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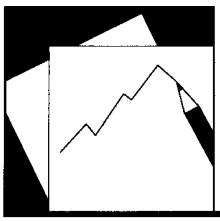

IMF Working Paper

Commodity Price Shocks and Fiscal Outcomes

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Commodity Price Shocks and Fiscal Outcomes

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Abstract

The experience of developing countries over 1990–2010 indicates that commodity prices have a significant impact on fiscal outcomes. Both revenue and expenditure rise in response to commodity (import or export) price increases; the response of the fiscal deficit is ambiguous. A floating exchange rate regime only partially offsets the impact; foreign-exchange reserves do not dampen the effects. Hence, there is a strong case for fiscal hedging against commodity price shocks. Hedging instruments based on a limited set of benchmark world prices for a narrow set of commodities may suffice to realize most of the potential benefits.

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I. INTRODUCTION

The impact of commodity price shocks on fiscal outcomes remains a subject of considerable controversy in both academic and policy circles. The 2007–08 boom in food and fuel prices, current indications that a second global food-price shock may be underway, and the observed volatility in commodity prices have all greatly intensified this interest. In particular, they have led to significant concerns that commodity price shocks may complicate the management of fiscal and debt policy, by increasing budget uncertainty, encouraging a pro-cyclical fiscal policy, and threatening debt sustainability. Such concerns are especially acute in the case of low-income countries (LICs), which are relatively more exposed to commodity price shocks, and may be expected to rise further as LICs continue to integrate into international markets. As a result, there is renewed debate on whether hedging commodity shocks, through either market-based instruments or contingent official financing, would be beneficial and feasible.[1] This paper pushes the debate forward by analyzing empirically two broad, related questions.

First, is there evidence that commodity price shocks significantly influence fiscal outcomes, inducing fiscal uncertainty? Put differently, is there a *prima facie* case for hedging against commodity price shocks? To this end, the paper assesses the impact of commodity export and import price shocks on fiscal revenue, expenditure, social expenditure, and public debt. It performs the analysis for several different economic groupings, including LICs, middle-income countries (MICs), commodity exporters, and commodity importers.

Second, is commodity price hedging, based on derivative instruments, likely to yield significant benefits in practice? This question, in turn, raises at least five separate issues. To start, can most of the adverse impacts of commodity price shocks be mitigated by traditional policy buffers, including floating exchange rate regimes and reserve assets?

Next, effective hedging instruments will, in the foreseeable future, likely be available at a reasonable cost only for a narrow set of commodities. Will such a limited set of instruments suffice to realize most of the potential benefits from hedging?

In addition, hedging instruments will likely be tied to a limited set of benchmark world commodity prices, rather than to country-specific commodity prices. Given the implied lack of precision in insuring against country-specific shocks ("basis risk"), will it still be possible to realize significant benefits from hedging?

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[1] For instance, the G20 has made it a priority, under the Development Agenda, to formulate concrete actions to manage and mitigate risks from agricultural price volatility. The G20's French presidency has shown particular interest in exploring contingent financing mechanisms for official lenders. In addition, the European Commission is currently in the process of considering options for the redesign of its shock facilities.

Also important is that commodity exports and imports are influenced by shocks to not just prices, but also volumes. Are price shocks sufficiently dominant that price hedging will suffice to stabilize export revenue? Finally, commodity export and import prices may move together over time. Will such co-movements act to stabilize fiscal outcomes, reducing the importance of additional hedging?

Overall, the paper assesses the extent of fiscal exposure to commodity price shocks, and makes a case for financial hedging by the public sector. The bulk of the existing literature on commodity price volatility focuses on its growth impact, and on the pass-through of international prices into domestic prices. A few papers discuss the fiscal impact of commodity price shocks. In particular, Kaminsky (2010) documents that terms-of-trade booms are not necessarily associated with large fiscal surpluses in developing countries, reflecting the pro-cyclicality of government spending. In the same vein, Medina (2010) and Villafuerte et al. (2010) find a strong response of fiscal revenue and expenditure to commodity prices in Latin America and the Caribbean, with significant differences across countries, and Arze del Granado et al. (2010) find evidence of pro-cyclicality in social spending in developing countries. However, these analyses only covers a limited set of fiscal variables and countries, and fail to distinguish between commodity import and commodity export price shocks. Again, Cespedes and Velasco (2011) show that fiscal policy in commodity-rich nations was historically quite pro-cyclical, with the fiscal balance often deteriorating as commodity prices increased, but find evidence of reduced pro-cyclicality in the 2000s. However, their analysis only focuses on large, sustained commodity booms, rather than on commodity price changes more generally.

As for the role of hedging, the limited literature focuses on private, micro-level hedging rather than public, macro-level hedging. Among the exceptions, Borensztein et al. (2009) demonstrate the welfare gains associated with hedging against commodity price risks for commodity-exporting countries. In particular, they show that introducing hedging financing enhances domestic welfare by reducing both export income volatility, and the need to hold foreign assets as precautionary saving. Likewise, Daniel (2001) argues that many governments could benefit substantially from hedging against oil-price risk.

A related strand of the literature argues that commodity exporters or importers can insure against volatility in commodity prices not just through financial hedging, but also through policy buffers and non-financial hedging (for instance, by accumulating foreign assets, diversifying exports, and employing conservative price assumptions in the budget). Indeed, the public sector has typically relied on nonfinancial hedging. Many governments have strived to build up policy buffers, including creating fiscal space through fiscal consolidation and public debt payment. Other buffers, such as commodity stabilization fund scheme, are generally set up to deal both with the expected depletion of commodity resources and the volatility of commodity-related income. There are trade-offs between financial and nonfinancial hedging. In particular, the potential limitations of nonfinancial hedging include the need for strong institutions and efficient policy coordination (see Ossowski et al., 2008).

Further, as stressed by Borensztein et al. (2009), building up financial asset for precautionary motives comes at the cost of reducing consumption and welfare. The costs of financial hedging include, for instance, ill-conceived contract negotiations which lock in commodity prices lower than market trends. More fundamentally, opportunities for financial hedging are incomplete, especially over longer horizons (Becker et al., 2007).

The rest of this paper is organized as follows. Section II sets out some key stylized facts, focusing on the importance of commodity trade, and some *prima facie* evidence that it may influence fiscal outcomes. Section III sets out a formal empirical methodology for examining the cross-country link between fiscal outcomes and commodity prices. Section IV discusses the results. Section V examines some of the above-mentioned potential problems with price hedging. Section VI concludes.

II. STYLIZED FACTS

A. The Importance of Commodity Trade

We set the stage by briefly illustrating the importance of commodity exports and imports, and showing that this has not diminished over time. We abstract from developments over the past couple of years, since these are dominated by the possibly temporary response to the financial crisis. Since 1980, for developing countries as a whole, exports and imports have grown, not just in absolute terms, but also relative to GDP (Figure 1). Middle-income countries (MICs) are broadly more open than LICs. In much of the subsequent analysis, we focus on "commodity exporters" or "commodity importers", defined as those countries where commodity exports or imports account for at least 20 percent of GDP.[2] Largely by construction, these countries are significantly more open than the average developing country. Commodity trade has broadly followed the same trend as overall trade. Both commodity exports and imports have generally grown relative to GDP (Figure 2).

Both commodity exports and imports are significantly concentrated, with no clear trend toward an increase or decrease in specialization over time. The share of the 3 most important commodities in total commodity exports or imports has remained roughly stable since the mid-1990's (Figure 3). Interestingly, the mean degree of specialization appears greatest in LICs. Even for developing countries as a whole, the top 3 commodities account on average for over 40 percent of total commodity exports. This suggests that, at least for some countries, hedging on a limited number of markets might yield significant insurance against aggregate commodity-revenue fluctuations. In the aggregate, crude oil dominates developing

[2] Roughly, the sample mean value of commodity exports or imports; the results were not sensitive to the precise cut-off. Given our focus, ratios to GDP are more relevant than ratios to total exports or imports.

countries' commodity exports and imports (Table 1 and Table 2). Other key commodities include copper, fish, coal, and iron.

Finally, commodity export and import prices are both very volatile. For developing countries as a group, the late 1990's saw a sharp decrease in commodity prices, followed by a boom for most of the 2000's, and a collapse in 2008–09 **(**Figure 4). Quantitatively, the developing-country average annual growth rate of commodity prices exhibits over most time periods a standard deviation on the order of at least 2–3 percentage points. For individual countries, fluctuations can be much more severe: commodity export and import prices both display an overall panel standard deviation on the order of 10 percentage points.

B. Commodity Price Shocks and Fiscal Exposure

This section employs simple statistics, based on correlation analysis, to illustrate to what extent movements in commodity prices are associated with changes in fiscal variables, including revenue, expenditure, deficits, and public debt. Overall, the data suggest strong correlations between world commodity prices and fiscal outcomes (Table 3). For instance, commodity export prices have positive, relatively large correlations with revenue / GDP, and negative correlations with debt / GDP. The correlations are even larger with respect to the prices of the 3 most important export commodities.[3] These preliminary results suggest a *prima facie* case that hedging against commodity price volatility may smooth fiscal adjustment.

III. METHODOLOGY

The empirical strategy involves reduced-form cross-country panel regressions. The dataset is an unbalanced annual panel, covering the period 1990–2010 and (depending on the precise variable) up to 116 countries. We focus on the extent of fiscal exposure to commodity price shocks, and adopt the following benchmark fiscal exposure equation:

$$\begin{aligned}\Delta Y_{it} \;=\; & \alpha_i + \beta_t + \gamma\,\Delta Y_{it-1} + (\delta_x + \delta_x^{er}.ER_{it} + \delta_x^{res}.RES_{it})\,\Delta p_{x,it}\,x_{it-1} \\ & + (\delta_m + \delta_m^{er}.ER_{it} + \delta_m^{res}.RES_{it})\,\Delta p_{m,it}\,m_{it-1} + \delta^{er}ER_{it} + \delta^{res}RES_{it} + w_{it} \qquad \textbf{(1)}\end{aligned}$$

The subscripts *i* and *t* denote, respectively, the country and the time period, while the subscripts x and m denote, respectively, commodity exports and imports.

[3] These results should be taken with caution, as they are based on univariate correlations, although they do allow for country-specific fixed effects.

ΔY_{it} denotes the percentage point change in each of the following dependent variables, in turn: (i) total revenue / GDP; (ii) total expenditure / GDP; (iii) social expenditure (on education and health) / GDP; (iv) fiscal balance (surplus) / GDP; and (v) public debt / GDP.[4]

$p_{x,it}$ and $p_{m,it}$ are the country-specific, time-varying commodity (spot) export and import price indices. They are constructed based on the actual weight of each commodity in the country's export or import basket, and on the world price of that commodity.

$x_{it} = \frac{X_{it}}{\text{GDP}_{it}}$ and $m_{it} = \frac{M_{it}}{\text{GDP}_{it}}$ are country-specific, time-varying weights set equal to, respectively, the share of commodity exports and imports in GDP. That is, commodity price indices are weighted by the country's total commodity exports or imports, relative to GDP. The weights are lagged to reduce endogeneity concerns.

In commodity exporters, we expect commodity export prices to be positively associated with revenue, through their impact on income taxes (and in particular profit taxes) and non-tax revenue (including royalties and production sharing agreements). The direct impact of commodity export prices on trade taxes is likely less significant, given that export taxes have been widely removed in most developing countries since the 1980s. We also expect commodity export prices to be positively associated with expenditure, including social expenditure. The magnitude of the response would optimally depend on the extent to which commodity price changes are seen as permanent, as well as whether public investment is required to take full advantage of the increased export prices. We have less definite priors on the response of the fiscal balance (surplus) and debt, although the general normative presumption is that, to the extent that the commodity price changes are seen as temporary, the fiscal balance should increase.

In commodity importers, we expect commodity import prices to be positively associated with revenue, through their direct impact on trade taxes. We also expect commodity import prices to be positively associated with expenditure, and in particular increased spending on social safety nets, or food and fuel subsidies. Again, we have less definite priors on the response of the fiscal balance and debt.

We also interact commodity prices with the following variables, to examine how they affect the impact of commodity price shocks:

1. ER_{it}, which denotes a country's de facto exchange rate regime. ER_{it} = 1 for fixed exchange rate regimes, and 0 otherwise (the classification is based on the Ilzetzki et

[4] The response of non-resource fiscal revenues and fiscal balance to commodity price shocks is not analyzed, owing to data limitation in most LICs.

al., 2009, approach).[5] The hypothesis is that floating exchange rates may weaken the impact of commodity-price changes on revenue, for two reasons. First, floating exchange rates may dampen any impact on output. Second, in response to, say, a reduction in commodity export prices, a depreciation would act to increase revenue from trade taxes (which tend to be significant in LICs). On the other hand, floating exchange rates may magnify the impact of commodity-price changes on external debt service and the debt burden, as long as debt is denominated in a foreign currency.

2. RES_{it}, which denotes a country's reserves (relative to imports). There are (at least) two competing hypotheses. First, greater reserves may allow for a smaller response of exchange rates to changes in commodity prices (and in particular to negative price shocks), reducing any dampening effect from exchange rate movements. Second, greater reserves may allow governments to smooth consumption in the face of negative shocks.

More precisely, we estimate four different specifications of equation (1) above: (i) with neither exchange-rate regime nor reserve interactions; (ii) with exchange-rate regime interactions; (iii) with reserve interactions; (iv) with both exchange-rate regime and reserve interactions. We also test for asymmetric fiscal responses to positive versus negative commodity-price shocks. The dynamic model is estimated using the Arellano - Bond difference GMM.[6]

For each specification, we estimate the response of each of the five fiscal outcomes for several different groups: (i) LICs; (ii) LIC commodity exporters; (iii) LIC commodity importers; (iv) MICs; (v) MIC commodity exporters; (vi) MIC commodity importers; (vii) LICs and MICs; (viii) LIC and MIC commodity exporters; and (ix) LIC and MIC commodity importers.[7] The focus on commodity exporters and importers is motivated by the hypothesis that any impact of increases in commodity export and import prices will be easier to observe in countries that are heavily reliant on commodity trade.

Further, we examine to what extent fiscal outcomes depend on price fluctuations for a narrowly defined set of commodities, and by extension whether hedging strategies based on a

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[5] All intermediate regimes (e.g., crawling pegs) are treated as fixed exchange rate regimes.

[6] Additional lags of the dependent variable were not found to be significant. For robustness, we also carried out fixed-effects estimation of a static version of the model, excluding the lagged dependent variable (detailed results available upon request). The test for asymmetry was carried out by expanding equation (1) to include both positive and negative price shocks. Positive price shocks are those for which the change in prices exceeds the mean plus 1.5 times the standard deviation of the series; negative price shocks are those for which the change in prices is smaller than the mean minus 1.5 times the standard deviation of the series.

[7] Owing to space constraints, the results for some groups are omitted.

narrow set of hedging instruments might prove useful. To do so, we re-estimate the above regression by replacing the aggregate commodity price indices with price sub-indices for the three most important commodities (the "top-3 commodities"), and for all other commodities (the "non-top-3 commodities"). These sub-indices are again based on the weight of each commodity in the country's export or import basket.

In addition, we present both the short-run impact and the long-run effect of a change in commodity prices on the fiscal variable of interest, where the long-run effect = short-run impact / $(1 - \gamma)$.

The forecast error variance decomposition is obtained by taking the variance of both sides of equation 1 above (averaged over time and across countries). The resulting terms on the RHS will include the fiscal variable's own effect, a pure commodity export price effect, a pure commodity import price effect, and various interactions.

Appendix I describes in greater detail the above variables and their sources. Appendix II lists the countries and country groupings. Appendix III provides summary statistics for the key variables.

IV. RESULTS

Overall, cross-country panel regressions suggest a large fiscal exposure to commodity-price shocks, stemming from automatic stabilizers on the revenue side, and a positive and significant response of expenditure, including social spending, to commodity prices. In LICs, and particularly in commodity exporters and importers, the magnitude of the responses is relatively high. Further, in these countries, expenditure tends to respond more strongly than revenue. As a result, we typically observe a significant, positive response of public deficits and debt to commodity import prices in LIC commodity importers, and even to commodity export prices in LIC commodity exporters. The effects are larger under fixed exchange-rate regimes, and persist over time. We now discuss these results in greater detail.

A. Commodity Export Prices and Fiscal Outcomes

All statistically significant fiscal responses to a change in commodity export prices are summarized in Table 4 and Figure 5. The full underlying baseline regressions are reported in Table 6 – Table 10.[8,9]

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[8] Throughout, we carry out residual first- and second-order serial correlation tests (Arellano and Bond, 1991) and the Hansen J test of over-identifying restrictions (to save space, the AR(1) tests are not reported). The AR(1) and AR(2) tests reject the null of no first-order serial correlation, but fail to reject the null of no second-

(continued…)

Total revenue rises in response to increases in commodity export prices, as expected (Table **6**). This response is particularly strong in commodity exporters, where a 10 percent increase in commodity export prices leads to an average short-run increase in tax revenue of 0.53 to 0.61 percentage points of GDP.[10]

Expenditure rises in response to commodity export price increases, particularly in LIC commodity exporters (Table 7). A 10 percent increase in commodity export prices leads to an average increase in public spending of 0.33 to 0.97 percentage points of GDP, with the highest response in LIC commodity exporters. This is consistent with the view that LIC commodity exporters tend to adjust spending as though commodity price increases were largely permanent.

Social expenditure responds strongly to increases in commodity export prices, particularly in LIC commodity exporters (Table 8). For instance, in LIC and MIC commodity exporters, a 10 percent increase in commodity export prices leads to an average increase in social expenditure of 0.45 percentage points of GDP. This result is in line with Arze del Granado et al. (2010).

The response of the fiscal balance (surplus) to commodity export price increases is ambiguous (Table 9). In the full sample, the fiscal balance increases. However, perhaps surprisingly, in LIC commodity exporters a 10 percent increase in commodity export prices leads to an average deterioration of the fiscal balance of 0.22 percentage points of GDP; put differently, here expenditure rises faster than revenue. One implication is that commodity price shocks may lead to strongly pro-cyclical fiscal policies. This result is in line with Kaminsky (2010), Medina (2010), Villafuerte et al. (2010), and Cespedes and Velasco (2011).

In a similar vein, public debt responds ambiguously to increases in commodity export prices (Table 10). In the full sample, the response of debt to commodity export price increases is either statistically or economically insignificant. However, in LICs (including LIC

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order serial correlation, supporting the specification in equation (1). The Hansen J test confirms the overall validity of the instrumental variables at the 10 percent significant level.

[9] Standard fixed-effects panel regressions (available on request) yielded broadly similar results, except that the estimated coefficient on the lagged dependent variable was greater.

[10] Unless otherwise stated, all quantitative estimates refer to the short-run effect on a benchmark economy such that: (i) the commodity export or import ratio equals the mean value in the relevant sub-sample (for commodity exports, this is 23.8, 50.2, 17.9, 27.0, and 45.2 percent of GDP in, respectively, LICs and MICs, LIC and MIC commodity exporters, LICs, LIC commodity exporters, and LIC commodity importers); and (ii) the exchange rate regime lies half-way between a floating and a fixed exchange rate regime. See below for a discussion of differences between short- and long-run effects, and between effects under floating and under fixed exchange rate regimes.

commodity exporters) public debt rises significantly. This is consistent with the above findings on expenditure and the fiscal balance in LIC commodity exporters.[11] This suggests that achieving debt reduction in highly indebted LICs, and especially in commodity exporters, may be challenging in that policy may be biased toward over-spending the earnings from export bonanzas.

The above discussion refers to short-run impacts. However, commodity price shocks exert even larger effects on fiscal outcomes in the long run, amplifying fiscal exposure and risks (Table 4). In the analysis, the coefficients on the lagged dependent fiscal variables are generally statistically significant across groups and model specifications. This evidence of persistence in fiscal outcomes is consistent with the empirical literature,[12] and highlights the fact that commodity price shocks exert a long-run effect on fiscal outcomes.

B. Commodity Import Prices and Fiscal Outcomes

All statistically significant fiscal responses to a change in commodity import prices are summarized in Table 5 and Figure 6. Again, the full underlying baseline regressions are reported in Table 6 – Table 10.

Total revenue rise in response to increases in commodity import prices, as expected (Table 6). A 10 percent increase in commodity import prices is associated with an average short-run increase in fiscal revenue of 0.15 to 0.59 percentage points of GDP. The responses are larger in LIC commodity importers.

Expenditure and social expenditure rise in response to commodity import price increases, again as expected (Table 7 and Table 8). The impact is especially large in LIC commodity importers, where a 10 percent increase in commodity import price is associated with an average increase in total expenditure of 0.91 percentage points of GDP.

In LIC commodity importers, the fiscal deficit and debt both increase significantly in response to an increase in commodity import prices (Table 9 and Table 10). For instance, a 10 percent increase in commodity import price leads to an average increase in the fiscal deficit of 0.22 percentage points of GDP. Again, all these responses generally build up over time.

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[11] Nigeria provides a dramatic example. During the oil boom of the early 1980's, the government's commodity-related revenue rose from 27 percent to 35 percent of GDP in 2000. At the same time, total government debt grew from less than 14 percent in 1980 to more than 68 percent of GDP in 2000.

[12] For some variables, the persistence may be explained by the fact that each year's budget takes into account the previous year's fiscal performance (Gali, 2003).

C. The Role of Traditional Buffers and the Potential for Hedging

The analysis suggests that policy buffers, including in particular a floating exchange rate and foreign-exchange reserves, can at best partially offset the fiscal exposures of LIC commodity exporters and importers to commodity price shocks (Table 4, Table 5, and Table 6 – Table 10, columns 1A–5A).

Specifically, floating exchange rate regimes partially dampen the impact of commodity price shocks on LICs. When regressing fiscal outcomes on commodity export and import prices, *as well as* exchange rate regimes interacted with commodity prices, the coefficients on the interaction terms are generally significant, and as expected imply that commodity prices have a bigger impact under a fixed exchange rate regime. That said, the offsetting effects from a floating exchange rate are limited. For instance, a 10 percent increase in commodity export prices leads to a deterioration of the fiscal balance by 0.18 (respectively, 0.26) percentage points of GDP in LIC commodity exporters that have a floating (respectively, fixed) exchange rate regime.

In contrast, there is no evidence that foreign exchange reserves provide any buffering in response to commodity price shocks in LICs. When regressing fiscal outcomes on commodity export and import prices, as well as reserves interacted with commodity prices, the coefficients on the interaction terms are typically insignificant. Further, if both the exchange rate regime and reserves are included (in interaction with commodity prices), the coefficients on the exchange rate regime generally remain significant, but those on reserves are generally insignificant. All this continues to hold under asymmetric specifications, where reserves are interacted separately with positive and negative shocks (detailed results available upon request). As discussed, this may reflect the fact that reserves exert distinct, potentially offsetting effects.

Controlling for the prices of the top-3 commodities, the impact of other commodity prices is on average statistically insignificant (Table 6 – Table 10, columns 1B–5B). Hedging may potentially be a useful strategy in dealing with commodity-price volatility. However, it is *a priori* unclear whether hedging on just a few commodity markets would be sufficient, or whether a much larger set of instruments would be required. As discussed above, the shares of the top-3 commodities in total exports and GDP are in many cases large and substantial (see stylized facts), and the top-3 commodities tend to drive the volatility of LIC / MICs overall commodity movements. We therefore estimate alternative models, using the same specifications and the same economic groups, but focusing on the impact of the top-3 versus the non-top-3 commodities. In most cases, the coefficients on the top-3 commodity prices are significant with the expected signs, whereas the coefficients on the non-top-3 commodity prices are generally insignificant. All this suggests that, after controlling for the top-3 commodity prices, the impact of non-top-3 commodity prices on fiscal outcomes is *on average* limited.

Finally, an alternative way to present these results is to use a simple variance decomposition analysis (as discussed in section III) to assess the extent to which changes in world commodity prices contribute to changes in fiscal variables. Figure 7 shows that, in LICs, commodity export prices account for a large share (typically, about ¼) of changes in fiscal revenue, public expenditure, and government debt; the effects are even stronger in LIC commodity exporters. Commodity import prices, as well as the interactions between commodity prices, exchange rate regimes, and reserves, generally have a somewhat smaller effect.

V. BROADER ISSUES

D. "Basis Risk"

The paper has focused on fiscal exposure to commodity price shocks, and the potential benefits from hedging these. However, hedging instruments will likely be based on a limited set of benchmark "world" prices for a given commodity, so as to benefit from more liquid and deeper markets. This raises the issue of "basis risk", which in this context relates to the difference between the benchmark world commodity price and the actual country-specific commodity price, that is, the price which a country receives or pays on world markets for its exports (or imports) of the commodity. These two prices may differ, and the gap may vary over time, for several reasons, including:

- Differences in quality. That is, commodities may not be fully homogeneous, generating a between average world prices and country-specific prices.

- Barriers to trade. These include, for instance, transportation costs (local trading centers may be far from the major global trading centers).

- Imperfect exchange-rate pass-through. Firms with market power may choose to dampen (or, in some cases, amplify) the impact of exchange-rate changes on local prices. In practice, such market segmentation will require the presence of some barrier to trade.

A large literature has examined the transmission of international food prices into local food prices.[13] The broad conclusions are that significant gaps exist, and any tendencies toward co-

[13] See, for instance, Arias and De Franco (2011) for food-price transmission in Honduras and Nicaragua; Gilbert (2011) for the pass-through from international to domestic prices for maize, wheat, and rice in several LICS; Martin and Anderson (2010) for the impact of trade distortions on the gap between international and local prices; Minot (2010) for price movements in international markets versus markets in nine sub-Saharan countries; OECD (2010) for price volatility in agricultural commodities, and the relationship between

(continued…)

movements are weak. Most papers, however, only consider a small range of commodities and countries, making their results hard to generalize. Further, their focus is typically on prices movements at the monthly frequency, whereas our interest is more on medium- to long-run developments. In addition, the results may reflect the presence of policy-induced gaps between domestic prices and external prices (for instance, because of tariffs, taxes, or subsidies), which are not directly relevant to the basis-risk issue.

To explore the issue further, we first obtain estimates of country-specific commodity prices for a broad sample of commodities and countries. We then analyze to what extent fluctuations in these country-specific prices are accounted for by changes in the world price of the relevant commodity.

As a first step, we obtain country-specific estimates of the unit value of exports of 40 different commodities using the UN COMTRADE database. Then, for each commodity, we carry out panel unit-root tests on the country-specific commodity prices. Where the unit-root null hypothesis is rejected, we estimate a panel regression of the country-specific commodity prices on the benchmark world commodity price, controlling for country fixed effects.[14] Where the unit-root null hypothesis is not rejected, we instead test for and estimate a cointegrating relationship between the country-specific commodity prices and the benchmark world commodity price, using the Pedroni (2000) heterogeneous-panel FM-OLS estimator. The results suggest several conclusions (Table 11 and Appendix IV):

- Country-specific commodity prices are statistically significantly correlated with world commodity prices.
- However, the correlation is significantly below unity. That is, a given change in world commodity prices is associated with a significantly smaller (proportionate) change in country-specific prices.
- World commodity prices only explain a fraction of the overall variation in country-specific commodity prices.
- For almost all commodities, the null hypothesis of a unit root in the underlying time-series is rejected.
- When the unit-root null is not rejected, a cointegrating vector is identified, it typically suggested that in the long run country-specific commodity prices moved one-to-one with world commodity prices.

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agricultural prices and prices of crude oil and fertilizer; and World Bank (2009) for determinants of the speed of adjustment of local prices. Most papers use some version of an error-correction methodology.

[14] The results were qualitatively similar when allowing for extra lags of the world commodity price.

Interestingly, for crude oil, an *a priori* relatively homogeneous commodity for which good-quality price data are available, there exists a tight link between country-specific and world commodity prices.

As a general caveat, much of the above analysis relies on unit value data, which may not be fully reliable. Using such data may introduce noise into the estimation, and exaggerate the magnitude of any basis risk.

Nonetheless, this section suggests that basis risk is clearly present. While countries may gain from hedging against fluctuations in world commodity prices, they will still remain subject to significant idiosyncratic fluctuations in country-specific commodity prices. The more heterogeneous the commodity, the greater the basis risk.

E. Commodity Prices versus Volumes

Again, the paper has focused on the potential benefits from hedging commodity price shocks. However, countries are subject to many other shocks, not so easily hedged. As an illustration, this section briefly analyzes to what extent fluctuations in commodity export revenue indeed reflect fluctuations in commodity *prices*, as opposed to commodity export *volumes*.

As a first step, we carry out an accounting decomposition of the observed changes in commodity export revenue over various time periods into the fraction due to changes in (world) commodity prices, and the fraction due to changes in commodity export volumes (Table 12). Overall, the results suggest that commodity prices largely drive changes in commodity export revenue.

Taking a slightly different approach, we also break down the variance of commodity export revenue into its components: the variance of commodity prices, the variance of commodity export volumes, and the covariance terms (Table 13). Again, these results suggest that fluctuations in commodity export revenue largely reflect fluctuations in commodity prices.

F. Co-movements in Export and Import Prices

This paper has considered separately shocks to commodity export prices and commodity import prices. However, the two are typically positively correlated (Table 14). This raises the possibility that co-movements in commodity export and import prices may act to either dampen or, conversely, amplify the impact on fiscal outcomes. Which scenario prevails depends on the sign and magnitude of the separate impacts of commodity export and import prices.

In this context, the analysis in section III above yields two relevant conclusions. First, the impact of commodity *import* prices is often statistically insignificant, except in the group of LIC commodity importers. Second, in this latter group, the impact of commodity *export* prices is typically statistically insignificant. The main cases where both impacts prove

statistically significant are tax revenue, total revenue, and total expenditure in the full sample, which all respond positively to increases in both commodity export *and* import prices. Put differently, the data suggest that the positive co-movements in commodity export and import prices will if anything *amplify* rather than dampen the impact of commodity price shocks on fiscal outcomes.

VI. CONCLUSIONS

This paper yields several important conclusions. First, commodity price shocks do have a significant impact on fiscal outcomes. Since commodity prices are difficult to project, this suggests that commodity price volatility can increase budget uncertainty, encourage a pro-cyclical fiscal policy, and threaten debt sustainability. The effects are especially significant, both statistically and economically, in LIC commodity exporters and importers. More specifically, tax revenue rises in response to commodity price increases, likely through the direct impact of commodity prices on trade taxes. Expenditure, including social expenditure, also rises in response to commodity price increases. This is consistent with the view that LIC commodity exporters tend to perceive commodity price increases as permanent, and increase spending accordingly. In commodity importers, the channel may be slightly different: increases in commodity import prices may lead to increased spending on social safety nets, or food and fuel subsidies. The fiscal balance deteriorates in response to commodity import price increases. Its response to commodity export price increases is more ambiguous; perhaps surprisingly, in LIC commodity exporters, an increase in commodity export prices leads to a deterioration of the fiscal balance (that is, expenditure rises faster than revenue). In general, not surprisingly, commodity exporters (respectively, importers) are relatively more exposed to increases in commodity export (respectively, import) prices. The effects are felt already within the year, and build up over time.

Second, traditional policy buffers to guard against fiscal exposure to commodity price volatility yield limited benefits. A floating exchange rate regime only partially offsets the fiscal impact of commodity price shocks. There is no evidence that foreign-exchange reserves dampen the effects of shocks.

Third, effective hedging instruments will, in the foreseeable future, likely be available at a reasonable cost only for a few commodities. Nevertheless, hedging instruments based on a narrow set of commodities may suffice to realize most of the potential benefits from hedging. Specifically, controlling for the prices of a few key commodities, the impact of other commodities is on average statistically insignificant.

Fourth, commodity price shocks are sufficiently dominant, relative to volume shocks, that price hedging may largely stabilize export revenue. Specifically, fluctuations in commodity export revenue largely reflect fluctuations in commodity prices.

Fifth, and less optimistically, hedging instruments will likely be tied to a limited set of benchmark world commodity prices, rather than to country-specific commodity prices. As a result, while countries may gain from hedging against fluctuations in world commodity prices, they will still remain subject to significant idiosyncratic fluctuations in country-specific commodity prices. The more heterogeneous the commodity, the greater this basis risk. This will reduce the overall benefits from hedging.

Finally, positive co-movements in commodity export and import prices if anything *amplify* rather than dampen the impact of commodity price shocks on fiscal outcomes.

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TABLE 1. TOP 10 COMMODITIES: EXPORTS AS A SHARE OF TOTAL COMMODITY EXPORTS, 2000–08 (AGGREGATE VALUES).

Rank	LICs		MICs		LICs & MICs		LIC Commodity Exporters		MIC Commodity Exporters	
1	Crude Oil	22.3	Crude Oil	31.8	Crude Oil	28.9	Crude Oil	26.4	Crude Oil	33.0
2	Gold	11.2	Copper	10.1	Copper	9.6	Cocoa	10.6	Copper	13.3
3	Cocoa	8.3	Fish	7.2	Fish	6.7	Gold	8.9	Fish	9.0
4	Copper	6.0	Coal	5.1	Coal	5.4	Copper	6.6	Coal	6.0
5	Coffee	5.8	Iron	4.1	Iron	4.2	Fish	6.2	Aluminum	3.8
6	Shrimp	5.7	Aluminum	4.1	Aluminum	4.0	Shrimp	5.6	Palm Oil	3.7
7	Fish	5.5	Palm Oil	3.0	Gold	3.3	Aluminum	5.1	Rubber	3.0
8	Aluminum	4.4	Soybean Meal	2.5	Palm Oil	2.8	Coffee	4.5	Gold	2.4
9	Rubber	3.5	Soybeans	2.3	Soybean Meal	2.6	Rice	4.1	Hides	1.9
10	Cotton	3.4	Gold	2.3	Rubber	2.6	Rubber	3.7	Soybean Meal	1.7

Source: IFS; WEO; World Bank; Commodity Prices Database; and COMTRADE/WITS.

TABLE 2. TOP 10 COMMODITIES: IMPORTS AS A SHARE OF TOTAL COMMODITY IMPORTS, 2000–2008 (AGGREGATE VALUES).

Rank	LICs		MICs		LICs & MICs		LIC Commodity Exporters		MIC Commodity Exporters	
1	Crude Oil	54.2	Crude Oil	51.4	Crude Oil	51.2	Crude Oil	56.4	Crude Oil	49.0
2	Wheat	6.5	Fish	7.1	Fish	6.7	Gold	5.1	Fish	7.9
3	Rice	4.8	Copper	5.7	Copper	5.4	Wheat	4.4	Copper	6.4
4	Fish	4.2	Iron	4.4	Iron	4.4	Fish	4.1	Iron	6.1
5	Palm Oil	4.0	Gold	3.7	Gold	3.8	Copper	3.8	Aluminum	4.3
6	Gold	3.1	Aluminum	3.6	Aluminum	3.5	Rice	3.7	Soybeans	3.1
7	Sugar	2.4	Coal	2.8	Coal	2.7	Hides	3.5	Hides	2.6
8	Cotton	2.4	Soybeans	2.3	Soybeans	2.2	Aluminum	2.7	Coal	1.9
9	Aluminum	2.2	Hides	2.1	Wheat	2.2	Soybean Meal	2.1	Wheat	1.5
10	Copper	2.1	Wheat	1.9	Hides	2.1	Palm Oil	1.7	Cotton	1.4

Source: IFS; WEO; World Bank; Commodity Prices Database; and COMTRADE / WITS.

TABLE 3. CORRELATION ANALYSIS: FISCAL OUTCOMES AND COMMODITY PRICES, 1990–2010

Change in:	Change in fiscal outcomes: Revenue / GDP	Expenditure / GDP	Fiscal Balance / GDP	General Government Debt / GDP	Commodity Export Prices	Commodity Import Prices	Top-3 Commodity Export Prices	Non-top-3 Commodity Export Prices
Low Income Countries								
Revenue / GDP	1							
Expenditure / GDP	0.26	1						
Fiscal balance / GDP	0.16	0.27	1					
General government	-0.21	0.19	-0.09	1				
Commodity export	0.53	0.29	0.39	-0.53	1			
Commodity import	-0.26	-0.32	0.36	0.40	0.38	1		
Top-3 commodity	0.56	0.47	0.58	-0.54	0.67	-0.03	1	
Non-Top-3 commodity	0.21	-0.16	0.18	-0.13	0.25	-0.01	0.07	1
Commodity exporters								
Revenue / GDP	1							
Expenditure / GDP	0.02	1						
Fiscal balance / GDP	0.18	-0.38	1					
General government	0.36	-0.62	-0.21	1				
Commodity export	0.57	0.47	0.53	0.82	1			
Commodity import	-0.10	0.37	-0.14	-0.23	-0.43	1		
Top-3 commodity	0.61	0.75	0.78	0.88	0.72	-0.05	1	
Non-Top-3 commodity	0.23	0.26	0.24	0.20	0.25	-0.01	0.01	1
Commodity importers								
Revenue / GDP			1					
Expenditure / GDP			0.87	1				
Fiscal balance / GDP			0.23	-0.32	1			
General government debt / GDP			0.31	0.58	-0.33	1		
Commodity export prices			0.01	-0.01	0.07	0.03	1	
Commodity import prices			0.64	0.46	0.37	0.30	0.66	1
Top-3 commodity export prices			0.03	0.01	0.06	0.01	0.85	0.57
Non-Top-3 commodity export prices			0.04	0.05	0.04	0.04	0.62	0.86

	1
	0.75
	1

TABLE 4. RESPONSE OF FISCAL OUTCOMES TO A 10 PERCENT INCREASE IN COMMODITY EXPORT PRICES (PERCENTAGE POINTS OF GDP).

	LICs & MICs	LIC & MIC Commodity Exporters	LICs	LIC Commodity Exporters	LIC Commodity Importers
Total revenue					
Short-run impact					
Floating exchange rate regime	0.28	0.25	0.40	0.53	0.08
Fixed exchange rate regime	0.45	0.33	0.43	0.61	0.08
Long-run impact					
Floating exchange rate regime	0.48	0.46	0.67	0.81	0.13
Fixed exchange rate regime	0.77	0.59	0.73	0.94	0.13
Total expenditure					
Short-run impact					
Floating exchange rate regime	0.33	0.37	0.35	0.84	
Fixed exchange rate regime	0.40	0.49	0.68	0.97	
Long-run impact					
Floating exchange rate regime	0.48	0.60	0.72	1.22	
Fixed exchange rate regime	0.58	0.80	1.40	1.42	
Social expenditure					
Short-run impact					
Floating exchange rate	0.07	0.42	0.55	0.38	0.12
Fixed exchange rate	0.13	0.48	0.78	0.38	0.15
Long-run impact					
Floating exchange rate	0.15	0.58	0.73	0.55	0.16
Fixed exchange rate	0.27	0.67	1.03	0.55	0.20
Fiscal deficit					
Short-run impact					
Floating exchange rate regime	-0.07	0.03	0.16	0.18	
Fixed exchange rate regime	-0.02	0.17	0.21	0.26	
Long-run impact					
Floating exchange rate regime	-0.11	0.04	0.33	0.30	
Fixed exchange rate regime	-0.03	0.21	0.44	0.43	
Government debt					
Short-run impact					
Floating exchange rate regime		0.06	0.10	0.21	
Fixed exchange rate regime		0.06	0.10	0.21	
Long-run impact					
Floating exchange rate regime		0.09	0.13	0.31	
Fixed exchange rate regime		0.09	0.13	0.31	

Source: Authors' calculations, based on regression results (Tables 6–11). The short-term response of a fiscal variable is computed as a linear combination of the statistically significant coefficients, excluding that on the lagged dependent variable.

TABLE 5. RESPONSE OF FISCAL OUTCOMES TO A 10 PERCENT INCREASE IN COMMODITY IMPORT PRICES (PERCENTAGE POINTS OF GDP)

	LICs & MICs	LIC & MIC Commodity Exporters	LICs	LIC Commodity Exporters	LIC Commodity Importers
Total revenue					
Short-run impact					
Floating exchange rate	0.15	0.31	0.29	0.29	0.47
Fixed exchange rate regime	0.25	0.31	0.38	0.29	0.59
Long-run impact					
Floating exchange rate	0.26	0.57	0.50	0.45	0.78
Fixed exchange rate regime	0.42	0.57	0.65	0.45	0.98
Total expenditure					
Short-run impact					
Floating exchange rate	0.32		0.45		
Fixed exchange rate regime	0.46		0.50		
Long-run impact					
Floating exchange rate	0.46		0.91		
Fixed exchange rate regime	0.67		1.02		1.41
Social expenditure					
Short-run impact					
Floating exchange rate	0.15		0.72	0.06	1.14
Fixed exchange rate	0.20	0.06	0.95	0.06	1.17
Long-run impact					
Floating exchange rate	0.31		0.96	0.09	1.49
Fixed exchange rate	0.43	0.08	1.25	0.09	1.54
Fiscal deficit					
Short-run impact					
Floating exchange rate	0.12		0.17		
Fixed exchange rate regime	0.12		0.22		
Long-run impact					
Floating exchange rate	0.17		0.36		
Fixed exchange rate regime	0.17		0.46		0.86
Government debt					
Short-run impact					
Floating exchange rate			0.25		
Fixed exchange rate regime			0.25		
Long-run impact					
Floating exchange rate			0.32		
Fixed exchange rate regime	0.26		0.32		0.69

Source: Authors' calculations, based on regression results (Table 6 - Table 10). The responses are computed as linear combination of the statistically significant coefficients.

TABLE 6. PANEL REGRESSIONS. DEPENDENT VARIABLE: CHANGE IN CENTRAL GOVERNMENT TOTAL REVENUE / GDP

	(1A)	(2A)	(3A)	(4A)	(5A)	(1B)	(2B)	(3B)	(4B)	(5B)
	Baseline–All commodity					Alternative–Top-3 commodity				
	LICs & MICs		LICs			LICs & MICs		LICs		
	All	Exporters	All LICs	Exporters	Importers	All	Exporters	All LICs	Exporters	Importers
Lag dependent variable: change in revenue-to-GDP	0.415***	0.447***	0.414***	0.355**	0.399***	0.319***	0.363***	0.407***	0.328***	0.571**
	(0.124)	(0.122)	(0.121)	(0.171)	(0.124)	(0.0139)	(0.105)	(0.110)	(0.00856)	(0.228)
Change in commodity export prices, weighted	0.1188***	0.1264***	0.1904***	0.2541***	0.0403*					
	(0.0307)	(0.0318)	(0.0429)	(0.0717)	(0.0218)					
Change in commodity import prices, weighted	0.0774**	0.1574**	0.1272**	0.1451**	0.1547**					
	(0.0336)	(0.0714)	(0.0618)	(0.0719)	(0.0718)					
Reserve assets	0.101*	0.098*	0.420	0.221***	1.166					
	(0.057)	(0.052)	(0.427)	(0.075)	(0.721)					
Change in commodity export prices, weighted, * Reserve assets	0.0891***	-0.339	0.0411**	0.0307**	-0.0227					
	(0.0202)	(0.395)	(0.0203)	(0.0152)	(0.0998)					
Change in commodity import prices, weighted, * Reserve assets	-0.113	0.234	0.1031*	0.177	0.1786**					
	(0.145)	(0.195)	(0.0571)	(0.183)	(0.0871)					
Exchange rate regime (floating=0)	0.247**	0.547**	0.108**	0.202**	0.277**					
	(0.099)	(0.231)	(0.053)	(0.097)	(0.133)					
Change in commodity export prices, weighted, * Exchange rate regime	0.0839**	0.0377***	0.0153**	0.0404**	0.0909					
	(0.035)	(0.0101)	(0.0075)	(0.0195)	(0.198)					
Change in commodity import prices, weighted, * Exchange rate regime	0.0457*	0.0229	0.0449***	0.0386	0.059***					
	(0.0241)	(0.0791)	(0.0118)	(0.2899)	(0.014)					
Change in top-3 commodity export prices, weighted						0.118*	0.261**	0.187	0.266*	0.128*
						(0.065)	(0.102)	(0.116)	(0.144)	(0.069)
Change in non-top-3 commodity export prices, weighted						1.101	0.108	0.836	0.123	-0.171
						(1.643)	(2.763)	(4.021)	(2.555)	(0.394)
Change in top-3 commodity export prices, weighted, * Exchange rate regime						0.0851*	0.104*	0.099*	0.139*	0.117
						(0.0455)	(0.0540)	(0.053)	(0.0727)	(0.0797)
Change in non-top-3 commodity export prices, weighted, * Exchange rate regime						-0.0787	-0.143	0.0756	-0.109	-0.0994
						(0.0667)	(0.177)	(0.0860)	(0.079)	(0.0991)
Observations	1,089	704	324	660	894	1,089	704	324	660	894
Number of countries	93	56	32	54	76	93	56	32	54	76
Arellano-Bond AR(2): z=	-0.99	-0.75	-1.04	-1.03	-1.18					
Hansen J Test: Chi^2(31)=	30.15	30.11	34.08	30.19	33.00					

Notes: All regressions include country- and year-effects. Robust standard errors in parentheses. *, **, and *** denote significance at the 10, 5, and 1 percent level.

TABLE 7. PANEL REGRESSIONS. DEPENDENT VARIABLE: CHANGE IN CENTRAL GOVERNMENT TOTAL EXPENDITURE / GDP

	(1A)	(2A)	(3A)	(4A)	(5A)	(1B)	(2B)	(3B)	(4B)	(5B)
	Baseline–All commodity					Alternative–Top-3 commodity				
	LICs & MICs		LICs			LICs & MICs		LICs		
	All	Exporters	All	Exporters	Importers	All	Exporters	All	Exporters	Importers
Lag dependent variable: change in expenditure-to-GDP	0.317***	0.386**	0.511***	0.315***	0.321***	0.165	0.351**	0.522***	0.331***	0.316***
	(0.0321)	(0.181)	(0.072)	(0.032)	(0.031)	(0.116)	(0.148)	(0.0637)	(0.0330)	(0.0298)
Change in commodity export price (weighted)	0.165***	0.139***	0.177***	0.391***	0.317					
	(0.0421)	(0.038)	(0.022)	(0.122)	(0.583)					
Change in commodity import price (weighted)	0.109***	0.305	0.223***	0.187	0.454***					
	(0.026)	(0.804)	(0.069)	(0.285)	(0.140)					
Reserve assets	0.320**	0.103*	0.510	0.127*	0.909					
	(0.134)	(0.054)	(0.555)	(0.070)	(1.013)					
Change in commodity export prices (weighted) * Reserve assets	0.093	0.089*	0.123	0.102*	0.288					
	(0.138)	(0.051)	(0.196)	(0.055)	(0.347)					
Change in commodity import price (weighted) * Reserve assets	0.209**	0.361	0.052	0.211	0.281					
	(0.096)	(0.481)	(0.205)	(0.177)	(0.229)					
Exchange rate regime (floating=0)	0.291**	0.308***	0.152*	0.243**	0.275**					
	(0.119)	(0.102)	(0.082)	(0.117)	(0.132)					
Change in commodity export price (weighted) * Exchange rate regime	0.034**	0.0633**	0.165**	0.0678**	0.381					
	(0.014)	(0.0296)	(0.074)	(0.0304)	(0.566)					
Change in commodity import price (weighted) * Exchange rate regime	0.0718**	0.392	0.0275**	0.761	0.0237***					
	(0.0312)	(0.448)	(0.0139)	(0.918)	(0.0075)					
Change in top-3 commodity export prices (weighted)						0.282***	0.150***	0.222**	0.241***	-0.275
						(0.087)	(0.0382)	(0.097)	(0.069)	(3.089)
Change in non-top-3 commodity export prices (weighted)						0.102	0.0161	3.698	-0.137	-0.339
						(0.087)	(0.0804)	(3.795)	(2.275)	(0.264)
Change in top-3 commodity export price (weighted) * Exchange rate regime						0.047**	0.119**	0.0745**	0.161***	-0.0883
						(0.019)	(0.0514)	(0.035)	(0.0403)	(0.0925)
Change in non-top-3 commodity import price (weighted) * Exchange rate regime						0.0730	0.0861*	0.210	0.0306	0.0817
						(0.0848)	(0.0488)	(0.163)	(0.0599)	(0.0969)
Observations	1,167	719	396	218	282	1,167	719	396	218	282
Number of countries	97	56	33	17	22	97	56	33	17	22
Arellano-Bond AR(2): z=	-1.09	-1.24	-1.08	-1.07	-1.04					
Hansen J test: Chi^2(31)=	35.92	38.21	32.60	38.19	30.54					

Notes: All regressions include country- and year-effects. Robust standard errors in parentheses. *, **, and *** denote significance at the 10, 5, and 1 percent level.

TABLE 8. PANEL REGRESSIONS. DEPENDENT VARIABLE: CHANGE IN CENTRAL GOVERNMENT SOCIAL EXPENDITURE / GDP

	(1A)	(2A)	(3A)	(4A)	(5A)	(1B)	(2B)	(3B)	(4B)	(5B)
	Baseline–All commodity					Alternative–Top-3 commodity				
	LICs & MICs		LICs			LICs & MICs		LICs		
	All	Exporters	All LICs	Exporters	Importers	All	Exporters	All LICs	Exporters	Importers
Lag dependent variable: change in social spending-to-GDP	0.525***	0.277***	0.244***	0.312***	0.238***	0.471***	0.244***	0.171***	0.162***	0.397***
	(0.145)	(0.0784)	(0.0602)	(0.0680)	(0.065)	(0.0236)	(0.069)	(0.0617)	(0.0514)	(0.0671)
Change in commodity export prices, weighted	0.124	0.158*	0.277**	0.154**	0.109					
	(0.412)	(0.083)	(0.118)	(0.077)	(0.291)					
Change in commodity import prices, weighted	0.186	0.434	0.361***	0.207	0.483**					
	(0.321)	(0.610)	(0.065)	(0.335)	(0.224)					
Reserve assets	0.221	0.141**	0.628	0.155*	0.274					
	(0.188)	(0.061)	(0.806)	(0.083)	(0.229)					
Change in commodity export prices, weighted, * Reserve assets	0.147***	0.105**	0.714	0.124***	0.131***					
	(0.0281)	(0.0391)	(0.905)	(0.0345)	(0.0429)					
Change in commodity import prices, weighted, * Reserve assets	0.306*	0.157	0.276	0.115*	0.187*					
	(0.164)	(0.415)	(0.517)	(0.0621)	(0.112)					
Exchange rate regime (floating= 0)	0.0207	0.519	0.417	0.413**	-0.254					
	(0.427)	(0.905)	(1.019)	(0.206)	(0.617)					
Change in commodity export prices, weighted, * Exchange rate regime	-0.101	-0.0287**	-0.093**	0.291	-0.483					
	(0.284)	(0.0131)	(0.042)	(0.623)	(0.910)					
Change in commodity import prices, weighted, * Exchange rate regime	0.0297**	0.0298**	0.113**	0.237	0.0182**					
	(0.016)	(0.0145)	(0.054)	(0.505)	(0.010)					
Change in top-3 commodity export prices, weighted						0.231*	0.149*	0.101*	0.240**	-0.064*
						(0.122)	(0.078)	(0.054)	(0.097)	(0.036)
Change in non-top-3 commodity export prices, weighted						0.586	-0.119	0.557	0.232	0.944
						(0.539)	(0.381)	(3.671)	(0.464)	(0.755)
Change in top-3 commodity export price, weighted, * Exchange rate regime						0.177	0.0181	0.215*	0.179*	0.172
						(0.126)	(0.268)	(0.130)	(0.101)	(0.124)
Change in non-top-3 commodity export prices, weighted, * Exchange rate regime						-0.167	0.00142	-0.0548	0.128	-0.113
						(0.104)	(0.377)	(0.0731)	(0.118)	(0.0854)
Observations	1,080	643	462	794	874	1,080	643	462	794	874
Number of countries	112	63	48	59	88	112	63	48	59	88
Arellano-Bond AR(2): z=	-1.42	-1.11	-1.00	0.39	-1.06					
Hansen J test: Chi^2(41)=	44.07	47.18	41.05	40.35	42.81					

Notes: All regressions include country- and year-effects. Robust standard errors in parentheses. *, **, and *** denote significance at the 10, 5, and 1 percent level.

TABLE 9. PANEL REGRESSIONS. DEPENDENT VARIABLE: CHANGE IN CENTRAL GOVERNMENT FISCAL BALANCE / GDP

	(1A)	(2A)	(3A)	(4A)	(5A)	(1B)	(2B)	(3B)	(4B)	(5B)
	Baseline–All commodity					Alternative–Top-3 commodity				
	LICs & MICs		LICs			LICs & MICs		LICs		
	All	Exporters	All LICs	Exporters	Importers	All	Exporters	All LICs	Exporters	Importers
Lag dependent variable: change in fiscal balance-to-GDP	0.325***	0.220***	0.521***	0.388***	0.405***	0.292*	-0.362*	0.483***	0.413***	0.424***
	(0.104)	(0.0509)	(0.106)	(0.092)	(0.117)	(0.173)	(0.209)	(0.120)	(0.129)	(0.105)
Change in commodity export prices, weighted	-0.037***	0.017***	0.079***	0.085**	0.101					
	(0.006)	(0.004)	(0.019)	(0.034)	(0.220)					
Change in commodity import prices, weighted	0.059**	0.209	0.079**	-0.128	0.079**					
	(0.025)	(0.301)	(0.038)	(0.225)	(0.035)					
Reserve assets	-0.246*	0.0707	0.237	0.288*	-0.116*					
	(0.145)	(0.0701)	(0.504)	(0.155)	(0.064)					
Change in commodity export prices, weighted, * Reserve assets	0.0329	0.247	0.152	0.0232**	0.559					
	(0.0487)	(0.201)	(0.169)	(0.0111)	(0.671)					
Change in commodity import prices, weighted, * Reserve assets	1.097	0.0107	0.0431***	0.589	0.202**					
	(1.222)	(0.0309)	(0.0135)	(0.774)	(0.094)					
Exchange rate regime (floating= 0)	0.387**	0.219*	0.336**	0.413**	0.538**					
	(0.191)	(0.120)	(0.147)	(0.206)	(0.217)					
Change in commodity export prices, weighted, * Exchange rate regime	0.0274***	0.066**	0.0272*	0.0391**	0.114					
	(0.0077)	(0.031)	(0.0146)	(0.0170)	(0.192)					
Change in commodity import prices, weighted, * Exchange rate regime	0.329	0.279	0.0232*	0.187	0.0854**					
	(0.499)	(0.415)	(0.0129)	(0.313)	(0.0388)					
Change in top-3 commodity export prices, weighted						0.175***	0.138***	0.277**	0.264***	0.284*
						(0.046)	(0.0410)	(0.124)	(0.087)	(0.154)
Change in non-top-3 commodity export prices, weighted						-0.117	0.0573	-3.069	0.188	-0.624
						(0.115)	(0.0947)	(3.217)	(0.205)	(2.890)
Change in top-3 commodity export prices, weighted, * Exchange rate regime						0.0845**	0.0716*	0.0886*	0.0891*	0.0437
						(0.0311)	(0.0384)	(0.0468)	(0.0482)	(0.0994)
Change in non-top-3 commodity export prices, weighted, * Exchange rate regime						0.0164*	-0.00786	-0.203	-0.0499	-0.169**
						(0.00846)	(0.0205)	(0.131)	(0.0923)	(0.0851)
Observations	1,317	656	472	794	1069	1,317	656	472	794	1069
Number of countries	104	52	38	59	85	104	52	38	59	85
Arellano-Bond AR(2): z=	-1.27	-1.05	-1.20	-1.15	-1.20					
Hansen J test: Chi^2(35)=	34.00	30.28	30.49	30.14	36.21					

Notes: All regressions include country- and year-effects. Robust standard errors in parentheses. *, **, and *** denote significance at the 10, 5, and 1 percent level.

TABLE 10. CROSS-COUNTRY PANEL REGRESSIONS. DEPENDENT VARIABLE: CHANGE IN CENTRAL GOVERNMENT GROSS DEBT

	(1A)	(2A)	(3A)	(4A)	(5A)	(1B)	(2B)	(3B)	(4B)	(5B)
	Baseline–All commodity					Alternative–Top-3 commodity				
	LICs & MICs		LICs			LICs & MICs		LICs		
	All	Exporters	All LICs	Exporters	Importers	All	Exporters	All LICs	Exporters	Importers
Lag dependent variable: change in debt-to-GDP	0.241**	0.329***	0.210***	0.309***	0.327***	0.089***	0.368*	0.0502**	0.087**	0.095**
	(0.0921)	(0.089)	(0.045)	(0.097)	(0.090)	(0.026)	(0.221)	(0.022)	(0.042)	(0.0462)
Change in commodity export prices, weighted	0.156	0.0333	0.0503***	0.107**	0.442					
	(0.348)	(0.0283)	(0.015)	(0.044)	(0.579)					
Change in commodity import prices, weighted	0.0979*	0.408	0.125**	0.491	0.198**					
	(0.0521)	(0.773)	(0.0466)	(0.624)	(0.089)					
Reserve assets	-0.207*	-0.302**	0.114	-0.282**	-1.104					
	(0.111)	(0.128)	(0.899)	(0.116)	(1.253)					
Change in commodity export prices, weighted, * Reserve assets	-0.0237	0.063**	0.0317	-0.318	0.243					
	(0.0951)	(0.0240)	(0.287)	(1.204)	(1.647)					
Change in commodity import prices, weighted, * Reserve assets	-0.0457	-0.0166	-0.0085	-0.441	-0.519					
	(0.0881)	(0.0667)	(0.055)	(0.838)	(1.311)					
Exchange rate regime (floating= 0)	0.370**	0.216**	0.303*	0.286	0.226					
	(0.144)	(0.107)	(0.161)	(0.184)	(0.155)					
Change in commodity export prices, weighted, * Exchange rate regime	0.0201	0.0118	-0.519	-0.0147	-0.394					
	(0.884)	(0.0772)	(0.801)	(0.577)	(0.481)					
Change in commodity import prices, weighted, * Exchange rate regime	0.284	0.0163	0.243	0.447	0.0335**					
	(0.484)	(0.0823)	(0.813)	(0.570)	(0.018)					
Change in top-3 commodity export prices, weighted, * Exchange rate regime						-0.476	0.0461**	0.103**	0.068***	-0.589
						(0.694)	(0.0234)	(0.049)	(0.016)	(0.833)
Change in non-top-3 commodity export prices, weighted, * Exchange rate regime						-0.628	-0.116	-0.279	-0.100	0.0804
						(0.521)	(0.170)	(1.270)	(0.509)	(0.283)
Change in top-3 commodity export prices, weighted, * Exchange rate regime						0.226	-0.243	-0.225	0.0724**	0.231
						(0.366)	(0.244)	(0.642)	(0.0294)	(0.363)
Change in non-top-3 commodity export prices, weighted, * Exchange rate regime						-0.161	-0.149	-0.170	0.000730	-0.150
						(0.186)	(0.396)	(0.236)	(0.249)	(0.177)
Observations	906	476	382	511	752	906	476	382	511	752
Number of countries	116	61	49	60	95	116	61	49	60	95
Arellano-Bond AR(2): z=	-1.50	-1.07	-1.73	-0.81	-1.29					
Hansen J test: Chi^2(39)=	46.70	30.23	30.18	23.95	47.11					

Notes: All regressions include country- and year-effects. Robust standard errors in parentheses. *, **, and *** denote significance at the 10, 5, and 1 percent level.

TABLE 11. BASIS RISK: CROSS-COUNTRY PANEL REGRESSION ANALYSIS.
Dependent Variable: Log Country-Specific Commodity Prices. Independent Variable: Log World Commodity Prices.

Commodity Group	Average β Coefficient	% of commodities s.t. p-value for β=0 < 10%	% of commodities s.t. p-value for β=1 < 10%	Avg R^2	Avg Countries	Number of commodities	Avg Obs
Food	0.50	95	100	0.47	92	23	1,566
Agricultural Raw Materials	1.46	100	100	0.34	89	7	1,481
Metals	0.74	100	75	0.49	93	8	1,568
Fuel	0.82	100	100	0.49	83	2	1,868

Notes: For each commodity, we carry out a panel unit-root test on the country-specific commodity prices. Where the unit-root null is rejected, we estimate a panel regression of the country-specific commodity prices on the benchmark world commodity price, controlling for country fixed effects. Where the unit-root null is not rejected, we estimate a cointegrating relationship between the country-specific commodity prices and the benchmark world commodity price, using the Pedroni (2000) heterogeneous-panel FM-OLS estimator. The results presented are averages for each commodity group; see Appendix III for results for each commodity.

TABLE 12. CHANGES IN COMMODITY EXPORTS: RELATIVE CONTRIBUTIONS OF PRICE VERSUS VOLUME CHANGES (PERCENT).

	Price change	Volume change
	During 1990–2010	
All Developing countries	59.7	40.3
Non-fuel exporters	62.0	38.0
Fuel exporters	67.3	32.7
All commodity exporters	60.5	39.5
All LICs	63.0	37.0
Non-fuel exporters	60.7	39.3
Fuel exporters	52.1	47.9
All commodity exporters	61.0	39.0
All commodity exporters	61.0	39.0
	During 2000–10	
All Developing countries	64.5	35.5
Non-fuel exporters	60.9	39.1
Fuel exporters	70.0	30.0
All commodity exporters	66.4	33.6
All LICs	64.0	36.0
Non-fuel exporters	59.3	40.7
Fuel exporters	57.3	42.7
All commodity exporters	58.7	41.3

TABLE 13. VARIANCE OF COMMODITY EXPORTS: DECOMPOSITION INTO VARIANCES OF PRICES VERSUS VOLUMES (PERCENT).[15]

	Pure Price Effect	Pure Volume Effect	Price and Volume Correlation Effect
		During 1990–2010	
All Developing countries	69.5	8.2	22.3
Non-fuel exporters	72.3	6.2	21.4
Fuel exporters	73.5	10.4	16.2
All commodity exporters	75.9	6.8	17.3
All LICs	82.8	4.2	13.0
Non-fuel exporters	69.9	8.2	21.9
Fuel exporters	27.4	49.2	23.4
All commodity exporters	72.2	7.4	20.4
		During 2000–10	
All Developing countries	65.2	5.6	29.3
Non-fuel exporters	74.4	3.2	22.4
Fuel exporters	77.5	3.0	19.5
All commodity exporters	77.1	2.6	20.3
All LICs	83.7	5.3	11.0
Non-fuel exporters	78.7	4.6	16.6
Fuel exporters	21.2	45.3	33.5
All commodity exporters	82.7	3.4	13.9

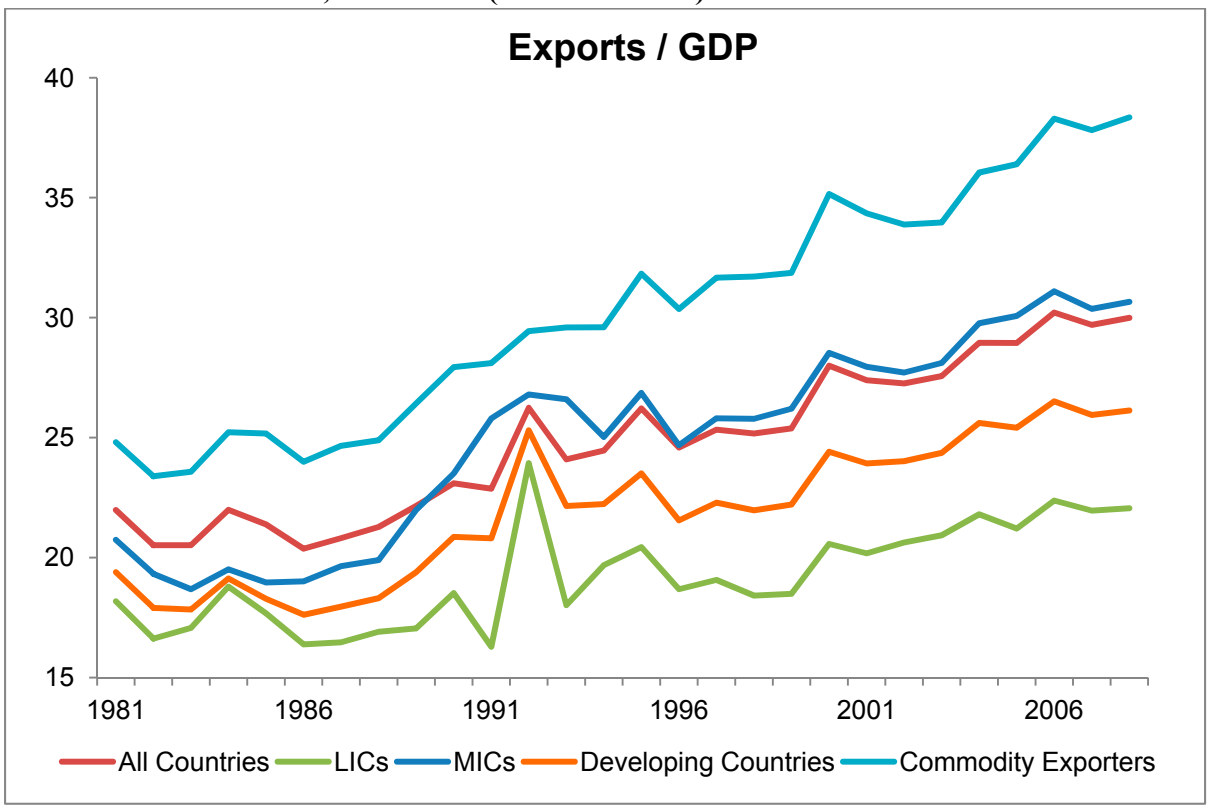
TABLE 14. CORRELATIONS BETWEEN CHANGE IN COMMODITY EXPORT PRICES AND CHANGE IN COMMODITY IMPORT PRICES, 1990–2010

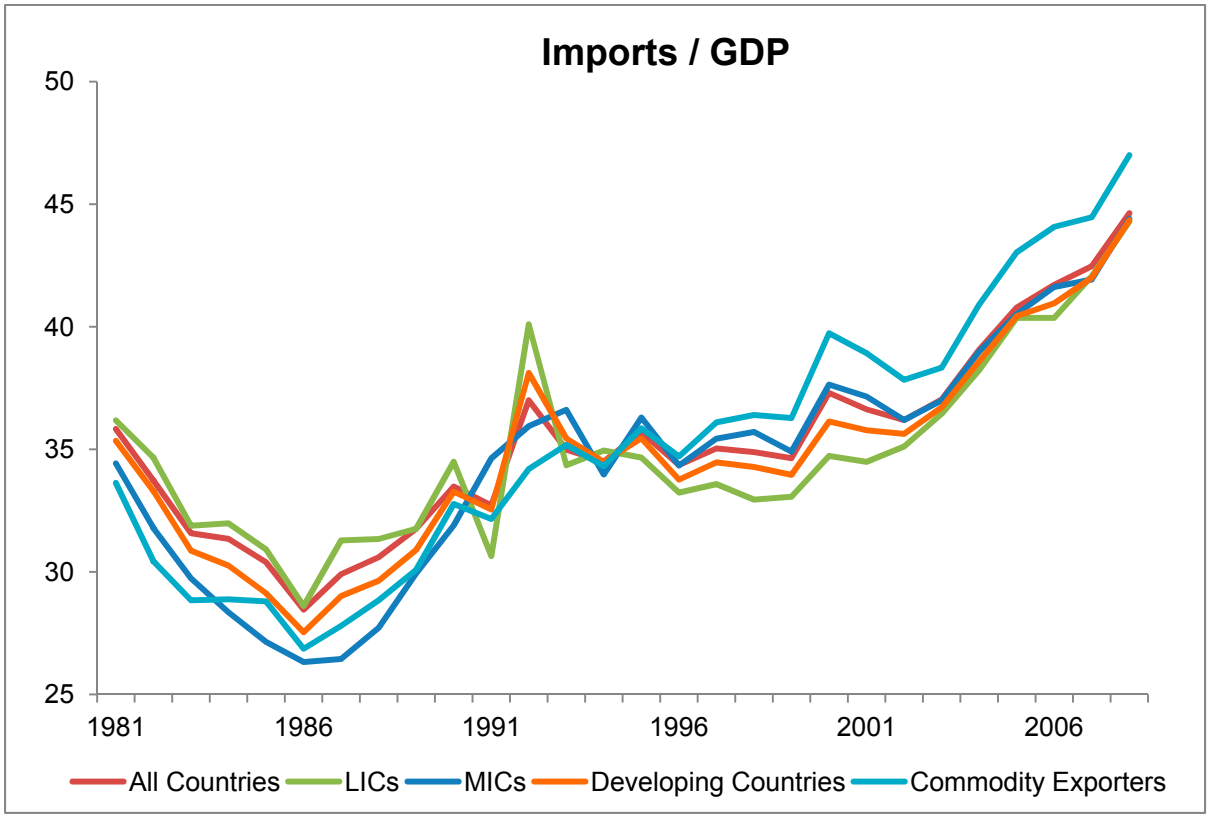
GROUP	CORRELATION
MICs and LICs	0.53
MIC and LIC Commodity Exporters	0.61
LICs	0.48
LIC Commodity Exporters	0.67
LIC Commodity Importers	0.68

Notes: Sample includes 85 MICs and 47 LICs. The coefficients control for country effects.

[15] Specifically, we use the identity: ln (Commodity Exports) ≡ ln (Commodity Price Index) + ln (Commodity Volumes). We then take variances on both sides, and express the variance of the RHS as the sum of the relevant individual variances and covariances.

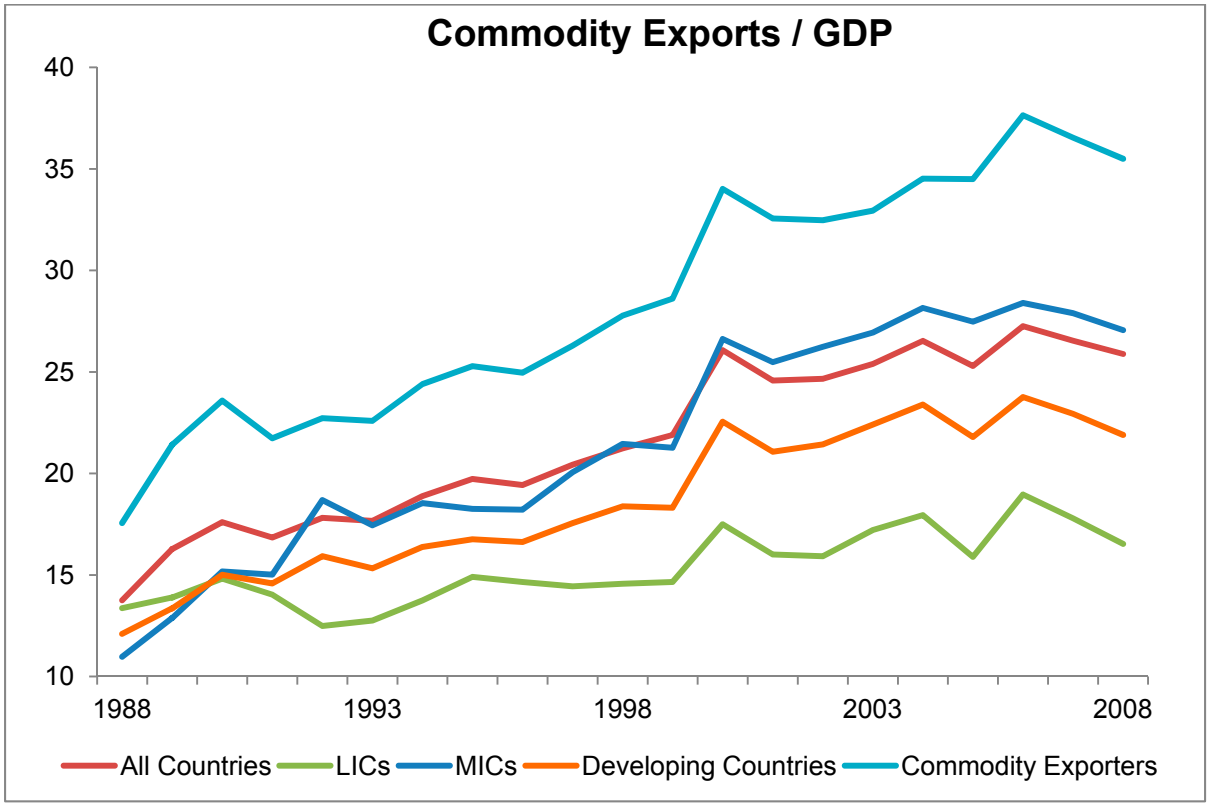
FIGURE 1. TRADE / GDP, 1981–2008 (MEAN VALUES)

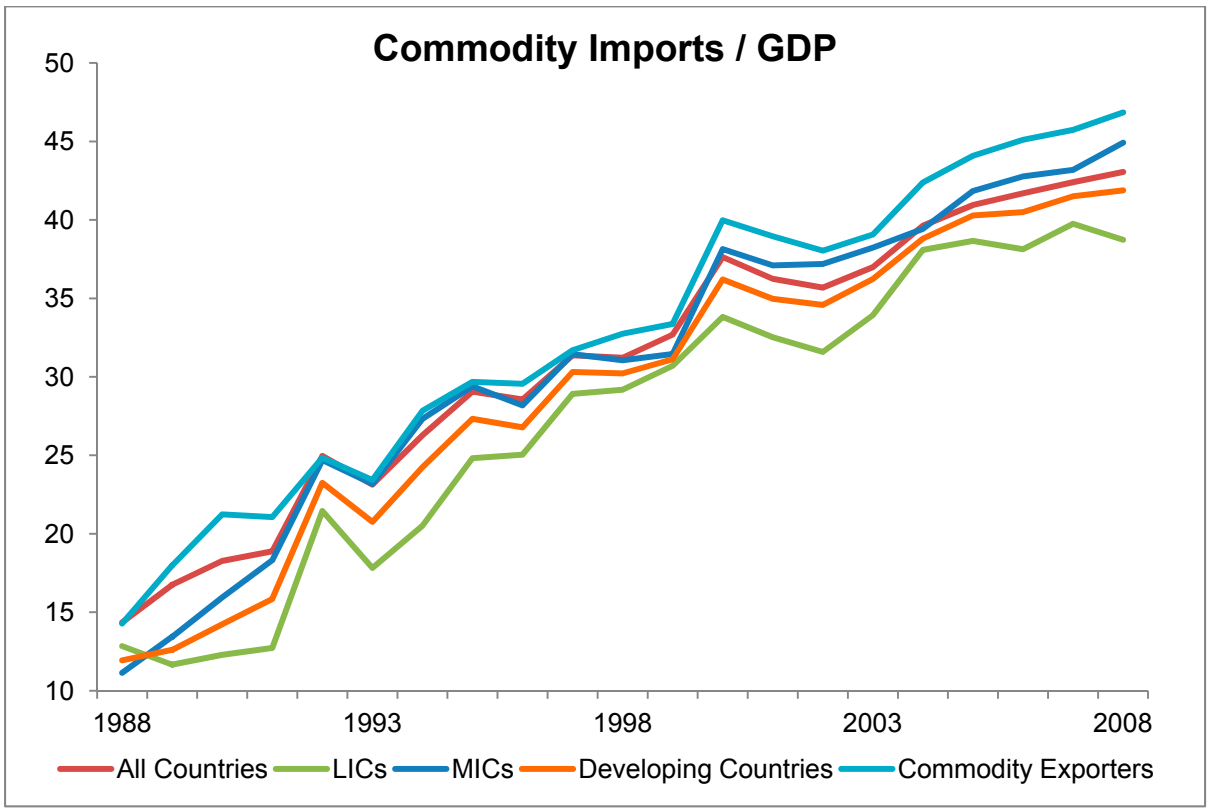




Source: IFS; WEO; World Bank; Commodity Prices Database; and COMTRADE/WITS.

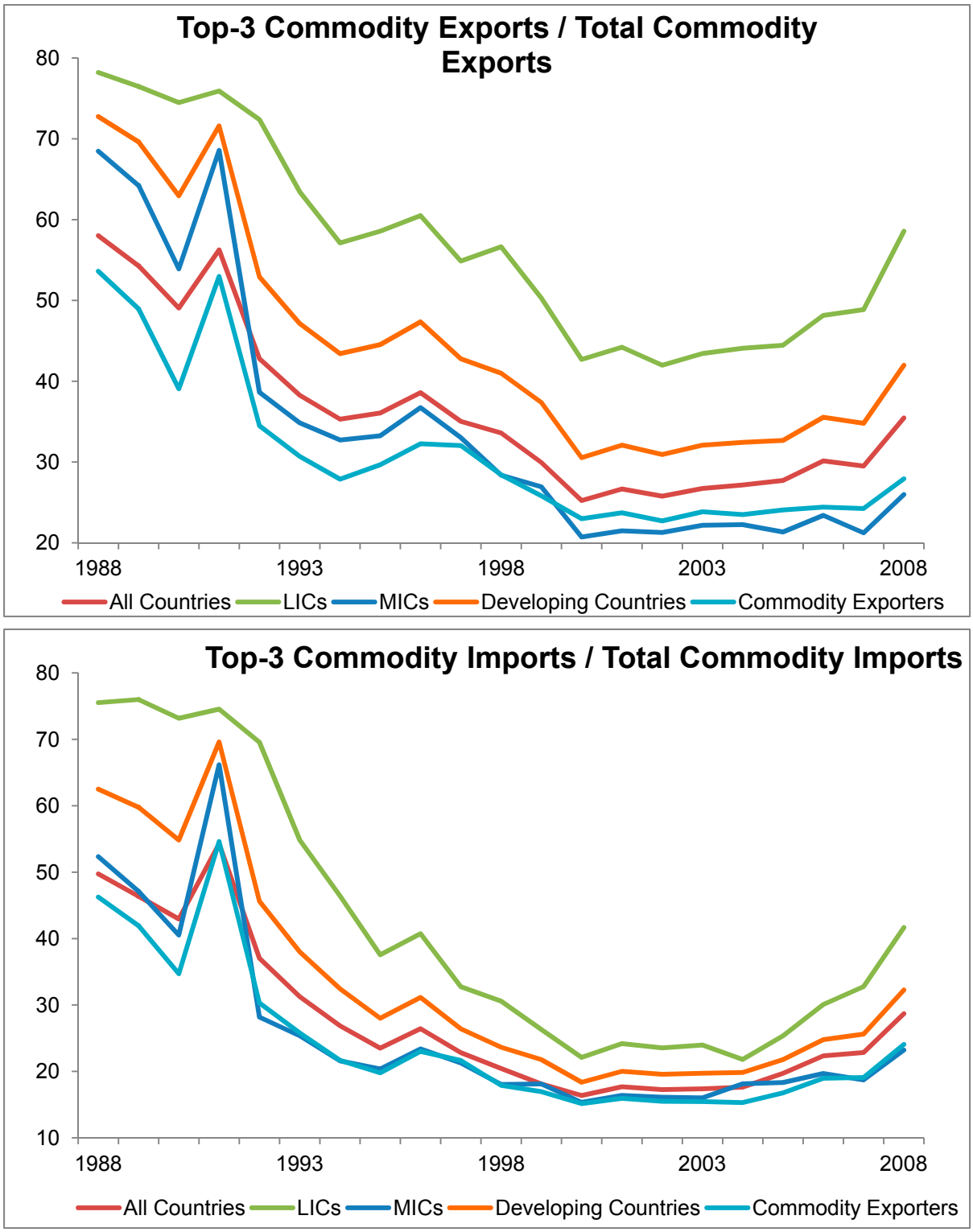
FIGURE 2. COMMODITY TRADE / GDP, 1988–2008 (MEAN VALUES).





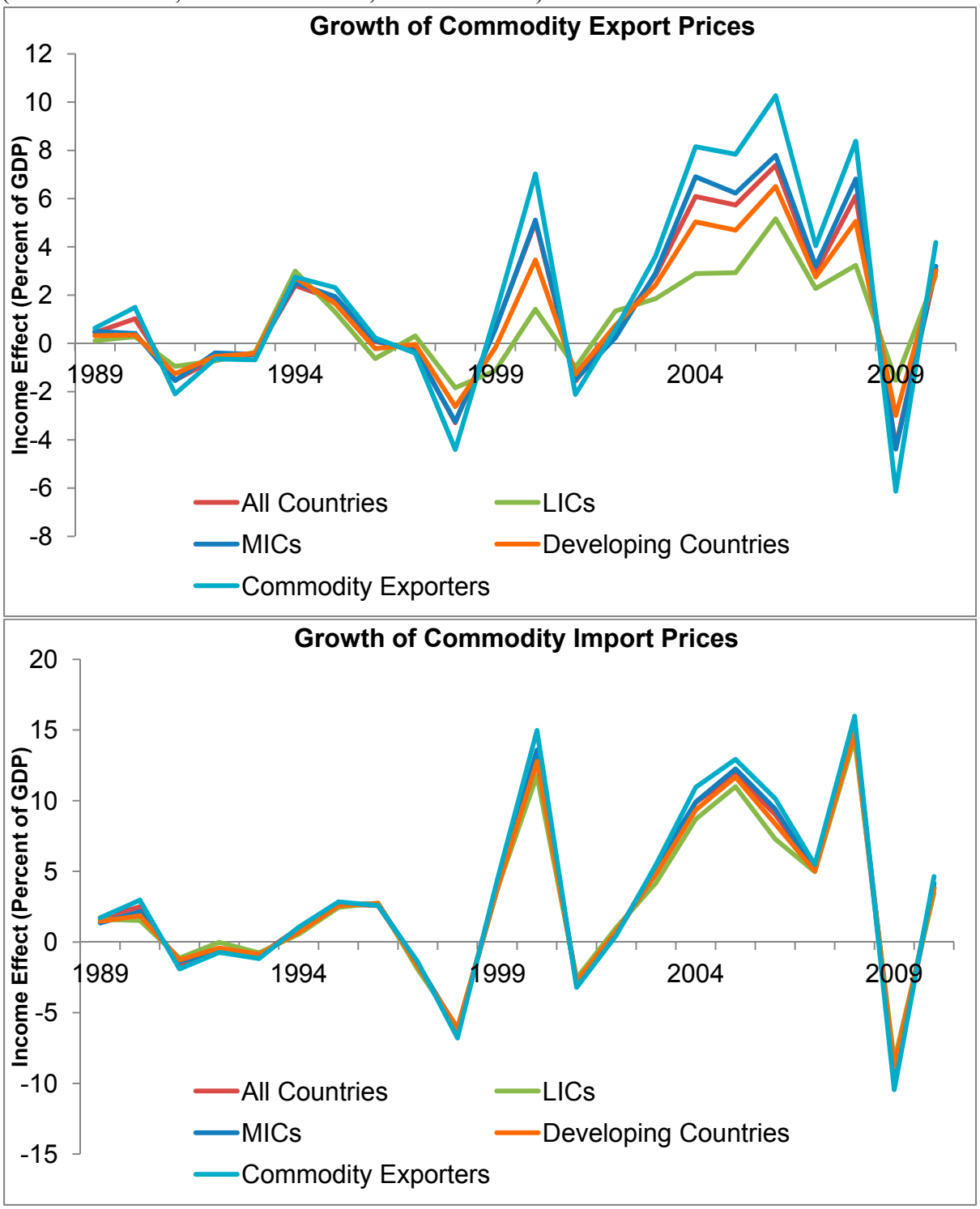
Source: IFS; WEO; World Bank; Commodity Prices Database; and COMTRADE/WITS.

FIGURE 3. SHARE OF TOP 3 COMMODITIES IN TOTAL COMMODITY TRADE, 1988–2008 (MEAN VALUES).



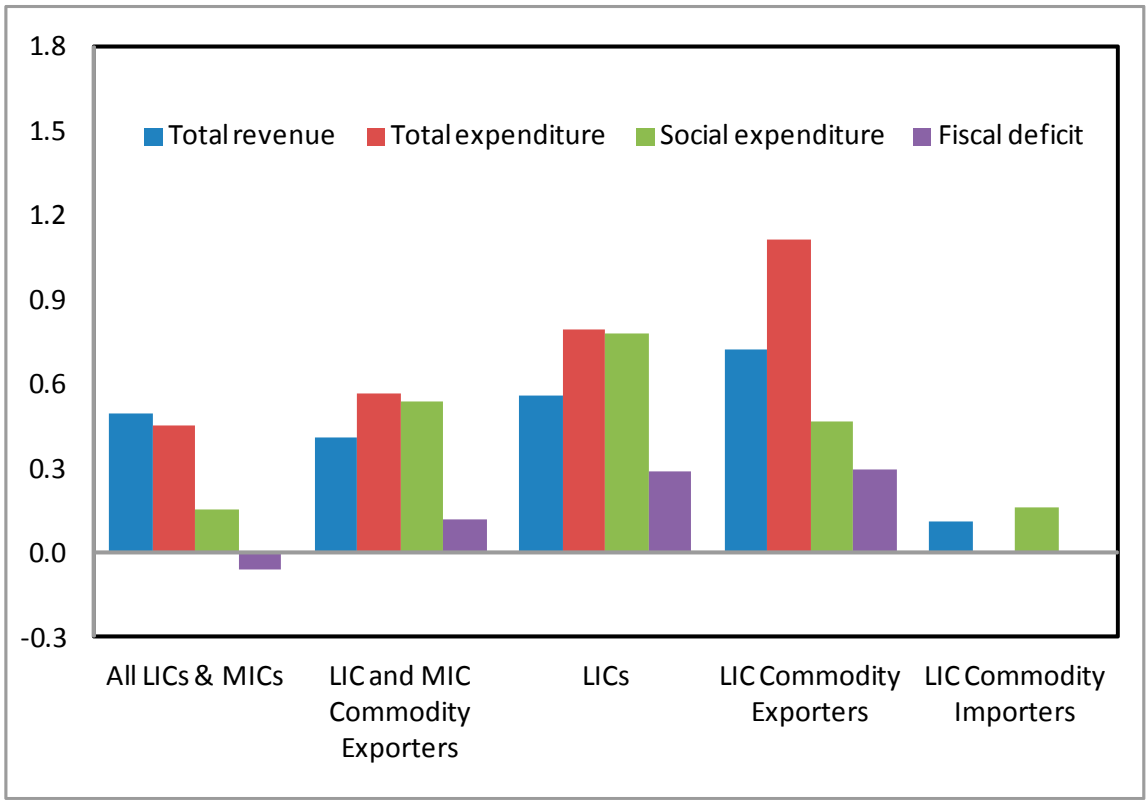
Source: IFS; WEO; World Bank; Commodity Prices Database; and COMTRADE/WITS.

FIGURE 4. GROWTH RATES OF COMMODITY EXPORT AND IMPORT PRICES, 1989–2010 (INCOME EFFECT, PERCENT OF GDP, MEAN VALUES).



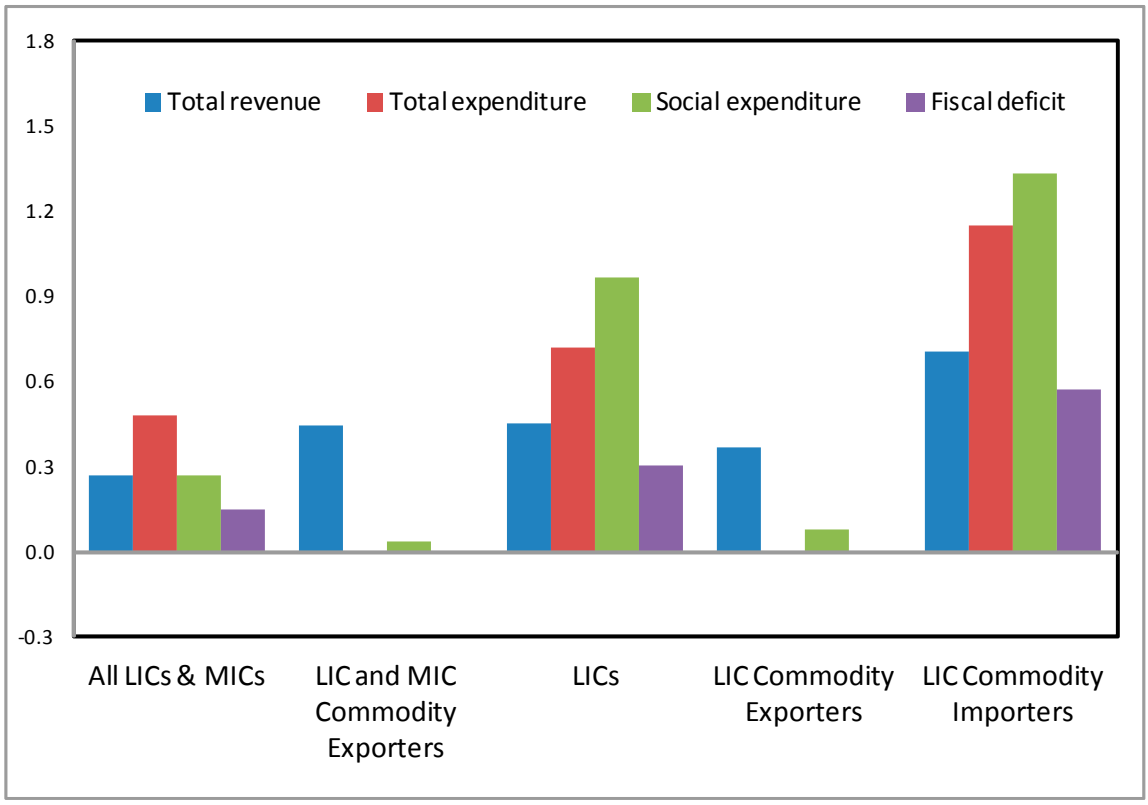
Source: IFS; WEO; World Bank; Commodity Prices Database; and COMTRADE/WITS.
Notes: Income effect is calculated as the growth rate of commodity export (or import) prices, multiplied by the share of commodity exports (or imports) in GDP.

FIGURE 5. SHORT-RUN RESPONSE OF FISCAL OUTCOMES TO A 10 PERCENT INCREASE IN COMMODITY EXPORT PRICES (PERCENTAGE POINTS OF GDP).



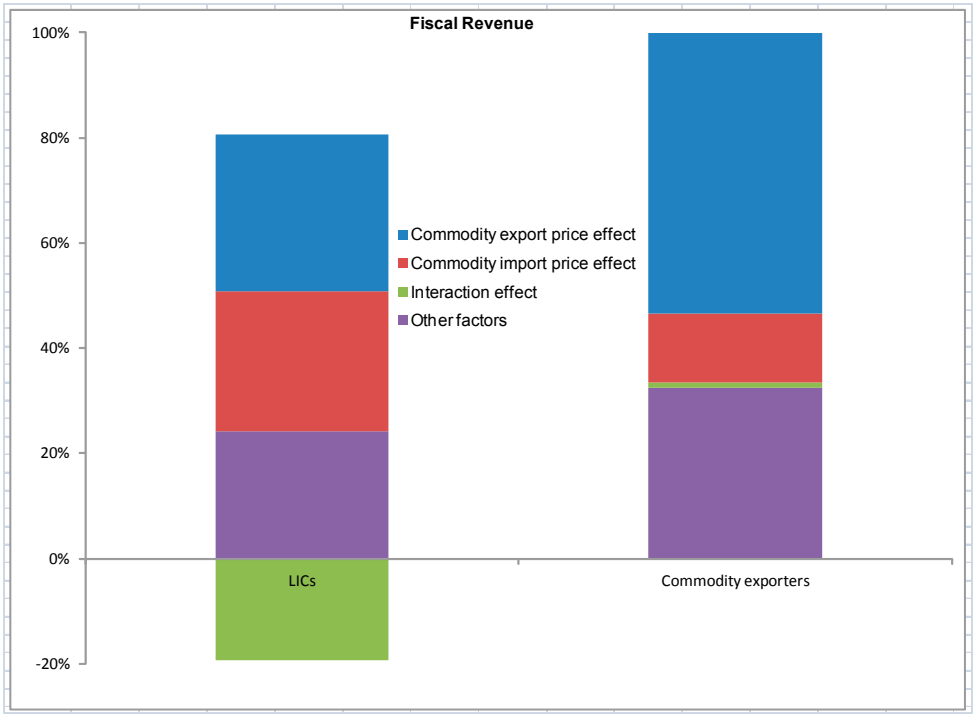
Source: IFS; WEO; World Bank; Commodity Prices Database; COMTRADE/WITS; and IMF staff estimates.
Notes: Depicts Arellano-Bond estimates of the average short run effects over 1990–2010 of a 10 percent increase in commodity export prices in a benchmark economy, where commodity exports / GDP equal 20 percent.

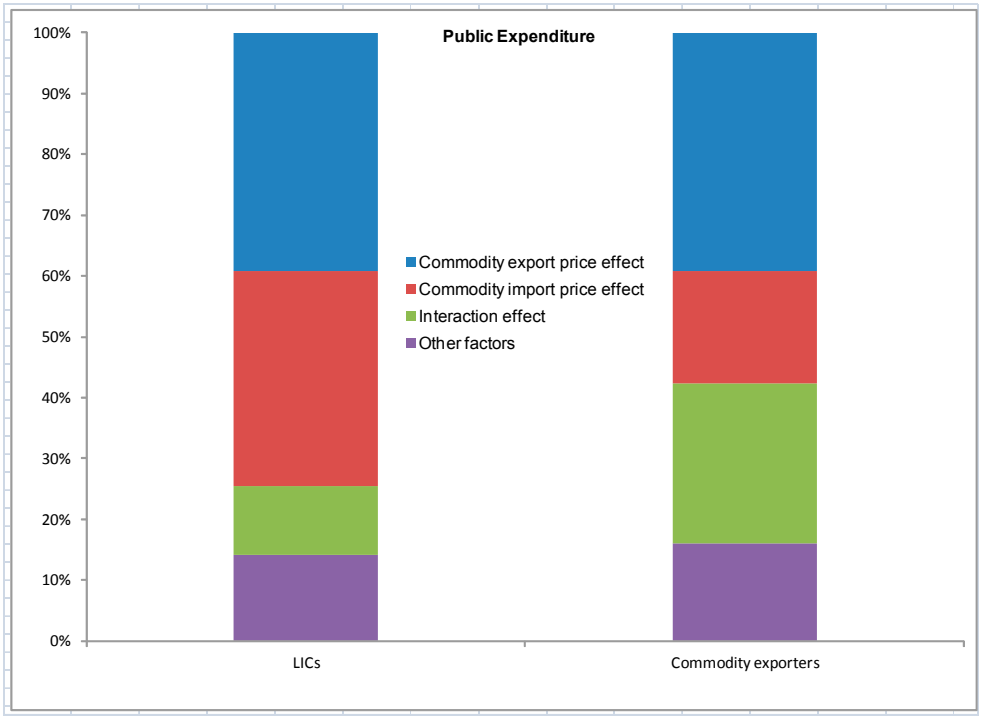
FIGURE 6. SHORT-RUN RESPONSE OF FISCAL OUTCOMES TO A 10 PERCENT INCREASE IN COMMODITY IMPORT PRICES (PERCENTAGE POINT OF GDP).

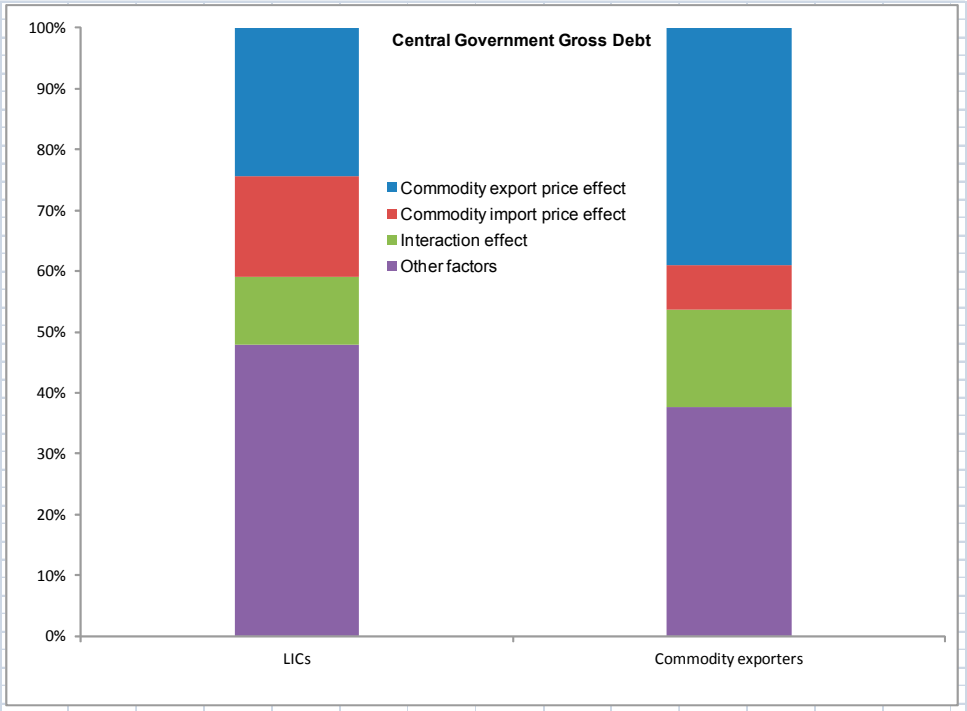


Source: IFS; WEO; World Bank; Commodity Prices Database; COMTRADE/WITS; and IMF staff estimates.
Notes: Depicts Arellano-Bond estimates of the average short run effects over 1990–2010 of a 10 percent increase in commodity import prices in a benchmark economy, where commodity imports / GDP equal 20 percent.

FIGURE 7. CONTRIBUTIONS OF COMMODITY PRICES TO CHANGES IN FISCAL OUTCOMES: VARIANCE DECOMPOSITION.







Source: IFS; WEO; World Bank; Commodity Prices Database; COMTRADE/WITS; and IMF staff estimates.

APPENDIX I: DATA DESCRIPTION AND SOURCES

Revenue: Government tax revenue, non tax revenue, and grants as share of GDP (percent). Source: IMF, *World Economic Outlook*.

Social spending: Government education spending and Government health spending as share of GDP. Source: IMF Fiscal Affairs Department.

Fiscal deficit: Government total expenditure minus government revenue (including grants) as share of GDP (percent). Source: IMF, *World Economic Outlook*.

Debt: Government gross debt as a share of GDP (percent). Source: IMF, *World Economic Outlook*.

Reserves: International Reserves in percent of prospective (subsequent year) import of goods and Services. IMF, *World Economic Outlook*; authors' calculations.

Exchange rate regime: floating = 0, fixed = 1 (based on the Exchange Rate Classification in Ilzetzki et al., 2009).

Commodity exports and ***commodity imports***. Source: UN COMTRADE. List of commodities:

Commodity type	*Commodities included*
Food	Bananas; Barley; Beef *; Chicken; Cocoa; Coconut Oil; Coffee; Corn; Fish; Fish Meal; Ground Nuts; Olive Oil; Orange; Pork; Rapeseed Oil; Rice; Shrimp; Soybean Meal; Soybean Oil; Soybeans; Sugar; Sunflower Oil; Tea; Wheat
Agricultural Raw Materials	Cotton; Hard Log; Hard Sawn; Rubber; Soft Log; Soft Sawn; Wool
Metals	Aluminum; Copper; Gold; Iron; Lead; Nickel; Tin; Zinc; Fuel
Fuel	Coal; Crude oil

Commodity exporter: = 1 if average commodity exports to GDP over 2005–09 exceed 20 percent. Sources: IMF, World Economic Outlook.

Commodity importer: = 1 if average commodity imports to GDP over 2005–09 exceed 20 percent. IMF, World Economic Outlook.

Commodity Export Price Index: For each country and year, a weighted average of the growth rate of commodity prices is constructed, using weights given by the ratio of exports of the given commodity to total commodity exports.

Commodity Import Price Index: For each country and year, a weighted average of the growth rate of commodity prices is constructed, using weights given by the ratio of imports of the given commodity to total commodity imports.

Commodity Export Price Index (2005=100), Weighted by Total Commodity Exports to GDP: For each country and year, constructed by multiplying the growth rate of the commodity export price index by total commodity exports to GDP.

Commodity Import Price Index (2005=100), Weighted by Total Commodity Imports to GDP*:* For each country and year, constructed by multiplying the growth rate of the commodity import price index by total commodity imports to GDP.

APPENDIX II: COUNTRY GROUPINGS[1/]

Country	Region	Income Group
Afghanistan	South Asia	Low income
Albania	Europe & Central Asia	Upper middle income
Algeria	Middle East & North Africa	Upper middle income
American Samoa	East Asia & Pacific	Upper middle income
Angola	Sub-Saharan Africa	Lower middle income
Antigua and Barbuda	Latin America & Caribbean	Upper middle income
Argentina	Latin America & Caribbean	Upper middle income
Armenia	Europe & Central Asia	Lower middle income
Azerbaijan	Europe & Central Asia	Upper middle income
Bangladesh	South Asia	Low income
Belarus	Europe & Central Asia	Upper middle income
Belize	Latin America & Caribbean	Lower middle income
Benin	Sub-Saharan Africa	Low income
Bhutan	South Asia	Lower middle income
Bolivia	Latin America & Caribbean	Lower middle income
Bosnia and Herzegovina	Europe & Central Asia	Upper middle income
Botswana	Sub-Saharan Africa	Upper middle income
Brazil	Latin America & Caribbean	Upper middle income
Bulgaria	Europe & Central Asia	Upper middle income
Burkina Faso	Sub-Saharan Africa	Low income
Burundi	Sub-Saharan Africa	Low income
Cambodia	East Asia & Pacific	Low income
Cameroon	Sub-Saharan Africa	Lower middle income
Cape Verde	Sub-Saharan Africa	Lower middle income
Central African Republic	Sub-Saharan Africa	Low income
Chad	Sub-Saharan Africa	Low income
Chile	Latin America & Caribbean	Upper middle income
China	East Asia & Pacific	Upper middle income
Colombia	Latin America & Caribbean	Upper middle income
Comoros	Sub-Saharan Africa	Low income
Congo, Dem. Rep.	Sub-Saharan Africa	Low income
Congo, Rep.	Sub-Saharan Africa	Lower middle income
Costa Rica	Latin America & Caribbean	Upper middle income
Côte d'Ivoire	Sub-Saharan Africa	Lower middle income
Cuba	Latin America & Caribbean	Upper middle income
Djibouti	Middle East & North Africa	Lower middle income
Dominica	Latin America & Caribbean	Upper middle income
Dominican Republic	Latin America & Caribbean	Upper middle income
Ecuador	Latin America & Caribbean	Upper middle income
Egypt, Arab Rep.	Middle East & North Africa	Lower middle income
El Salvador	Latin America & Caribbean	Lower middle income
Eritrea	Sub-Saharan Africa	Low income
Ethiopia	Sub-Saharan Africa	Low income
Fiji	East Asia & Pacific	Lower middle income
Gabon	Sub-Saharan Africa	Upper middle income
Gambia, The	Sub-Saharan Africa	Low income

Georgia	Europe & Central Asia	Lower middle income
Ghana	Sub-Saharan Africa	Lower middle income
Grenada	Latin America & Caribbean	Upper middle income
Guatemala	Latin America & Caribbean	Lower middle income
Guinea	Sub-Saharan Africa	Low income
Guinea-Bissau	Sub-Saharan Africa	Low income
Guyana	Latin America & Caribbean	Lower middle income
Haiti	Latin America & Caribbean	Low income
Honduras	Latin America & Caribbean	Lower middle income
India	South Asia	Lower middle income
Indonesia	East Asia & Pacific	Lower middle income
Iran, Islamic Rep.	Middle East & North Africa	Upper middle income
Iraq	Middle East & North Africa	Lower middle income
Jamaica	Latin America & Caribbean	Upper middle income
Jordan	Middle East & North Africa	Upper middle income
Kazakhstan	Europe & Central Asia	Upper middle income
Kenya	Sub-Saharan Africa	Low income
Kiribati	East Asia & Pacific	Lower middle income
Korea, Dem. Rep.	East Asia & Pacific	Low income
Kosovo	Europe & Central Asia	Lower middle income
Kyrgyz Republic	Europe & Central Asia	Low income
Lao PDR	East Asia & Pacific	Lower middle income
Latvia	Europe & Central Asia	Upper middle income
Lebanon	Middle East & North Africa	Upper middle income
Lesotho	Sub-Saharan Africa	Lower middle income
Liberia	Sub-Saharan Africa	Low income
Libya	Middle East & North Africa	Upper middle income
Lithuania	Europe & Central Asia	Upper middle income
Macedonia, FYR	Europe & Central Asia	Upper middle income
Madagascar	Sub-Saharan Africa	Low income
Malawi	Sub-Saharan Africa	Low income
Malaysia	East Asia & Pacific	Upper middle income
Maldives	South Asia	Upper middle income
Mali	Sub-Saharan Africa	Low income
Marshall Islands	East Asia & Pacific	Lower middle income
Mauritania	Sub-Saharan Africa	Lower middle income
Mauritius	Sub-Saharan Africa	Upper middle income
Mayotte	Sub-Saharan Africa	Upper middle income
Mexico	Latin America & Caribbean	Upper middle income
Micronesia, Fed. Sts.	East Asia & Pacific	Lower middle income
Moldova	Europe & Central Asia	Lower middle income
Mongolia	East Asia & Pacific	Lower middle income
Montenegro	Europe & Central Asia	Upper middle income
Morocco	Middle East & North Africa	Lower middle income
Mozambique	Sub-Saharan Africa	Low income
Myanmar	East Asia & Pacific	Low income
Namibia	Sub-Saharan Africa	Upper middle income
Nepal	South Asia	Low income
Nicaragua	Latin America & Caribbean	Lower middle income
Niger	Sub-Saharan Africa	Low income

Nigeria	Sub-Saharan Africa	Lower middle income
Pakistan	South Asia	Lower middle income
Palau	East Asia & Pacific	Upper middle income
Panama	Latin America & Caribbean	Upper middle income
Papua New Guinea	East Asia & Pacific	Lower middle income
Paraguay	Latin America & Caribbean	Lower middle income
Peru	Latin America & Caribbean	Upper middle income
Philippines	East Asia & Pacific	Lower middle income
Romania	Europe & Central Asia	Upper middle income
Russian Federation	Europe & Central Asia	Upper middle income
Rwanda	Sub-Saharan Africa	Low income
Samoa	East Asia & Pacific	Lower middle income
São Tomé and Principe	Sub-Saharan Africa	Lower middle income
Senegal	Sub-Saharan Africa	Lower middle income
Serbia	Europe & Central Asia	Upper middle income
Seychelles	Sub-Saharan Africa	Upper middle income
Sierra Leone	Sub-Saharan Africa	Low income
Solomon Islands	East Asia & Pacific	Lower middle income
Somalia	Sub-Saharan Africa	Low income
South Africa	Sub-Saharan Africa	Upper middle income
South Sudan	Sub-Saharan Africa	Not classified
Sri Lanka	South Asia	Lower middle income
St. Kitts and Nevis	Latin America & Caribbean	Upper middle income
St. Lucia	Latin America & Caribbean	Upper middle income
St. Vincent and the Grenadines	Latin America & Caribbean	Upper middle income
Sudan	Sub-Saharan Africa	Lower middle income
Suriname	Latin America & Caribbean	Upper middle income
Swaziland	Sub-Saharan Africa	Lower middle income
Syrian Arab Republic	Middle East & North Africa	Lower middle income
Tajikistan	Europe & Central Asia	Low income
Tanzania	Sub-Saharan Africa	Low income
Thailand	East Asia & Pacific	Upper middle income
Timor-Leste	East Asia & Pacific	Lower middle income
Togo	Sub-Saharan Africa	Low income
Tonga	East Asia & Pacific	Lower middle income
Tunisia	Middle East & North Africa	Upper middle income
Turkey	Europe & Central Asia	Upper middle income
Turkmenistan	Europe & Central Asia	Lower middle income
Tuvalu	East Asia & Pacific	Lower middle income
Uganda	Sub-Saharan Africa	Low income
Ukraine	Europe & Central Asia	Lower middle income
Uruguay	Latin America & Caribbean	Upper middle income
Uzbekistan	Europe & Central Asia	Lower middle income
Vanuatu	East Asia & Pacific	Lower middle income
Venezuela, RB	Latin America & Caribbean	Upper middle income
Vietnam	East Asia & Pacific	Lower middle income
West Bank and Gaza	Middle East & North Africa	Lower middle income
Yemen, Rep.	Middle East & North Africa	Lower middle income
Zambia	Sub-Saharan Africa	Lower middle income
Zimbabwe	Sub-Saharan Africa	Low income

APPENDIX III: SUMMARY STATISTICS

All LICs and MICS, 1990–2010

	Obs	Mean	Std. Dev.	Min	Max
			(Percent of GDP)		
Revenue	3100	21.1	15.6	6.9	46.9
Tax	1358	15.2	17.9	5.1	38.0
Expenditure	3220	25.2	17.4	12.2	45.5
Social expenditure	2067	6.6	3.6	5.0	28.5
Fiscal balance	3640	-3.0	14.1	-14.3	7.6
Debt	1700	53.1	6.6	11.0	98.1
			(Change in ratio to GDP)		
Revenue	2914	0.2	11.1	-4.5	2.8
Tax	1223	0.0	13.4	-3.3	3.7
Expenditure	3026	0.2	11.4	-1.5	4.1
Social expenditure	1875	0.1	1.2	-1.7	1.2
Fiscal balance	3455	0.0	11.9	-5.0	3.4
Debt	1547	0.6	6.7	-2.0	4.6

LIC and MIC Commodity Exporters, 1990–2010

	Obs	Mean	Std. Dev.	Min	Max
			(Percent of GDP)		
Revenue	1600	23.3	16.5	20.0	46.9
Tax	752	15.1	16.3	8.6	38.0
Expenditure	1655	26.5	16.5	18.7	43.3
Social expenditure	1026	6.8	2.9	9.9	17.3
Fiscal balance	1886	-3.0	16.0	-8.3	7.6
Debt	836	49.1	8.2	11.4	77.3
			(Change in ratio to GDP)		
Revenue	1512	0.2	14.9	-4.5	2.8
Tax	688	0.0	12.8	-3.3	3.7
Expenditure	1567	0.1	15.0	-1.1	2.2
Social expenditure	937	0.1	1.0	-0.4	1.2
Fiscal balance	1797	0.0	6.5	-4.8	7.6
Debt	760	0.3	6.2	-1.6	4.7

LICs, 1990–2010

	Obs	Mean	Std. Dev.	Min	Max
			(Ratio to GDP, percent)		
Revenue	1275	17.8	14.1	6.9	30.9
Tax	446	13.9	18.1	5.1	28.7
Expenditure	1299	23.4	17.5	12.2	34.3
Social expenditure	984	6.5	4.2	5.0	16.1
Fiscal balance	1472	-3.5	7.4	-14.3	8.4
Debt	586	70.6	8.3	11.0	98.1
			(Change in ratio to GDP)		
Revenue	1187	0.2	4.0	-4.5	2.0
Tax	392	0.2	11.9	-3.3	1.6
Expenditure	1203	0.2	7.2	-1.5	4.1
Social expenditure	900	0.1	1.4	-1.7	1.7
Fiscal balance	1384	0.0	7.7	-5.0	2.7
Debt	520	0.8	5.2	-2.0	4.6

LIC Commodity Exporters, 1990–2010

	Obs	Mean	Std. Dev.	Min	Max
			(Ratio to GDP, percent)		
Revenue	371	19.1	8.9	20.0	30.9
Tax	147	13.5	4.1	8.6	28.7
Expenditure	382	26.8	15.0	18.7	34.3
Social expenditure	312	10.4	3.2	9.9	16.1
Fiscal balance	429	-4.2	9.5	-8.3	8.4
Debt	154	35.3	6.4	11.4	77.3
			(Change in ratio to GDP)		
Revenue	351	0.1	5.2	-4.5	2.0
Tax	132	0.2	1.8	-3.3	1.6
Expenditure	360	0.0	11.4	-1.1	2.2
Social expenditure	290	0.1	1.1	-0.4	0.8
Fiscal balance	407	0.0	8.7	-4.8	2.7
Debt	131	1.4	7.0	-1.6	3.9

LIC Commodity Importers, 1990–2010

	Obs	Mean	Std. Dev.	Min	Max
			(Ratio to GDP, percent)		
Revenue	788	19.4	14.9	6.9	25.2
Tax	289	13.7	4.1	5.1	20.9
Expenditure	816	21.0	19.6	12.2	29.2
Social expenditure	648	5.4	4.3	5.0	8.5
Fiscal balance	917	-3.9	16.5	-14.3	2.6
Debt	405	42.5	35.1	11.0	95.0
			(Change in ratio to GDP)		
Revenue	733	0.1	4.1	-4.5	1.4
Tax	255	0.2	1.7	-3.3	1.4
Expenditure	761	0.3	8.4	-1.5	4.1
Social expenditure	595	0.2	1.4	-1.7	1.7
Fiscal balance	864	-0.1	4.1	-5.0	1.4
Debt	357	1.2	3.3	-2.0	4.6

APPENDIX IV: ADDITIONAL RESULTS

TABLE 15. BASIS RISK: CROSS-COUNTRY STATIONARY PANEL REGRESSION ANALYSIS.
Dependent Variable: Log Country-Specific Commodity Prices. Independent Variable: Log World Commodity Prices.

Commodity	β	SE (β)	R^2	Countries	Observations
Food					
Bananas	0.37	0.06	0.64	82	1,399
Barley	0.64	0.06	0.59	86	1,499
Beef *	0.56	0.16	NA	21	456
Chicken	0.47	0.08	0.61	24	429
Cocoa	0.70	0.04	0.51	84	1,454
Coconut Oil	0.54	0.06	0.43	41	719
Coffee	0.54	0.03	0.64	111	1,899
Corn	0.53	0.07	0.53	99	1,663
Fish	0.24	0.11	0.70	135	2,238
Fish Meal	0.53	0.05	0.31	71	1,201
Ground Nuts	0.59	0.07	0.59	64	1,089
Olive Oil	0.59	0.08	0.34	59	1,053
Orange	0.16	0.05	0.34	102	1,812
Pork	0.12	0.14	0.39	12	214
Rapeseed Oil	0.56	0.06	0.42	53	892
Rice	0.55	0.05	0.39	106	1,791
Shrimp	0.10	0.05	0.47	95	1,635
Soybean Meal	0.65	0.07	0.35	68	1,072
Soybean Oil	0.68	0.05	0.37	87	1,436
Soybeans	0.72	0.07	0.49	65	1,139
Sugar	0.47	0.21	0.22	117	1,956
Sunflower Oil	0.55	0.04	0.39	83	1,396
Tea	0.35	0.10	0.58	99	1,720
Wheat	0.73	0.05	0.42	124	2,048
Agricultural Raw Materials					
Cotton	0.69	0.08	0.39	109	1,836
Hard Log	1.90	0.36	0.2	85	1,243
Hard Sawn	1.56	0.21	0.22	109	1,820
Rubber	0.63	0.04	0.45	69	1,206
Soft Log	-2.37	0.59	0.19	61	930
Soft Sawn	5.60	0.37	0.31	94	1,599
Wool	0.36	0.05	0.59	68	1,225
Metals					
Aluminum	0.71	0.06	0.64	117	2,018
Copper	0.74	0.03	0.55	109	1,852
Gold	1.13	0.11	0.39	107	1,622
Iron	0.32	0.06	0.44	78	1,309
Lead	0.75	0.03	0.4	96	1,578
Nickel	0.56	0.06	0.59	61	1,114
Tin	0.93	0.06	0.39	60	1,093
Zinc	0.70	0.05	0.44	83	1,450
Fuel					
Coal	0.68	0.06	0.43	72	1,536
Crude oil	0.91	0.03	0.53	90	2,200

Notes: For each commodity, we carry out a panel unit-root test on the country-specific commodity prices. Where the unit-root null is rejected, we estimate a panel regression of the country-specific commodity prices on the benchmark world commodity price, controlling for country fixed effects. Where the unit-root null is not rejected (denoted by * after the commodity name), we estimate a cointegrating relationship between the country-specific commodity prices and the benchmark world commodity price, using the Pedroni (2000) heterogeneous-panel FM-OLS estimator.