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Does Aid Mitigate External Shocks?[1]

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Abstract

This paper investigates the role of aid in mitigating the adverse effects of commodity export price shocks on growth in commodity-dependent countries. Using a large cross-country dataset, we find that negative shocks matter for short-term growth, while the ex ante risk of shocks does not seem to matter. We also find that both the *level* of aid and the flexibility of the exchange rate substantially lower the adverse growth effect of shocks. While the mitigating effect of aid is significant in both countries with pegs and countries with floats, the effect seems to be smaller for the latter, suggesting that aid and exchange rate flexibility are partly substitutes. We investigate whether aid has historically been targeted at shock-prone countries, but find no evidence that this is the case. This suggests that donors could increase aid effectiveness by redirecting aid towards countries with a high incidence of commodity export price shocks.

Keywords: commodity prices; aid; growth; external shocks

JEL classification: F35, O13, O47

Introduction

This paper empirically investigates the role of aid in mitigating the adverse effects of commodity export price shocks on growth in commodity-dependent countries. Adverse price shocks can have negative effects, both ex ante and ex post. Ex ante, proneness to shocks increases uncertainty about future returns, which might reduce investment and hence growth, a problem sometimes referred to as *vulnerability*. Ex post, realized shocks can harm economic growth in the short run through their effect on aggregate demand or a government's fiscal position.

Aid might mitigate these effects through two distinct routes. Where aid can be made shock-continent, it acts like insurance. However, even if aid is not responsive to the realization of shocks, it might finance precautionary expenditures which make the economy more resilient to shocks, a proposition first seriously advanced by Guillaumont and Chauvet (2001). Potentially, each form of aid might mitigate either effect. Aid as insurance directly compensates realized adverse shocks whereas aid for precautionary spending reduces their cost to the economy. Both thereby make the economy less vulnerable.

Since insurance is the most appropriate solution to risk where it is feasible, shock-contingent aid has some evident attractions. However, it faces three impediments. First, administratively it is generally only feasible to compensate the *government* of the country suffering the adverse shock. Where the shock affects the private sector such as export agriculture, compensation to government will cushion the macro economy but, through the exchange rate effect, it will compound the shock to its primary recipients. Second, aid disbursements are generally slow, so that entitlements triggered by a shock are only likely to reach the economy some years later. This was exemplified by the STABEX shock-contingent instrument of the European Commission, the disbursements from which were so heavily lagged that they were on average *pro*-cyclical. Third, shock-contingent aid would only reduce the costs of vulnerability if it was regarded as a credible long-term commitment, yet aid policies are widely perceived to be subject to fashion.

If adverse shocks generate substantial economic costs, aid might more feasibly address them through precautionary effects which depend upon the level of aid rather than its responsiveness. One straightforward precautionary effect is that the higher is aid the less exposed is the economy to import compression resulting from a shock to commodity export earnings: a given absolute shock will require a smaller proportionate reduction in imports. Aid might also finance liquidity, both higher levels of foreign reserves and greater financial depth, which can then be used to cushion shocks to external income. Aid might also finance investments that enhance the flexibility of the economy. For example, by financing human capital it might make the workforce more adaptable, and by financing infrastructure it might make factors more mobile.

In our analysis we first test to what extent shocks matter for growth, both through increased vulnerability (*ex ante*), and through the realization of shocks (*ex post*). We then investigate whether either the level of aid, or shock-contingent aid, mitigate the negative effects of shocks.

We allow for exchange rate flexibility as an alternative or additional instrument to mitigate shocks. Broda (2004) finds that the short-run output response to terms-of-trade changes is significantly smaller in countries with flexible exchange rate regimes than in those with fixed regimes. The underlying argument is that when economies are hit by real shocks and prices are sticky, the exchange rate can play a crucial role in smoothening quantity responses by allowing for a quicker adjustment of relative prices. We test the robustness of Broda's results for commodity export price shocks. In addition, we investigate whether exchange rate flexibility and aid are potentially substitutes. In particular, we test whether the effect of aid is different in countries with fixed exchange rates, which do not have an automatic alternative line of defense, than in countries with flexible exchange rates.

Using data for 100 countries from 1971 till 2003, we find that negative commodity export price shocks matter substantially for short-term growth, while the *ex ante* risk of shocks does not seem to matter for long-run GDP. We also find that both the *level* of aid and exchange rate flexibility substantially lower the adverse effect of shocks. *Incremental*, shock-contingent aid, does not seem to mitigate the effect of shocks. While the level of aid mitigates shocks, regardless of a country's exchange rate regime, the mitigating effect seems to be somewhat smaller for countries with flexible exchange rates, suggesting that aid and exchange rate flexibility are partly substitutes. Having established that aid can be effective in shock-prone countries, we then investigate whether aid has historically been targeted at such countries, but find no evidence that this is the case. This suggests that donors could increase aid effectiveness by redirecting aid towards countries that suffer from a high incidence of commodity export price shocks.

This paper is related to the literature on terms-of-trade shocks and aid effectiveness. It is most closely related to Collier and Dehn (2001), who show that the adverse effects of negative shocks can be mitigated by offsetting increases in aid. This paper improves upon their study by using instrumental variables for aid, applying several alternative dynamic panel estimation techniques, and allowing the effect of shocks to be proportional to commodity exports. We also test the importance of the *ex ante* risk of shocks as well as the realized shocks, and investigate the role of a country's exchange rate regime. In addition, we look at whether aid and exchange rate flexibility are substitutes or complements and we use a much larger and richer dataset.

The remainder of this paper is organized as follows. Section 2 describes data, methodology, and the construction of variables, and deals with the endogeneity of aid. Section 3 presents the main findings. Section 4 provides sensitivity analysis. Section 5 investigates whether aid has historically been targeted at shock-prone countries. Section 6 concludes.

2. Data and Methodology

Our estimation strategy involves two steps. We first test the importance of commodity export price shocks and commodity export price uncertainty as determinants of GDP. Having established which of these have negative effects on GDP, we then investigate the potential role of foreign aid in mitigating these negative effects. The effects of shocks and uncertainty, as well as the mitigating effect of aid are analyzed using the following error-correction model[2]:

$$\Delta Y_{i,t} = \alpha_i + \delta_t + \lambda Y_{i,t-1} + \beta_1 X_{i,t-1} + \beta_2 \Delta Y_{i,t-k} + \beta_3 \Delta X_{i,t-k} + \beta_4 S_{i,t-n} + \beta_5 M_{i,t-n}$$
$$+ \beta_6 X_{i,t-1} M_{i,t-n} + \beta_7 S_{i,t-n} M_{i,t-n} + u_{i,t} \qquad (1)$$

where $Y_{i,t}$ is log real GDP per capita in country i in year t and α_i and δ_t are country-specific and year-specific fixed effects, respectively. $X_{i,t-1}$ is a vector of long-run determinants of GDP per capita (all in logs). This vector includes our indicator of commodity export price uncertainty to test its long-run effect on GDP. In addition, we include several controls. Four variables are taken from the empirical growth literature: i) trade openness, measured as the ratio of trade to GDP, ii) external debt to GNI, iii) inflation, measured as the consumer price index (cpi), and iv) financial development, measured as the ratio of M2 to GDP. Following Collier and Goderis (2007), we also include indices of commodity export prices and oil import prices to control for the long-run effect of commodity prices on GDP. Section 2.1 explains how these variables were constructed.

$S_{i,t-n}$ is a vector of three types of shock variables that are expected to have a short-run effect on growth. We first include our indicators of commodity export price shocks (see section 2.1) to estimate the effects of large changes in commodity export prices. In addition, we include measures of geological, climatic, and human disasters (Raddatz, 2007), and dummy variables for civil wars and coup d'états as controls. $k > 0$ and $n \geq 0$ denote lag orders.

$M_{i,t-n}$ is a vector of variables that could mitigate the adverse effects of commodity export price shocks and uncertainty. First, we include a dummy variable which takes a value of 1 for a *de facto* flexible exchange rate, and 0 for a *de facto* fixed exchange rate. Second, we include both the level and the first difference of the log of (1 + foreign aid), where foreign aid is measured as a % of GNI.[3] We refer to the variable "log (1 + foreign aid)" as "aid". In section 2.2 we discuss the endogeneity of aid. The interactions of $X_{i,t-1}$ and $S_{i,t-n}$ with $M_{i,t-n}$ are used to test the central hypotheses: if commodity export price shocks and commodity export price uncertainty harm economic performance, the losses will be smaller for countries that receive more aid.

Our dataset consists of all countries and years for which data are available, and covers 100 countries between 1971 and 2003. Table 1 reports summary statistics. Table 2a lists the countries and their share of commodity exports in GDP. The data appendix describes data and sources.

2.1 Constructing indicators of commodity export prices, shocks, and uncertainty

The commodity export price index was constructed using the methodology of Deaton and Miller (1996), Dehn (2000), and Collier and Goderis (2007). We collected data on world commodity prices and commodity export values for as many commodities as data availability allowed. Table 2b lists the 58 commodities in our sample. For each of the countries, we calculate the total value of 1990 commodity exports and construct weights by dividing the 1990 export values for each commodity by this total. These weights are held fixed over time and applied to the world price indices of the same commodities to form a country-specific geometrically weighted index.

It is important that the commodity export price index is exogenous, i.e. not correlated with the error term in equation (1). As argued by Deaton and Miller (1996), one of the advantages of using international commodity prices is that they are typically not affected by the actions of individual countries. Also, by keeping the weights constant over time, supply responses to price changes are not included. As a result, we believe the index to be exogenous with respect to GDP or the determinants of GDP. In our estimation, we use the log of the commodity export price index, weighted by the level of commodity exports over GDP as of 1990 (%), which allows the impact of commodity prices to be proportional to a country's commodity exports.

We next use the unweighted logged index to construct indicators of commodity export price shocks and uncertainty. Following Collier and Dehn (2001), we identify shocks by differencing the commodity export price index to make it stationary, and then removing predictable elements from the stationary process by running the following basic annual forecasting model:

$$\Delta I_{i,t} = \alpha_0 + \alpha_1 t + \beta_1 \Delta I_{i,t-1} + \beta_2 I_{i,t-2} + \varepsilon_{i,t} \qquad (2)$$

where $I_{i,t}$ is the log commodity export price index and t is a linear time trend. We collect the residuals $\varepsilon_{i,t}$ from (2) and derive the 10^{th} and 90^{th} percentile of its distribution. We next define positive and negative commodity export price shock episodes as the observations with residuals above the 90^{th} percentile or below the 10^{th} percentile, respectively.[4] Having identified the shock episodes, we construct 2 variables. The first captures *positive* commodity export price shocks and equals the first log difference of the commodity export price index for the *positive* shock episodes, and 0 otherwise. The second captures *negative* commodity export price shocks and equals minus the first log difference of the commodity export price index for the *negative* shock episodes, and 0 otherwise. Table 1 provides summary statistics. The sample contains 223 positive and 231 negative shocks. We perform one further procedure. Any impact of commodity price shocks is likely to be bigger for more commodity-dependent countries. We therefore use the log difference of the index, *weighted by the (log of the) share of commodity exports in GDP as of 1990*. This allows the effect of export price shocks to be log linearly proportional to a country's exposure.

In addition to actual shocks, we also include a measure of export price *uncertainty*. Following Dehn (2000), we use a GARCH (1,1) model in which the actual volatility in a country's commodity export prices is explained by past volatility and past expected volatility:

$$\begin{aligned} \Delta I_t &= \alpha_0 + \alpha_1 t + \beta_1 \Delta I_{t-1} + \beta_2 I_{t-2} + \beta_3 D_t + \varepsilon_t \\ \sigma_t^2 &= \gamma_0 + \gamma_1 \varepsilon_{t-1}^2 + \gamma_2 \sigma_{t-1}^2 \end{aligned} \qquad (3)$$

where I_t is the log commodity export price index in quarter t, t is a linear time trend, D_t is a vector of quarterly dummies to remove seasonal effects, and σ_t^2 denotes the variance of ε_t, conditional upon information up to period t. We use the fitted values of the second equation in (3) as a measure of commodity export price uncertainty, since it captures the "predicted" variance of the innovations in commodity export prices from past actual and expected volatility. Intuitively, this makes use of the concept of volatility clustering: big shocks tend to be followed by big shocks in either direction. This implies that historical information about the volatility in commodity prices can be used to predict future volatility. It is the (log) of the predicted future volatility that we use as a measure of uncertainty. Again, to allow the effect of commodity price uncertainty to be (log linearly) proportional to the importance of commodity exports, we weigh the indicator of uncertainty by the (log of the) share of commodity exports to GDP as of 1990.

The oil import price index was constructed by taking a logged index of world oil prices and interacting it with a dummy for net oil importers. This variable is important as oil enters the commodity export price index but is at the same time likely to affect oil importers as well. Failing to control for this effect would therefore have the consequence that the coefficient on the commodity export price index, instead of capturing the effect of higher oil prices for oil exporters, would capture the difference between the effects on oil exporters and importers.

2.2 The endogeneity of aid: using instrumental variables

Aid is likely to be endogenous with respect to growth. Past growth or even expected future growth of recipient countries may affect the aid allocation decisions of donors. These decisions may also be correlated with omitted variables that affect growth. In both cases the OLS estimator is biased. To address this problem, we use instruments for aid in all our specifications.[5] Tavares (2003) argues that, "when an OECD country increases its total aid outflows, developing countries that are culturally and geographically closer to that donor country experience an exogenous increase in aid inflows as a share of their GDP." We follow Tavares by constructing aid instruments as follows. We collect total bilateral aid outflows from the five largest OECD donors: France, Germany, Japan, the UK, and the US, and express them as a proportion of GNI. In 2003 about half of total global aid was provided by these five donors. We then generate four variables that capture the political, geographical, and cultural distance for each donor/recipient combination. For political distance we use an index of UN voting affinity (Gartzke and Jo, 2002). For each donor/recipient combination we calculate the average value of the index over the available years and use this average for every year.[6] For geographical distance, we use the inverse of the distance in kilometers between the recipient countries' capitals and the donor countries' capitals.[7] Cultural distance is measured by 2 dummies. The first dummy takes a value of unity if the donor and recipient share a common language (CIA Factbook 2003). The other dummy takes a value of unity if the same religious group dominates in both the donor and the recipient country.[8] All distance indicators are invariant over time but vary across recipient countries while the aid outflows vary over time but not across recipient countries. We construct 20 instruments by interacting each of the indicators with each of the aid outflows. These variables will be used as instruments for *the level of aid*. We first-difference the 20 instruments to create an additional 20 instruments for *differenced aid*. Next to the level and difference of aid we include several interactions of the aid variables with the shock variables. We create instruments for these interactions by regressing the aid variables on all aid instruments and other regressors and interacting the predicted values with the shock variables to construct additional instruments (following Goderis and Ioannidou, 2007). We use all instruments and perform two-stage least-squares estimation.

3. Estimation Results

Table 3 reports estimation results for the model in equation (1) but without the vector of variables that potentially mitigate the effect of adverse shocks ($M_{i,t-n}$) and its interactions with shocks ($S_{i,t-n}M_{i,t-n}$) and uncertainty ($X_{i,t-1}M_{i,t-n}$). This allows us to test the effects of negative commodity export price shocks and commodity price uncertainty on GDP.

The contemporaneous and lagged negative export price shocks enter negative but only the lagged shock is significant (at 5 %). The coefficient is also much larger for the lagged shock, suggesting that, if there is an effect of negative export price shocks on growth, it occurs in the year after the shock.[9] The coefficient is -0.017 which suggests that for a country with sample average commodity exports to GDP (9.42 %), a sample average negative export price shock (30%) lowers next year's growth by 0.017*log(9.42)*0.30 = 1.14 % points.

While negative commodity export price shocks significantly lower growth, we do not find evidence of a long-run negative effect of commodity export price uncertainty on GDP. Although the indicator of uncertainty enters with the expected negative sign, it is far from significant.

The other long-run coefficients all have the expected signs. Trade to GDP enters positive and is significant at 1 %, indicating that more open countries tend to have higher long-run GDP levels. External debt and the consumer price index enter negative, suggesting that countries with fiscal imprudence or historically high inflation rates have lower long-run GDP. However, the coefficients are insignificant, so should be viewed with caution. The same goes for M2 to GDP, which enters with a positive sign, indicating that financial development boosts long-run GDP. The commodity export price index enters negative and is significant at 5 %, consistent with Collier and Goderis (2007), who find that, while higher commodity prices boost growth in the short run, their long-run effect on GDP is negative. Higher oil import prices also negatively affect GDP, although this effect is insignificant. The coefficient of the lagged level of GDP per capita is negative and significant at 1 %. The size suggests a speed of adjustment of 6% per year.

Most of the short-run coefficients also have the expected signs. The first lag of the dependent variable enters positive and is highly significant, while the fourth lag has a significant negative effect, suggesting some mean reversion. Contemporaneous and lagged increases in trade openness and inflation are also important for growth. As expected, positive export price shocks have a positive effect on growth, both in the same year as in the next, while coups and wars have large adverse effects. A coup appears to cut growth by around 2.7 % points in the same year, while for wars this effect is 1.9 %, roughly consistent with Collier (1999) who documents a growth loss during war of 2.2 % points. Geological shocks significantly reduce growth by 1.1 % in the same year and by another 0.8 % in year t+2. Climatic shocks have no significant effect in the same year but actually augment growth in the next three years by around 0.5 %, which may be due to external assistance. Humanitarian shocks do not appear to have significant growth effects.

3.1 The effect of negative commodity export price shocks

Having established that commodity export price shocks significantly harm growth in the next year, we now investigate whether aid mitigates this effect.[10] To save space, Table 4 only reports results for the variables of interest. Column (1) shows the coefficient of the lagged negative export price shock variable. We choose the lag of the shock rather than its contemporaneous value as, according to our preferred specification in Table 3 (which excludes the insignificant export price uncertainty variable), this is the most important for contemporaneous growth. The coefficient on the lagged shock is -0.018, which is similar to its previous value, and is again significant at 5 %. It indicates that for the average commodity-dependent country the effect of a negative shock of 30 % on next year's growth is a -1.21 % point reduction in the growth rate of GDP. But for a more commodity-dependent country like Cameroon, which has commodity exports of 15.2 % of GDP (around the 75^{th} percentile of the distribution in our sample), this effect is higher: a -1.47 % point reduction. A highly commodity-dependent country like Zambia with commodity exports of 34.9 % of GDP, suffers even more severe: -1.92 % points.

We next add instrumented aid to test whether the effect of adverse shocks is less severe in countries that receive more aid. Because in principle both the level of aid and the change in aid could be important, we add nine additional regressors to the specification in column (1): the lagged level of aid, the contemporaneous and lagged first difference of aid, and interactions of each of these three variables with both the lagged positive and the lagged negative export price shock variables. Table 4, column (2), reports the results for the lagged negative export price shock and its interactions with the three aid variables. The lagged shock again enters negative, has gained in size and is now significant at 1 %. The interaction of the shock with the lagged level of aid enters positive and is also significant at 1 %. This indicates that the growth loss from shocks is smaller for countries with higher levels of aid. In other words, aid mitigates shocks. The interactions of the lagged negative shock with both contemporaneous and lagged first differenced aid enter positive as well, but are not significant. Hence, aid is effective in mitigating shocks but only through the *level* of aid in the year of the shock and not by any *increases* in aid, either in the year of the shock or the next year. In Table 4, column (3), we drop lagged differenced aid and the interactions of differenced and lagged differenced aid. The interaction of the level of aid with the shock again enters positive and remains significant at 1 %, while the size of the coefficient is similar to its previous value. Recall that for the average commodity-dependent country, the effect of a negative export price shock of 30 % on next year's growth is -1.21 % points. Although the results in Table 4, column (3) are best interpreted as linear approximations that apply within the core range of the observed variables, taken literally they imply that a country that received no aid would lose 3.16 % points[11], while the adverse growth effects would be fully offset for a country that received aid of 6.72 % of GNI.

We next investigate whether a country's exchange rate regime also matters for shock mitigation. When an economy is hit by a real shock and prices are sticky, a flexible nominal exchange rate allows for a quicker adjustment of relative prices and limits the output loss. Broda (2004) has found that developing countries with more flexible exchange rates suffer lower growth losses from adverse terms-of-trade shocks. We test whether his finding is robust to adverse commodity export price shocks using the Reinhart and Rogoff (2004) classification of *de facto* exchange rate flexibility. Hence, we add six additional regressors to the specification in Table 4, column (3): a contemporaneous and a lagged indicator of exchange rate flexibility, and interactions of these two indicators with the contemporaneous and lagged export price shock variables, respectively. The results are reported in Table 4, column (4). The interaction of lagged exchange rate flexibility with the lagged export price shock enters positive and is significant at 1 %. This indicates that, consistent with Broda (2004), countries with flexible exchange rates suffer less from a negative shock. However, the mitigating effect of the level of aid is robust to adding exchange rate flexibility as an additional mitigation instrument. The interaction of aid with the shock again enters positive, although the coefficient is smaller, and is significant at 5 %. The shock itself again enters negative, is slightly bigger, and remains significant at 1 %.

Having established that both aid and exchange rate flexibility are important for the mitigation of adverse shocks, we again consider the effect of a negative export price shock of 30 %. Figure 1 illustrates the mitigating roles of both instruments by showing next year's growth loss for different levels of exports and different levels of aid and exchange rate flexibility. The 'fixed and zero aid' line corresponds to the growth effect of a negative shock in countries that run a fixed exchange rate and do not receive aid. The effect is (log linearly) proportional to a country's exposure and for commodity exports to GDP ratios above 1 %, is always significant at 1 %. It is also economically relevant: a country with 20 % exports to GDP suffers a 5.5 % growth loss in the year after the shock. The 'flexible and zero aid' line shows the growth effect in countries that have a flexible exchange rate and do not receive aid. The location of the line above the 'flexible and zero aid' line indicates that a flexible exchange rate mitigates the effect of shocks, although not fully offsetting it. The country with 20 % exports to GDP that suffered a growth loss of 5.5 % points under a peg, suffers 'only' 2.1 % points of growth loss under a flexible exchange rate.

The 'fixed and average aid' line illustrates the growth effect in countries with a peg that receive a sample average of aid of 3.8 % of GNI. Average aid also mitigates the negative effect of shocks, although to a smaller extent than exchange rate flexibility. The country with exports to GDP of 20 % that suffered a growth loss of 5.5 % points under a peg with no aid, suffers 'only' 3.5 % points of growth loss with average aid. Finally, the 'flexible and average aid' line shows the growth effect in countries that have a flexible exchange rate and receive average aid of 3.8 % of GNI. The line is almost horizontal and lies just below the horizontal axis. The very small negative effects are never significant. This suggests that the combination of exchange rate flexibility and average aid fully offsets the negative effect of commodity export price shocks.

The results in Table 4, column (4), and Figure 1 assume that aid and exchange rate flexibility are *complements*. The mitigating effect of either one of them does not depend on whether the other instrument is also at work. We next investigate whether the two instruments are to some extent *substitutes*. It could be that there is less of a role to play for aid in countries that already have a mitigating instrument through their flexible exchange rate. Aid would then be most effective in countries with pegged exchange rates, as they are most in need of a shock cushioning instrument. However, if aid and exchange rate flexibility are complements, then aid can contribute to the mitigation of shocks in all countries, regardless of their exchange rate regime.

To test the potentially different effects of aid in countries with fixed and flexible exchange rates, we re-estimate the specification in Table 4, column (3), for sub-samples of countries and years with a pegged exchange rate in the year of the shock, and countries and years with a flexible exchange rate in the year of the shock. The results are reported in Table 4, column (5) and (6). In both columns, the interaction of aid and the shock enters negative and is statistically significant at 5 %. This provides evidence that aid and exchange rate flexibility are not full substitutes. Even in countries with flexible exchange rates aid can be used to further mitigate the negative effects of shocks. The smaller coefficient of the shock itself in column (6) is consistent with the earlier finding that countries with flexible exchange rates suffer less from adverse export price shocks. However, although the interaction of aid with the export price shock is significant in both columns, the coefficient is much smaller in column (6). This points at the possibility that, although aid always cushions shocks, it does so more strongly in countries with fixed exchange rates.[12]

This result is pertinent for the debate on whether aid is more effective in the context of good policies, a proposition initiated by Burnside and Dollar (2000). Our results imply that some 'good' policies, notably exchange rate flexibility, are substitutes for aid, suggesting that policies need to be decomposed before a clear relationship can be established. For example, aid effectiveness might plausibly be complemented by good processes for public spending. If aid and exchange rate flexibility are substitutes, what might this imply for aid allocation? Donors would presumably be reluctant to 'reward' poor choice of exchange rate policy with additional aid. However, there might be a case for reallocating aid *within* exchange rate regimes, so that among those countries with fixed exchange rates greater weight was given to the proneness of a country to shocks. This may be particularly pertinent to French aid to Franc Zone countries. Since the French government is committed to the maintenance of the fixed exchange rate regime for these countries, the issue of rewarding poor policy choices does not arise. But within the zone aid will be differentially effective in those countries most exposed to adverse shocks.

4. Sensitivity Analysis

The model in equation (1) assumes that the level variables are cointegrated. Collier and Goderis (2007) perform tests to establish whether this assumption is valid and find that this is the case. However, for sensitivity we also experiment with a model in which we strip the specification in (1) by removing the vector of long-run GDP determinants, $X_{i,t-1}$, and the lagged level of GDP per capita, $Y_{i,t-1}$. We rerun the specifications in Table 4, columns (1) and (3) to (6) without these variables. The results are reported in Table 5.[13] Our findings prove robust to these alternative specifications. All our results on the effect of the shock, the cushioning effects of aid and exchange rate flexibility, and the difference in the effects of aid in countries with pegs and countries with flexible exchange rates, go through.

The model without the vector of long-run variables runs into a possible endogeneity problem. As the model is no longer a reparameterization of the autoregressive distributed lag model in levels, but a differenced model, the error terms are also first differenced. As a result, the error terms are first-order serially correlated by construction and the first lagged dependent variable is correlated with the contemporaneous error term, causing a biased coefficient. A second source of possible bias is the inclusion of fixed effects in our model, as the within group estimator is inconsistent for panels with relatively small T. This bias is likely to be small, given that for most countries T is relatively large. In the absence of other instruments for the lagged dependent variable in Table 5, we use an alternative instrumental variables technique first suggested by Anderson and Hsiao (1981). This technique proposes to first transform the model by first-differencing to eliminate possible individual effects and then instrument the lagged dependent variable with suitable lags of its own levels and first differences. Although consistent, the estimator is not efficient for panels with more than three periods, as for the later periods in the sample additional instruments are available. Arellano and Bond (1991) applied the generalized method of moments (GMM) approach to use all available instruments. Arellano and Bover

(1995) extended this difference-GMM estimator by adding the equations in levels to the system, creating what is often called the system-GMM estimator. This addition increases the number of moment conditions, thereby increasing the efficiency of the estimator. Blundell and Bond (1998) showed that exploiting these additional moment conditions provides dramatic efficiency gains.

We use the system-GMM estimator to deal with the endogeneity of the lagged dependent variable.[14] In the differenced equation, which corresponds to the differenced version of the specification in Table 5, we instrument the lagged dependent variable with the third lag of its own level. This ensures that even if there is first- and second-order serial correlation in the error term of the differenced model, the instrument for the dependent variable is not correlated with the contemporaneous error term. In the levels equation, which corresponds to the specification in Table 5, we instrument the lagged dependent variable with the second lag of its own difference. This ensures that in the presence of first-order serial correlation in the errors, the instrument for the lagged dependent variable is not correlated with the contemporaneous error term.

The number of instruments in a system GMM can potentially grow very large, which causes problems of overfitting in finite samples and weakens the Sargan test of instrument validity up to the point where it generates implausibly good p values of 1.00. To minimize this problem, we take two steps to limit the instrument count (Roodman, 2006). First, we only use instruments at t-3 and t-2 in the differenced and levels equations, respectively, and thus leave out all instruments beyond t-2 and t-3. Second, we "collapse" the instrument set, which means creating one instrument for each variable and lag distance, rather than one for each period, variable, and lag distance.

The system-GMM estimation results are reported in Table 6, columns (1) to (3). For the specifications in columns (4) and (5), the number of GMM instruments was very large compared to the number of countries. Therefore, we replaced the GMM estimator in these columns by a 2SLS fixed effects estimator in which we not only instrument for aid but also for the first lagged dependent variable. As an additional instrument, we use the second lag of the level of log GDP per capita. The results in Table 6 lend further support to the idea that negative export price shocks harm growth in the next year and that both aid and exchange rate flexibility mitigate this growth effect. In particular, the shock enters negative and is significant at 1 % in the preferred specifications of columns (1) to (3). The interaction of aid with the shock again enters positive and is significant at 5 % in column (2) and at 10 % in column (3). The coefficient on the interaction of exchange rate flexibility with the shock is also positive and is significant at 5 %. The Sargan tests and Difference Sargan tests do not reject the null of exogenous instruments, while the Arellano and Bond AR(1) and AR(2) tests show negative first-order serial correlation and no second-order serial correlation in the error terms. The latter suggests that the error terms in the original model of Table 5 are not serially correlated, which together with the relatively large T in our panel casts doubts on whether the lagged dependent variable is in effect suffering from endogeneity. The results in column (1) of Table 6 are consistent with these doubts as the coefficient on the lagged dependent variable is very similar to the corresponding coefficient in Table 5, column (1). However, for the other four columns the coefficients are quite different and suggest that the coefficients on the lagged dependent variable in Table 5 were downward biased.

Finally, the specifications in Table 6, columns (4) and (5), should be viewed with caution as they do not use GMM but an instrumental variables technique which is known to be less efficient. In column (4), the shock enters with a negative sign and remains significant, although only at 10 %, while the interaction of the shock with aid is positive but no longer significant. While the coefficients of the shock and the interaction of the shock with aid are again smaller in countries with flexible exchange rates (column (5)), both coefficients are now significant at 5 %.

We next perform two more robustness checks. First, we experiment with an alternative shock definition by defining positive and negative shocks as the observations with equation (2) residuals above the 95th percentile or below the 5th percentile, respectively, instead of the 90th or

10th percentile. All our results are highly robust to this more restrictive shock definition. In particular, our results on the effect of the shock, the cushioning effects of aid and exchange rate flexibility, and the difference in the effects of aid in countries with fixed exchange rates and countries with flexible exchange rates, go through. Secondly, we check the robustness of our results when dropping all interaction terms except for the ones with the lagged negative export price shock. Again, all our results go through. To save on space, we do not report these results.

We next construct three sub-indices to investigate which commodities drive our results[15]: one for oil only, one for agricultural commodities only, and one for non-oil, non-agricultural commodities only. For each of the three types, we construct a positive shock variable, which equals the first log difference of the index for the shock episodes that we identified in section 2.1 and zero for all other observations, and a negative shock variable, which equals minus the first log difference of the index for the shock episodes and zero for all other observations. To test the importance of each commodity type in explaining our findings, we rerun the specification in Table 4, column (4), but with the decomposed shock variables instead of the general shock variables. The results are reported in Table 7 and indicate that our results are primarily driven by non-agricultural commodity export price shocks. The coefficients of the oil price shock and its interactions with aid and exchange rate flexibility ((1), (4), and (7)) are fully consistent with the results in Table 4, column (4), and have the same levels of statistical significance. The coefficients for the other non-agricultural commodities ((2), (5), and (8)), although less significant, have the same signs as the coefficients for oil. Wald tests of coefficient equality, reported in Table 7, panel (b), do not reject the null of equal coefficients for oil and non-oil non-agriculture (tests (1)=(2), (4)=(5), and (7)=(8)). This indicates that there is no statistically significant difference between the effects of oil and other non-agricultural commodities. By contrast, the results for agriculture are not consistent with Table 4, column (4). In particular, the coefficients of the agricultural price shock and its interaction with aid have the opposite sign, while all three agricultural price shock variables are insignificant. The Wald tests indicate that the coefficients of the agricultural shock are always significantly different from the coefficients of the oil shocks (tests (1)=(3), (4)=(6), and (7)=(9)). This clearly suggests that the results in Table 4, column (4), are not driven by agricultural price shocks but instead can be explained by non-agricultural price shocks. This does not imply that aid does not mitigate adverse agricultural shocks. It merely means that the results of our analysis should be interpreted as strong evidence that aid mitigates the adverse effects of non-agricultural commodity export price shocks.[16]

5. Does aid go to shock-prone countries?

Our results suggest that the level of aid can be used to mitigate commodity export price shocks. A natural question is whether historically aid has been targeted at shock-prone countries. If not, donors might want to consider a re-allocation of their aid to make it more effective. We next investigate whether past aid has been targeted at shock-prone countries. In particular, we regress the country average level of aid over the sample years on 3 indicators of vulnerability to shocks and several controls. All variables, except for the 1960 (initial) level of GDP per capita, are expressed as country averages over the sample years. Hence, our units of observation are countries and we estimate by OLS. The results are reported in Table 8. Our three measures of proneness to shocks are the average number of shocks per year, using both our shock definitions, and the standard deviation of changes in the commodity export price index. The results in Table 8 show a lack of any robust evidence that aid is targeted towards shock-prone countries. The coefficients of the indicators of shock proneness are almost always insignificant. This finding is robust to the inclusion of colonial dummies, and the use of initial GDP per capita instead of average GDP per capita (as the latter might be endogenous) as a control variable. As a result, a re-allocation of aid towards shock-prone countries might be beneficial as a means to improve aid effectiveness and assist commodity-dependent countries in coping with export price shocks.

6. Conclusions

We have found that large adverse commodity export price shocks reduce constant price GDP. The costs arise from realized shocks rather than the *ex ante* risk of shocks. This is a problem that continues to be faced by a relatively small group of low-income countries that have failed to diversify their exports. The decline in constant price GDP compounds the decline in income that is an inevitable consequence of terms of trade deterioration, and so subjects already fragile societies to episodes of economic crisis. It is now known that even temporary periods of intensified poverty can have long-lasting effects. At the household level temporary poverty can lead to permanent deterioration in human capital. At the societal level, growth collapses increase the risk of civil war (Miguel *et al.*, 2004). Hence, it is pertinent to determine whether aid can mitigate such episodes. We find that shock-contingent aid does not appear to be effective but that a sustained higher level of aid does significantly mitigate shocks. *De facto* exchange rate flexibility also mitigates shocks and is, to an extent, a substitute for aid. However, even with a flexible exchange rate, aid significantly reduces the cost of adverse shocks.

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Table 1: Summary statistics

	Obs	Mean	St dev	Min	Max
GDP per capita (log)	2319	6.80	1.12	4.31	9.17
Trade to GDP (log)	2306	4.05	0.57	1.84	5.43
External debt to GNI (log)	2317	3.90	0.84	-0.11	7.10
CPI (log)	2312	2.52	4.27	-26.98	7.00
M2 to GDP (log)	2317	3.31	0.55	1.41	5.02
Commodity export price index (log)	2319	43.19	39.36	0.04	205.39
Commodity exports to GDP	2319	9.42	8.83	0.01	44.61
Export price uncertainty (log)	2319	0.09	0.19	0.00	3.70
Oil import price index (log)	2319	3.27	1.85	0	4.96
Flexible exchange rate	1736	0.62	0.49	0	1
Aid (log)	2311	1.57	1.05	-1.17	4.59
Δ GDP per capita (log)	2319	0.01	0.05	-0.36	0.30
Δ Trade to GDP (log)	2306	0.01	0.14	-1.20	1.40
Δ CPI (log)	2312	0.17	0.37	-0.14	5.48
Δ Aid (log)	2310	-0.01	0.27	-1.38	1.62
Coup d'etat	2319	0.03	0.18	0	2
Civil war	2319	0.10	0.30	0	1
Geological shocks	2319	0.06	0.24	0	2
Climatic shocks	2319	0.27	0.52	0	3
Humanitarian shocks	2319	0.03	0.16	0	2
Export price shocks					
	Number	Mean	St dev	Min	Max
Positive shocks	223	0.34	0.16	0.12	1.03
Negative shocks	231	0.31	0.13	0.15	0.81

Notes: This table reports summary statistics for all observations used in estimation.

Table 2a: List of countries and their shares of commodity exports in GDP (%)

Albania (3)	Congo, D.R. (9)	India (1)	Pakistan (2)	Tonga (0)
Algeria (15)	Congo, Rep. (29)	Indonesia (15)	Panama (5)	Tr.& Tob. (19)
Angola (35)	Costa Rica (11)	Iran (14)	P. N. Guin. (18)	Tunisia (6)
Argentina (3)	Cote d'Ivoire (14)	Jamaica (18)	Paraguay (12)	Turkey (1)
Bangladesh (1)	Dominica (19)	Kenya (6)	Peru (6)	Uganda (4)
Barbados (2)	Dom. Rep. (7)	Laos (1)	Philippines (3)	Uruguay (4)
Belize (13)	Ecuador (21)	Lesotho (0)	Poland (3)	Vanuatu (5)
Benin (0)	Egypt (2)	Lithuania (0)	Romania (1)	Venezuela (32)
Bolivia (12)	El Salvador (6)	Madagascar (2)	Rwanda (4)	Vietnam (18)
Botswana (7)	Eq. Guinea (6)	Malawi (20)	Samoa (1)	Yemen (1)
Brazil (2)	Ethiopia (2)	Malaysia (21)	Senegal (6)	Zambia (35)
Bulgaria (2)	Fiji (12)	Maldives (2)	Seychelles (0)	Zimbabwe (9)
Burkina Faso (3)	Gabon (31)	Mali (7)	Sierra Leone (7)	
Burundi (6)	Gambia (4)	Mauritania (25)	Sol. Islands (8)	
Cambodia (3)	Ghana (11)	Mauritius (15)	South Africa (3)	
Cameroon (15)	Grenada (4)	Mexico (4)	Sri Lanka (7)	
Cape Verde (1)	Guatemala (8)	Morocco (4)	Sudan (2)	
C. Afr. Rep. (2)	Guin.-Bissau (1)	Mozambique (1)	Swaziland (22)	
Chad (6)	Guyana (45)	Nepal (0)	Syria (15)	
Chile (16)	Haiti (1)	Nicaragua (17)	Tanzania (5)	
China (2)	Honduras (20)	Niger (0)	Thailand (4)	
Colombia (11)	Hungary (2)	Nigeria (35)	Togo (14)	

Table 2b: List of commodities

		Non-agricultural		
Aluminum	Gasoline	Natural gas	Phosphatrock	Uranium
Coal	Ironore	Nickel	Silver	Urea
Copper	Lead	Oil	Tin	Zinc
		Agricultural		
Bananas	Fish	Oliveoil	Rice	Sunfloweroil
Barley	Fishmeal	Oranges	Rubber	Swinemeat
Beef	Groundnuts	Palmkerneloil	Shrimp	Tea
Butter	Groundnutoil	Palmoil	Sisal	Timber
Cocoabeans	Hides	Pepper	Sorghum	Tobacco
Coconutoil	Jute	Potash	Soybeans	Wheat
Coffee	Lamb	Poultry	Soybeanmeal	Wool
Copra	Linseedoil	Plywood	Soybeanoil	
Cotton	Maize	Pulp	Sugar	

Table 3: Estimation results cointegration model

Long-run coefficients		***Short-run coefficients (cont'd)***	
Trade to GDP (log)	0.456***	Δ CPI $(\log)_{t-1}$	-0.009***
	(0.122)		(0.003)
External debt to GNI (log)	-0.071	Positive price shock_t	0.010**
	(0.048)		(0.005)
CPI (log)	-0.004	Positive price shock_{t-1}	0.011**
	(0.007)		(0.005)
M2 to GDP (log)	0.056	Negative price shock_t	-0.001
	(0.095)		(0.006)
Commodity export price index (log)	-0.014**	Negative price shock_{t-1}	-0.017**
	(0.006)		(0.008)
Export price uncertainty (log)	-0.076	Coup_t	-0.027***
	(0.154)		(0.009)
Oil import price index (log)	-0.106	War_t	-0.019***
	(0.118)		(0.006)
Short-run adjustment coefficient		Geological shock_t	-0.011**
GDP per capita $(\log)_{t-1}$	-0.058***		(0.005)
	(0.009)	Geological shock_{t-1}	-0.001
Short-run coefficients			(0.004)
Δ (GDP per capita $(\log))_{t-1}$	0.138***	Geological shock_{t-2}	-0.008**
	(0.034)		(0.003)
Δ (GDP per capita $(\log))_{t-2}$	-0.039	Climatic shock_t	-0.001
	(0.027)		(0.002)
Δ (GDP per capita $(\log))_{t-3}$	0.043	Climatic shock_{t-1}	0.005**
	(0.033)		(0.002)
Δ (GDP per capita $(\log))_{t-4}$	-0.072***	Climatic shock_{t-2}	0.005**
	(0.025)		(0.002)
Δ (Trade to GDP $(\log))_{t-1}$	0.018*	Climatic shock_{t-3}	0.006***
	(0.010)		(0.002)
Δ (Trade to GDP $(\log))_{t-2}$	0.019**	Humanitarian shock_t	-0.004
	(0.009)		(0.009)
Number of observations	2319	R-squared within	0.17
Number of countries	100		

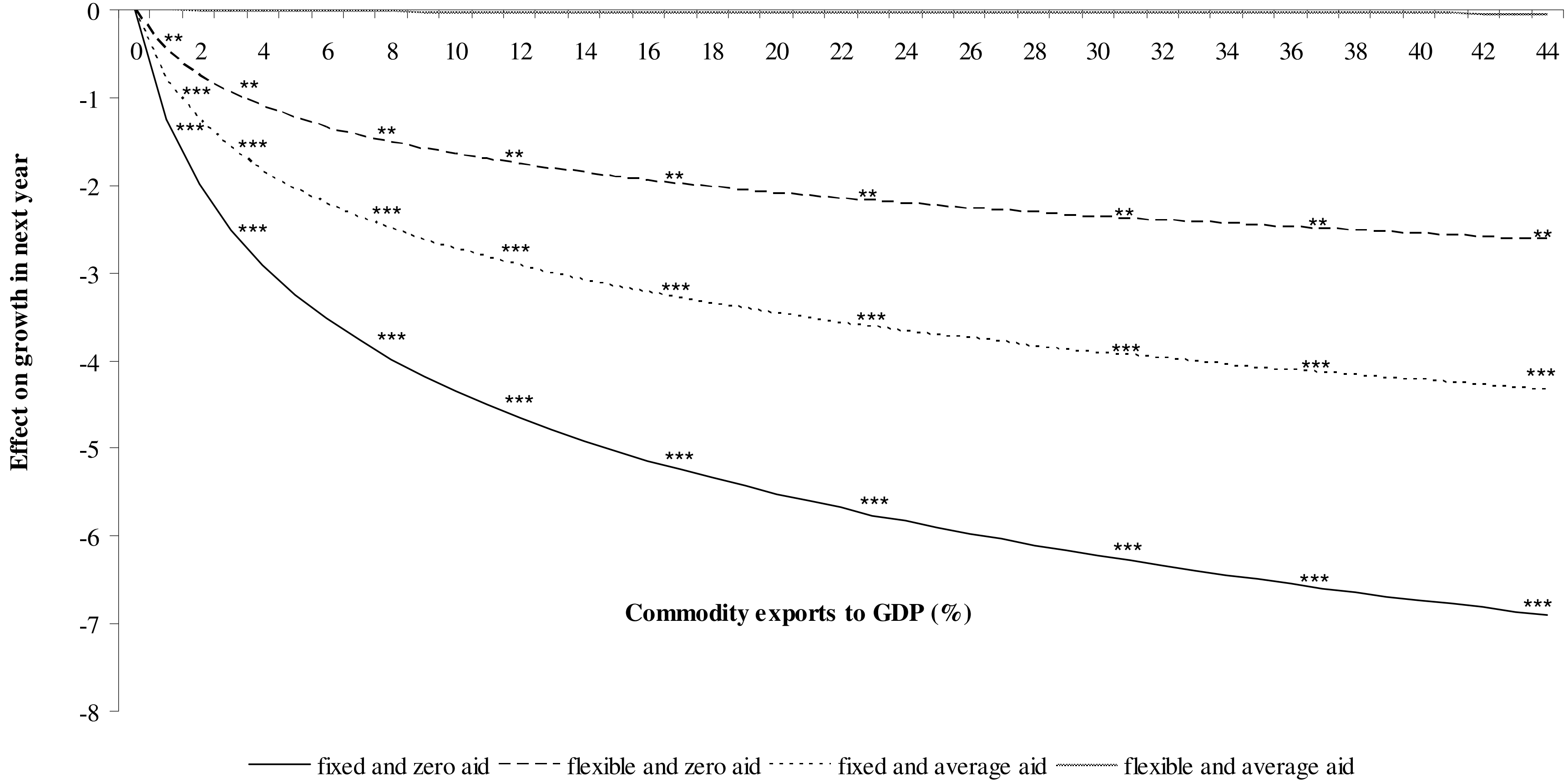
Notes: The dependent variable is the first-differenced log of real GDP per capita in year t. All regressions include country-specific and time-specific fixed effects. Robust standard errors are clustered by country and are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Table 4: The effect of negative commodity export price shocks – cointegration model with instrumented aid

	full sample	full sample	full sample	full sample	pegs	floats
	(1)	(2)	(3)	(4)	(5)	(6)
Negative export price shock$_{t-1}$	-0.018**	-0.056***	-0.047***	-0.060***	-0.092***	-0.027**
	(0.008)	(0.014)	(0.012)	(0.015)	(0.036)	(0.011)
Aid$_{t-1}$ * Negative export price shock$_{t-1}$		0.025***	0.023***	0.014**	0.045**	0.016**
		(0.008)	(0.007)	(0.007)	(0.021)	(0.007)
ΔAid$_{t-1}$ * Negative export price shock$_{t-1}$		0.063				
		(0.056)				
ΔAid$_{t}$ * Negative export price shock$_{t-1}$		0.017				
		(0.075)				
Flexible exchange rate$_{t-1}$ * Negative export price shock$_{t-1}$				0.038***		
				(0.011)		
Number of observations	2319	1513	1514	1170	405	765
Number of countries	100	88	88	70	45	54
R-squared within	0.17	0.13	0.17	0.23	0.29	0.26

Notes: Table 4 only reports coefficients and standard errors of the variables of interest. The dependent variable is the first-differenced log of real GDP per capita in year t. All regressions include country-specific and time-specific fixed effects. Robust standard errors are clustered by country and are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively. The six columns correspond to the following specifications: Column (1) - specification in Table 3 but without export price uncertainty; column (2) – previous column with nine additional regressors: lagged level of aid, contemporaneous and lagged differenced aid, and interactions of each of these three variables with both lagged export price shock variables; column (3) – specification in column (1) with four additional regressors: lagged level of aid, differenced aid, and the interaction of the lagged level of aid with both lagged export price shock variables; column (4) – previous column with six additional regressors: contemporaneous and lagged floating exchange rate indicator and interactions of these indicators with the contemporaneous and lagged two export price shock variables, respectively; column (5) – specification of column (3) but applied to subsample of countries and episodes with a pegged exchange rate; column (5) specification of column (3) but applied to subsample of countries and episodes with a flexible exchange rate.

Figure 1: The effect of a negative commodity export price shock of 30% (sample mean) for different levels of exchange rate flexibility and aid



Notes: Figure 1 is based on the estimation results in Table 4, column (4). A value of -2 on the vertical axis corresponds to a growth loss of 2 % points. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Table 5: The effect of negative commodity export price shocks – ARDL in differences with instrumented aid

	full sample	full sample	full sample	pegs	floats
	(1)	(2)	(3)	(4)	(5)
Δ (GDP per capita (log))$_{t-1}$	0.173***	0.077***	0.073**	-0.042	0.074**
	(0.032)	(0.026)	(0.029)	(0.061)	(0.035)
Negative export price shock$_{t-1}$	-0.018***	-0.036***	-0.062***	-0.100***	-0.035***
	(0.007)	(0.012)	(0.015)	(0.035)	(0.011)
Aid$_{t-1}$ * Negative export price shock$_{t-1}$		0.014**	0.015**	0.047**	0.017***
		(0.007)	(0.007)	(0.021)	(0.007)
Flexible exchange rate$_{t-1}$ * Negative export price shock$_{t-1}$			0.031***		
			(0.012)		
Number of observations	3805	1620	1257	419	838
Number of countries	147	97	79	49	64
R-squared within	0.14	0.14	0.17	0.23	0.22

Notes: Table 5 only reports coefficients and standard errors of the variables of interest. The dependent variable is the first-differenced log of real GDP per capita in year t. All regressions include country-specific and time-specific fixed effects. Robust standard errors are clustered by country and are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively. The five columns correspond to the specifications in columns (1) and (3) to (6) of Table 4 but excluding the long-run level variables as regressors.

Table 6: The effect of negative commodity export price shocks – System GMM and IV with instrumented aid

	full sample	full sample	full sample	pegs	floats
	(1)	(2)	(3)	(4)	(5)
Δ (GDP per capita (log))$_{t-1}$	0.194***	0.304**	0.266*	0.311**	0.379***
	(0.075)	(0.136)	(0.136)	(0.160)	(0.139)
Negative export price shock$_{t-1}$	-0.017***	-0.081***	-0.079***	-0.073*	-0.030**
	(0.006)	(0.029)	(0.025)	(0.040)	(0.012)
Aid$_{t-1}$ * Negative export price shock$_{t-1}$		0.039**	0.020*	0.026	0.016**
		(0.016)	(0.012)	(0.024)	(0.007)
Flexible exchange rate$_{t-1}$ * Negative export price shock$_{t-1}$			0.038**		
			(0.019)		
Number of observations	3912	1634	1265	419	846
Number of countries	147	97	79	49	64
Number of instruments	136	90	94	39	39
P-value Sargan test	0.56	0.40	0.88	-	-
P-value Difference Sargan test	0.37	0.30	1.00	-	-
Arellano and Bond AR(1) test	-4.96***	-3.67***	-3.26***	-	-
Arellano and Bond AR(2) test	-1.34	0.79	0.70	-	-

Notes: The five columns correspond to the five columns in Table 5. In columns (1) to (3), instead of 2SLS fixed effects we apply the Arellano-Bover (1995)/Blundell-Bond (1998) two-step system GMM estimator with Windmeijer's finite-sample correction and drop the second, third, and fourth lagged dependent variable. We use the third lagged dependent variable (only) as an instrument for the lagged dependent variable in the differenced equation, and the second lagged differenced dependent variable (only) for the first lagged dependent variable in the levels equation. To limit the instrument count, we "collapse" the instrument set. For the specifications in columns (4) and (5), the number of GMM instruments was very large compared to the number of countries. In fact, the Sargan/Hansen test of overidentifying restrictions generated implausibly good p values of 1.00 (see Roodman, 2006). Therefore, we replaced the GMM estimator in columns (4) and (5) by a 2SLS fixed effects estimator in which we not only instrument for aid but also for the first lagged dependent variable. As an additional instrument, we use the second lag of the level of log GDP per capita.

Table 7: Which commodities drive the effect of negative commodity export price shocks?

(a) estimation results

(1) Negative oil price shock$_{t-1}$	-0.101***
	(0.023)
(2) Negative non-oil, non-agricultural price shock$_{t-1}$	-0.050
	(0.041)
(3) Negative agricultural price shock$_{t-1}$	0.020
	(0.029)
(4) Aid$_{t-1}$ * Negative oil price shock$_{t-1}$	0.033**
	(0.015)
(5) Aid$_{t-1}$ * Negative non-oil, non-agricultural price shock$_{t-1}$	0.030*
	(0.017)
(6) Aid$_{t-1}$ * Negative agricultural price shock$_{t-1}$	-0.009
	(0.011)
(7) Flexible exchange rate$_{t-1}$ * Negative oil price shock$_{t-1}$	0.059***
	(0.016)
(8) Flexible exchange rate$_{t-1}$ * Negative non-oil, non-agricultural price shock$_{t-1}$	0.009
	(0.035)
(9) Flexible exchange rate$_{t-1}$ * Negative agricultural price shock$_{t-1}$	0.003
	(0.019)
Number of observations	1170
Number of countries	70
R-squared within	0.25

(b) Wald tests of coefficient equality

hypothesis	p-value	hypothesis	p-value	hypothesis	p-value
(1) = (2)	0.29	(4) = (5)	0.87	(7) = (8)	0.19
(2) = (3)	0.18	(5) = (6)	0.07*	(8) = (9)	0.89
(1) = (3)	0.00***	(4) = (6)	0.02**	(7) = (9)	0.02**

Notes: Panel (a) reports estimation results of the specification in Table 4, column (4), but with shock variables that are decomposed into oil price shocks, non-oil, non-agricultural commodity price shocks, and agricultural commodity price shocks. We only report coefficients and standard errors of the variables of interest. Robust standard errors are clustered by country and are reported in parentheses. Panel (b) reports Wald tests of coefficient equality for the estimated coefficients in panel (a). ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Table 8: Does aid go to shock-prone countries?

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Number of shocks per year (10)	0.19			0.19			-0.53			-0.25		
	(0.88)			(0.88)			(1.05)			(1.00)		
Number of shocks per year (5)		2.63*			2.59*			0.06			0.37	
		(1.43)						(1.66)			(1.47)	
Standard deviation of change in			0.41			0.49			-0.55			-0.31
commodity export price index (log)			(0.85)			(0.85)			(0.97)			(0.89)
GDP per capita, PPP (log)	-0.82***	-0.82***	-0.81***	-0.80***	-0.80***	-0.78***						
	(0.06)	(0.05)	(0.06)	(0.05)	(0.05)	(0.05)						
1960 GDP per capita, PPP (log)							-0.62***	-0.61***	-0.61***	-0.62***	-0.62***	-0.62***
							(0.06)	(0.06)	(0.06)	(0.05)	(0.05)	(0.05)
Population (log)	-0.29***	-0.28***	-0.32***	-0.28***	-0.27***	-0.29***	-0.27***	-0.27***	-0.27***	-0.27***	-0.27***	-0.27***
	(0.03)	(0.03)	(0.03)	(0.02)	(0.02)	(0.02)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
German colony	-0.05	-0.04	-0.06				-0.21	-0.19	-0.19			
	(0.09)	(0.11)	(0.09)				(0.14)	(0.13)	(0.14)			
US colony	0.11	0.04	0.11				-0.02	-0.02	-0.02			
	(0.07)	(0.08)	(0.07)				(0.10)	(0.10)	(0.10)			
French colony	-0.03	-0.07	-0.10				0.21	0.21	0.22			
	(0.11)	(0.11)	(0.11)				(0.13)	(0.14)	(0.13)			
UK colony	-0.13	-0.12	-0.19				-0.08	-0.06	-0.07			
	(0.12)	(0.12)	(0.12)				(0.16)	(0.15)	(0.15)			
Japanese colony	0.58***	0.62***	0.58***				0.10	0.12	0.09			
	(0.08)	(0.08)	(0.10)				(0.11)	(0.10)	(0.11)			
Number of observations	147	147	78	147	147	124	78	78	78	78	78	78
R-squared	0.71	0.72	0.72	0.70	0.71	0.73	0.72	0.71	0.72	0.70	0.70	0.70

Notes: All columns report cross-sectional OLS results. The dependent variable is the country average level of aid for all available years in our sample. The number of shocks per year(10) and the number of shocks per year(5) denote the country average numbers of (10% and 5% threshold) shocks per year for the years in our sample. The standard deviation of the change in the export price index is calculated per country for all the available years. GDP per capita, PPP, and population, are expressed as country averages for the years in our sample. The colonial dummies are time invariant. Robust standard errors are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Data appendix

This appendix provides the data sources for the variables used in estimation.

Real GDP per capita in constant 2000 US dollars (World Development Indicators, WDI).

Trade openness trade as a % of GDP (WDI).

External debt to gross national product (Global Development Finance).

Inflation consumer price index (2000=100) (WDI).

Financial development money and quasi money (M2) as % of GDP (WDI).

Commodity export price index 1990 commodity export values from UNCTAD Commodity Yearbook 2000 and United Nations International Trade Statistics 1993/1994; quarterly world commodity price indices from International Financial Statistics (IFS, series 76, except for butter and coal where we use series 74). Coal, plywood, silver, and sorghum price series had several short gaps in the early sample periods. Following Dehn (2000), we filled these gaps by holding the price constant at the value of the first available observation. Palmkerneloil, bananas, tobacco, and silver price series had 1, 2, or 3 missing quarterly values in the middle. These gaps were filled by linear interpolation. Price series with larger gaps were not adjusted. However, where gaps would cause missing export price index observations in countries for which this commodity was relatively unimportant (share of commodity's exports in total < 10%), these price series were left out. The geometrically weighted commodity export price index was first calculated on a quarterly basis and deflated by the export unit value (IFS, series 74..DZF). We then calculated the annual averages and took the log, which gave us the unweighted commodity export price index. This index was used to construct the indicators of commodity export price shocks and uncertainty. In our estimation, we use the commodity export price index, weighted by the ratio of commodity exports to GDP (%).

Commodity exports to GDP (%) 1990 commodity export values, see commodity export price index. GDP is in current US dollars for 1990 (WDI).

Commodity export price shocks & export price uncertainty See Section 2.1.

Oil import price index world oil price index from IFS (series 00176AADZF); dummy variable for net oil importing countries based on 2001 net oil imports; net oil imports are crude oil imports plus total imports of refined petroleum products minus crude oil exports minus total exports of refined petroleum products, all from Energy Information Administration's (EIA) International Energy Annual 2002. Since these components are expressed in thousands of barrels per day, we multiplied them by 365 times the 2001 average weekly world oil price per barrel, also from EIA. If oil imports > 0, dummy=1, 0 otherwise.

Geological, climatic, and human disasters geological disasters: earthquakes, landslides, volcano eruptions, tidal waves; climatic disasters: floods, droughts, extreme temperatures, wind storms; human disasters: famines, epidemics. Each variable is constructed as the annual number of episodes that qualify as large disasters according to the criteria of the IMF (2003): ≥ 0.5% of population affected, or damage ≥ 0.5% of GDP, or ≥ 1 death per 10000 people. Data from WHO Collaborating Centre for Research on the Epidemiology of Disasters.

Civil war dummy variable: 1 for civil war, 0 otherwise (Gleditsch, 2004).

Coup d'etat number of extra constitutional or forced changes in the top government elite and/or its effective control of the nation's power structure in a given year (Banks' Cross-National Time-Series Data Archive). Unsuccessful coups are not counted.

Exchange rate flexibility dummy variable based on the course classification of exchange rate regimes in Reinhart and Rogoff (2004); dummy=1 for episodes with no separate legal tender, a pre-announced peg, a currency board, a pre-announced horizontal band that is narrower than or equal to +/- 2%, or a de facto peg, 0 for all other episodes.

Foreign aid as a % of GNI Official development assistance from all donors as a % of GNI (OECD International Development Statistics, variable 286).

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[2] This model is based on the model in Collier and Goderis (2007). For sensitivity, we also run the model without the long-run cointegrating vector of level variables (see Section 4). Results are robust.

[3] In order to use the log linear form, we use 1 + foreign aid.

[4] These cut-off points are admittedly arbitrary. For sensitivity, we also run our specifications when using the 5th and 95th percentile as cut-off points. The results are robust to this alternative definition of shocks.

[5] We thank Anke Hoeffler for providing the aid instruments data.

[6] due to the fact that data are only available until 1996 and for Germany only start in 1974 (UN admittance).

[7] For the three European donor countries we use the distance to Brussels. Data are from the World Bank.

[8] Source: Barrett (1982). The dummy takes a value of 1 if 30 % or more of the population belongs to one religious group in both the donor and recipient country.

[9] We tried adding further lags but they proved unimportant.

[10] Since it is insignificant, we drop commodity export price uncertainty in all subsequent specifications.

[11] Hence the log of (1 + foreign aid) equals zero.

[12] We tested this hypothesis by re-estimating the specification in Table 4, column (4), but adding an interaction between the exchange rate dummy and the aid-shock interaction. We also experimented with interactions between the exchange rate dummy and all other regressors. In both cases, the interaction between exchange rate flexibility and the aid-shock interaction entered with the expected negative sign but was insignificant.

[13] Below we apply system GMM to deal with the endogeneity of the lagged dependent variable. We report the coefficient and standard error of the lagged dependent variable in Table 5 for comparison with Table 6.

[14] We use the xtabond2 procedure in Stata (Roodman, 2005).

[15] We thank an anonymous referee for this suggestion.

[16] As a final sensitivity test, we reran all specifications in Tables 3 and 4 for a subsample of Sub-Saharan Africa. All results were highly similar. We thank an anonymous referee for this suggestion.