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Commodity Price Volatility, Vulnerability and Development

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This article examines the meaning and consequences of the developing countries' vulnerability to the volatility of commodity prices. It first considers how to define and measure a country's shocks and exposure arising from commodity price volatility in order to identify structural as distinct from policy vulnerability. The main channels through which price vulnerability influences economic growth are then presented. Finally, the policy implications for development aid, its allocation and design, are outlined. It is found that, while structural vulnerability is bad for growth, a policy of openness contributes to resilience. With the right rules, aid could play an important growth-enhancing and poverty-reducing role if allocated at least partly on the basis of vulnerability.

While the sentiment prevails that economic openness is favourable to development, the persistent volatility of commodity prices is seen by many countries as a serious source of vulnerability. At the same time, there is a growing interest in the different ways in which economic vulnerability makes itself felt. For example, the UN General Assembly's request for an indicator of economic vulnerability applicable to small island states, the establishment of such an index by the UN Committee for Development Policy (1999, 2000) to identify the least developed countries, the efforts of other international institutions to establish an index of this kind (e.g., Easter, 1999; Crowards, 1999), the work that has been done on risks to the financial system in the wake of the Asian crisis (e.g., Berg and Patillo, 1999) or on the factors affecting the volatility of growth (Combes et al., 2000), and the renewed analysis of the consequences of trade shocks (e.g., Collier et al., 2000).

The shocks to which developing countries are subject may be of a natural or climatic kind (typhoons, earthquakes, volcanoes, floods, drought) or of an external nature, linked to finance (instability of interest rates and financial markets, etc.)[1] or trade (instability in world prices or demand). The volatility of commodity prices remains one of the main factors behind the vulnerability of low-income countries, even if it is not adequately reflected in the instability of the terms of trade related to the export and import of goods and services. This article addresses, first, the vulnerability of developing countries to volatility in their exports, and more particularly in commodity prices, and how to measure it. It then examines the ways in which this vulnerability can

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1. Or the instability of aid itself (Lensink and Morrissey, 2000), when not occurring as compensation for other shocks.

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impede growth. Finally, it attempts to identify the implications for co-operation policies and development assistance.

How can vulnerability linked to commodity price volatility be measured?

Economic vulnerability means the risk of being negatively affected by exogenous, i.e., unforeseen and uncontrollable, shocks, in this case the volatility of international commodity prices. It can be understood either in a static sense, as the immediate welfare cost of a shock, or in a dynamic sense, as the consequences of such shocks on growth, development, poverty reduction, etc. Macroeconomic vulnerability, affecting a country as a whole, clearly implies microeconomic vulnerability, the risk that individuals, in particular agricultural producers, will be affected by a shock (price volatility) in ways that will keep them poor.

Three components of vulnerability: shocks, exposure, resilience

The risk that a country will be affected by unforeseen events, in this case commodity price volatility, can be broken down into three elements (Guillaumont, 1999): the potential size of the shocks, the exposure to them, and the country's capacity to react to them, in other words its resilience.[2]

The vulnerability of a commodity-exporting country thus depends on fluctuations in world prices for its exports, as reflected in the instability of its terms of trade; its exposure to these fluctuations, represented by the ratio of its exports to GDP, i.e., its trade dependency; and its resilience, i.e. its capacity to manage shocks effectively as they occur.

We may distinguish between structural economic vulnerability (determined by shocks and, in part at least, by exposure to them) and policy-induced vulnerability, which is temporary and more readily reversible. In seeking to establish an economic vulnerability index for identifying certain countries (e.g., least developed countries) as the targets of sustained support by the international community, the focus has to be on structural vulnerability. In the case of a small country (a price-taker), the instability of the prices of the goods it exports is exogenous. On the other hand, its resilience, or its capacity to manage shocks, will depend essentially on the policies it follows. Exposure to shocks, in this case the export to GDP ratio, is somewhat ambiguous, since it depends both on structural factors and on economic policy.

Here we can distinguish between these two sources of observed trade dependency, as measured by the ratio of exports to GDP (or to internal supply), namely, (i) structural factors (population size, GDP per capita, the presence of mineral resources, whether the country is landlocked and the average distance to the major markets) and (ii) economic policy (trade policy and other components of policy as well). The estimated value

2. The notion of resilience is widely used in studies dealing with environmental or ecological vulnerability. It is clearly applicable in the economic realm as well, where it refers to the ability to manage or absorb shocks. In a similar vein, Rodrik (1999a, 1999b), in examining the risk that domestic conflicts pose for growth, points to the severity of the shocks, the depth of the underlying social conflicts (which may exacerbate their impact), and the quality of conflict-management institutions.

derived from a regression on only structural factors using either international cross-sectional or panel data measures the degree of structural openness, independent of economic policy, also called natural openness (Rodrik, 1998). The residual of the same function may be considered a proxy of policy openness (Guillaumont and Guillaumont, 1988, 1994; Combes et al., 2000), relative to other observations of the sample (see Annex 1).

Measuring external shocks generated by price volatility

A good approximation of the magnitude of shocks suffered during a given period as a result of the volatility of international commodity prices is, of course, the instability of the terms of trade. Since price movements may be dampened (or exacerbated) by quantity movements, however, it is often more useful to consider the instability of the real value of export receipts directly.[3] It should be noted that most available measures of countries' foreign trade are annual, so that instability must be examined on a year-to-year basis.

Several problems are associated with measuring volume and price indices in trade at the country level. UNCTAD's estimates of unit values and terms of trade are only tentative, and in any case cover only goods exports.[4] The indices proposed by Deaton and Miller (1995), as reproduced by Dehn and Gilbert (1999), which are an average of international commodity prices weighted by a fixed trading structure for each country, have the drawback that unit export values of each product for each country may behave quite differently from international commodity prices.

Once a suitable terms-of-trade (or export) series has been established, the measure of instability has to be selected. The most widely used measure is the variance of deviations from a trend or reference value, expressed as a percentage thereof (unless the series is expressed in log). The key problem then is to choose the trend or reference value against which instability is to be measured. In the literature on export instability, it has long been assumed that there is a deterministic trend, where exports are a function of time. But the possibility of a non-stationary series with a stochastic trend component must also be considered. Since, on the other hand, the trend component may not be purely stochastic, the best way to compare a large number of countries is to take account of both the deterministic and the stochastic components, i.e., to have a 'mixed' trend.[5] In fact, the choice of a trend measure generally has little influence on the instability measure. Thus, for the real value of goods and services exports (using World Development Indicators data) measured over several periods (1970-80, 1980-90, 1975-85, 1985-95) and across a broad sample of countries, the rank correlation coefficient

3. Exports can be either goods or goods and services, the latter being preferable, since services often represent a large proportion of a small country's total receipts even if terms-of-trade shocks are generally dampened when the share of services is larger.
4. In the case of export instability, it would then seem preferable to deflate the value of exports (in current dollars) by an index of world export prices, i.e., to express the exports of goods and services of different countries in terms of their purchasing power in reference to the same basket of goods.
5. For example ($\log x_t = \gamma + \alpha \log x_t\text{-}1 + \beta.t + \varepsilon_t$). If $\alpha = 1$ and $\beta = 0$, then we have a frequently used measure of instability, i.e., the variance of growth rates. The drawback of this method is precisely the hypothetical restriction that it introduces.

between different measures (deterministic trend, linear or exponential, lagged endogenous variables, a combination of the two, etc.) falls between 0.87 and 0.93.[6]

Of course, vulnerability indicators designed to be internationally comparable do not necessarily represent risk as perceived by economic agents, since to represent this would imply specifying a model of expectations formation.[7] As we shall see, however, instability may be harmful not only because it is a source of risk but also because of the asymmetric reactions that an increase or decrease in prices (or exports) can generate. All we have to do, then, is to measure deviations from an observed past trend, without the need of any model for dealing with expectations.

Measured in this way, year-to-year volatility in the terms of trade of developing countries, and in the real value of their exports, is still high, although it is declining in comparison with the two previous decades (see Table 1). Oil price shocks are a major factor explaining the evolution, firstly of course for oil exporters, but also through the import price of other countries.

Table 1: Terms-of-trade instability (%)

Country Group	1965-73	1973-81	1981-89	1989-97
NAME	11.20	21.59	12.30	7.44
SSA	10.52	12.97	7.69	5.26
LAM	8.39	13.08	8.55	5.30
ECA	Ns	7.03	4.05	Ns
EAP	12.36	10.03	6.56	3.63
SAS	9.17	8.33	5.41	3.15
DCO	9.86	13.87	8.46	5.35

Notes: NAME: North Africa, Middle East; SSA: Sub-Saharan Africa; LAM: Latin America; ECA: Europe, Central Asia; EAP: East Asia and Pacific; SAS: South Asia; DCO: developing countries.
Source of gross data: World Development Indicators.

Exposure to shocks

The fact that we are dealing with the issue at the country level, i.e., examining the instability of a country's terms of trade or its export receipts, implicitly relies on a weighting between the unit values of exports (and imports), and thus introduces an element of exposure to shocks produced by the volatility of market prices. Depending on the structure of a country's trade, world price volatility will have a greater or lesser impact on the volatility of its terms of trade or on the real value of its export receipts.

For any given degree of instability in the terms of trade, a country's vulnerability will be the greater the more exposed it is. It would seem natural, then, to measure vulnerability to price volatility by weighting the terms-of-trade instability or that of exports (of goods and services) by the export to GDP ratio (of goods alone, or of goods

6. CERDI calculations available on request.
7. Some authors, in dealing with the effects of external instability, use conditional variance measures, which supposedly provide a better reflection of economic agents' risk perceptions.

and services).[8] Such a measure of the weighted instability of terms of trade, or of exports, has been used in several studies to test its effects on growth (for example, Guillaumont, 1994; Guillaumont et al., 1999).[9]

Yet if the intention is to measure only structural vulnerability, the weighting to be used should not be the ratio of exports to GDP, i.e., the observed degree of trade dependency, since this results both from structural factors and from economic policy. It is better to use the export ratio estimated in terms of structural factors alone, chief among which is population size, on the hypothesis that, all other things being equal, smaller countries are more exposed and hence more vulnerable. The degree of openness estimated in terms of structural factors alone (natural openness in the Rodrik meaning) is itself an index of structural exposure to external shocks.[10]

Synthetic indices of structural vulnerability

While we are primarily interested in vulnerability related to external trade, we shall ultimately have to consider it under the broader concept of structural economic vulnerability, for which several indices have recently been established. These indices are intended to reflect naturally occurring shocks as well as external shocks, and they imply a weighting of the composite indicators of these different shocks.

One logical way of weighting different indicators is to estimate the long-term *impact on growth* of different components of vulnerability and to use the resulting coefficients as weighting elements if they are significant. Vulnerability measured in this way must then clearly be considered a handicap to growth. We have been able thereby to establish an index of economic vulnerability representing the estimated impact on growth of instability in agricultural output and in goods and services exports, of the trend in the terms of trade and of population size (in log), the latter representing the principal (negative) structural factor of shock exposure. These four variables are significant in addition to the conventional control variables in a model covering 95 country observations pooled over two periods of 11 years (Guillaumont and Chauvet, 1999).[11] The resulting indicator measures, in a sense, the growth impact both of exogenous shocks and of countries' exposure to these shocks.

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8. The instability of the ratio of exports to GDP can also be measured directly (Dawe, 1996), but this measure of instability is paradoxically greater the less export fluctuations are reflected by proportionate fluctuations in GDP.
9. Weighting the instability of the terms of trade by the export to GDP ratio helps to explain why African countries, with a relatively high trade dependency ratio, have been relatively more affected by the terms-of-trade shocks than other developing countries. Vulnerability to external shocks has been recognised as one of the major constraints on their development (Collier and Gunning, 1999).
10. The export to GDP ratio, although determined in part by policy, is nevertheless used in various composite indices of vulnerability (Briguglio, 1995; Crowards, 1999; Easter, 1999).
11. It is not always appropriate to use an econometric model for the choice of weighting, if what we are looking for is a transparent index for identifying countries that might benefit from special treatment by the international community, as in the case of least developed countries. For this reason the UN Committee for Development Policy gives equal weighting to 5 indicators that it has selected for building the new economic vulnerability index, intended to replace the old economic diversification index in the criteria for identifying least developed countries (cf. United Nations, 1999, 2000). It is also tempting to use the volatility or instability of GDP growth as a synthetic indicator of economic vulnerability. But this volatility results not only from structural factors but also from economic policy (cf. Combes et al., 2000; Easterly et al., 2000).

How does price vulnerability impede growth?

We shall now examine how growth, taking into account the conventional control variables (such as initial output per head, human capital, initial social and financial structures), can depend on structural vulnerability to (year-to-year) volatility in international commodity prices. We show that the effects of structural vulnerability can be moderated by suitable policies and by aid. To this end, we put forward a number of propositions drawn from previous studies, supplemented by some new tests.

While export growth promotes economic growth, export instability will diminish it. The same relationship applies in the terms of trade

Much research and debate has been devoted to the effects of export growth in developing countries, and to their export instability. Any analysis of the effects of export growth on economic growth naturally assumes that the problem of exogeneity is properly handled. Analysing the effects of the instability of exports, and of their growth, implies that the two kinds of effects, of expectedly opposite sign, must be considered simultaneously. When export growth and instability are introduced simultaneously into the GDP growth function, and when both are weighted by the observed export ratio, export growth will appear to have a significantly positive effect on economic growth, and export instability a significantly negative effect (Dawe, 1996; Guillaumont, 1994).[12] The same combined effect, respectively positive and negative, of weighted growth and instability in the terms of trade has been tested and found to be statistically significant (e.g., Guillaumont et al., 1999).

Vulnerability has a greater effect on factor productivity than on capital accumulation

Growth equations containing indicators of instability in the terms of trade or exports may or may not include the rate of investment, along with other control variables. Consequently, the coefficient of these indicators will, depending on the case, reflect an effect on the growth residual alone (roughly, factor productivity) or a total effect through this residual and through investment.

While some authors have argued that risk (reflected by instability measures) can reduce the investment rate (Aizenman and Marion, 1999), the literature remains doubtful on this aspect, because of a possible positive effect on precautionary savings or a permanent income effect. In fact, we find no evidence that (weighted) instability in the terms of trade reduces the investment rate (Guillaumont et al., 1999). In general terms, various cross-sectional studies of the economic growth effects of a series of instabilities (in the terms of trade, in agricultural output, in economic policy) (ibid.) or of the instability of exports alone (Guillaumont, 1994; Dawe, 1996) or of the instability in the rate of economic growth (Ramey and Ramey, 1995), show that these instabilities reduce factor productivity growth rather than the investment rate. The test described in the Annex 2, relating to terms-of-trade instability alone, confirms these results.

12. See the summary of these works in Araujo et al. (1999).

The effects of structural vulnerability make themselves felt largely through intermediary variables of economic policy

Economic policy consists of two parts, one of which is induced by exogenous structural factors, in this case international commodity prices volatility, while the other is autonomous with respect to those factors. We have tested the hypothesis that 'primary' instabilities (terms-of-trade instability, but also political instability) can influence growth through two 'intermediary' instabilities, namely, instability in the investment rate and in relative prices, which are linked to economic policy (Guillaumont et al., 1999).

In the first place, commodity price instability is a factor in investment rate instability which reduces productivity. Indeed, if the marginal productivity of capital declines with increasing investment, the total output gain from a high level of investment will be less than the loss from a low level, for any given mean level. This effect, curiously ignored in the literature on growth, shows up during boom periods of over-designed, ill-prepared and unproductive investment, and primarily concerns public investment.

The second intermediary instability, that of relative prices, in particular the effective real exchange rate, also appears to have a strongly negative effect on growth. This negative effect of instability in the real exchange rate has also been examined in several other articles (e.g., Aizenman and Marion, 1999; Ghura and Grennes, 1993; Serven, 1997).[13]

To these two intermediary instabilities, we must add the degree to which world price instability is transmitted to agricultural producers, which will depend on how well it is managed by the state or by intermediary institutions, and which will have an effect on agricultural supply. It is well established that agricultural supply reacts negatively to instability in the prices paid to producers (see Araujo et al., 1999).

The effects of export instability, and those of terms-of-trade instability, are dampened by a policy of openness

While observed openness, when used for weighting instability, tends to increase its negative impact, a policy of openness would seem, in contrast, to diminish the absolute value of the (negative) coefficient linking (weighted) instability to growth. This becomes apparent if we introduce an additional multiplicative variable (weighted instability x indicator of openness policy) (Guillaumont, 1994). In other words, while structural (or natural) openness increases exposure to shocks, an openness policy enhances the capacity to manage those shocks, i.e., it increases resilience.[14] An analysis

13. A further policy effect of external instability was recently presented by Rodrik (1998), who tested the hypothesis that export instability leads to an increased rate of public spending, for insurance purposes. In this case, structural vulnerability can be said to generate resilience.

14. From a broader perspective that embraces social as well as economic variables, Rodrik (1999a: 386) argues 'that the effect of external shocks on growth is larger the greater the latent conflicts in an economy and the weaker its institutions of conflict management'. He shows, in a cross-sectional growth regression, the negative effect of an indicator called 'social conflict', defined as the product of three elements: a shock index (an index of terms-of-trade instability weighted by the export ratio), a latent conflict index (i.e., the social factors of exposure to shocks, either an index of income inequality or the index of ethno-linguistic fragmentation, often used in the literature), and finally an index representing the lack of effective conflict

of the factors behind growth volatility produces results consistent with earlier findings: while the structural factors of openness increase volatility, an openness policy reduces it (Combes et al., 2000). In other words, structural vulnerability makes growth less stable, while an openness policy makes it more stable.

The way in which the (negative) effects of instability in the terms of trade are conditioned by openness has been specifically tested for this article (see further details in Annex 2). It appears, from an examination of a panel of four periods running from 1965 to 1997, that, once we have controlled for the influence of structural factors, growth depends significantly on the terms of trade, in three ways:

- growth in the terms of trade has a positive effect;
- instability in the terms of trade, weighted by the structural component of openness (i.e., structural vulnerability to price volatility), has a negative effect (Table 2);
- this effect is itself moderated by openness policy (instability weighted by the indicator of openness policy), i.e., by resilience.

Column 2 + 3 in Table 2 is the impact of terms-of-trade instability on growth of per capita GDP in different groups of countries: it is not negligible, except in East and South Asia. Although openness policy moderates this impact, this beneficial effect appears relatively limited.

Table 2: Contribution of terms-of-trade instability to growth (%)

Country Group	Growth rate	Contribution of resilience	Contribution of structural vulnerability	Contribution of terms-of-trade instability
	(1)	(2)	(3)	(2)+(3)
NAME	1.17	0.12	-0.42	-0.30
SSA	0.24	0.06	-0.29	-0.23
LAM	1.25	-0.11	-0.39	-0.49
ECA	2.25	-0.11	-0.15	-0.26
EAP	3.57	0.30	-0.23	0.08
SAS	2.71	0.05	-0.12	-0.07
DCO	1.14	0.03	-0.32	-0.39

Notes: As for Table 1.

The effects of structural vulnerability are also moderated by external assistance

There has been broad debate in recent years about the effectiveness of aid. Burnside and Dollar (1997), quoted by the World Bank (1998), maintain that aid has only been

management institutions (the lack of democracy or the low level of the public institutions quality index, again often used). The model implicitly relies on the restricted hypothesis according to which the growth impact of the three components of instability is identical.

effective when economic policies were sound, taking as one indicator (among three) of economic policy the Sachs-Warner openness indicator. According to this study, therefore, an openness policy enhances the effectiveness of aid.

This relationship has been discussed in several works (for example, Hansen and Tarp, 2000; Lensink and White, 2000). In our case, we have examined a different hypothesis, namely, that aid will be more effective the more vulnerable a country is (with vulnerability defined, as indicated above, by the growth impact of four shock indicators and of the degree of exposure to shocks). According to our tests, this hypothesis cannot be rejected, while the Burnside and Dollar hypothesis is rejected (Guillaumont and Chauvet, 1999). The positive effect of the multiplicative variable, aid x (structural) vulnerability, produces one or other of two equivalent propositions: that aid is more effective the more vulnerable the country, or that the effects of vulnerability are dampened by aid. A similar relationship has been tested significantly by looking more specifically at the interaction between aid and uncertainty in international commodity prices (Dehn and Gilbert, 1999).

What are the implications for development assistance?

The conclusions to be drawn from the empirical literature on the vulnerability of developing countries to international commodity price volatility have implications both for the allocation of aid among countries and for its targeting within countries.

Implications for aid allocation

The last argument presented above, on the positive impact of structural vulnerability on the effectiveness of aid (in other words, the fact that aid can moderate the consequences of vulnerability), suggests that structural vulnerability should be taken into account in allocating aid. Aid to the most vulnerable countries, in particular those faced with sharp volatility in their terms of trade, can not only compensate for a welfare loss, but will serve to enhance the contribution of aid to growth. Consequently, aid will have a greater capacity for poverty reduction if it is, at least partly, allocated according to the vulnerability of the countries, i.e. to their export price volatility, but also to the other shocks they face and their structural exposure to these shocks (higher in small countries).[15]

However, in order to give incentives for policy improvements as well, it is possible to design aid-allocation criteria likely to combine the creation of such incentives and the increase of aid effectiveness as a function of vulnerability (see Guillaumont and Chauvet, 2001). This means allocating aid according to the performances of countries, defined as outcomes (growth or poverty reduction) adjusted for the impact of the exogenous factors, i.e. factors not induced by policy, in particular, terms-of-trade volatility.

15. This means a higher average level for vulnerable countries, other things equal, preferably on a regular basis. It could be even better if aid could be distributed on a countercyclical basis, but this is difficult to manage, and instability of aid, when not clearly countercyclical, is itself a negative factor of growth (Lensink and Morrissey, 2000).

This proposition is consistent with substituting performance conditionality for instrument conditionality (Guillaumont and Guillaumont, 1994; Collier et al., 1997). Not only can it directly increase the effectiveness of aid (which will be greater in the more vulnerable countries), but it can also induce sound policy (which will improve outcomes for any given degree of vulnerability). The quality of policy will then be revealed by its performance, rather than by any (inevitably arbitrary) judgement about the nature of the policy instruments used. The political advantage of this approach, compared with an allocation based solely on policy criteria, is not only to take into account vulnerability, but also to leave the country free to choose the policy instruments by which it tries to obtain outcomes.

It may be noted that the choice made by the UN Committee for Development Policy of an economic vulnerability indicator as one of the main criteria for identifying least developed countries, a category of country expected to mobilise a relatively larger amount of aid than other developing countries, is consistent with the argument of higher aid effectiveness in vulnerable countries.

Implications for aid targeting

What can aid do to reduce a country's vulnerability to volatility in international commodity prices? It can do relatively little to reduce structural vulnerability. Attempts to moderate international price volatility have not been very effective. There is no way to reduce structural exposure to shocks without cost, or without abandoning openness policy which, as we have seen, can reduce the impact of structural vulnerability. The only recourse is to help improve the capacity to react to price shocks (resilience) at both the macroeconomic and the microeconomic level, in particular for agricultural producers. Aid can provide such support by encouraging mechanisms of insurance against price volatility, at both the macroeconomic and microeconomic levels.

Some kinds of aid have in fact been aimed at dealing with vulnerability, such as the compensatory and contingency financing provided by the IMF and the former Stabex and Sysmin programmes under the agreements between the European Union and ACP countries. The experience with Stabex, in particular, offers some lessons, since it was designed mainly to assist small agricultural producers facing instability in their output and in the prices paid for it.

Stabex initially offered automatic compensation whenever there was a fall in ACP country earnings from exports of a limited list of agricultural products, taken independently. Under the successive Lomé Conventions, control was increasingly exerted over the use of these funds, so that disbursements lags increased and automaticity declined. We have examined ways of reforming Stabex so as to reconcile the initial principles of automaticity (quick disbursement) and income support for poor farmers, principles that were never really respected because of growing disbursement delays, fungibility and possible 'Dutch disease' effects (Collier et al., 1998, 1999).

The proposed solution would be to negotiate agreements between ACP countries (taken individually) and the European Commission on rules that would allow resources to be used immediately in support of insurance mechanisms against falling prices, or 'new style' price stabilisation mechanisms, i.e., market-based mechanisms independent of the public finances. External financial support for insurance mechanisms would allow these to operate at lower cost to the producer, on the understanding that with such

mechanisms beneficiary self-selection would be positive rather than adverse, and moral hazard would be controlled. As to stabilisation mechanisms, market-based and externally supported, they could work effectively if the supporting aid were conditional on keeping the funds outside the state financing circuit (preferably outside the country), on maintaining a close link between prices paid to producers and world price trends, and on limiting export taxation levels during boom periods.

The new Cotonou agreement between the European Union and the ACP countries makes no mention of Stabex, but it does call for support at times of short-term fluctuations in export receipts. The goal here is 'to safeguard macroeconomic and sectoral reforms and policies that are at risk as a result of a drop in revenue and to remedy the adverse effects of instability of export earnings, in particular from agricultural and mining output' (art. 68). To the extent that the new agreement can be implemented in different ways, the proposals for reforming Stabex discussed above remain relevant in the new framework of EU-ACP relations.

In short, external assistance, depending on the rules adopted, can help to support or reinforce mechanisms for helping poor farmers protect themselves against risk and for encouraging governments at the same time to manage price instability more effectively. As we know, it is bad management during boom times that is largely responsible for the problems encountered when a downturn arrives.

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Annex 1: Calculating the indicator of relative openness policy

We use a panel of 210 countries and four nine-year periods (1965-73, 1973-81, 1981-9 and 1989-97), leading to a total of 840 observations.

We estimate (OLS plus correction for heteroscedasticity) a model for determining an indicator of relative openness policy. The latter corresponds to the residual ε_x of a function explanatory of the logarithm of the export to GDP ratio (x) where the explanatory variables are exclusively structural factors independent of economic policy. The export ratio thus includes a structural or natural (estimated) component $\hat{x}$ and a policy (residual) component ε_x:

$$x = \hat{x} + \varepsilon_x .$$

Our indicators of outward-looking policies are estimated by eliminating the impact of structural factors through a standardisation equation. We assume, firstly, that a greater population induces a lower degree of specialisation and so less trade dependency. Moreover, when a country is richer, the demand is stronger and then probably more differentiated. This effect favours international trade. Obviously, the natural resources endowment rises as well as the trade dependency. Lastly, the trade dependency depends negatively on the transaction costs.

Hence, the explanatory variables are the logarithm of population (*pop,* expected negative sign); the logarithm of initial output per capita at purchasing power parity (y,

expected positive sign); the logarithm of the distance to major world markets as a proxy of the transaction costs (*dist*, expected negative sign); the logarithm of the fuel and mining export rate (*ress*, expected positive sign) and the distance to the equator and its square (*lat* and *lat2*). These last two variables proxy the natural resources endowment.[16]

$$x = \underset{}{2{,}908} + \underset{(3{,}08)***}{0{,}326.y} - \underset{(8{,}40)***}{0{,}217.pop} - \underset{(11{,}81)***}{0{,}173.dist} + \underset{(1{,}67)*}{0{,}061.ress} - \underset{(4{,}15)***}{0{,}027.lat} + \underset{(4{,}81)***}{0{,}0002 \cdot lat^2} + \underset{(3{,}04)**}{\varepsilon_x}$$

$R^2 = 0.54$, in parentheses, the *t*-ratios and their significance levels (***: significant to 1%, ** to 5%, * to 10%)

Annex 2: Testing terms-of-trade impact on growth under different openness policies

We used a panel of 56 developing countries and four nine-year periods (1965-73, 1973-81, 1981-9 and 1989-97), or a total of 224 observations.

We estimated (2SLS plus correction for heteroscedasticity) a model to explain growth in per capita GDP g_y, as well as a model for determining simultaneously the indicator of relative policy openness. The effect of the terms of trade is controlled using the variables normally found in the literature: logarithm of initial output per capita (*y*, expected negative sign), population growth rate (*p*, expected negative sign), population density and its square (*dens* and $dens^2$, expected positive and negative signs), logarithm of initial life expectancy (*life*, expected positive sign), logarithm of distance from the equator and its square (*lat* and lat^2, expected negative and positive signs, disadvantage of countries located in the tropics), a human capital indicator, logarithm of number of students per teacher (*human*, expected negative sign), and finally the characteristics peculiar to each period and common to all the countries. These control variables have the expected sign and are significant.[17]

The terms of trade are then assumed to exert different effects on growth, all other things being equal:

- terms-of-trade growth g_{TT}, weighted by the export ratio, should have a positive effect;
- terms-of-trade instability I_{TT}, weighted by the structural component of openness, should have a negative effect: the variable $I_{TT}.\hat{x}$ expresses both the magnitude of price shocks and structural exposure to such shocks;

16. We added a dummy variable taking the value one when the country is landlocked. This variable is not significant.
17. We added an indicator for openness policy which is supposed to impact positively on growth. This variable is not significant.

- this effect is itself moderated by a policy of openness: this implies that the variable $I_{TT}.\varepsilon_{x,}$ expressing resilience, has a positive coefficient.

The terms-of-trade effects are shown in the following equation, where none of our hypotheses is rejected. The robustness of this equation is evaluated at a confidence level of 5% with the usual tests (stability of coefficients, functional form, appropriateness of 2SLS, validity of instruments, normal distribution of the residual):

$$g_y = -0.826.y - 0{,}361.p + 5{,}700.life + 0{,}004.dens$$
$$(1{,}96)* \quad (2{,}22)** \quad (3{,}95)*** \quad (4{,}77)***$$

$$-6{,}2910^{-07}.dens^2 - 1{,}245.human - 1{,}444.lat + 0{,}330.lat^2$$
$$(3{,}51)*** \quad (2{,}24)** \quad (2{,}45)** \quad (2{,}33)**$$

$$+ \ldots + 0{,}002 \cdot g_{TT} \cdot x - 0{,}006 \cdot I_{TT} \cdot \hat{x} + 0{,}016 \cdot I_{TT} \cdot \varepsilon_x$$
$$(3{,}96)*** \quad (1{,}82)* \quad (1{,}92)*$$

$R^2 = 0.41$, in parentheses, the *t*-ratios and their significance levels (*** : significant to 1%, ** to 5%, * to 10%)

If we introduce the investment rate (instrumented), this has a positive and significant effect on growth. The estimated coefficients for the three preceding variables are not significantly affected, however. The negative impact of terms-of-trade instability on growth thus works through factor productivity more than through accumulation.