³ The smallholder agricultural sector also tends to be better documented than the ASM sector. See Hilson and Maponga (2004) in relation to ASM information shortages.

The same mechanism works for excess demand resulting from negative supply shocks or positive demand shocks. These result in destocking, thereby augmenting supply. The catch is that destocking requires an inventory. Once stockout occurs, price is determined simply by equality of production and consumption demand. The non-negativity constraint implies that stockholding behaviour will be more effective in moderating downward price movements than upward ones. This is consistent with the findings that commodity price cycles exhibit long flat bottoms, punctuated by occasional sharp peaks and that commodity price distributions are typically skewed to the right.

There have been significant advances in the modeling of inventory-moderated commodity price cycles. Samuelson (1957) illustrated the effects of storage on grain prices. The competitive storage rule was first characterised by Gustafson (1958), again writing in the context of grains. Deaton and Laroque (1992) derived the rational expectations equilibrium in a simple non-dynamic model of agricultural supply and demand with a single state variable – availability, defined as production plus lagged carryover. Wright and Williams (1991) used numerical methods to approximate this equilibrium both in this and in more complicated dynamic models involving two or three state variables.

2.2.2 Investment cycles

Despite these theoretical advances, the empirical usefulness of these models is less evident. In particular, the price autocorrelation through storage is insufficient to account for the observed price autocorrelations unless harvests are also autocorrelated. Deaton and Laroque (1995, p. S39) report “The i.i.d. model with storage seems like a very poor candidate for explanation of the data. The model with autoregressive shocks does better, but not a great deal better than a simple autoregressive 1 (AR) without storage...Storage seems to play only a small part in generating the autocorrelation of prices.” See also Deaton and Laroque (1996).

This does not imply that simple AR models are superior to structural models. The Deaton-Laroque (1992) model implies that prices should be autocorrelated when stocks are held, but not otherwise. This was confirmed by Ng (1996), who showed that simple AR(1) representations for commodity prices fail specification tests against nonlinearity, but that these nonlinearities may be accounted for by the self-exciting Threshold Autoregressive (SETAR) model proposed by Tong and Lim (1980). This suggests that the stockholding model captures part of the reason for commodity price autocorrelation but that, by itself, it is insufficient.

It seems possible that the missing part of the modelling story relates to investment. The simple version of the Deaton-Laroque (1992) model discussed above supposes that the expected harvest is constant. More recently, Deaton and Laroque (2003) have argued that supply is infinitely elastic at a long run price. What is less clear is whether this is a behavioural relationship or an equilibrium condition. In any case, the infinite elasticity of supply assumption makes the investment function implicit.

Commodity investment is probably best analysed in a real options framework. Firms with proven mineral reserves have an option to mine these reserves, but will only do so if expected prices are such that the development is likely to be profitable. The same is true of farmers or countries with the possibility of investing in tree crop commodities. If a simple price process is posted, there will be a trigger price at which investment will take place. A stylised version of this model is developed by Dixit and Pindyck (1994), using both a standard price diffusion and a mean reverting (Ornstein-Uhlenbeck) process. The latter is more realistic for primary commodity prices since prices are constrained to move back toward production costs.

The modelling agenda consists in the integration of these two approaches. The major problem is that the Dixit and Pindyck (1994) real option approach starts from an assumed price process. However, although prices are exogenous to an individual enterprise, they must be endogenous within a market model. It seems unlikely that anything so simple as the basic Ornstein-Uhlenbeck process would emerge. However, if a successful model can be developed, it promises to deliver an integrated view of commodity prices that can answer questions relating to over-investment and the claimed need for supply management policies. In the context of minerals, it could also explain resource depletion issues along the lines raised by Hotelling (1931).

2.2.3 Price variability across commodities

The extent of price variability differs across commodities reflecting differences in industrial structure (competitive versus monopolistic or oligopolistic markets), the presence or absence of intervention schemes, the magnitude of the demand and (in competitive markets) the supply elasticities and the magnitude of the shocks impacting production and consumption.

Volatility can be measured as the standard deviation (or coefficient of variation) of either changes in the commodity price, or of deviations from trend. In the columns labelled "changes" in Table 1, are the standard deviations of the changes in the logarithms of annual averages of the US dollar prices of a number of commodities, in each case deflated by the US Producer Prices Index (all items). Note, however, for the four gemstones where there no publicly available price series, we have substituted the unit value of imports into the United States.⁴ There are variability estimates for four gemstones (diamonds, emeralds, rubies and sapphires), two precious metals (gold and silver), six non-ferrous metals (aluminium, copper, lead, nickel, tin and zinc), three other industrial minerals (coal, iron ore and phosphates) and, for purposes of comparison, ten agricultural food and five non-food commodities.

This measure of variability is natural in econometric or financial modelling since this measure corresponds to the volatility in the diffusion model which underlies many such analyses. However, it is arguably less useful in analysing the situation faced by commodity producers who are concerned as to whether and by how much they are covering their production costs – it is possible to have prices beneath production costs but which nevertheless are relatively stable, as currently in the coffee market. Therefore, an alternative measure of variability has also been calculated as the standard deviation of prices about an estimated trend. This is given in the column labelled "deviations" in Table 1.

Table 1: Price Volatilities, 1983-2002

	Gemstones and Precious Metals		Non-Ferrous Metals		
	Deviations	Changes		Deviations	Changes
Diamonds	8.6%	8.2%	Aluminium	19.9%	21.3%
Emeralds	35.7%	40.7%	Copper	24.5%	16.7%
Rubies	28.2%	28.3%	Lead	22.9%	19.0%
Sapphires	22.6%	18.9%	Nickel	32.8%	32.2%
Gold	10.0%	10.9%	Tin	10.8%	16.9%
Silver	11.5%	17.6%	Zinc	21.1%	18.5%

⁴ Data sources: US Producer Price Index (all items) and all prices except gemstones: IMF, *International Financial Statistics* (cd-rom); gemstone unit values, US Department of the Census, *Import Statistics* (cd-rom). The smooth trends were estimated using the STAMP software – see Koopman *et al.* (2000).

Agricultural Foods			Other Minerals		
	Deviations	Changes		Deviations	Changes
Cocoa	24.1%	20.9%	Coal	6.3%	8.5%
Coffee	34.6%	28.9%	Iron Ore	7.8%	7.9%
Maize	16.7%	16.3%	Phosphates	9.3%	9.1%
Palm Oil	32.0%	29.3%	Agricultural Non-Foods		
Pepper	52.3%	36.2%		Deviations	Changes
Rice	21.6%	13.2%	Copra	31.5%	35.6%
Soybeans	13.4%	12.9%	Cotton	19.0%	19.8%
Sugar	39.5%	24.3%	Jute	19.5%	25.9%
Tea	15.9%	16.6%	Rubber	23.0%	20.1%
Wheat	21.4%	18.8%	Sisal	15.3%	12.2%

Changes are percentage changes in log deflated prices. Deviations are percentage deviations of log prices from estimated smooth trends. Deflation is by the US Producer Prices Index (all items). Trends are estimated over the sample 1971-2002 except for rubies and sapphires (1982-2003) and pepper (1983-2002).

Data sources: All prices except coffee and gemstones: IMF, *International Financial Statistics* (cd-rom); coffee, ICO Indicator Price, International Coffee Organisation; gemstone unit values, US Department of the Census, Import Statistics (cd-rom).

The trend may be thought of as a proxy for unobserved production costs. Technical progress results in downward pressure on production costs and this appears to be sufficiently rapid in most minerals industries to offset the depletion effects central to the Hotelling (1931) model – see Slade (1982). Similarly, Lewis (1954) argued that the prices of commodities produced in developing countries are held down by the infinite elasticity of supply of labour at the subsistence wage rate, and that also appears to remain true. Nevertheless, there is no reason to suppose that the rate of technical progress is constant over time, and the evidence suggests that, for many commodities, it is not – see Gilbert (2003) in relation to agricultural commodities. The standard practice of measuring volatility relative to a linear trend may over-estimate the extent of variability by making insufficient allowance for cost variability. A more flexible trend estimation procedure has therefore been adopted.⁵ Details of the estimated trends are given in an appendix table.

This second “deviations” variability measure tells broadly the same story as the “changes” measure (the simple correlation between the two measures is 0.87), although individual statistics are quite different for certain commodities. The commodities fall into three broad groups, depending whether price variability is low, medium or high. This classification is given in Table 2, where the low group are those commodities with variability measured on the deviation of measure of less than 15% per annum, the high group are those commodities with annual variability in excess of 25%, and the medium group are the remainder. The cut-off points are obviously arbitrary, and the classification would have been slightly different the change measure of variability had been used, but the broad story would be unaltered.

⁵ The logarithm of each series is decomposed into a smooth trend (possibly with stochastic slope) plus one of more of a first order autoregression, a short cycle, a long cycle and an irregular component. In general, it is not possible to fit all these components and a parsimonious specification has been selected. Estimation uses the STAMP package- see Koopman *et al.* (2000).

Table 2

Commodity Groups Classified by Variability			
Low Variability	Moderate Variability		High Variability
Coal	Sisal	Rice	Rubies
Iron Ore	Tea	Sapphires	Copra
Diamonds	Maize	Lead	Palm Oil
Phosphates	Cotton	Rubber	Nickel
Gold	Jute	Cocoa	Coffee
Tin	Aluminium	Copper	Emeralds
Silver	Zinc		Sugar
Soybeans	Wheat		Pepper
Ranking is according to the deviation variability measure for 1982-2003 given in Table 1. Coal is the commodity with lowest reported variability and pepper that with the highest variability. The low variability group has variability less than 15% per annum, the high group has variability in excess of 25% per annum and the moderate group is the remainder.			

A number of features stand out from Table 2. In particular the low variability group contains only a single agricultural commodity – soybeans – and this has the highest variability in that group. Instead, six out of the eight high variability commodities are agricultural. Agricultural commodities appear more variable than metals and minerals. By contrast, three of the principal ASM commodities – diamonds, gold and tin – appear in the low variability group. For these commodities, price variability does not appear to have been of great magnitude historically. However, apart from diamonds, other gemstones appear to show much higher price variability.⁶ The overall conclusion is that, with the exception of coloured gemstones, price variability appears to be less acute in the products produced in the ASM sector than for other primary commodities.

2.2.4 Pass-Through

The prices analysed in section 2.2.3 were international prices. The pass-through issue concerns the extent to which movements in international prices are passed through to the producer prices paid in a particular sector.

The extent of pass-through will depend on a number of features. Most obviously, international prices will only determine domestic prices to the extent that the commodity in question is exported (or imported). This will partly be determined by transportation and other costs, and partly by the presence or absence of export restrictions or taxes. In the ASM sector, metals and gemstones with high value to weight ratio will typically be traded, while aggregates and some other minerals with low value to weight ratios may be extracted solely or largely for domestic consumption. We should therefore expect to see high price through for the former group and zero or low pass-through for the latter. Where there is little or no pass-through, price variability at the international level has no implication for national price variability. At present, it is not evident that there is data

⁶ Coal, iron ore and phosphates are also mined in ASM sector, but because these products have a low value to weight ratio it is less clear that the international prices provide a clear guide to the prices which would be obtained in the ASM sector.

which allows one to say anything about the variability of prices at the national level for this group of minerals.

The second important determinant of pass-through is the extent of competition in intermediation. Where producers are faced with a large number of potential buyers, competition will force these buyers to offer keen prices. Where producers are faced with few alternative buyers, these buyers will be able to squeeze their purchase prices down to levels close to production costs. In that case, changes in world prices will primarily affect the profits of the intermediaries and pass-through will be low.

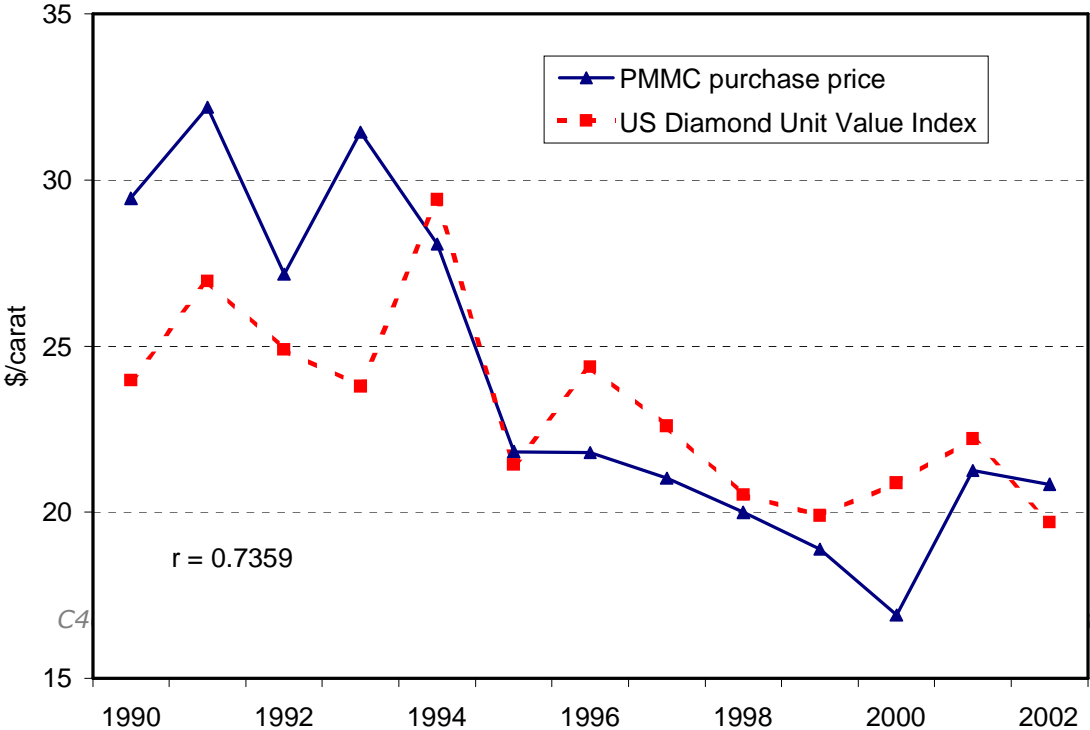
There are two preconditions for competition: free entry into intermediation and a sufficient number of producers to cover the costs of a large number of traders. The consequence is that the intensity of competition tends to be higher in zones in which producers are concentrated, and lower in small and isolated production zones.

Pass-through is also enhanced if producers are well-informed about the prices they can expect to obtain. This information is usually obtained from local newspapers or the radio. Producers will generally make it their business to be well informed about prices, but this process can be facilitated by good publicly-run price information systems.

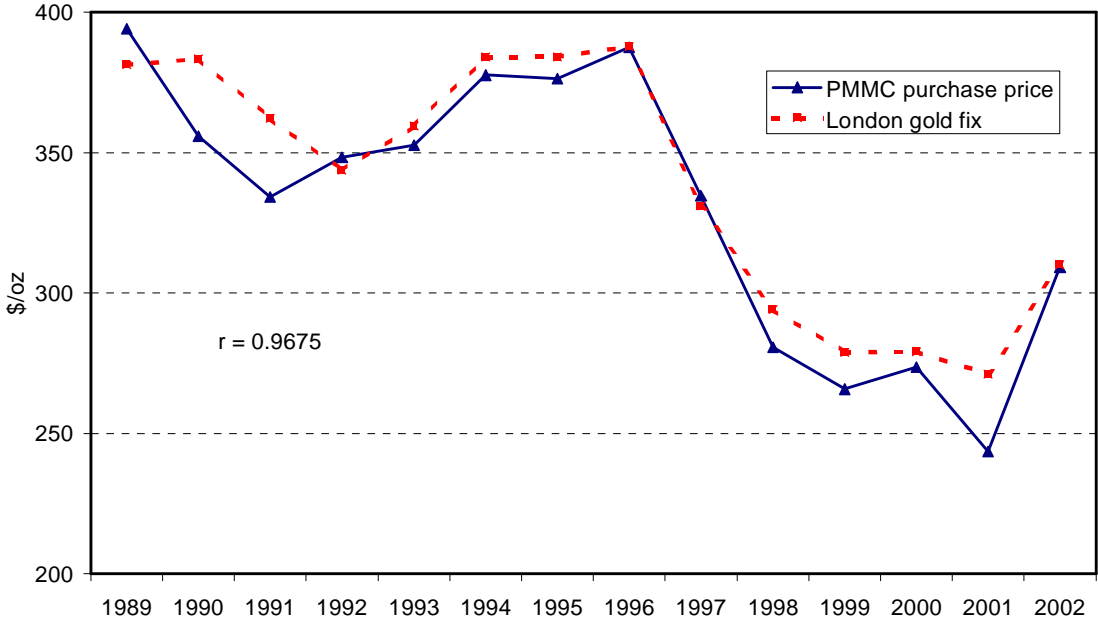
Monopsony marketing boards form an alternative intermediation structure – see section 3.2.2. Depending on how these boards are organised, they have the possibility of ensuring that producers are not exploited by intermediaries, although this is no guarantee that the price paid by the board will be generous. Pass-through depends on the extent to which the board changes its selling prices in relation to changes in world prices. In some cases, boards simply see themselves as providing efficient intermediation, while in other cases they attempt to smooth out variations in world prices. Pass-through will be high in the former and low in the latter case. Where smuggling is possible (gemstones and precious metals), monopsony boards will be obliged to pay close to world prices – this will be the normal case in much of the ASM sector.

2.2.5 Figure 1: Pass-Through in Ghanaian Diamonds

In this section pass-through in the Ghanaian ASM sector is examined where gold and diamonds produced in the ASM sector is sold through the Precious Minerals Marketing Corporation (PMMC). Miners have the option either of selling directly to the PMMC in Accra, or of selling to agents (Licensed Buying Agents) who in turn sell to the PMMC. The



PMMC buys gold at 2% under London prices, converted into cedis. This implies full pass-through. In diamonds, the PMMC operates through a set of Licensed Buying Companies who sell the diamonds on the world market (typically in Antwerp) through affiliates. The LBCs negotiate the prices they pay LBAs or miners, and obtain a margin relative to the prices they achieve in Antwerp or elsewhere. Payment, however, is made through the PMMC which operates the fiction of being the monopoly seller. There is a large number of LBCs so competition should again ensure a good pass-through.



2.2.6 Figure 2: Pass-Through in Ghanaian Gold

These conjectures are substantiated in Figures 1 and 2 which show movements of annual averages of the PMMC diamond and gold purchasing prices in relation to a US diamond unit value index⁷ and the London gold fix respectively over the period 1989-2002 (1990 for diamonds). The PMMC gold purchase price does indeed move closely with the London gold price ($r = 0.9675$) reflecting the formula under which the purchase price is set. The diamond price moves less closely with the unit value index ($r = 0.7359$), but the relationship appears to have become closer over recent years. This less than perfect fit may be evidence of the variability of unit values which can vary as the result of variations in the average quality of diamond bought or imported, as much as to problems in pass-through. Overall, these two figures can be viewed as demonstrating a high degree of pass-through in the Ghanaian ASM sector.

How does the variability of producer prices compare with that of international prices? In general terms, intermediation costs are independent of the level of the commodity price. With competitive intermediation, one would therefore expect producer prices to vary by broadly the same dollar amount as international prices. Taking into account the intermediation margin, this implies that producer prices should be more variable than international prices, particularly when world prices are low. This volatility amplification has been important over recent years in a number of agricultural commodities, in particular robusta coffee, where prices have fallen to unprecedentedly low levels.

⁷ The diamond unit value series is an index constructed as 1.75 x the unit value of unworked (rough) diamond imports into the USA (7102214000), 0.025 x the unit value of small worked diamond imports (7102310010) and 0.0075 x the unit value of large worked diamond imports (7102310050). The weights were determined by regression analysis. Data source: US Bureau of the Budget, *Import Statistics* (cd-rom).

In the Ghanaian case discussed above, the volatility of PMMC gold purchase prices, calculated as the standard deviation of changes in logarithmic prices, was 11.0% against an international volatility of 7.6% (1990-2002). This is in line with the amplification hypothesis. Instead, for diamonds we find that the PMMC diamond purchase price was slightly less volatile (13.4%) than the US import unit value index (14.0%, 1990-2002). However, as noted in section 2.2.2, the unit value index may vary more than actual diamond transactions prices as the result of quality variation from one year to another in the composition of US diamond imports.

2.3 Summary

The most important metals and minerals in the ASM sector are diamonds and other gemstones, metals which can be extracted from alluvium, in particular gold but also tin, and also construction aggregates. This is a relatively small number of minerals, and relevant experience is correspondingly low. However, it is argued here that small-scale mining has much in common with smallholder agriculture, and indeed is often carried out by the same households, or members of the same households. In looking at price volatility, it therefore makes sense to look across the entire spectrum of commodities, and to apply that experience to the ASM sector.

Examination of the variability of international prices generates an important finding. Those metals and minerals which are important in the ASM sector typically exhibit relatively low degrees of price variability. This is true of diamonds, gold and tin. It is not true of coloured gemstones. The finding implies that price variability may not be so much of a problem in the ASM sector as in other commodity industries. Pass-through to the prices received by producers will depend on industry characteristics, in particular the degree of competition in intermediation. This makes generalisation difficult. However, experience from Ghana suggests high pass-through with the result that volatility of producer prices is comparable with that of world prices.

3 Types of Commodity Intervention

Commodity policy has generally been directed towards either moderating or offsetting price and/or revenue variability. This paper considers arrangements which seek to moderate price variations in section 2.1 and 2.2 and schemes which seek to offset the effects of such variation in section 2.3. Wider objectives, such as market development, research and development and diversification, have received some attention, particularly from the Common Fund for Commodities, but the quantity of resources allocated to these activities has been small, both absolutely and in relation to stabilisation objectives.

Commodity market interventions arose out of perceived problems of "burdensome surplus" in the interwar period. Supply management agreements were negotiated by large producing firms, generally with the support of colonial governments. Some of these evolved into commodity agreements. Colonial governments also set up national stabilisation schemes and these arrangements were generally maintained in the post-colonial period – see Rowe (1965). These were complemented by compensatory finance schemes which aimed to compensate governments of commodity-producing countries for shortfalls in export revenues.

3.1 International Schemes

Stabilisation schemes may either be international (this section) or national (section 2.2). Regional schemes would also be possible, although as yet no significant instances of these have been publicised.

Prices of major primary export commodities are set internationally. In particular, the prices of the many of the most important traded commodities are determined on organised commodity futures exchanges. Commodities for which this is true include crude oil, the major non-ferrous and precious metals (aluminium, copper, gold, lead, nickel, silver, palladium, platinum, tin and zinc) and important agricultural export crops (cocoa, coffee, natural rubber, palm oil, soybeans, soybean oil, sugar and wheat). Contractual prices for particular transactions, for example between a particular producer or exporter and the importing company, are typically on an “unknown” basis, i.e. the contract will specify the exchange price on (or around) the delivery date of the commodity (which price is unknown at the contracting date) plus or minus a negotiated premium or discount, reflecting factors such as quality and location.

Prices of some other major export commodities, such as bauxite, coal, iron ore and steel, are determined through bilateral negotiations between mining and consuming companies. The negotiations between the major players generate a type of marker price which forms the starting point for negotiations between other parties. Again, there is an international price upon which the prices for individual transactions will be based. On both these cases, we may think of a particular transaction price as comprising two elements – the common international price and an idiosyncratic component (the price “basis” in futures market terminology).

For exchange-traded commodities, changes in transactions prices over time will normally be dominated by changes in the international price. This is because basis variability undermines hedge quality, and a balance between hedging and speculative interests is a prerequisite for viable futures trading. Indeed, basis risk is a major reason why commodities such as coal and steel are priced through producer-consumer negotiations. (Another important reason is that monopolistic or oligopolistic producers dislike the transparency introduced by organised futures trading). For exchange-traded commodities, producers have sought stabilisation primarily at the international level.

In what follows, three forms of international intervention are considered: international commodity agreements, producer-only agreements and monopolistic or cartel arrangements involving individual producing companies or countries.

3.1.1 International Commodity Agreements

The term “international commodity agreement” (henceforth ICA) refers to a treaty-agreement between governments of both producing and consuming countries to regulate the terms of international trade in a specified commodity.⁸ There have been five economically active ICAs, in cocoa, coffee, natural rubber, sugar and tin.

⁸ The discussion of ICAs follows Gilbert (1987, 1996, 2004). The discussion here excludes agreements which lack “economic clauses” (i.e. clauses sanctioning market intervention), and which are therefore unable to directly affect international trade in the commodity. There is a large number of such “study group” style agreements whose functions are information collection and dissemination, market promotion and, in certain cases, the fostering of research and development. The Lead and Zinc Study Group is a prominent example of organizations of this type.

ICAs have a long history. During the nineteen thirties, primary commodity markets exhibited low prices and substantial excess capacity. There was a general expectation that similar conditions might return in the post-war period, and the unratified 1948 Havana Charter, which would have set up the International Trade Organisation as the third pillar of Bretton Woods, included measures aimed at the alleviation of situations of what was described as “burdensome surplus” (Rowe, 1965). It was envisaged that this would be accomplished primarily through supply regulation - typically export controls. In the absence of the institutional structures which the Havana Charter would have created, interested governments negotiated free-standing agreements of which the 1954 International Sugar Agreement (ISA) and International Tin Agreement (ITA) were the first. Both relied primarily on supply management - the ISA entirely so, while the ITA also involved a buffer stock, the initial purpose of which was seen as supporting the price over the period in which export restrictions took effect – see Fox (1974). The tin industry is characterised by a relatively high degree of concentration at the smelting stage, and there had been a history of co-operation among the producing companies and colonial administrations in the interwar period. Although sugar is produced in a large number of both developed and developing countries, the sugar refining industry is also relatively concentrated. Production in developing countries was substantially in what were then colonial territories and in which there had been a tradition of supply management by the colonial authorities.

The situation was somewhat different with the International Coffee Agreement (ICOA) negotiated in 1962. At that time, coffee was predominantly a Latin American commodity, although production was expanding in Africa. Brazil and Colombia were the largest exporters. The Instituto Brasileiro do Cafe (the IBC) was responsible for Brazilian coffee policy and had favoured supply management for many decades, but the Colombians had resisted this, preferring to expand under unfettered conditions. However, as coffee consolidated in Colombia, political power shifted in favour of the coffee-growing regions – see Bates (1997). The United States was, and remains, the single largest coffee consuming nation, and the crucial element which resulted in the ICOA, which was modelled on the ISA as a pure export control agreement, was the willingness of the US government to agree to export controls. This was the period immediately following the socialist revolution in Cuba, and it is often supposed that the US saw the advantage of higher coffee prices for its Latin American friends as outweighing the disadvantages arising from a controlled market. Bates (1997) argues that the highly concentrated and imperfectly competitive US coffee roasting industry was more concerned with reliability and security of supply than with price and may have seen agreement to controls as an acceptable price for governmental goodwill. A different interpretation is offered in Gilbert (2004).

While coffee is predominantly a Latin American commodity, cocoa is predominantly west African, although there is significant production in south-east Asia. Many of the West African cocoa producers are also coffee producers, and west African cocoa had inherited a tradition of state-controlled marketing from the British and French colonial administrations. In this context, it was natural that the cocoa producers would seek an agreement similar to that negotiated in coffee. However, perhaps in part because, at that time, west Africa was not perceived as having major strategic importance, or because the cocoa grinders and chocolate manufacturers⁹ were generally not disposed towards controls, the US government declined to join the 1972 International Cocoa Agreement (ICCA). The ICCA differed from the ICOA in that its primary instrument was the buffer stock, with export controls playing a supplementary role.

⁹ Cocoa beans are ground (processed) to produce cocoa butter and cocoa powder. Cocoa butter is the intermediate product in chocolate manufacture. There is incomplete (and declining) vertical integration between processing and chocolate manufacture.

With the 1964 foundation of the United Nations Conference on Trade and Development (UNCTAD), ICAs moved into a more political environment. Existing ICAs came under the auspices of UNCTAD, which also sought, from 1976, to stimulate the negotiation of new agreements as part of the Integrated Programme for Commodities (IPC) in connection with the so-called New International Economic Order (NIEO). The NIEO was intended to set up what its proponents viewed as a more equitable system of trading relations between the developed and the developing world. Governments of developed countries generally remained at best ambivalent towards the NIEO, which many of them saw as attempting to substitute governmental regulation for market forces. The IPC was endorsed by the United Nations General Assembly in 1974. Its most explicit statement is in UNCTAD Resolution 93(IV) which sought the stabilisation of commodity prices around levels which would be "remunerative and just to producers and equitable to consumers" (UNCTAD, 1976). UNCTAD produced a list of ten "core" commodities in which it hoped to see ICAs¹⁰ but developed country governments argued for a commodity-by-commodity approach to negotiations. These negotiations took place in Geneva over the following years – see Brown (1980) for an account.

Although the rhetoric of these negotiations related to the variability of commodity prices, with buffer stock intervention now the favoured instrument, developed countries remained suspicious that the producers' main intentions related to the level rather than the variability of prices. Developed country governments saw price stabilisation as an expensive diversion of funds, which produce relatively few benefits, from more pressing development objectives.¹¹ Further, they suspected that many of the producing countries wished to substitute a socialist-style "planned" commodity economy which would be inefficient and might result in what for them would have been an unfavourable shift in the terms of trade. In effect, the consumer governments filibustered the negotiation process with the consequence that only a single new agreement emerged – the 1980 International Natural Rubber Agreement (INRA).

From this point onwards, the ICA movement went into reverse. The ISAs had never managed to overcome the problems caused by the USA's 1962 decision to deny access to Cuba, then the largest sugar-exporting country, to the US market, and by the substantial growth in sugar production in the European Union (EU). The fourth ISA terminated in 1984 and was replaced by an agreement which did not contain market intervention clauses (Gilbert, 1987). The ICCA does remain in existence and does, in principle, allow the possibility of market intervention through unspecified production management measures, but no longer through the buffer stock. However, the ICCAs have never had either the finance or the country coverage to be able to have more than a small effect of the cocoa market (Gilbert 1987, 1996). Effectively, therefore, the active ICAs consisted of the ITA, the ICOA and the INRA. The ITA broke down spectacularly on United Nations Day (24 October) 1985, and the ICOA effectively abandoned supply management ambitions on (US) Independence Day (4 July) 1989. This left the INRA to stagger on until 1999, a year prior to the formal ending of the 3rd INRA, when first Malaysia (13 October 1999) and then Sri Lanka and Thailand gave notice of withdrawal from the agreement. This left insufficient producer representation for the agreement to function, and effectively terminated the agreement and hence also the ICA movement.

¹⁰ Cocoa, coffee, copper, cotton, jute, rubber, sisal (later extended to all hard fibres), sugar, tea and tin.

¹¹ Theoretical analysis established that, in the absence of a complete set of forward and contingent markets, there is no reason to suppose that the competitive allocation is even constrained Paretian (i.e. Paretian relative to the markets that do exist, see Newbery and Stiglitz, 1981). That suggests there might be a basis for intervention. However, there is no reason to suppose that private sector storage is generally inadequate, as is presupposed by arguing for public buffer stock stabilization. Furthermore, buffer stock stabilization would be expensive, in terms of the opportunity cost of funds employed.

Table 3: Summary Features of International Commodity Agreements (ICAs)

	Cocoa (ICCA)	Coffee (ICOA)	Natural Rubber (INRA)	Sugar (ISA)	Tin (ITA)
First Agreement	1981	1962	1980	1954	1956
Breakdown or lapse of intervention	Suspended 1988	Suspended 1989	terminated 1999	Lapsed 1983	collapsed 1985
US membership	No	Yes	yes	Yes	no ¹²
Buffer stock	Yes	No	yes	No	yes
Export controls	supplementary ¹³	Yes	no	Yes	yes

Table 3 summarises the general features of the five ICAs. The principal instruments used by ICAs have been supply management and buffer stock intervention. Supply management presupposes the ability of government to control either production or exports. Both smuggling and problems in controlling re-exports can undermine export controls. Effective buffer stock stabilisation supposes storability together with a relatively competitive (international) market structure (since otherwise large producers could act strategically with respect to the buffer stock). Both forms of intervention are made more difficult to the extent that the commodity lacks homogeneity.¹⁴

The extent to which ICAs have (a) raised and (b) stabilised prices remains controversial. Evaluations have typically relied on counter-factual simulation of econometric models, for example Smith and Schink (1976) on tin, and Palm and Vogelvang (1981) on coffee. Exercises of this sort are subject to qualification with regard to the extent that the models employed in the simulations adequately reflect market behaviour. These worries are underlined by the observation that stockholding and other strategies will adapt to the policies followed by the stabilisation authority (Miranda and Helmberger, 1988).

Table 4: Post-ICA Price Changes

Year	Cocoa	Coffee	Natural Rubber	Sugar	Tin	Average (excl. rubber)
- 1	100.0	100.0	100.0	100.0	100.0	100.0
0	61.0	64.5	105.0	58.6	57.7	60.4
1	49.4	69.9	94.7	57.1	54.4	57.7
2	58.3	59.9	113.5	86.0	45.5	62.5
3	56.5	54.7	n.a.	87.1	54.9	63.3
4	50.2	74.6	n.a.	102.9	43.1	67.7
average 5-9	57.2	107.9	n.a.	120.2	38.7	81.0

¹² The US was a member of the first five ITAs, but not of the sixth ITA which collapsed in 1985.

¹³ The first two ICCAs made provision for export controls but these were never employed. The fourth ICCA provided for producing member countries to "withhold" supplies in the event that the buffer stock reached its maximum level. This provision was never implemented. The fifth ICCA, which came into effect in 1993, no longer provides for a buffer stock but does allow the possibility of "production management". Again, this provision has not been implemented.

¹⁴ No commodity is completely homogeneous but only in coffee was heterogeneity an important factor in the operation of the agreement. The ITAs employed both export controls and a buffer stock with the emphasis within the successive ITAs shifting from supply controls towards increased reliance on buffer stock stabilization. The ICCA was conceived as relying on a buffer stock but with the possibility of supply controls held in reserve.

The results of a cruder evaluation procedure can also be recorded. For example, table 4 gives the annual price averages for cocoa, coffee, natural rubber, sugar and tin over the five years following cessation of intervention.¹⁵ In each case, prices are measured relative to the IMF Commodity Price Index (non-fuel commodities), with the ratio normalised to 100 in the twelve month period prior intervention ceased or was abandoned. The indices in Table 4 should therefore be seen as indices relative to the general level of non-energy commodity prices. Except in the case of natural rubber, the ending of intervention was associated over the following two years with prices around 40% lower than in the final year of control. Despite subsequent recovery in coffee and sugar, on average prices remained 30% lower over the next three years, and much of this difference persisted over the following five years.

Taken at face value, the figures in Table 2 suggest that ICAs raised commodity prices by a substantial amount. However, this conclusion is too simple. Excluding rubber, for which the post-agreement history is still too short for judgement, the remaining four commodities considered in Table 2 fall into two groups. In cocoa and sugar, the agreements lapsed at least in part because over-supply made it impossible to maintain prices at historic levels. For these two commodities, the price falls were caused by this over-supply and not by the ending of control. It is difficult to claim that this over-supply was caused by the ICAs themselves. In coffee and tin, by contrast, it is plausible to argue that the price falls are attributable to the ending of controls. In particular, both agreements saw the release of stocks which had been held off the market, by producers in the ICOA and by the buffer stock in the ITA. It is generally believed in the respective industries that the scale of this stock release took prices below long run production costs. It is plausible that both agreements did raise prices above production costs, but the 40-50% figures in Table 2 probably over-estimate this.

Even if ICAs did raise the relevant international prices, it is less clear that the producers benefited in terms of higher producer prices since part of the benefit of higher prices may have been dissipated in the administration of the stabilisation scheme, or in other ways. Rent extraction of this form was a problem with quota-based agreements, and in particular, the ICOA. The administration of export quotas required an elaborate machinery in each exporting country, and even where this administration was conducted honestly, it absorbed resources. This was a one major motivation for the 1990 abolition of IBC – see Gilbert (1996, 2004). But it was also possible for dishonest officials to capture the benefits of high prices themselves, or for their relatives, through the manner in which quotas were distributed – see Bohman *et al.* (1996).

Perhaps of even greater importance, the high prices generated by the ICOA allowed the growth of relatively high cost production of poor quality robusta coffee in west Africa. Much of this production is uneconomic in the more competitive post-ICOA environment, and the smallholder farmers who planted this coffee will have received a poor return for their funds and effort. A significant component of the higher prices generated by coffee “stabilisation” were therefore expended on loss-making investments which gave rise to inefficient production.

Did the ICAs stabilise prices? The post-stabilisation experience provides mixed evidence on this question. Looking at the three year period immediately following the lapse or collapse of controls in relation to the three year period immediately preceding this, the coefficient of variation of monthly coffee prices fell from 23.6% to 10.7%, while the coefficients of variation for cocoa and tin rose from 6.9% to 14.3% and from 8.3% to 14.3% respectively. Coffee moved from a regime of high but volatile prices to one of

¹⁵ This table is taken from Gilbert (2004). It updates a similar table in Gilbert (1996).

stable depressed prices.¹⁶ However, economic theory suggests that commodity prices should be less variable when supply is plentiful, (see Williams and Wright, 1991; Deaton and Laroque, 1992; and Brunetti and Gilbert, 1995), and the rise in the coefficients of variation for cocoa and tin was in fact entirely attributable to lower average prices - the price standard deviations are almost identical before and after the end of stabilisation. (The sugar price remained highly variable before and after the lapse of the ISA, probably reflecting the residual nature of the free market in sugar at that time).

Evaluation of the overall "success" of the ICAs is problematic on account both of the ambiguity relating to their objectives and because of rent extraction. The rhetoric of the agreements, at least over the past two decades, stressed reduction in price variability, but here the effects have been at best marginal. By contrast, producer governments have always seen ICAs as a means of raising prices, or at least of avoiding low prices, and on this criterion, two agreements - the ICOA and the ITA - do appear to have enjoyed some success. At the same time, most discussion gloss over possible abuses (probably more important in coffee than in tin). By contrast, the ICCA and ISA had negligible market impact, either in raising or stabilising prices. The INRA experience is more debatable, but its price-stabilising impact was at best small.

The two successful ICAs achieved their success for different reasons. The coffee agreement export quotas were enforced by importing countries, and the success of that agreement depended crucially on their willing cooperation. In Gilbert (2004), it is argued that this cooperation derived from consumers' appreciation that the only realistic alternative to an agreement was a producer cartel, and that prices were likely to be more favourable with an agreement than under a cartel. The agreement lost its viability once the producers were no longer able to credibly threaten a cartel. By contrast, in tin, the success of the ITA (to 1980) derived from the relatively low incentive to invest in the industry in the circumstance in which there was an implied commitment of releases from the US strategic stockpile whenever prices might rise. This generated a static supply situation in which there was no incentive for new producers to free-ride the agreement. Once the US stockpile had attained its desired long term level, and there was no longer the likelihood of US sales into high prices, new production was forthcoming outside the constraints of the agreement. The resulting excess supply was the major factor which led to eventual breakdown.

It is incorrect to argue that international stabilisation of commodity prices cannot work. However, the coffee and tin experience shows that it is difficult to envisage successful international intervention without the active support of all major consuming country governments. Currently, there is no general support in the developed world for the view that this is a good way to use scarce development resources.

3.1.2 Producer-only Agreements

Producer only agreements attempt to replicate the effects of commodity agreements but without the participation of consumer governments. OPEC is the most notable of these arrangements. Attempts to replicate this success in other industries - notably coffee and natural rubber - have been less successful. The comparison of crude oil and coffee is particularly interesting as it demonstrates that either a dominant producer or consumer government support is likely to be required to enforce export quotas, a conclusion which is reinforced by the experience in the aluminium industry.

¹⁶ This conclusion is sensitive to the choice of window. In the final eight (calendar) years during which the ICOA controls were in effect (1981-88), monthly nominal coffee volatility, measured as the standard deviation of logarithmic monthly average prices, was 14.8% while in the eight post-intervention years (1990-97), it doubled to 37.0%. However, this rise in volatility mainly reflects the impact of the 1994 Brazilian frosts.

OPEC is the best-known commodity cartel, and also illustrates the importance of a dominant producer. OPEC member countries were responsible for 41% of world crude oil production over 1999- 2001 but held 78% of proven world crude oil reserves.¹⁷ To the extent that OPEC has been effective, this has been due to Saudi Arabia which has 12% of world production and 20% of world reserves. In particular, Saudi Arabia has been willing to vary its production levels in order to achieve a broad balance between production and consumption. Gilbert and Smit (2003) demonstrate the importance of the Saudi role in OPEC by comparing movements of the crude balance of production over consumption of crude oil from 1981-2001 with a counterfactual balance adjusted as if Saudi crude production had changed in the same proportion each year as did other OPEC members. The adjusted balances are much more variable than the historical balances at least up until the mid 1990s. Saudi Arabia dramatically reduced production over the recession of 1982-83, restoring balance to what would otherwise would have been a massively over-supplied market. Subsequently, Saudi Arabia substantially increased production in 1990-92 in the context of the destruction of the Kuwaiti oil fields, again restoring balance. Effectively, OPEC has stabilised prices because Saudi Arabia has acted in such a way as to ensure this result.

The aluminium experience is less widely known but illustrates the difficulties faced by private companies in attempting to counter excess production problems. In the early 1990s, following the collapse of aluminium consumption in what had been the Soviet Union, aluminium from the ex-Soviet Union CIS began to flood Western markets. By the fourth quarter of 1993, the London metal Exchange (LME) cash price for aluminium, which serves as the market price for the entire world aluminium industry, had fallen below \$1100/ton relative to a normal range of \$1500-2000/ton. The industry made an effort in late 1993 and early 1994 to implement a concerted round of production cuts. In January 1994, multilateral talks involving all aluminium-producing countries resulted in a Memorandum of Understanding (MoU). Because of anti-trust concerns, these production cuts were negotiated by governments on behalf of producing countries. The agreement envisaged that world aluminium production would be cut for a period of up to two years by around 8%-9%.

Although historically, aluminium smelting had been relatively concentrated, this was no longer the case by the nineteen nineties. The MoU demonstrates that in industries which lack a dominant producer, effective supply management relies on the active support of consumer governments. Aluminium smelting, which is highly energy intensive, takes place in cheap energy locations, and a considerable number of these are in consumer countries. One may conjecture that such support is likely to be less forthcoming in industries where there is less direct consumer country interest.

As it turned out, production cuts of the scale envisaged by the MoU turned out not to be necessary. Western producers did cut production in 1994 by 520,000 tons, but production cuts in the ex-Soviet Union amounted in the end to only 156,000 tons. 1994 saw the end of a three-year recession and, as a result, Western world consumption alone increased by over 1.6m tons. The Western world surplus of primary aluminium, which exceeded 1.2m tons in 1993, turned in 1994 into a deficit of over 1.0m tons. The prices of most metals - not just aluminium - soared. By the first quarter of 1995, prices were above \$1,900/ton. If the goal of the MoU was to provide a stable market environment for the aluminium industry, then it was timed wrongly. If it had been implemented in 1991, it might have stabilised the market during the ensuing period of recession. Coming as it did, just when a strong economic recovery was beginning, it caused prices to overshoot a sustainable long-term target.

¹⁷ Source: *BP Statistical Review of World Energy*, 2002.

There are similarities between the experience in aluminium and those in the coffee market over the same period. The 1989 breakdown of coffee market intervention under the ICOA was followed by prices 40% lower than those preceding the breakdown. Despite a modest recovery through 1990 and the early months of 1991, prices drifted lower through 1992 so that at its lowest level, in the summer of 1992, the ICO's Composite Indicator Price was only a little over 40% of its level during the final six months of controls. These low prices had three causes:

- Stocks, previously retained by producers, were transferred to consuming countries. While held in exporting countries, the stocks had effectively been financed by taxpayers, in consuming countries they were held by private sector dealers who looked for a return from stockholding. They could only reasonably expect this return if they had bought at sufficiently low prices.
- A number of countries, most notably Colombia, whose exports had been restrained under the International Coffee Agreement, took the opportunity of expanding export levels.
- It was initially unclear whether or not a fifth International Coffee Agreement, with active intervention clauses, could be negotiated. The allocation of export quotas was an issue in these negotiations, and current and historic export levels were one factor relevant to arguments for a favourable allocation. This awareness discouraged export restraint.

The consequence was that the coffee price fell to a level lower (in real terms) than at any time since 1945.

The response of the coffee producers, led by the Central American producers, was to set up a Retention Scheme. The full 20% export withholding agreed under the scheme was to take place so long as the ICO Composite Indicator Price remained beneath 75 ¢/lb, dropping to 10% for prices within the range 75-80 ¢/lb. A price above 85 ¢/lb would trigger release. These trigger prices may be compared with those in the Fourth International Coffee Agreement - defined by the range 115-150 ¢/lb. The original 75-85 ¢/lb plan was finalised in September 1993 by which time it had the consent of all major producing countries including Indonesia, a country which had earlier been most sceptical in relation to the possibility of price support. This wide level of acceptance assured doubters that the domestic costs of withholding exports would be covered by the additional revenues raised on the 80% or production exported through enhanced prices. The coffee producers also agreed to form a new organisation, to be known as the Association of Coffee-Producing Countries (the ACPC) which would manage the coffee retention programme, in place of the previous *ad hoc* Coffee Retention Committee.

The announcement of the Retention Scheme had an immediate effect on the coffee price which rose from a first quarter 1993 average of 65.4 ¢/lb to reach 73.5 ¢/lb in the final quarter of 1994, a rise of 12%. However, these announcements did not have any effect on actual exports until the initial months of 1994. By that time, and in common with the aluminium MoU, the Retention Scheme was overtaken by market developments which resulted in it being apparently successful but in practice superfluous. Coffee price rose between two and three-fold over the period three years from mid-1993. To a considerable extent, this was a common movement with other non-oil commodity prices in the recovery stage of the business cycle - overall, non-oil commodity prices were up around 35% in 1995 over mid-1993. However, the rise in the price of coffee over the same period was an order of magnitude greater - the ICO Composite Indicator Price was nearly 150% higher in 1995 relative to its mid-1993 level reflecting the effects of the June 1994 frosts in the main Brazilian coffee producing states. These high prices rapidly led to the termination of retention the net effects of which had therefore been a

retardation of exports and therefore, possibly, some anticipation of a price rise which was driven by market fundamentals.

In summary, although it would be too strong to argue that the 1993 Retention Scheme was in no way responsible for the rise in the coffee price over 1993-94, its main effect was to bring forward price rises by a few months from 1994 to the end of 1993 in a context in which the market was, in any case, strengthening, and where its subsequent strength had nothing to do with producer actions. As with the aluminium MoU, coffee retention was planned in a period of weak market fundamentals but implemented when the market was already moving sharply in the other direction. Retention may have advanced the price rise, but despite the claims of its authors, did not cause it.

The coffee market has again become very weak in the period since 1999. This is the result of substantial increases in production Brazil and Vietnam, which replaced Colombia as the second largest coffee exporting country in crop year 2000-01. This took place in the context of very modest growth in coffee consumption.

This was the background against which the ACPC struggled to implement its second retention scheme. The new retention was agreed by the ACPC in May 2000. Member countries agreed to retain 20% of their exportable production until such time as the ICO indicator price should rise to 95c/lb against a then current level of 65c/lb. Normal exports would resume only when the price reached 105c/lb. The scheme was to become effective from the October 2000 start of the new crop year. This second retention scheme had a negligible impact on the market and the price fell to beneath 50c/lb by the year end, and 42c/lb by September 2001. These prices were lower in both nominal and real terms than those which had prevailed in 1991-92 and which had provoked the 1993 Retention Scheme and the birth of the ACPC. The major reason for the ineffectiveness of this new scheme is that it failed to address the massive expansion of coffee production in Brazil and Vietnam which was the cause of the over-supply. With their production continuing to grow, the ACPC retention scheme appeared at best cosmetic. As a direct consequence, the ACPC announced its self-dissolution from January 2002.

The ICO has subsequently attempted to address the over supply situation in the coffee market by linking this to the abundance of low quality coffee. This poor quality coffee is predominantly robusta and is held to be a particular problem with coffee originating from non-traditional coffee-producing countries. This coffee clearly finds a market, albeit at a low price. Often it is mixed with higher quality coffee to produce what roasters may deem an acceptable quality for the bulk market. It is preferable to interpret the ICO's quality concerns as primarily a means of selling supply management to consumer member governments of the ICO. But, whatever their basis, they have led the ICO to examine schemes for the diversion of low grade coffee to alternative uses (cattle feed and the production of construction aggregates were two possibilities) under the name of the Coffee Quality-Improvement Programme.

The programme commenced in October 2002. It committed ICO producing country members to prohibition of export of coffee with high defect levels and excess moisture content.¹⁸ If successful, this programme would have served the twin purposes of reducing the availability of coffee and increasing its average quality. Both effects should be price-raising. In fact, the scheme has floundered on difficulties in obtaining the funds required to remove the low quality coffee from the market. At the same time, coffee prices have recovered from their lowest levels, largely as the result of the market's perception that the market balance may now be moving into deficit. The robusta market, in particular, became significantly tighter in the expectation of a sharp fall in Vietnamese production.

¹⁸ ICO Resolution 407, 1 February 2002.

As noted above, country concentration in coffee production is low even despite the importance of Brazil. This makes it difficult to attain the degree of cooperation required to make a producer only supply management agreement effective. This view is reinforced by the history of the ACPC makes this clear. The organisation never managed to attain a comprehensive producer membership. The apparent success of its initial set of supply management measures in 1993-94 disguises the fact that market fundamentals were moving in a favourable direction even without export controls, which were in practice not implemented. When the ACPC reapplied controls in the much more difficult market situation of 1999-2002, they had no effect and the organisation was forced into dissolution with the baton passed back to the ICO. The ICO's less ambitious measures have probably also as yet had little effect, but they in turn are now benefiting from some independent improvement in fundamentals.

This history suggests that the successes of coffee control under the ICOAs was due to more than producer determination to obtain high prices. The crucial feature of the coffee agreements, not present in other agreements, was that consumer member countries enforced export quotas on behalf of the producers. This made free riding by producers impossible (although consumer non-member countries were able to free ride). Essentially, therefore, the coffee story is that in an industry with relatively dispersed production, supply management can only be effective if it has consumer support. Perhaps sadly, that support is currently relatively weak.

In a similar way, the natural rubber producers responded to the 1999 demise of the INRA by setting up a producer-only agreement. In the following two years, the three largest producing countries (Thailand, Indonesia and Malaysia) attempted to establish a minimum selling price to be enforced through a withholding scheme. A body would oversee the sales and supervise the procedures. They agreed in 2001 to establish the Tripartite Rubber Council (TRC) to administer this arrangement.

As was the case in aluminium and coffee a decade earlier, market developments have made rubber supply management irrelevant. Recovery of the world economy, and in particular booming demand in Asia itself, have resulted in sharp rises in rubber prices even in the context of increased production. It is not possible to state whether rubber retention would have been effective if the market had remained depressed.

3.1.3 Monopolies and Cartels

Commodity cartels are arrangements in which producing governments or companies act together to stabilise or raise commodity prices without involving the governments of consuming countries. Actions of this sort undertaken by companies will violate anti-trust laws. Such actions are therefore seldom durable, the major exception being the diamond cartel. In this section, monopolistic arrangements in the diamond and nickel industries are considered.

De Beers is the single largest diamond mining company in the world. It directly owns or controls mining operations responsible for around 45% of world diamond production.¹⁹ This figure is much higher than the share of the largest firm in any other major minerals or metals industries. Although falling short of outright monopoly, this dominant position gives De Beers significant market power. However, De Beers control over diamond distribution is even more extensive than their ownership of production. By means of a set of marketing arrangements with other diamond mining companies, De Beers has been able to vertically extend and enhance its dominant position in production into the

¹⁹ The next largest producer was Alrosa Ltd., a Russian enterprise, with a 20% share. These figures may include some mines which are jointly owned or operated with other companies or with national governments. Source: General Accounting Office (United States) (2002).

distribution of diamonds. According to the European Commission, "For much of the 20th century De Beers has controlled over 80% of the supply of rough diamonds worldwide. In addition to its own mines in South Africa, De Beers also controls large diamond resources in Botswana, Namibia and Tanzania where it has entered into joint venture agreements with local governments. Furthermore, over the years De Beers has entered into sales agreements with its main competitors in order to secure the distribution of their production, in whole or in part, on the world market through its own sales and marketing division the CSO, now renamed the DTC." The European Commission estimated that De Beers controlled 60% of worldwide diamond supplies in 2002, with the remainder being very fragmented.²⁰ De Beers' market power in diamond distribution therefore exceeds even the high level of market power that derives from its dominant position in diamond production.

Contrary to the message of much advertising, diamonds are not particularly rare in the earth's crust, although larger stones are much rarer than small stones. Indeed, diamonds are much less rare than many coloured gems, such as sapphires, which crop in only a few locations on the earth's surface. However, the coloured gem industry is highly fragmented with no producer having significant market power. As a consequence, diamond prices are much higher than prices for coloured gems (except possibly for exceptional stones) and, moreover, have held up at these high levels at a time when minerals prices generally, and the prices of coloured gems in particular, have fallen reflecting technological advances in mining and processing. There are no clear prices for diamonds in the international market, partly because of heterogeneity and possibly also because the diamond cartel has little interest in market transparency. However, one can obtain a measure of the extent to which the cartel has sustained high diamond prices from the unit values of imports into the United States, the major world market for cut gemstones. These figures show in 2002, the unit value of emeralds, rubies and sapphires entering the United States were respectively 70.3%, 30.5% and 16.5% lower than in 1982 (the first year for which the Bureau of the Census gives separate data for rubies and sapphires). By contrast, the unit value of cut diamonds entering the United States was 31.6% higher in 2002 than in 1982.²¹ Using the same figures, the volatility of the unit values of cut diamonds entering the United States was 9.0% over the period 1983-2002, compared with annual volatilities of 39.7%, 27.6% and 18.3% for emeralds, rubies and sapphires respectively. These statistics demonstrate the success of the diamond cartel in obtaining a significant monopoly premium (perhaps as high as 100%), and also in ensuring relatively stable prices over time.

As in the case of the ICAs, much of the "benefit" of high diamond prices appears to have been dissipated in inefficiency by sheltering the growth of additional diamond mining capacity around the world. Some of these new mines had higher costs than would have been compatible with profitability in a competitive market.²² De Beers has been obliged to subsidise these inefficient mining operations. It did this in two ways. First, it spent large amounts of money on advertising to try to ensure that diamond purchases would grow in line with production. De Beers incurred the entire costs of these advertising campaigns but a large part of the benefits went to the inefficient new mines which had

²⁰ The CSO was the Central Selling Organization and the DTC is the Diamond Trading Company. See European Commission (2003, paragraphs 9 and 10).

²¹ Source: US Bureau of the Census.

²² It appears probable neither the major expansions in diamond mining capacity in Canada or Russia which have taken place over the past two decades would have been profitable in a competitive diamond market. Together, these account for around 20% of current world diamond mining capacity. Effectively, from the viewpoint of society, the money spent on developing these mines has been wasted. However more detailed cost information for these developments are required to be certain of this claim. Even-Zohar (2000) compared production costs of \$0.46 per \$1.00 of rough diamonds produced at the largest Russian mine, Udachnye, to costs of \$0.07 per \$1.00 of rough diamonds at Botswana's Jwaneng mine.

expanded under the De Beers umbrella. Second, De Beers established a buffer stock which held back excess diamond production, originating both from De Beers' own mines and from the mines of competitors, in order to prevent this excess supply from flooding the market and driving prices down to competitive levels. The cost to De Beers of operating this buffer stock was that a large proportion of the company's funds was tied up in a non-appreciating and illiquid diamond inventory. Diamond industry analyst Even-Zohar (2000) asserted that "fringe producers" were enjoying a "free ride" on both "market and price support activities" and also on "consumer marketing and promotion programs". Further, there is substantial evidence from the minerals industries and elsewhere that competition spurs cost-saving productivity advances. The cushion provided to De Beers by its monopolistic position may have spurred less urgency to reduce costs than in otherwise comparable industries, resulting in a lower rate of productivity advance than in those industries. To the extent that this is the case, the De Beers' monopolistic position will not only have shielded inefficiency in other diamond producers but will also have shielded inefficiency within De Beers itself

The "success" of the diamond cartel derives from a number of factors, but the principal of these are De Beers' dominant position in production, and its absence from the United States in either production or, directly, marketing. The absence from the United States is important in that De Beers' marketing arrangements clearly violate, and have been judged to violate, the Sherman Anti-Trust Act and the Wilson Tariff Act.²³ Other countries, including the competition authorities of the European Union and the United Kingdom in particular, have taken a more relaxed view of the cartel's activities. De Beers' very substantial dominant position in production, together with its enforced absence from the United States, makes it difficult to suppose that a private sector cartel could operate in any other sector.

Historically, the nickel industry was dominated by the Canadian producer Inco and was one of the most highly concentrated metals industries. Inco is now a large producer but not dominant. The other very large producer is the previously state-owned but now private Russian firm Norilsk. Industry concentration is higher than in other major non-ferrous industries it is substantially lower than in the diamond industry. In 2002, the top four firms had a 49% share of the market and the top ten firms a share of 77%.²⁴ Although these shares are too small to give any firm the ability to control the market price, the two largest producers are sufficiently large that their actions influence prices. Norilsk may therefore be seen as a classic Cournot oligopoly where producers have the ability to set production with strategic price objectives. This has become abundantly clear over the most recent years. In 2002, Norilsk (which is responsible for approximately 90% of Russian nickel output and 20% of world output) announced a three-year stock financing arrangement on 60,000 tonnes of its "strategic reserves", the material to be held outside Russia but off the market. Industry estimates suggest that, at its peak, the Norilsk stock amounted to around 7% of annual world production. This stockpiling action almost certainly raised prices from what Norilsk (in retrospect, correctly) saw as low levels in 2001-02 and allowed them to profit from the nickel price boom of 2003-04.

3.1.4 Relevance to the ASM sector

The International Tin Agreement is the only commodity agreement which has operated in a metals or mineral industry. Furthermore, tin is an industry in which there is significant small-scale dredging. That might appear to establish tin as the most relevant experience for the ASM sector. Despite this, the circumstances of tin market stabilisation were highly idiosyncratic since, over the period in which the agreement was active, the industry was dominated by releases from the US General Services Administration (GSA) strategic

²³ U.S. versus De Beers, Civ. 29-446.

²⁴ Source: CRU International Ltd.

stockpile. The International Tin Organization (ITO) effectively operated in tandem with the GSA with the GSA selling into high prices and the GSA buying to support the market in periods of low prices. Since the breakdown of the agreement in the mid nineteen eighties, and the ending of GSA stockpile sales, the tin market has shown low volatility without the need for intervention.

The wider experience with international commodity agreements shows that, while it is not true that these can never be effective, the only circumstances in which they have a reasonable prospect of effectiveness is when they have wide consumer government as well as producer government support, and, in the case of buffer stock schemes, they are adequately financed. Producer only agreements appear to dispense with the requirement for consumer support, but these rely on there being a dominant producer. The absence of both a dominant producer and consumer government support gives full rein to free riders to ignore supply management decisions.

The only ASM industry with a dominant producer is diamonds where the De Beers cartel has delivered high and stable prices. Elsewhere, there is neither a dominant producer nor likely consumer government support for a stabilisation agreement. We can therefore conclude that neither the commodity agreement nor the producer only agreement route appear very promising for the ASM sector.

3.2 National Schemes

Many governments also operated domestic stabilisation programmes either to complement international stabilisation efforts or as a substitute for international schemes where these did not exist or were ineffective. These took varying forms, depending on objectives, the international context and the particular country's administrative traditions. The most widely-used approaches were domestic buffer stock schemes; marketing boards with monopolies on trade; buffer funds (or caisses de stabilisation) and variable tariff schemes. Schemes of this sort are surveyed by Knudsen and Nash (1990) and Gilbert (1993).

3.2.1 National buffer stock schemes

National buffer stock schemes operate according to the same principles, and suffer from the same problems, as the international schemes considered in section 2.1.1. Use of a national buffer stock presupposes that the commodity in question is non-traded, or that international trade is relatively unimportant – otherwise, the country would be essentially attempting to single-handedly stabilise the world price. Lack of trade could either result from high transport costs in relation to value, or from import and export restrictions. Such schemes have therefore been largely confined to basic food commodities, principally maize, rice and wheat. The buffer stock has generally been just one of a number of instruments used to ensure adequate food supplies at stable and affordable prices.

It is well-established that private storage will reduce price volatility (Williams and Wright, 1991; Deaton and Laroque, 1992). The premise for storage by the public sector must therefore be that private storage is insufficient. The principal problem with buffer stock schemes is that, to the extent that they are sufficiently well-financed to have a stabilising influence, they tend also to suppress the incentives for private storage – see Miranda and Helmberger (1988). The consequence is that the stabilisation authority is obliged to assume a much larger, or even the entire, burden of carrying stocks – see Pinckney and Valdés (1988) for evidence on this. Buffer stocks therefore aggravate the situation that they are attempting to alleviate. As a consequence, they are a very expensive means of stabilising prices.

The high costs, in terms of financial outlay and economic efficiency, of public sector stockholding leads Knudsen and Nash (1990) to recommend that stabilisation authorities should always avoid handling the physical commodity. If there is a perceived problem of inadequate storage, this is better addressed by facilitating private storage by, for example, encouraging credit provision or improving warehouse receipt systems.

3.2.2 Marketing boards

Monopsony-monopoly marketing boards were the structure favoured by the British colonial authorities, particularly in Africa. These structures were typically maintained by the post-colonial administrations. However, the same arrangements also existed in other countries, such as Peru.

Marketing boards are best suited to export crops in which there is little or no domestic consumption and where production takes place in small-scale enterprises. Cocoa and coffee are therefore prominently represented in these schemes. However, they have also operated (and in some cases, continue to operate) in conjunction with small-scale mining. The operating principal was that the board would maintain a stable price subsidising in periods in which the world price was low and taxing in periods in which it was high. To the extent that the board was successful, domestic prices would be more stable than world prices.

The structure of many export industries is that major exporters (who may also be the importers in the final market) have often confined their activities to the ports and have had little or no up-country presence. Intermediaries buy the commodity from the producer (miner or farmer) and sell to the exporters, in certain cases after some processing (for example, drying, and in some cases fermentation, in cocoa). The intermediaries clearly have a degree of market power relative to the producers, particularly if there is little competition in the marketing chain. This monopsony power may be exacerbated by the producers' informational disadvantage. These considerations have been used to justify elimination of the intermediaries and substitution of a monopsonistic board which would commit to buying either at a mark-down of world prices (as in the Ghanaian diamond sector) or at pre-announced prices (as in the Ghanaian cocoa sector).

Monopsony also has its costs. One of the most acute is that marketing boards have generally set constant prices across all parts of the country irrespective of transport costs to the port, and, in the case of pre-announced prices for agricultural crops, constant prices across the crop year, irrespective of availability and storage costs – see Knudsen and Nash (1990) on the impact of the Peruvian National Milling Corporation on the rice market. Secondly, by suppressing competition in the marketing chain, monopsony discourages cost-saving innovations – see Gilbert and Varangis (2004) for discussion in relation to cocoa.

Exercise of monopoly power in exporting was intended to ensure that the marketing board would capture the profits from this activity. In addition, monopoly power also enabled the authority to sell production forward. This was the standard practice with the Ghanaian and Nigerian cocoa marketing boards. Around seventy-five per cent of the following year's crop would be sold forward, usually through merchants rather than on and London cocoa futures market, with the result that the boards would know in advance, to a good approximation the price they could offer farmers in the following year. Forward sales therefore underwrote the monopsony selling price – see Gilbert (1997). Note that private exporters only sell forward once they have purchased (previous to this, they have no price exposure) and therefore cannot easily offer advance price

commitments. The monopsonist-monopolist is in a position to sell forward in advance of purchase because he is committed to purchasing the following year's production.

To what extent have marketing boards stabilised domestic prices? Knudsen and Nash (1990) produce general evidence to show that producer prices are generally more stable than world prices but these statistics relate to all forms of intervention, and not just marketing boards. Further, producer prices are usually official prices and may vary less than the prices at which producers actually sell. Gilbert and Varangis (2004) argue that the Ghanaian cocoa marketing board Cocobod actually destabilised real producer prices because, with fast and variable cedi inflation, intra-annual stabilisation of nominal cedi prices resulted in greater uncertainty in real prices than would have resulted if farmers had obtained spot prices converted at the spot exchange rate. Nominal stabilisation makes little sense without at least a reasonable degree of certainty about exchange rates.

Marketing board schemes have been problematic in a number of respects. The first is that they can be undermined by smuggling. Price stabilisation in one country will result in prices which are at times higher and at times lower than in its neighbours. This generates an incentive to smuggle the commodity in or out of the country, depending on the differential. Togolese cocoa exports have been notoriously sensitive to the internal cocoa price in neighbouring Ghana. The result is that the marketing boards tend to subsidise producers in neighbouring countries when world prices are low but fail to fully benefit from high world prices when these occur.

The second problem is that the stabilisation objective has often been over-ridden by governments' requirements for tax revenues. Governments have been happy to set prices below international prices at times when the latter have been high but unable or unwilling to set prices above, or at least closer to, international levels, at times when these have been low. This problem has arisen in part because low world prices result in low export earnings, which is exactly the time governments may be in greatest need of buoyant revenues; but also because marketing board surpluses have often been invested in illiquid, and sometimes loss-making, projects of supposed national importance with the result that funds have been unavailable at the times they have been required – see Helleiner (1964) and Bauer (1967) on the colonial and post-colonial Nigerian experience.

Third, rent extraction has been a problem. The boards became large organisations, often exercising significant political power, and absorbing a substantial share of countries' cocoa export earnings. Marketing costs therefore tended to be significantly higher in countries with boards than in those with free markets. This partly reflected the lower incentives towards efficiency but there is also reason to suppose that this involved a significant element of rent extraction. For example, Williams (1985) wrote of the Nigerian agricultural marketing boards shortly before their abolition in 1986, "They have replaced the European firms at the apex of the buying system and shaped it to serve the needs of ruling parties, governments and the Northern aristocracy to expand and consolidate their networks of patronage."

Market reforms over the past two decades have eliminated the majority of active marketing boards in tropical export crops – see Akiyama *et al.*, (2001). Had this not been the case, these boards would have found it increasingly difficult to operate in the globalised market place in which there is major emphasis on the encouragement of intra-regional trade. Some boards continue to exist, most notably in Ghana, but the price stabilisation objective has generally been dropped or has reduced priority. The remaining boards therefore operate much more in line with world market conditions.

3.2.3 Caisses de Stabilisation

French colonial territories, and the successor post-colonial governments, have tended to intervene through arms length *caisse de stabilisation* arrangements rather than through monopoly-monopsony marketing boards. The major advantage of the *caisse* system is that it leaves both intermediation and exporting in the hands of the private sector.

As in marketing board schemes, *caisses* operate through a pre-announced producer price which is intended to be less variable than the world price. Exports require a licence, and these have typically been granted by competitive auction. The licence requires the exporter to pay into the *caisse* the difference between the international price and the producer price, or to receive this difference in the event that the producer price is above the world price. Because the *caisse*, and not the exporters, bears the price exposure, it can sell forward in the same way as the marketing board and use the average forward price from these sales as the basis for setting the producer price for the following year.

The evidence from the cocoa market for Côte d'Ivoire and Cameroon, who operated this type of system, demonstrates that up to they did succeed in stabilising producer prices until the end of the nineteen eighties (Gilbert and Varangis, 2004). Furthermore, inflation in the CFA zone was not a serious problem, so nominal stabilisation did imply real stabilisation. However, the *caisses* were used for taxation as much as for stabilisation and rent extraction was also substantial. Producer prices were held at much lower levels than the average levels in countries with free markets – see McIntire & Varangis (1999). Finally, as with the marketing boards, where surpluses were invested, this was in illiquid assets. The consequence was that, in the face of a sustained decline in world prices affecting almost all major commodities through the nineteen eighties, the *caisses* became insolvent and unable to honour their stabilisation commitments.

Overall, the French *caisse* system is more compatible with microeconomic efficiency considerations than the British marketing board system, and appears to have functioned better, at least in the cocoa industry. However, it has suffered from the same basic problem that the stabilisation objective has been consistently over-ridden by other considerations with the result that producers have lost the benefit of high prices without receiving significant offsetting benefits when world prices have fallen.

3.2.4 Variable export taxes

Many commodity-exporting countries levy export taxes. In such cases, it is straightforward to vary these taxes in relation movements in world prices. A government which does this is acting very much in the same way as a *caisse de stabilisation* but with the government itself acting as the stabilisation agency. In practice, the government may delegate this power to a board with the consequence that the difference becomes more one of terminology than substance.

Papua New Guinea (PNG) has used variable export taxes extensively for its agricultural exports. Knudsen and Nash (1990) discuss this experience and conclude that it has been generally successful. The tax was initially conceived as a progressive tax on profits rather than revenues, with profits calculated relative to a notional average cost of production. Later, this costs estimate was replaced by a moving average of past prices. In periods in which the world price is beneath this level, the tax became a subsidy. There was no official producer price and transmission of the stabilisation effects to farmers relied on competition in the marketing chain and good information systems so that farmers would know what prices they should expect. Knudsen and Nash (1990) judge that this worked well in PNG. However, in common with the *caisse* schemes discussed in section 2.2.3, the

PNG schemes failed to survive the persistent price declines of the nineteen eighties. They were formally wound up in 1999.

The judgement made here is that the favourable performance of the PNG scheme relative to the African caisse schemes owes less to its structure, since the differences are more of terminology than of substance, and more to genuine independence of the PNG board which was able to provide support funds when these were required. In particular, the PNG fund was required to hold 60% of its surpluses with the central bank.

3.2.5 Nation stabilisation schemes - summary

National stabilisation schemes have generally been more successful than international schemes, but many of these schemes broke down with the prolonged decline of commodity prices in the nineteen eighties. As with international schemes, it is clearly incorrect to argue that price stabilisation cannot work, but it is also clear that some preconditions are required if it is to work. Schemes such as those discussed in this section could be applied in the ASM sector.

The major precondition is that there should be a commitment to stabilisation, since otherwise stabilisation surpluses are subverted for other purposes – normally, general revenue. This is a type of time consistency problem. At the outset, governments are indeed committed to price stability, but as soon as world prices have risen to an extent such that a surplus has been banked, government may put a higher value on this money for other purposes than on keeping the funds to support producers in future periods of low prices. That temptation increases the longer prices remain high and the larger the surplus. Effective stabilisation therefore requires that government precommits to maintaining such funds for stabilisation purposes. What is required is an institutional framework which guarantees that precommitment.

This is the same problem as that of guaranteeing low inflation across the electoral cycle. In that case, the solution is obtained by making the central bank independent of government. For price stabilisation, the stabilisation authority should also be independent of government. Against this, there is an obvious danger that an independent stabilisation authority will absorb excessive resources for its own purposes, and government will be unable to prevent this. While a number of possible solutions are available, the PNG experience indicates that putting the stabilisation authority under the (independent) central bank (or indeed, making this a central bank function) could have the desired effect.

There are also other lessons, of which the most important is that, for export commodities, variable export taxes (equivalently, caisse de stabilisation mechanisms) are more likely to be successful than marketing boards. The advantage of the variable export tax scheme is that it does not prejudice efficient marketing. Instead, to the extent that marketing boards do set prices away from those which would otherwise prevail, they impose high costs in terms of lower efficiency and reduced incentives to innovate in the marketing system. For non-export commodities, emphasis should be on facilitation of private sector storage rather than substituting public for private sector storage, as in buffer stock schemes.

The overall conclusion for the ASM sector is that, if a government is interested in stabilising domestic prices it is best advised to do this through variable export taxes. The major constraint for many ASM minerals and metals is that high value to weight ratios will make smuggling attractive. That possibility is likely to imply that, in those industries, any taxes will need to be kept at a low level, and this may preclude the degree of variation required if they are to act as a stabilisation instrument.

3.3 Compensatory Finance Schemes

Compensatory finance schemes aim to compensate governments of commodity-exporting countries for shortfalls in export revenues. The potential advantage of such schemes is that they cover quantity as well as price risk. However, there are no direct transfers to the commodity producers themselves. The two most important schemes which have adopted the compensatory principle are the EU's Stabex scheme and the IMF Compensatory Finance Facility.

3.3.1 Stabex, Sysmin and Flex

The EU's Stabex program operated in the period 1975-2000 as part of the succession of Lomé Conventions signed by the EU member countries and the African, Caribbean and Pacific Group of countries (the ACP). Its aim was to remedy "the harmful effect of the instability of export earnings" (EC, 1990) by providing compensation for shortfalls in the export earnings of the ACP states, caused by price or quantity fluctuations, or both. It was an all-grant scheme, targeted on selected agricultural commodities, but a number of commodities important for the exporting countries, such as sugar (covered separately by the Sugar Protocol which gave ACP countries favoured access to EU markets), meat and tobacco.

Stabex was designed to deal with the effects of export earnings instability on the developing countries and not with the causes of this instability. An important feature of the Stabex scheme was that it operated on a commodity-by-commodity basis, i.e. fluctuations in one sector could trigger a compensatory transfer regardless of what happened with the export receipts at a country level. Because most larger agricultural exporters were diversified to a greater or lesser extent, stabilisation of the earnings of the subset of export crops covered by Stabex was not an efficient means of stabilising overall export earnings. Hewitt (1993) and Brun (2001) noted that it was possible to compensate falling export earnings of one commodity while the overall balance of payments was improving. Aiello (1999) showed that although Stabex was successful in stabilising sectoral export earnings of the crops with which it was concerned, it had a negligible stabilising impact on total export earnings – see also Herrman (1983), Faber (1984), Herrman *et al* (1990), Lim (1991) and Brun *et al* (2001),. Further, stabilisation of sectoral earnings did not directly benefit farmers in the sectors concerned.

Over its twenty-five year lifetime, Stabex evolved from being essentially a mechanism providing revenue support to governments to a component of the EU's developmental aid programme (Hewitt 1993). This evolution implied increasingly tight direction of Stabex funds to ensure developmental benefits. The first Lomé Convention, Lomé I, gave recipient governments considerable flexibility in the use of funds through the diversification objective. In subsequent agreements, this was replaced by conditions requiring that funds be directed towards the sectors suffering from export decline. By blocking the diversification option, this exacerbated the tendency towards export concentration, which was seen as one of the major causes of slow growth. Further, the increased number and complexity of conditionalities together with tighter funding limits slowed disbursements to the extent that Stabex assistance became pro- rather than counter-cyclical (Brun *et al*, 2001).

Sysmin operated over the period 1980-2000. It was designed as the counterpart of Stabex targeted at the alleviation of fluctuations in revenue arising from the production and sale of minerals (bauxite, aluminium, copper, cobalt, iron, tin, phosphates, manganese and uranium). Sysmin funds allocated to governments could be transferred to mining companies "in need of restructuring, with a view to preventing difficulties in the future" (EC, 2001). The design of the scheme was similar to Stabex as were the problems associated with its operations.

Sysmin was never perceived as a success. The 1970s and 80s saw widescale nationalisation of large mining enterprises in many developing countries. The nationalised companies were seldom successful (Chile provides an exception) since the nationalised companies lacked the technical expertise to develop and the incentives to cut costs. Output tended to decline – Zambian copper is the most tragic example of this process. Revenue decline was therefore led by output declines and exacerbated by the cost-driven declining price trend. Sysmin could do little to offset this and lacked the funding to do even that. Paradoxically, this process bypassed the artisanal and small-scale miners who were left completely to the vagaries of the market.

The evolution of Stabex and Sysmin from revenue support to developmental assistance may be understood once it is acknowledged that, at its inception, it was not considered as a stand-alone scheme but as a complement to the national stabilisation schemes discussed in section 2.2. Where these schemes were effective, farmers were protected against short term price fluctuations. However, the balance of payments and tax revenue impacts still remained. Stabex, as originally conceived, aimed to provide governments with the revenue support which essentially underwrote farmgate stabilisation. Later, as the domestic schemes broke down and/or were abandoned, that justification disappeared. At that point, it became clear that Stabex and Sysmin were only providing revenue support and there was little or no trickle down to the farmers – hence the move towards greater sectoral focus and increased conditionality.

At that point, the question naturally arose as to whether it was sensible to condition a large fraction of the EU's development assistance on export shortfalls of traditional export crops. This was not seen either as being efficient either from a general developmental standpoint or as consistent with a specific poverty focus. This led to pressure for an abandonment of Stabex and Sysmin and reincorporation of the funds within the overall development budget – effectively the outcome embodied in the 2001 Cotonou Treaty.

The EU responded to the unsatisfactory operation of Stabex and Sysmin with the establishment of the Fluctuations of Exports scheme (Flex) in 2000, based on the same principles as Stabex and Sysmin, but structures in such a way as (hopefully) to learn from the operational problems of the earlier schemes. There are two main differences: first, Flex aims to give rapid disbursement of funds to eligible countries, and second, funds are triggered by losses of overall export earnings as opposed to the commodity-by-commodity operation of Stabex and Sysmin. As Flex has only been operational since June 2002, it is too early to offer an evaluation.

3.3.2 The IMF Compensatory Finance Scheme

The IMF's Compensatory Financing Facility (the CFF) provides loan finance to governments of countries that experience temporary shortfalls in export earnings that trigger balance-of-payments difficulties and which are deemed to be beyond the country's control. It was intended a means of cushioning export earning fluctuations. The CFF was used most heavily in the 1970s and early 1980s (IMF, 2003). Its importance for developing countries has steadily declined due the availability of cheaper funds and because the IMF has insisted on what have been viewed as increasingly onerous conditionalities.

A number of studies had demonstrated that the CFF has contributed little to the objective of stabilising export earnings. Even where there has been a beneficial impact in particular countries, this has been short-lived (Finger and Derosa, 1980; Herrmann, 1983; Lim (1987, 1991); Herrmann *et al*, 1990). As in the case of Stabex, the requirement to

negotiate on conditionalities has compromised timeliness with the result that, at least in certain instances, its impact has been pro- and not counter-cyclical (Brun *et al.* 2001).

From the standpoint of borrowing countries, the main benefit has been that of an additional IMF window. CFF loans are made at rates relating to the IMF's borrowing rate, and so are market-related but below commercial rates. Because this is a cheap form of finance, governments have often chosen not to repay CFF loans once export earnings recover. Finger and Derosa (1980) suggest that as countries choose "not to make repayments in such a way as to increase export stability indicates that they do not consider stability a particularly important benefit." Lim (1987) concluded that the lack of symmetry of disbursements and repayments on the scheme has made it a "source of funds for general development purposes" (Lim 1987).

3.3.3 A possible "shocks" facility

There is some evidence that exceptional adverse shocks to export earnings retard growth and perhaps also inhibit efforts to reduce poverty more than proportionately to the size of the shocks (Collier and Gunning, 1999; Dehn, 2000; see also Dehn *et al.*, 2004, for a discussion). IMF (2003) notes that adverse commodity price shocks are one of the major factors which have jeopardised the prospects of countries participating in the Bank-Fund Heavily Indebted Poor Countries (HIPC) Debt Initiative from achieving debt sustainability – see also Gilbert and Tabova (2003).

The shocks hypothesis amounts to an assertion that the impact of shocks is nonlinear and possibly asymmetric. The most extreme version of this hypothesis asserts that only large price shocks have an impact – countries suffer from adverse shocks to export earnings but fail to benefit from positive shocks. Nonlinear responses might arise because agents (farmers, miners, stabilisation authorities, governments) are well-adapted to normal price fluctuations but either do not expect or do not consider it worth making provision against extreme events that arise only with low probability. Asymmetric responses can reflect asymmetry in constraints. For example, borrowing may be constrained while lending is unconstrained.

The perception that governments of poor countries which have managed to adopt policies oriented towards the promotion of growth and poverty reduction can nevertheless be thrown off course by adverse shocks to their export revenues has led to increased interest in the possibility of a new compensatory finance scheme which would shield countries from the effects of such shocks. It would be impossible, and probably also undesirable, to fully protect governments from the impact of export revenue shocks. However, there is merit in considering compensatory finance proposals which would ring-fence those components of government expenditure which support the most vulnerable members of society – in particular, health, educational and related social program budgets. All compensatory finance schemes operate in the first instance by compensating governments and not producers (farmers or miners). A merit of this proposal is that by protecting socially-oriented expenditures, the assistance is to some extent (that is, ignoring issues of fungibility) directed towards the groups who suffer most acutely from the commodity shocks.

As with the EU's Flex scheme, such proposals should learn from the experience of previous schemes, in particular Stabex and the CFF. A major lesson from those schemes is the importance of timeliness. This suggests that it is desirable that countries should pre-qualify for support, perhaps within the World Bank's standard PRSP and PRSC framework for assistance, since this would eliminate the need for complex negotiations over conditionalities. Proposals along these lines are currently under active consideration.

3.3.4 Application to the ASM sector

The compensatory finance experience is only indirectly relevant to the ASM sector since its point of reference is, in the first instance, government export revenues and not producer revenues. There are countries in which the metal or mineral produced in the ASM sector does form an important share of exports. A clear instance is Ghana where gold exports amounted to 39.5% of total exports over the decade 1991-2000.²⁵ However, a compensatory scheme would relate to the entirety of gold exports and not simply to ASM gold exports.

More generally, the purposes of compensatory finance schemes are either primarily macroeconomic, or are intended to complement other stabilisation measures. Rather than look for a compensatory finance scheme with specific regard to the ASM sector, it may be preferable to use a compensatory mechanism, such as a shock facility, designed primarily for macroeconomic stabilisation purposes, to provide the finance for an intervention in favour of miners in the ASM sector.

3.4 Summary of the historical stabilisation experience

The discussion in the preceding sections has emphasised the wide variety of schemes that have been used across the range of primary commodities and commodity-dependent countries over the six decades since Bretton Woods and the end of the Second World War. Over that time, the "commodity problem" has assumed greater or lower prominence depending on the perceived success of the development process and, on the other, the weakness or strength of primary prices. Currently, the perception that Africa has been left behind in the development process, and that this is in part because of its dependence on primary commodities, has re-ignited interest in the sector.

Stabilisation policies have been employed to raise and/or stabilise prices at the international level, to support domestic prices and to compensate countries for shortfalls in export earnings. Often, these interventions were designed to be mutually complementary rather than as alternatives. The experience is mixed and it would be wrong to conclude that all these schemes have failed to achieve their objectives although this is true of a significant proportion. In other cases, the stabilisation objectives have either turned out to be less valued than other objectives or have been compromised by "real world" factors not taken into account in the design of the schemes.

International price stabilisation schemes have attracted the most attention but have been the least successful. In part, this is because they have been under-financed, although that in turn reflects the fact that, by suppressing private storage, buffer stock stabilisation is always expensive. Equally, intervention authorities have often veered on the side of over-optimism in estimating the level of prices sustainable over the long term without controls over exports and probably also production. Where such controls were unavailable or insufficiently comprehensive, as in tin, stabilisation eventually broke down; where, as in coffee, they were available, the stabilisation agreement was used to deliver monopolistic price levels, and that objective superseded that of stabilisation; where, as in natural rubber, there was an automatic mechanisms to ensure that stabilisation prices did not get out of line with market conditions, producers abandoned the agreement as being not worth while.

Overall, the evidence from the international schemes suggests the unsurprising conclusion that commodity producers give a higher priority to high than to stable prices.

²⁵ Source: Gold export values were obtained by multiplying export volumes by the world gold price. Gold volume exports – World Bureau of Metal Statistics, *World Metal Statistics*; gold price and total exports – IMF, *International Financial Statistics*.

The relatively small number of international commodity agreements arises from the perception on the part of consumer governments that the producer priority is indeed higher prices than would be delivered by the market.

Producer-only stabilisation schemes appear to give the producers the power to achieve the twin objectives of stable and high prices without the requirement to take consumer government pressures into account. However, these schemes have been even less successful than international schemes including both producer and consumer governments. This is because, in the absence of a dominant producer with a significant degree of monopoly power, producers require consumer government involvement in any scheme to prevent free-riding.

Where schemes have been relatively successful in stabilising prices, as has been the case with some of the national marketing board and *caisse* stabilisation schemes, governments have tended to hold prices down for taxation purposes. Paradoxically, therefore, where governments have sought higher prices, this has been for their own purposes and not for the benefit of the producers. Further, by pre-empting stabilisation funds, governments have compromised the stabilisation objective.

In three industries – coffee, diamonds and crude oil – cartels have succeeded in holding prices above competitive levels for a considerable period of time. In coffee, this was through the actions of an international commodity agreement which was successfully able to impose tough export restrictions; while the oil and diamond cartels have relied on the actions of a dominant producer (Saudi Arabia and De Beers respectively). While oil production is typically undertaken by large, and in many cases nationalised enterprises, coffee and diamonds are to a greater or lesser extent produced by small enterprises or individual producers. In coffee, rent extraction and other abuses limited the extent to which smallholders benefited from the higher prices generated by coffee agreements, and in both the coffee and diamond industries, higher prices sheltered high cost production. However, because De Beers has had limited power to control production levels in small mines, the major costs of the diamond cartel were probably borne disproportionately by larger enterprises.

This experience is not very encouraging, and has generally come to be perceived as such. It does not lead one to be very confident that schemes of this sort could play a large role in the ASM sector. Reflecting this pessimism, emphasis has tended to shift away from schemes which alter price and revenue distributions and towards schemes which assist producers in coping with price and revenue variability.

4 Market-based schemes

As the deteriorating performance of stabilisation schemes became more evident, emphasis shifted toward policies that worked within markets, taking market prices as a given, rather than against markets, by attempting to alter prices away from those generated by the market. Important contributions to the academic and policy literature were McKinnon (1967), O'Hara (1984), Gemmill (1985), Gilbert (1985), Overdahl (1987), Rolfo (1980), Claessens (1991), Myers and Thompson (1991), Wright and Newbery (1991) and Claessens and Duncan (1993).

These discussions were reinforced in the 1980s and 1990s by a pervasive series of reforms aimed at market liberalisation, undertaken in part at the urging of multilateral lenders such as the EU, USAID, and the World Bank. Akiyama *et al* (2001) illustrate the rapid pace of these reforms for Africa. While the reforms swept away many of the ineffective institutions that were mandated to stabilise domestic markets, they did not address two key problems related to commodity risks: at the macroeconomic level, the

inability of some governments to prudently manage volatile revenue and expenditures; and at the household level, the high cost paid by vulnerable rural households, often in terms of forgone productivity, to limit the consequences of risks. This distinction between the macroeconomic and microeconomic costs of commodity price variability had been inadequately emphasised in the stabilisation agenda partly because international commodity policy had been based on a raft of interventions designed to be mutually complementary.

4.1 Macroeconomic aspects of commodity price volatility

While many developing countries that were previously dependent on commodity exports have been successful in diversifying their economies and are therefore less sensitive to economy-wide commodity shocks, a number of poor developing countries, mainly in Africa, still remain very dependent on few commodities. These are the countries in which commodity price volatility is likely to throw up the most acute problems.

The major difficulty in addressing macroeconomic policy issues arising out of commodity price volatility is the lack of clear evidence that volatility generally does have adverse long-term consequences, in particular for growth rates. The implication is that some, perhaps even most, primary exporting countries appear to be managing to accommodate price volatility. This suggests that policy should be addressed toward bringing the remaining countries up to best practice rather than attempting to devise new initiatives. There are two specific areas of concern: government revenues and the exchange rate.

4.1.1 Government revenues

Most governments of primary producing countries have managed to diversify their tax bases away from the primary sector, even where export concentration remains high. However, a number of governments, mainly in Africa, have failed to make progress in this respect. These governments will continue to find that their ability to fund necessary public expenditure will be restricted in periods in which their export prices are low, unless counter-cyclical budgetary assistance is forthcoming in a timely manner. One possibility would be for these governments to hedge their revenue positions on the financial markets. A more reliable and less dangerous long-term alternative is for government to diversify its tax base away from the traditional primary sector.

Like other economic agents, governments are well advised to save a large part of windfall revenues when prices are high so that these become available when revenues decline due to prices declines. Reliance on foreign capital markets to borrow when prices and revenues decline may not be an option. Most poorer commodity-dependent countries have little or no access to international lenders, particularly when they need them most: that is, when prices have declined. A standard way to formalise governmental saving is to create a stabilisation fund to stabilise government expenditures but not to support or stabilise commodity prices. Such funds tend to be used in relation to oil and metals revenues, where governments capture significant royalty payments. Examples are the Norwegian and Oman oil funds and the Chilean copper stabilisation fund. However, funds can often run into problems because of difficulties in distinguishing between transient and permanent price changes (see discussion above) and because of the potential for mismanagement of fund resources.

4.1.2 The exchange rate

Where a commodity accounts for a large proportion of a country's exports, commodity price variability can translate into variability of the real exchange rate and of inflation, generalising the initial volatile process across the entire economy. This generalisation process may be desirable in part as the burden of adjustment is spread across a larger number of economic agents, each of whom may thus be expected to incur lower

proportionate costs. Dutch Disease is problematic because the costs imposed on the non-boom sector can be proportionately high, perhaps because of higher labour intensity (consider an oil boom) or because of hysteresis effects which imply that, once retired, physical and human capital is lost permanently. For these reasons, governments will look to contain the effects of commodity price volatility from affecting the exchange rate.

Three strategies are available. First, maintenance of a fixed exchange rate insulates the non-boom traded sector until such time as the trade surplus feeds through into inflation. This may take sufficiently long that the commodity price will have fallen. This will either reduce the need for adjustment or, at worst, spread it over time, which will result in lower overall costs under the standard assumption of convexity. However, avoidance of Dutch Disease is only one of many considerations in the decision on the choice of exchange regime, which will also need to take into account issues of feasibility. A more reasonable position is to argue on sequencing grounds that a move away from a fixed rate to follow rather than precede the development of dependable independent central banking.

Second, regional currency zones, such as the West African CFA zone, are an intermediate position between fixed and floating rates. The consequence of pooling within a regional currency bloc is that, provided there is no a dominant member, the bloc commodity concentration will be lower than that of individual member countries and hence Dutch disease effects will be proportionately lower. This is an effective means of spreading adjustment. It is likely that such a move will increase central bank independence. The cost is that monetary policy will be less well adapted to the individual circumstances of particular member countries.²⁶

The third approach is to sterilise windfall earnings through purchase of overseas assets. One possibility is for government to issue foreign currency-denominated bonds. For example, in Colombia during the coffee boom of the 1980s, the central bank issued "coffee bonds" to exporters in exchange for foreign currency earned from exports. However, given liquid capital markets, the holders of such debt can borrow against these bonds to obtain domestic currency, desterilising the surplus.

If government operates a commodity stabilisation fund, it is desirable that the fund be invested overseas. In this way, the current account surplus resulting from high export prices will be offset by capital outflows, thus reducing the required exchange rate appreciation. Conversely, capital inflows will offset the extent of exchange rate depreciation required in periods of low prices in which the fund is drawn down. This potential of a stabilisation fund to offset Dutch Disease is a further powerful argument for its adoption. Despite this logic, it may be politically difficult to persuade voters in countries with low capital stocks that the nation's resources are best invested overseas. Governments will often require assistance in educating their citizens in relation to the distinction between resources devoted to stabilisation and insurance, which should be insulated from shocks to the domestic economy, and resources to devoted to capital investment, which cannot escape country-specific risk.

4.2 Microeconomic Aspects of Commodity Price Volatility

Small-scale miners and smallholder farmers are dependent on volatile and unpredictable revenue flows. Market liberalisation has tended to increase volatility of producer prices by increasing the pass-through from international prices. Revenue volatility imposes both costs and benefits on commodity producers. Costs arise through concavity of the utility function, i.e. because producers lose more from a revenue shortfall than they gain from a

²⁶ The CFA experience is complicated by the fact that this pooling took place in a system which also pegged the nominal rate.

comparable rise in revenue (Newbery and Stiglitz, 1981). Benefits derive from the ability to devote effort and resources to alternative activities when prices are low, and vice versa in period of high prices (Oi, 1961).

It is generally assumed that the former, risk aversion, effect will predominate, but this depends on crop and household characteristics. The more risk averse the household, the higher the costs of variability. Against this, the benefits deriving from substitution across activities depends on the availability of alternative opportunities and the ease of substitution between these. Less obviously, whereas the substitution benefit rises linearly with the share of the commodity in the producer's revenue, the importance of the risk aversion effect is proportional to the squared share (Gilbert, 2002). The implication is that risk aversion effects are likely to be small for a producer who is well-diversified and the substitution benefits will predominate, while the reverse is the case for relatively undiversified producers. Diversification is therefore central to evaluation of the costs of commodity price volatility.

Households also make use of various informal risk-sharing arrangements, usually involving systems of mutual assistance between family networks or within members of a community. Most studies find evidence of partial risk-sharing – see Coate and Ravallion (1993), Udry (1994), Platteau (1997) and Dercon (2002). Poorer households have fewer contacts on which to rely in cases of shocks. Sustainability is also a problem because of the lack of consistent enforcement. Furthermore, systematic shocks, such as price and weather shocks, can cause a break-down of these arrangements by exposing entire groups of households to the same risk. Informal risk-sharing arrangements are thus important in helping poor households cope with idiosyncratic risks but not with systematic risks.

4.2.1 Diversification

Diversification is the most easily available do-it-yourself insurance policy at the household level. For farm householders, diversification can be between alternative crops, often an export crop and subsistence crops which can also be sold on local markets. For households involved in artisanal mining, substitution may be between mining and agricultural activities, particularly if the two activities take place in the same vicinity. For households near urban settlements, diversification can be between farm or mine and urban activities. Such diversification can involve reallocation of time of a particular household member across alternative activities, or can be based on allocation within the household, with different individuals undertaking different activities, perhaps including migrant labour.

Diversification is costly. Where specific capital is required for each activity, this may be less fully utilised than if the individual or household were fully specialised. Perhaps of greater importance, diversification involves sacrifice of expected returns for lower return variability. Risk aversion therefore inhibits poor households from specialising in the activities in which they have a comparative advantage. Poor households are inhibited from entering into riskier higher return activities because the downside risks are simply too great in the event of a crisis whereas richer households can borrow more easily to carry themselves through such periods – see Barghouti et al. (1990) and Jaffee (1993). Dercon (2002) argues that these results reflect the constraints on the risk management and risk-coping strategies that poorer households face rather than wealth-related differences in risk aversion.

So although diversification does allow poor households to cope with risk, this may be at high cost. One of the major motivations of recent commodity policy initiatives has been to attempt to provide lower cost means for such households to insure themselves.

4.2.2 Risk-sharing markets

In addition to informal risk-sharing arrangements, there are markets that allow economic agents to share risks. Formal markets for price risks include forward markets, futures and options markets, and over-the-counter markets. For weather-related risks, there are insurance markets and weather risk markets. For illnesses, there is health insurance. For livestock, there are livestock insurance products. The advantage of these formal markets is that they externalise the risk outside the community and even outside the overall economy. However, there are a number of preconditions and issues for producers in developing countries to access these markets.

Formal risk markets have the potential to strengthen and complement existing risk-sharing arrangements within a group of farmers or a community. For example, formal risk management contracts can protect the group against systematic risks, leaving the redistribution of the proceeds or payments to the group in the event of an actual crisis. This principle can be applied to both price hedging (to protect the group against price shocks) and also weather risk markets (to protect against droughts and other negative weather shocks). The principle instruments available for these purposes are futures and options contracts, either defined relative to the international price of the commodity or to specified weather-related events.

Market-based tools that insure against price volatility, such as those based on futures and options, already exist and are widely used in high-income countries. Despite this, the vast majority of agricultural producers and miners in developing countries are unable to access these markets. This is because:

- The minimum size of contracts traded on organised exchanges far exceeds the annual quantity of production of individual small and medium-sized producers.
- Small producers, as well as many market intermediaries in developing countries, lack knowledge of such market-based price insurance instruments and an understanding of how to use them.
- Sellers of such instruments, generally international banks and brokerage houses, are often unwilling to engage with a new and unfamiliar customer base of small-scale producers, characterised by high transaction costs (often increased by regulatory concerns directed at money laundering), diminished access to credit, and performance risk.

For the most part, use of forward, futures, and options contracts in developing countries is confined to large (private or public) organisations and companies (including mining companies), and also some large farmers in countries where these are present. For exportable commodities, price hedges are undertaken at the point of export. This cover seldom extends back to intermediaries and almost never to smallholder farmers or small-scale miners.

It is often argued that the bottom line in any market-based approach to commodity risk management must be the willingness of farmers or miners to pay for the insurance provided. This must be true over the longer term, but it may be over-optimistic to expect insurance costs to be fully covered at the inception of a scheme (see Gilbert 2002). If, as discussed above, villages or wider communities tend to self-insure, albeit on an informal basis, individual farmers will tend to purchase sub-optimal levels of market insurance, since they will bear the entire cost of such purchases but share only partially in the benefits. This argument indicates that insurance-based schemes may require subsidies over an initial period if they are to become established.

4.2.3 The International Task Force on Commodity Risk Management

One approach to mitigating the impact of price uncertainty on small farmers and small-scale miners in developing countries is to intermediate access to risk management instruments currently available on international markets. In 1999, the World Bank, with support from several donor governments, and in collaboration with other international organisations and private sector representatives, initiated the International Task Force on Commodity Risk Management (ITF) to make price risk management instruments available to small-scale producers, particularly smallholder farmers, through cooperatives, producer organisations, banks and other rural financial institutions, and traders – see ITF (1999). These form the so-called “local transmission mechanism” (LTM).

Price insurance would be provided on a wholesale basis, probably by a major international bank, against movements in a reliable and widely disseminated international price. Generally, this will be the settlement price on an international commodity exchange, or an average of such prices, perhaps over a month. These wholesale contracts will be sold to the LTM intermediating organisations who in turn will make them available to their members of clients, either as a membership benefit or for an appropriate fee. It is envisaged that the instrument which is likely to be most widely used is an out-of-the-money OTC (“over the counter”) put option which provides an insured price floor somewhat below the market price at the time of the sale at modest cost and zero risk.²⁷

The ITF aims to provide technical assistance, capacity building, and training to producer organisations and local financial institutions to assist them in purchasing price risk management instruments from private sector providers. This market-oriented approach provides the growers, producer organisations, and local financiers with the ability to hedge their short-term exposure to price risks, which should improve their business management and access to credit.

Several small transactions have been concluded to date, benefiting a number of small coffee farmers in three countries. Scaling up the initiative will require overcoming significant operational challenges. Nonetheless, the ITF approach holds promise for improving the lives of smallholders by helping them mitigate the effects of short-term risk. It can also help increase sustainability of reform programmes by giving governments an alternative to the failed approaches of the past. Although conceived primarily to help smallholder farmers, the same principles may be extended in a straightforward way to artisanal and small-scale miners.

The ITF approach has a number of advantages, but it also has certain inherent limitations. One of the most important of these limitations arises out of basis risk – see Gilbert (2002) and Dehn *et al.* (2004). Price risk contracts written by the wholesale provider will relate to an international price, typically set on a major commodity exchange. Movements in the prices obtained by producers in a particular exporting country will not correlate perfectly with movements in the exchange price. Instead, cif prices will be at a variable premium (or discount) to the exchange price reflecting quality, locational and reputational factors. Basis risk results from variations in the premium and implies that price insurance contracts written on the international price will provide at best imperfect insurance for producers. This risk will be exacerbated by variations in the cif-fob differential and by variations in local intermediation (“fobbing”) costs. Gilbert and Tabova (2003) show that basis risk can be substantial for developing country agricultural

²⁷ Another possibility would be zero cost participatory collars, in which the insurance provider foregoes his fee in favour of equity participation in price rises above a pre-specified level. However, structures such as this raise serious performance problems and could bankrupt participating LTM organisations if producers fail to meet their contractual obligations.

exports. However, it is possible that for metals, where quality differentials are less acute, this problem may be less serious.

The quality of economic policy is also important. Macroeconomic stability, improvements in the functioning of credit and asset markets, and better access of financial markets by poor households could increase the use of assets and credit to provide self-insurance. Where inflation is high and variable, this adds risk in nominal contracts. Controls and regulations, including reporting requirements on foreign exchange transactions, can increase the costs associated with hedging.

4.2.4 Quantity risk and weather insurance

A strategy based on protecting farmers against price risk does little or nothing to offset quantity (yield) risk. In many cases, this type of risk may be as or more important than price risk – see Gilbert and Tabova (2003). There are insurmountable difficulties in offering quantity or yield insurance to smallholder farmers or small-scale farmers since this would generate incentives to divert effort and resources to alternative activities. However, for many products, the major component of quantity risk arises from weather conditions which are largely common across all producers in a particular regions.

Meteorological stations maintain reliable records extending back for long periods of time even in poor countries. This allows a bank or an insurance company to write weather derivatives relating to the readings at such stations. Smallholder farmers might be interested in derivatives which pay out in the circumstance that rainfall is lower than a specified threshold over a crucial period. By contrast, miners will seek a pay-out if the rainfall exceeds a (higher) threshold value. The ITF approach has been expanded to include weather (and area-yield) based index risk management instruments based on the results from earlier feasibility studies conducted by the World Bank's research and financial sector departments - see Skees *et al.* (2001, 2002) and Varangis *et al.* (2003).

4.2.5 Risk management and credit

One of the major benefits cited by producers as arising from purchase of price insurance is improved access to credit – see Gilbert (2002). Since lower than anticipated prices are one cause of default on commodity-related loans, purchase of price insurance will result in superior loan performance and will thereby increase borrowing capacity. This is in line with historical experience – commodity futures developed as an adjunct to credit provision in the nineteenth century Atlantic grain and cotton trades. Where banks are willing to lend to farmers or (more usually) cooperatives against either future crop revenues or against products in storage, the proportion of the value that they will advance will depend on price and other risks. Purchase of price insurance gives banks confidence to advance a higher proportion of the crop or product value.

Seen in this way, improved intermediation of commodity risk management instruments may be a thought of as an extension of the micro-credit movement. This conclusion applies to both price and quantity (weather) insurance instruments. It suggests that these instruments are likely to prove useful to producers who perceive credit access rather than price or quantity risks as the major impediment that they face. Price and weather insurance are a component in the development of flexible financial intermediation in the rural sector.

4.2.6 Application to the ASM sector

The risk management instruments currently being employed in smallholder agriculture have an equal potential in the ASM sector. The fundamental problem, in the ASM sector as in the smallholder sector, is to devise a low cost means of intermediating the instruments to the producers. Intermediation requires a reliable and well-functioning

institutional structure. Banks and cooperatives have been the main candidates for this role in agriculture.

The ASM sector is in certain respects more varied than smallholder agriculture, with informal and in certain cases transient artisanal mining at one extreme, and significant mining enterprises at the other extreme. While the required institutional structures are certainly lacking for artisanal miners, governments do generally regulate small-scale mining operations, and that regulatory structure suggests itself as a candidate for intermediation. Furthermore, it would be possible to provide insurance against weather as well as, or instead of, price risk. The risk management approach therefore merits serious consideration in any country in which either or both of these risks are considered major problems in small-scale mining.

5 Risk in the ASM Sector

This section brings together the implications of the preceding analysis for the ASM sector, and looks in greater detail at a number of specific metal and mineral industries.

5.1 Risk dimensions

Miners face a number of dimensions of risk of which price risk is just one. Among other important risks are weather risk and yield risk. Weather is important in that heavy rain can make both small-scale mines and artisanal mining impossible or more difficult. Yield risk is important for miners who are obliged to contract for a plot of land on the basis of conjectures about yield. Either or both of these risks may be as or more important than price risk. At present, no attempts to quantify the relative magnitudes of these risks are currently publicly available.

The view that commodity risk is multi-dimensional parallels findings in the literature on smallholder farming. According to Dehn *et al.* (2004), survey results cite weather-related risks, yield risks, price risks, illness, livestock problems, weak markets or demand to sell their products, and weak demand for their off-farm labour because of economy-wide shocks. They state that while poorer farmers tend to consider weather-related risks, yield risks, illnesses of household members, and weak demand as the main sources of risk, more commercially oriented farmers with surplus production and cash crop incomes also consider price risks as very important – see ITF (2002a,b). This difference may be explained by the greater specialisation of larger farmers. In the event of a revenue shortage, the larger farmers would be able to borrow or access savings to tide them through, while poorer farmers, who lack both savings and access to credit, are obliged to diversify at the cost of loss of the potential benefits from specialisation.

Similarly, at the macroeconomic level of export earnings, Gilbert and Tabova (2004) show that for ten African HIPCs, quantity risk is at least as important as price risk in causing shortfalls in export revenue. Their findings echo Lim (1991) who stated that volume instability is more pronounced than price instability at the country level.

5.1.1 Price Risk

In section 2.2.3 evidence was provided to demonstrate that price variability is generally less severe in metals and minerals than in agricultural commodities, and that the variability of international prices is particularly low for diamonds, gold and tin, three minerals which are important in the ASM sector. It was also noted that coloured gemstones appear to be an exception to this statement. It is also possible that other so-called minor metals which are important in the ASM sector may have high price variabilities. Despite these qualifications, it is reasonable to conclude that price risk will

frequently, but not invariably, be less serious a problem in the ASM sector than in smallholder agriculture.

This conclusion is reinforced when it is recalled that the costs (and possible benefits) of price variability are proportional to the price variance – see section 4.2. If one compares diamonds, where the annual price change standard deviation is 8% with sugar with a standard deviation of 24%, the volatility costs would be nine, not three, times higher for sugar than diamonds if all other factors were the same.

In section 2.1.2 it was noted that in artisanal mining in certain countries, households will divide their time between agriculture and mining depending on the season and weather conditions. This is true of gold households in Mpatoam, Ghana, where the main export crop is cocoa, which requires intensive activity at the harvest period but considerably less attention at other times of the year. It is reasonable to conjecture that the relative price of cocoa and gold would also be a factor in determining the household's time allocation, although I am not aware of any direct evidence on this. To the extent that substitution of this sort is feasible and attractive, price variability is an advantage to households – see Oi (1961).²⁸ Put another way, gold and cocoa provide a natural diversification, the benefit from which is proportional to the variance of the relative price ratio of the two commodities. Households in this type of circumstance would be made worse off by price stabilisation – see Gilbert (1985, 2002).

The principal application of price stabilisation schemes, whether national or international, has been to tropical agricultural commodities. Only a proportion of those schemes has been successful in achieving their objectives. This discussion suggests that the magnitude of the volatility in the ASMS sector implies that there is likely to be little benefit in attempting to replicate even the successful agricultural price stabilisation schemes.

5.1.2 Quantity risk

As already noted, quantity risk has at least two dimensions – weather risk and yield risk. The former will in principle affect both artisanal and small-scale mining operations. Its importance will depend on the metal or minerals and the nature of the terrain. Yield risk will primarily affect small-scale miners who have formal contracts or title to the terrain they mine.

The price stabilisation schemes discussed in section 2.1 and 2.2 do not offer producers any protection against quantity variations. Further, to the extent that quantity shocks are common across a sufficiently large number of producers, there will be an inverse relation between these and price shocks, with the result that price stabilisation will actually increase revenue variability (Newbery and Stiglitz, 1981). Compensatory finance schemes, discussed in section 2.3, might in principle assist but these are aimed in the first instance at government budgetary support. An intermediation mechanism is required if these schemes are to compensate producers. Attention therefore focuses on the risk management schemes discussed in section 3.

Moral hazard problems prevent yield insurance based on a farmer's crop or a miner's output. These considerations will also prevent any useful yield insurance for miners who contract prior to knowing the mineral content of their terrain. In practice, this form of risk is likely to be best resolved through a risk-sharing schemes such as share-cropping where the miners and the land owners share the yield risk. However, weather insurance,

²⁸ Suppose cocoa and gold prices were equally remunerative and their prices move such that a high gold price always coincided with a low cocoa price, and vice versa. By always allocating their labour time to the high price commodity, households would obtain the average of the high prices which would necessarily exceed the average price of each crop.

discussed in section 4.2.4, does now appear feasible and it is possible that, in this instance, the agricultural experience may be transferable to the ASM sector.

There are two preconditions for viable weather insurance. The first is the existence of weather stations in the mining area with sufficiently long and reliable records to enable an insurance company to calculate the actuarial risk of weather events. This requirement will limit the range of countries in which schemes of this sort are viable – civil wars, for example, can result in loss of meteorological capital. Second, miners must be willing to pay the required insurance premium. The agricultural evidence indicates that it is the medium sized rather than the smallest or largest farmers who are willing to pay such premia. (The largest farmers can absorb the risks while the smallest cope with risk through diversification). This suggests that small-scale miners rather than artisanal miners are likely to find it attractive to purchase weather insurance.

5.1.3 Credit

Even small-scale mining requires substantial capital investments. For example, a small gold mine will typically have an excavator, a concentrator and a truck for transporting the gravel concentrates (the excavator can also do this allowing a possible economy). In diamond extraction, terrace-mining requires minimal capital, but pit mining requires a pump (absolutely necessary in the wet season) and, if possible, a small excavator. By contrast, artisanal miners typically possess minimal capital.

Small-scale mines can either buy or lease machines. In gold, concentrators must be purchased since these need to be assembled on sight and cannot easily be moved. However, excavators can be leased. The leasing company keeps an employee on site to guard the machinery and to undertake maintenance. Purchase of machines requires credit which is not easily forthcoming. Lack of easy availability to credit is widely perceived by small-scale mine operators as one of the major constraints they face. Hentschel *et al.* (2002) discuss credit provision in the ASM sector.

It was stressed in section 4.2.5 that improved access to credit is one of the major advantages that derives from purchase of risk management instruments. This may make purchase of such instruments attractive even where price and quantity risks are not themselves seen as the major problem faced by miners. However, it also suggests that the provision of such instruments should be viewed as part of a wider programme to enhance credit availability in the sector, and not as a stabilisation tool. The emphasis in such a programme would be on increasing bank penetration in the sector, an objective which may be attained through a mixture of education and training, financial incentives and provision of new instruments.

5.2 ASM Policy by Industry

5.2.1 Copper

Copper mining takes place predominantly in large and medium sized mines. Some of the largest mines, such as Bingham Canyon in the USA and Chuquibambilla in Chile, are among the largest mines in the world. The economies of scale which make the large mines highly profitable also make small-scale mining relatively unprofitable. A consequence is that where small-scale mining does exist, it often requires subsidisation.

There is significant small-scale copper mining in south America. Enami, the Chilean governmental enterprise which promotes the small and medium-sized sector, provides a possible model for other countries. In line with the foregoing observations, Enami remains reliant on heavy subsidies. The mines supported by Enami, many of which are

medium rather than small-sized, are generally in remote and arid Andean areas where there is little alternative employment. Population moved to these areas to exploit the copper deposits, and, in the absence of support, would now be obliged to move away.

Enami supports its client operations by buying copper from them at a price held above production costs. This involves an element of subsidy at times of low prices. This type of floor price guarantee may be seen as the provision of a free put option. That being the case, there may be merit in making this explicit. Firstly, this would allow the Chilean government to value the cost of future support explicitly on an *ex ante* basis instead of waiting to see the *ex post* subsidy outcome. Secondly, the government could use financial markets to lock into the *ex ante* cost by purchase of market options, or through the construction of synthetic positions using futures.

The Chilean government's continued support of Enami, which is doubtless also motivated by electoral considerations, should be seen as a closure policy.²⁹ The strategy is to allow mining companies to work out existing deposits so that population declines gradually over time. It is arguable that the costs of this strategy are lower than alternative and more precipitate closure strategies. Whether or not this is the case will depend on the extent to which the strategy is successful in supporting existing mines without encouraging new investment. If within an explicit option scheme of the type outlined above, the government were to ask mining companies to cover a proportion of the option premium, this would reduce the extent to which Enami is obliged to support mines which would make severe losses in the absence of subsidies.

5.2.2 Tin

Tin occurs in two forms – cassiterite (tin dioxide) and tantalite (complex mineral containing both tin and tantalum). Cassiterite may either be extracted alluvially or by deep mining while tantalite is non-alluvial. The tantalum content of tantalite is generally of greater value than the tin content. Both minerals occur in greatest abundance in Asia – China (now the largest producer), Thailand, Malaysia and Indonesia. Alluvial extraction (dredging or panning) is dominant in Thailand, Malaysia and Indonesia and is also important in China. The other important producing area is Peru, Bolivia and the contiguous area of Brazil where both technologies are employed.³⁰ Africa has only a small level of tin production – predominantly in Nigeria and the Central African Republic.

Tin is an exception in the metals industries in so far as economies of scale appear quite limited. There are few very large operations and relatively little involvement on the part of major mining companies. Further, the importance of small-scale and artisanal mining has tended to increase over the past decade, contrary to the trend in other metal industries. Much of the growth in artisanal mining has been in Indonesia in the wake of the 1999 rupiah devaluation which has translated moderate dollar tin prices into very high local prices. As a consequence the dominant national producer P.T. Timah has been unable to prevent large numbers of artisanal miners from illegally operating on its terrain.

Tin stabilisation was effective until the early nineteen eighties. Over the period 1987-2002, tin price volatility, measured as the standard deviation of changes in logarithmic prices, has been just 12.9%, substantially less than the average of 17.7% in the period 1972-84 when the price was actually subject to stabilisation. The current level of tin price variability should not result in this being a major component of risk. Intervention to stabilise prices therefore seems superfluous and possibly counter-productive. Indeed, the

²⁹ Mine closure policies are an important element of a national mining policy. Cesare and Maxwell (2003) discuss mine closure policies in relation to Indonesia.

³⁰ See Quiroga (2002) for a recent discussion of the Bolivian ASM tin sector.

very high volatility of tantalum prices over recent years is likely to be more important for those miners who extract tin and tantalum jointly.

5.2.3 Gold

Gold mining takes place at an artisanal level, in small-scale mines and in much larger mines often owned and operated by major mining companies. Extraction can either be alluvial, through open pit extraction or by underground mining. Although artisanal mining is generally alluvial, small-scale mining can use any of these technologies.

The gold mining industry exhibits a low degree of concentration and there are no dominant players. Prices are determined competitively and, since the U.S. Federal reserve Board ended its commitment to buy and sell gold at a fixed price in 1971, there has been no direct governmental intervention in the gold market. Despite this, the gold price has been among the least variable of all commodity prices – see section 2.2.3. This lack of variability is the consequence of the enormous stock of gold in the world, both that in the hands of the private sector, either as a store of wealth or in the form of jewellery (which may also be a store of wealth), or held by central banks as part of their reserve – see Lawrence (2003).

Official reserves at the end of 2003 amounted to 31,964 tons against 2003 mine production of just 2,590 tons.³¹ Official gold reserves are therefore equivalent to over twelve years annual production. Many central banks are keen to replace gold reserves by assets which earn a return, and reserves have therefore been declining over time. In 2003, central banks sold a net total of 559 tons of gold, equal to approximately one fifth of mine production. Variations in the rate of sale can therefore compensate for fluctuations in demand or production. This effect is compounded by the practice of many central banks of lending their gold reserves on the gold forward market in order to obtain the gold lease rate – see Neuberger (2001). Gold which is so lent forms part of the privately held stock, even if its legal ownership remains with the lending central bank. A higher level of privately held stocks reduces price variability – see section 2.2.1. To this should be added the impact of privately held stocks. Gold Fields Mineral Services has estimated the total stock of above ground gold at the end of 2001 as 145,200 tins (Lawrence, 2003), although this estimate is necessarily impressionistic. Subtracting official reserves gives an estimate of the privately-held stock as 113,400 tons.

There are multiple risks in artisanal and small-scale gold mining – see, for example, Heemskerk (2003) – but these relate primarily to weather, yield and, depending on the ease or difficulty of releasing the gold, on pollution risks. Price risk does not appear high on this list, at least on the basis of the historical experience. Policy in this area should therefore focus on these other risks. As discussed in section 4.2.4, there is merit in looking at the applicability of weather insurance at least for small-scale mines.

5.2.4 Diamonds

The diamonds industry was discussed in in section 3.1.3. Diamond prices have been stabilised at a high level by the De Beers cartel. The consequence is that the volatility of diamond prices is amongst the lowest of all commodity price volatilities. So long as the cartel remains effective, price risk is unlikely to be a serious problem affecting the ASM diamond sector.

This judgement requires qualification in relation to differences between small diamonds (referred to in the trade as “Indian goods”), largely destined for industrial uses, and large diamonds. Over the nineteen eighties and nineties, De Beers’s control largely broke down for smaller diamonds but remains intact for larger diamonds. This may be seen from

³¹ Source: World Gold Council.

Figure 3 which charts the unit value of U.S. diamond imports of cut diamonds broken down between large diamonds (those greater than 0.5 carats) and small diamonds (those less than 0.5 carats).³² The unit values of the two categories moved closely together until the mid nineteen eighties, but then showed very different price trends, with the prices of small diamonds falling back while those of large diamonds rose to become close to their 1981 peak.

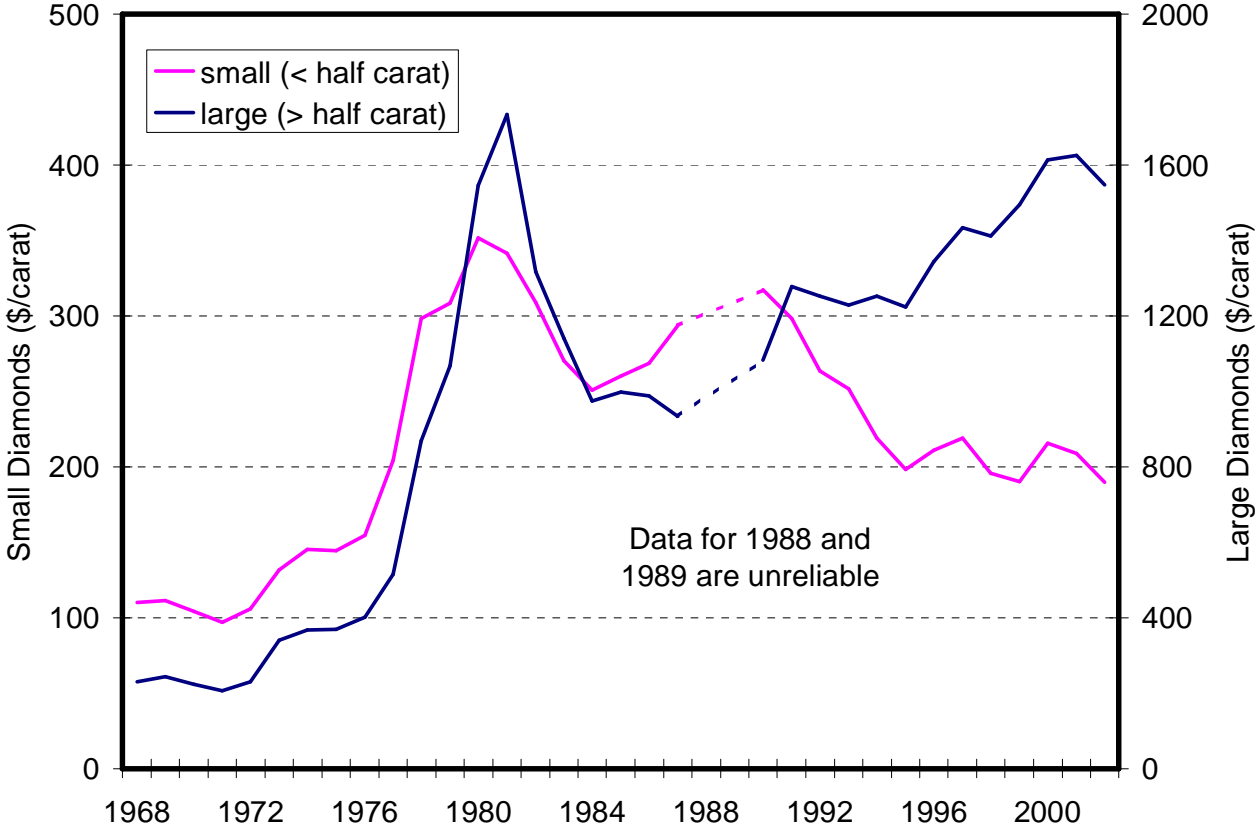


Figure 3: US Import Unit Values for Small and Large Cut Diamonds, 1968-2002

It seems likely that these divergent movements are the result of the large quantity of diamonds coming onto the market in the nineteen eighties as the result of new developments, in particular in Australia and Russia. De Beers responded to these increased quantities by limiting production over those mines which it controlled or could influence through its marketing agreements, and by stockpiling excess production. However, stockpiling is expensive, in that it tied up De Beers’s capital, and it seems possible that this may have been confined to or concentrated on larger diamonds. Some lower quality large diamonds may also have been cut and sold as small diamonds.

³² The reported data for 1988 and 1999 appear to show significant proportion of small diamonds as being classified as large diamonds. This may result from packets containing both small and large diamonds being classified as large. There does not appear to be any problem with the aggregate figures. I therefore omit 1988 and 1989 from Figure 3 and the three years 1988-90 from the variability calculations. Source: US Bureau of the Census, *Import Statistics* (cd-rom). Prices of uncut (rough) diamonds move closely with those of cut diamonds but there is a paucity of data on these prices distinguished by size.

These developments have depressed the prices of smaller diamonds to around 60% of their peak value. However, the variabilities of the prices of the two categories of diamond are not notably different – the standard deviation of the annual changes in the logarithmic prices over the period 1983-2002 (omitting the years 1988-90 where the data are unreliable) are 8.0% for large diamonds and 8.3% for small diamonds. It remains true that price risk, as measured by historic variability, is low both for small and large diamonds.

The implications of these developments for the ASM sector depend on whether the balance of production is smaller or larger stones. This balance varies across producing countries. The ASM sectors of countries which produce large as well as small diamonds will have benefited from the De Beers cartel in terms of both high prices and low price variability, but unlike De Beers themselves and other large mining companies, they will not have been subject to production restrictions. De Beers's inability to control the ASM sector has effectively allowed them to free ride the cartel's actions. By contrast, the benefits to countries, such as Ghana, where the ASM sector produces predominantly industrial quality diamonds, are smaller – De Beers's actions appear to have stabilised prices but at a level which has been declining over time.

The greatest threat to small-scale diamond mining probably arises from the possibility that the De Beers cartel will eventually collapse. This would almost certainly result in a major decline in diamond prices, a fall which is likely to be most acute for larger diamonds. It also seems likely that in the absence of the cartel, diamond prices would become as variable as those of other gemstones (see section 2.2.3), substantially increasing price risk in the sector. While there is no immediate likelihood of collapse, the fact that the cartel contravenes U.S. anti-trust laws, and has been so judged, suggests that its continued existence cannot be guaranteed. In that light, the best advice for governments with ASM diamond sectors may be to accelerate production as fast as possible at the same time as making provision for resettlement of the diamond miners in other activities if and when prices do actually fall.

5.2.5 Coloured Gemstones

There is a large variety of coloured gemstones. The International Colored Gemstone Association lists 57 different types of gem.³³ Some of these 57 gemstones occur only in a very limited range of locations. Indeed, many coloured gemstones are much rarer than diamonds, where the De Beers cartel has used advertising to create a myth of scarcity in order to justify high prices to consumers.

Coloured gemstones are typically mined in relatively small-scale operations and artisanal mining is also important. However, there is an absence of good data on the extent to which this is true. They sell in relatively thin markets. Changes in production in particular producing areas can therefore have a large impact on availability in the relevant market. This is a recipe for price volatility. There is a lack of publicly-available historic price data for the majority of these gems, but the unit value data for three most important coloured gemstones – emeralds, rubies and sapphires – given in section 2.2.3 show that price volatility is indeed high. Coloured gemstones therefore appear to be the only internationally traded major ASM metal or mineral in which price risk is likely to be perceived as important.

Because gemstones are often highly concentrated in terms of geographical location, governments of producing countries have the potential to exert a degree of monopoly power. Competition among the different coloured gemstones probably limits the potential for raising prices, and the experience in national buffer stock schemes for agricultural

³³ http://www.gemstone.org/index_gemsite.html

products discussed in section 3.2.1 counsels against a storage strategy. However, through the establishment and financing industry or trade associations, governments could do more to promote sales of coloured gems.

It would also possible to take similar initiatives at an international level through the establishment of an international commodity body (ICB) for coloured gemstones, perhaps on the model of the International Lead and Zinc Study Group. Coloured gemstones have suffered from the success of the diamond industry. Prior to the mid twentieth century, diamonds had no particular pre-eminence over other gemstones. However, through a combination of advertising and market management, the De Beers cartel has promoted as being different in kind from other gems. A coloured gemstone ICB would give greater prominence to the industry and could also facilitate advertising for stones in which there are multiple producers. An ICB would also have access to the Common Fund for Commodities which has money available for market promotion.

Promotional efforts of this sort would not directly limit price variability. However, they might allow coloured gemstones to recapture market share from diamonds permitting higher prices, increased production or a combination of these. Further, an environment in which demand growth is more robust and prices are stronger would encourage the jewellery trade to carry greater inventory in times of weak prices which should have a dampening effect on price variability. Overall, one could expect an improvement in the structure and performance of the industry.

6 Conclusions: The directions for policy

The main conclusion from this study is that price risk is generally not the main risk faced by producers in the ASM sector. There are exceptions, particularly in the mining of coloured gemstones, but in the three most important ASM minerals – diamonds, gold and tin – price variability has been low.

While there can be no guarantee that this will remain true in the future, there would appear to be little reason to give priority to policies aimed at the alleviation of these low current levels of price risk. So far as artisanal miners are concerned, by reducing the gains from diversification across mining and other activities, price stabilisation may even be a “bad”. Risk management in the ASM sector should therefore focus on non-price risks. Weather risk, yield risk and, in certain cases risk from pollution, appear to be the most important of these risk categories.

This is in many ways fortunate because the history of intervention to stabilise primary commodity prices is far from encouraging. Although it is incorrect to argue that stabilisation schemes can never be successful, the preconditions for success are severe. In particular, international stabilisation schemes require wide consumer as well as producer government support if they are to prevent free riding. Producer only stabilisation agreements will not work unless there is a dominant producer. The only ASM sector mineral where these conditions apply is diamonds, where the price is effectively stabilised by the De Beers cartel.

The agricultural experience suggests that nationally-based stabilisation schemes can be more effective, but only if governments can find an institutional structure which precommits them to keeping stabilisation surpluses for price support at times of low prices. In general, this has not proved possible. Rent extraction has also tended to absorb a significant proportion of potential stabilisation benefits. Smuggling would be likely to be a problem for any such schemes introduced in the internationally traded ASM sector on account of the high value to weight ration of the products. However, there may

be some merit in considering such schemes for non-traded ASM products such as aggregates.

International policy has gravitated away from attempts to alter commodity price distributions and towards strategies aimed at assisting commodity producers in coping with market risk. The International Task Force for Commodity Risk Management in Developing Countries has pioneered this approach, which has potential applications in the ASM sector. In particular, there is merit in actively considering offering weather insurance to small-scale mining enterprises. A major advantage of this approach to risk management is that it can improve access to credit. This is important because difficulties in obtaining credit are frequently cited as one of the major brakes on expansion in the ASM sector.

More generally, the small-scale and artisanal mining sector is an integral part of the rural economy of many poor countries. One of the general lessons in rural development is that major improvements to the livelihoods of those working in the sector will come as much from improving the opportunities to work outside the sector as from providing benefits in the sector. This is particularly important in relation to artisanal miners, who are often among the poorest members of society. Many artisanal miners would not devote time and effort to these activities if more profitable opportunities were to present themselves. Policy towards the ASM sector should therefore be seen as part of the overall strategy for rural development rather than on a stand alone basis.

Appendix: Estimated Price Trends

Trend Estimates									
	Standard Deviations					Coefficients		Periodicities	
	trend slope	auto-regressive	short cycle	long cycle	irregular	Trend	AR(1)	short cycle	long cycle
Diamonds	1.3%			7.2%		0.8%			10.5
Emeralds		27.4%	0.0%			-5.1%	0.4059	5.1	
Rubies		21.7%	0.0%			-2.7%	0.7219	4.0	
Sapphires		17.7%				-2.7%	0.8261		
Gold	3.0%		5.2%		8.3%	-3.7%		6.9	
Silver	3.1%		13.7%			-3.2%		5.2	
Aluminium		16.7%	0.0%			-1.2%	0.6253	4.1	
Copper		16.8%	0.0%			-2.4%	0.7195	6.8	
Lead				14.3%	7.7%	-3.0%			10.8
Nickel		22.2%		3.1%		-1.4%	0.5467		12.7
Tin	4.6%	10.4%	0.0%			-6.9%	0.0713	5.0	
Zinc		19.5%	1.2%			-1.3%	0.7234	5.1	
Coal	4.2%	0.3%	4.9%			-3.6%	0.4296	6.6	
Iron Ore	3.2%		3.6%	0.0%	4.1%	-0.9%		7.1	15.2
Phosphates	1.0%		13.0%		7.3%	0.2%		6.7	
Cocoa			0.3%	17.7%		-3.6%		3.6	16.0
Coffee		23.4%		0.0%		-4.1%	0.6230		9.6
Maize		8.1%	7.1%		3.6%	-3.2%	0.8199	6.3	
Palm Oil			10.1%	5.0%		-4.0%		4.2	18.3
Pepper				15.7%		1.1%			10.6
Rice			11.3%	0.0%		-4.1%		5.7	19.5
Soybeans		6.6%	8.2%			-3.4%	0.7963	4.5	
Sugar		29.2%	5.3%			-4.5%	0.7063	7.1	
Tea		12.3%	0.0%			-1.0%	0.5348	6.5	
Wheat		12.2%	7.3%			-3.0%	0.8029	6.8	
Copra			16.9%	1.8%	1.0%	-3.7%		4.4	18.8
Cotton		14.4%	1.1%			-3.3%	0.6335	3.5	
Jute	0.5%	15.3%	0.0%			-3.4%	0.3742	5.7	
Rubber				16.6%		-2.3%			9.3
Sisal		10.8%	8.7%		5.1%	-1.7%	0.8504	6.0	

Trends are estimated over the sample 1971-2002 except for rubies and sapphires (1982-2003) and pepper (1983-2002). The dependent variable is the logarithm of the price deflated by the US Producer Price Index (all items). Each series is decomposed into a smooth trend (possibly with stochastic slope) plus one or more of a first order autoregression, a short cycle, a long cycle and an irregular component. In general, it is not possible to fit all these components and a parsimonious specification has been selected. The error standard deviations show the standard error of each component. Note that in certain cases, one or both cycles are estimated as deterministic. The trend coefficient shows the annual trend rate of increase in the deflated price. This is constant in the case of trends with deterministic slope, but for those with stochastic slope, the italicised coefficient reports to the trend slope in 2002. The autoregressive coefficient is that of the AR(1) process, where estimated. Cycle periodicities are in years.

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