CHAPTER 4

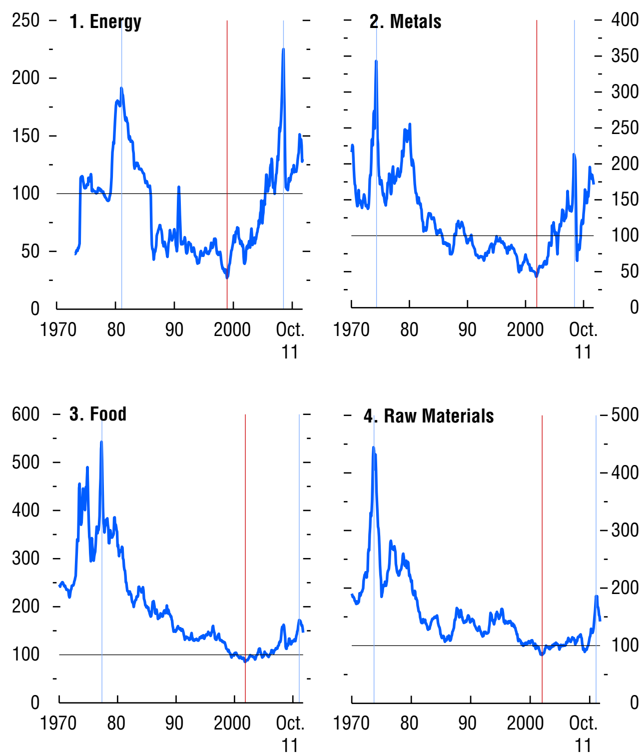
COMMODITY PRICE SWINGS AND COMMODITY EXPORTERS

How do commodity price swings affect commodity exporters, and how should their policies respond? These questions have become relevant again with the confluence of a weak global economy and the sustained buoyancy of commodity markets following the slump of the 1980s and 1990s. This chapter reexamines the macroeconomic performance of commodity exporters during commodity price cycles. It highlights how performance moves with the price cycle. The economic effects on commodity exporters are strong when commodity prices are driven by the global economy. Countercyclical fiscal policies—which build buffers during commodity price upswings that can be used during downswings—can help insulate small commodity exporters that are exposed to economic volatility induced by commodity price fluctuations. However, when price increases endure permanently, higher public investment and lower labor and capital taxes can boost private sector productivity and welfare. Against the backdrop of near-record commodity prices, coupled with unusual uncertainty in the global outlook, the priority for commodity exporters is to upgrade their policy frameworks and institutions in addition to building fiscal buffers. However, if high price levels persist, a cautious approach—which maintains fiscal buffers while gradually incorporating new information to allow a smooth adjustment to potentially permanently higher prices—is a sensible way forward.

Commodity prices have risen dramatically over the past decade, interrupted only briefly by the global financial crisis. By the end of 2011, average prices for energy and base metals in real terms were three times as high as just a decade ago, approaching or surpassing their record levels over the past four decades (Figure 4.1). Food and raw material prices also rose markedly, although they remain well below the highs reached in the 1970s. Many analysts attribute elevated commodity prices to the sustained

Figure 4.1. World Commodity Prices, 1970–2011
(In real terms)

There has been a broad-based rise in commodity prices during the past decade.



Source: IMF staff calculations.
Note: The real price index for a commodity group is the trade-weighted average of the global U.S. dollar prices of the commodities in the group deflated by the U.S. consumer price index and normalized to be 100 in 2005. The blue vertical lines indicate long cycle peaks, and the red vertical lines indicate long cycle troughs. The exact dates of these turning points are as follows (where M = month). Energy: 1981:M1, 1998:M12, 2008:M7. Metals: 1974:M4, 2001:M12, 2008:M6. Food: 1977:M4, 2001:M11, 2011:M2. Raw materials: 1973:M9, 2002:M1, 2011:M2. See Appendix 4.1 for a full description of the underlying data.

The main authors of this chapter are John Bluedorn, Rupa Duttagupta (team leader), Andrea Pescatori, and Stephen Snudden, with support from Murad Omoev, Katherine Pan, and Marina Rousset. Julia Bersch and Susan Yang also contributed.

growth in emerging market economies over the past decade.[1]

Looking ahead, given the weak global activity and heightened downside risks to the near-term outlook, commodity exporters may be in for a downturn (see Chapter 1). If downside risks to global economic growth materialize, there could be even greater challenges facing commodity exporters, most of which are emerging and developing economies (Figure 4.2). Conversely, if geopolitical risks to the supply of oil materialize, oil prices could rise temporarily, but the ensuing slowdown in global growth could lead to a decline in the prices of other commodities. This chapter addresses these concerns by asking the following questions:

- How is the economic performance of commodity exporters influenced by commodity price cycles? How do standard indicators such as real GDP growth, credit growth, and external and fiscal balance behave over the course of such cycles?
- What are the effects on exporters of commodity price fluctuations driven by unexpected changes in global activity?
- How should small, open commodity exporters shield their economies from commodity price swings? What is the role of fiscal policy? How should fiscal and monetary policy interact? How do the preexisting public debt level and other structural characteristics, such as the share of commodity exports in the economy, affect policy choices?

This chapter contributes to the policy debate in several ways. First, it sheds light on how exporters of different commodities—energy, metals, food, and agricultural raw materials—may have different sensitivities to commodity price cycles. It also recognizes that not all commodity price changes are alike in terms of their potential effects and identifies the economic effects of commodity market shocks driven by global activity.[2] Finally, using the IMF's workhorse Global Integrated Monetary and Fiscal model (GIMF), it assesses the optimal fiscal policy response to globally driven commodity price changes for small, open commodity exporters. This model-based analysis complements a related literature on the role of fiscal policy in commodity-exporting economies by distinguishing between the effects of global commodity price shocks that are demand driven from those that are supply driven. The analysis also highlights how the appropriate fiscal policy response depends on other prevailing policies and structural characteristics of the commodity exporter, as well as the implications of these domestically oriented policies for global economic stability.[3]

It is important to stress that macroeconomic stabilization in the face of commodity price volatility is only one of many policy priorities for commodity-exporting emerging market and developing economies. Others include resource exhaustibility, intergenerational equity, and Dutch disease challenges associated with resource discoveries. The relative priority of addressing various policy challenges depends on country-specific conditions, including the structure of the commodity endowment, institutional capacity, and the level of development.[4] Although we also consider the effects of permanent commodity price changes, a full-fledged analysis of optimal policies, given the whole gamut of cyclical and longer-term objectives of commodity exporters, is beyond the scope of this chapter.

The main conclusions of this analysis are as follows:

- Macroeconomic performance in commodity exporters tends to move with commodity price cycles. Economic activity and external and fiscal balances deteriorate (improve) during commodity price downswings (upswings), whether the latter entail long periods of falling (rising) commodity prices or shorter commodity price swings that last for only a few years. This behavior is generally

[1]See Heap (2005) and previous *World Economic Outlook* chapters (Chapter 5 in the September 2006 issue, Chapter 5 in April 2008, and Chapter 3 in October 2008).

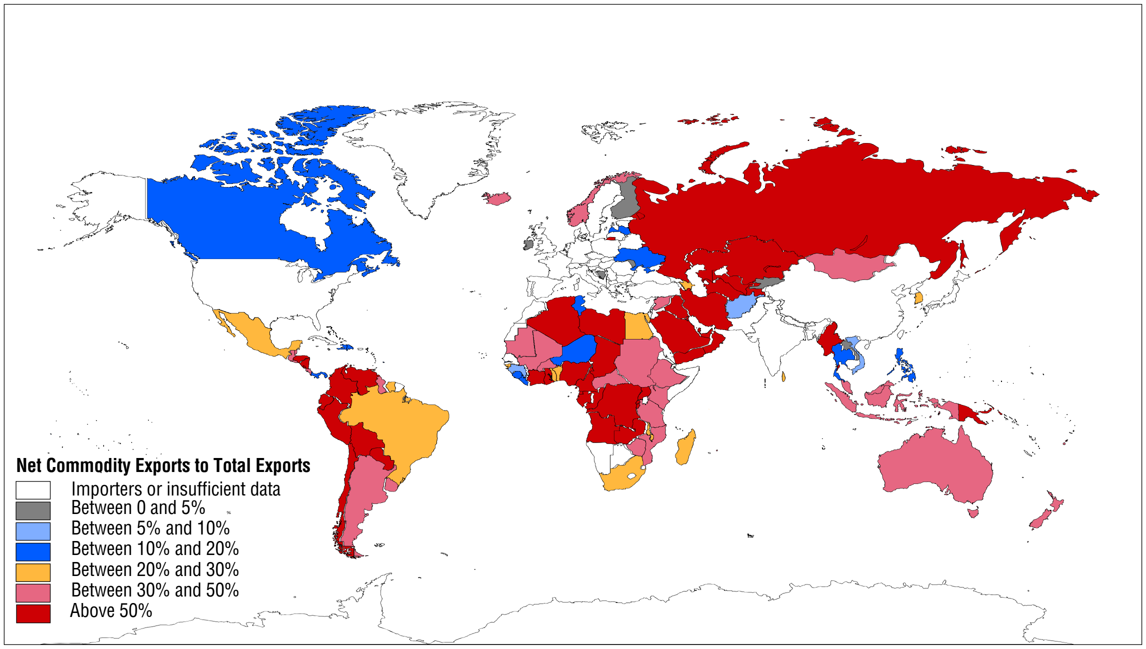
[2]To do this we use a variant of the identification strategy in Kilian (2009); Kilian, Rebucci, and Spatafora (2009); and Kilian and Murphy (2010) for estimating the effect of global demand and commodity production shocks on crude oil, copper, coffee, and cotton prices.

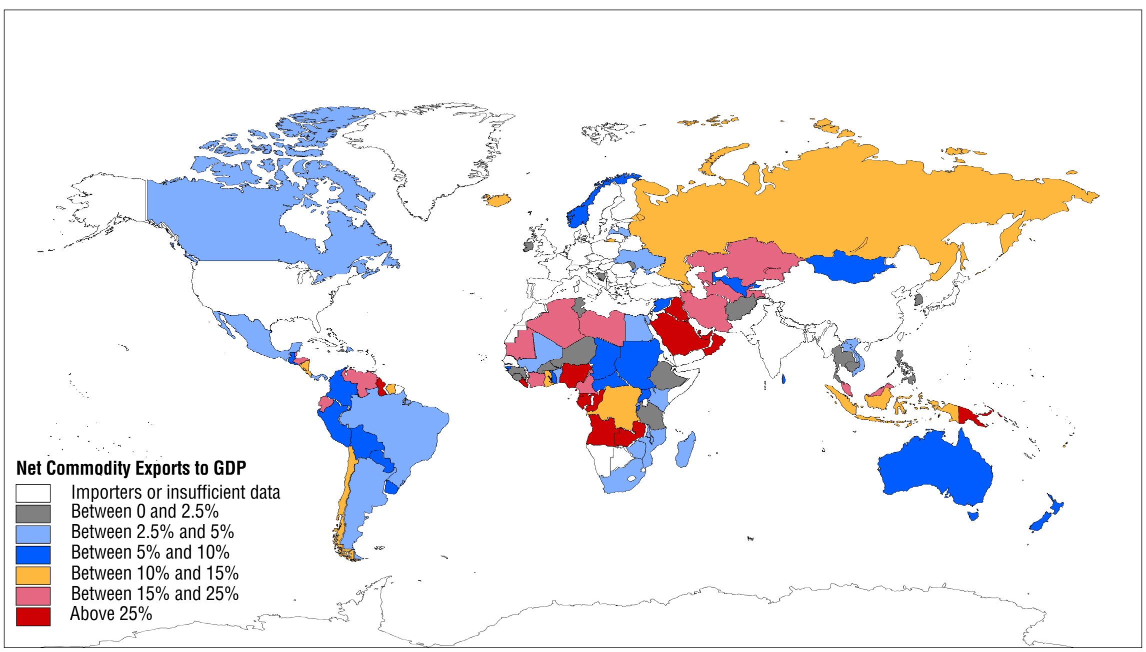
[3]See IMF (2009) and Baunsgaard and others (forthcoming) for a discussion of the role of commodity exporters' fiscal institutions in addressing macroeconomic stabilization against commodity price shocks.

[4]See Baunsgaard and others (forthcoming), Medas and Zakharova (2009), Deaton (1999), Collier and Goderis (2007), and Eyzaguirre and others (2011) for a discussion of some of these issues.

Figure 4.2. Share of Net Commodity Exports in Total Exports and GDP
(Percent)

Net commodity exports comprise a sizable share of total goods exports and GDP in many emerging market and developing economies.





Source: IMF staff calculations.
Note: These maps show the economy averages using the available yearly data for 1962–2010. See Appendix 4.1 for a full description of the underlying data.

more prominent for energy and metal exporters than for exporters of food and raw materials, possibly because energy and metal prices are more sensitive to the global business cycle and because they generally account for a higher share in total exports and GDP.

- The source of the commodity price change matters in terms of its economic effects on commodity exporters. In particular, commodity prices underpinned by unexpected changes in global activity (demand) have a significant effect on exporters' real activity and external and fiscal balances, while those driven by unexpected changes to global commodity production (supply) are not always significant. This effect is generally stronger for oil exporters than for exporters of other commodities.
- The optimal fiscal policy response to commodity price fluctuations for small commodity exporters is a countercyclical policy stance: save commodity-related revenue increases during upswings and use these buffers during downswings. Such a fiscal stance dampens the macroeconomic volatility arising from commodity price fluctuations.
- The effectiveness of a countercyclical policy stance, however, also depends on the degree of monetary policy autonomy—fiscal policy is more effective under an inflation-targeting regime with a flexible exchange rate because monetary policy helps reduce inflation volatility. It also depends on the level of public net debt—at high levels of debt, debt reduction should become a priority to help reduce the sovereign risk premium and build credibility. Furthermore, for some commodity market shocks and under some circumstances, a less countercyclical policy response in major commodity exporters might be the preferred solution from the perspective of collective action.
- Under permanent commodity price changes, the pivotal issue becomes how best to adjust to the permanently higher or lower commodity-related fiscal revenue levels. For a permanent price increase, increases in public investment and reductions in taxes on labor and capital boost private sector productivity and welfare. However, distinguishing between temporary and permanent commodity price changes is not a trivial exercise. This underscores the need to enhance policy frameworks and fiscal buffers, while gradually incorporating new information about the persistence of commodity prices.

What messages do these findings provide for commodity exporters? The weak global economic outlook suggests that commodity prices are unlikely to increase at the pace of the past decade. In fact, under the baseline *World Economic Outlook* projections, commodity prices are forecast to decline somewhat during 2012–13 (see Chapter 1). Sizable downside risks to global growth also pose risks of further downward adjustment in commodity prices. In contrast, if oil prices were to rise sharply as a result of greater supply-side concerns, this could unexpectedly depress global demand and eventually lower the prices of all other commodities. If prices were to enter such a cyclical downswing, commodity exporters would likely suffer, given historical patterns. A number of commodity exporters are ready to handle such a downswing, having strengthened their policy frameworks over time or having already adopted operating principles to guide fiscal policy. Others should use the opportunity presented by strong prices to lower debt levels, strengthen institutions, and build fiscal room to support a timely countercyclical policy response in the event of a commodity price downswing.

What are the lessons for the longer term? Commodity prices may be experiencing a long upswing and prices may stay close to current historic highs.[5] Alternatively, they may retreat in response to increasing user efficiency and the unwinding of earlier supply constraints. Given the unusual uncertainty and the difficulty of projecting commodity market prospects in real time, the best approach is a cautious one that builds buffers to address cyclical volatilities and gradually incorporates new information to allow a smooth adjustment to potentially permanently higher commodity prices.[6]

The chapter is structured as follows. The first section presents stylized facts on domestic economic

[5]See the Commodity Market Review in Chapter 1, and Erten and Ocampo (2012).

[6]These conclusions are not without precedent. Frankel (2011) underscores the need for commodity exporters to avoid procyclical fiscal policy that exacerbates economic volatility. Baunsgaard and others (forthcoming) stress the importance of designing fiscal frameworks that gradually incorporate new information.

indicators during commodity price swings. The second discusses the economic effects of commodity market shocks. The third examines the optimal policy responses to commodity price changes. The final section summarizes and concludes.

Commodity Price Swings and Macroeconomic Performance

How does commodity exporters' economic performance relate to commodity prices?[7] This question is examined in two parts. First, we focus on performance during the two most prominent recent commodity price booms (periods of sustained increases in commodity prices)—the early 1970s and the 2000s—and the intervening period of slumping commodity prices during the 1980s and 1990s.[8] This exercise sheds light on how commodity exporters' performance relates to the level of commodity prices. Next, we study regular commodity price swings and cycles during the past 50 years. This sheds light on any comovements between exporters' economic conditions and commodity price cycles, regardless of the underlying trends in prices. These descriptive analyses uncover useful correlations between global commodity price cycles and domestic economic indicators, without implying any causal relation between the two. Differences are highlighted across four distinct commodity groups—energy, metals, food (and beverages), and agricultural raw materials. These groups differ across many dimensions—in terms of the basic structure of the underlying markets, the nature of the commodity (for example, renewable versus exhaustible resource bases), and their association with global activity (for example, metals and energy are more important for industrialization and infrastructure building, and as such their prices may be more strongly correlated with the global business cycle than the prices of food and agricultural raw materials). We also focus on one major commodity from each of the four groups—crude oil (energy), copper (metals), coffee (food), and cotton (raw materials)—so as to study whether the broad patterns observed for commodity groups also hold at the commodity-specific level.[9]

Economic Performance Leading into Commodity Price Booms and Slumps

Commodity exporters experienced stronger macroeconomic performance during the 1970s and 2000s, when commodity prices were high in real terms, compared with the 1980s and 1990s, when prices were weak (Table 4.1).[10] Real GDP growth for the median commodity exporter was 1½ to 3½ percentage points higher during the 1970s and 2 to 4 percentage points higher during the 2000s, compared with the interim period.[11] In addition, despite higher commodity prices, consumer price index (CPI) inflation was lower during both booms compared with the interim period, when many exporters experienced crises and struggled to achieve macroeconomic and financial stability.

Energy and metal exporters appear to have fared relatively better during the recent decade compared with the 1970s. They achieved strong gains in real GDP growth and sizable reductions in inflation during the past decade. The latter may represent a shift toward inflation targeting among emerging and developing economies in the 2000s, including among commodity exporters (Brazil, Chile, Colombia, South Africa, and Thailand, among others).[12] These economies also reduced their public debt levels considerably during the

[7]We define commodity exporters as those whose share of net exports of the commodity (or commodity group) in total goods exports is at least 10 percent. See Appendix 4.1 for details.

[8]We focus on three long stretches in commodity prices over the past 50 years (see Figure 4.1 and Radetzki, 2006): the run-up to the peak in the mid-1970s (energy prices peaked in the 1980s); the subsequent protracted slump until 2001 (energy prices troughed in 1998); and the rebound thereafter.

[9]These commodities are also notable as being relevant among the commodities within their groups for the largest number of commodity exporters in the sample (that is, the largest number of commodity exporters with at least a 10 percent share of net exports of these commodities in total goods exports).

[10]Throughout, we use real commodity prices for the study: the global U.S. dollar–denominated commodity prices are deflated by the U.S. CPI. See Appendix 4.1 for details.

[11]For each indicator, we take the cross-sample median value of the country averages.

[12]See Heenan, Peter, and Roger (2006) and Roger (2010) for cross-country evidence on the adoption of inflation targeting. Batini and Laxton (2005) find that emerging and developing economies that adopted inflation targeting made significant progress in anchoring inflation and inflation expectations.

Table 4.1. Average Economic Performance of Net Commodity Exporters, 1970–2010

	1970s Boom	1980–2000 Slump	2000s Boom	Average 1960–2010
		Real GDP Growth (percentage points)		
Net Energy Exporters	5.6	2.5	4.6	4.3
Net Metal Exporters	5.6	2.2	6.4	3.5
Net Food Exporters	5.1	2.9	4.5	4.0
Net Raw Material Exporters	5.0	3.3	5.3	4.3
		Differential in Real GDP Growth Relative to Emerging and Developing Noncommodity Exporters (percentage points)		
Net Energy Exporters	1.1	–0.8	–0.8	0.5
Net Metal Exporters	2.0	–1.8	0.5	–0.4
Net Food Exporters	0.6	–0.8	–0.6	0.2
Net Raw Material Exporters	1.4	–0.6	0.2	0.5
		Level of Public Debt to GDP (percent of GDP)		
Net Energy Exporters	31.3	63.9	24.1	44.4
Net Metal Exporters	36.2	52.7	27.3	52.4
Net Food Exporters	21.9	78.7	37.4	50.0
Net Raw Material Exporters	33.6	80.2	34.5	57.4
		Change in Public Debt to GDP (percentage points; increase = deterioration)		
Net Energy Exporters	0.7	1.1	–4.5	–0.4
Net Metal Exporters	1.5	1.2	–4.0	–0.4
Net Food Exporters	0.8	1.5	–3.9	0.4
Net Raw Material Exporters	0.1	1.7	–5.9	–0.3
		Average Inflation (percentage points)		
Net Energy Exporters	8.6	14.4	6.6	12.5
Net Metal Exporters	8.4	22.5	9.2	16.1
Net Food Exporters	6.4	13.2	7.3	10.7
Net Raw Material Exporters	4.6	12.4	6.8	10.1

Source: IMF staff calculations.

Note: Unless indicated otherwise, numbers represent the median value of the averages over the relevant period, except for the level of public debt to GDP, which is the median end-of-period value. Commodity exporters are those whose share of net exports of the particular commodity (or commodity group) in total goods exports is at least 10 percent; noncommodity exporters are those whose share is less than or equal to zero. See Figure 4.1 for the exact dates that mark the long cycles for each commodity group. Because the underlying data for the table are annual, the dates are rounded to the nearest year.

recent decade, relative to the 1970s boom.[13] Finally, only in the 2000s was there a marked improvement in average fiscal balances—proxied by the change in the public-debt-to-GDP ratio—for exporters in all commodity groups; there was none in the 1970s.

Macroeconomic policies in commodity exporters appear to have continued to improve during the 2000s. We examine the behavior of economic indicators in commodity exporters in three snapshots from the past decade—at the beginning of the boom, at mid-decade, and at the end of the decade (Table 4.2).[14] Inflation and public debt levels fell sharply through the 2000s, notwithstanding the Great Recession. In contrast, the overall and cyclically adjusted fiscal balance improved until mid-decade but deteriorated toward the end of the decade. The deterioration in fiscal positions in 2010 is likely related to fiscal action in response to the global crisis. Moreover, policies and economic conditions interacted such that despite the deterioration in fiscal balances, some debt reduction was accomplished by commodity exporters by the end of the decade.[15]

[13]We use the change in public debt to GDP as a proxy for fiscal position because the cyclically adjusted primary balance is not available for many countries over the period between 1960 and 2010. We also do not have data on noncommodity real GDP for all the commodity exporters in the sample, which could better gauge economic performance outside the commodity sector.

[14]Note that prices of energy and metal commodities peaked in 2008, while those of food and agricultural materials crested in 2010.

[15]Empirical analysis of the fiscal stance in commodity producers during commodity price cycles is relatively recent (compared

Table 4.2. Economic Performance of Net Commodity Exporters during the 2000s

	2001	2005	2010	Average 2001–10
		Public Debt to GDP (percent)		
Net Energy Exporters	59.8	38.7	20.7	41.1
Net Metal Exporters	52.7	41.1	36.4	47.6
Net Food Exporters	78.7	65.8	37.4	54.5
Net Raw Material Exporters	80.2	52.9	34.5	53.9
		Change in Public Debt to GDP (percentage points)		
Net Energy Exporters	–1.0	–6.7	–1.8	–4.2
Net Metal Exporters	–7.1	–7.6	–0.8	–3.0
Net Food Exporters	1.5	–5.4	–0.4	–3.4
Net Raw Material Exporters	–1.0	–6.5	–0.3	–4.8
		Overall Fiscal Balance (percent of GDP)		
Net Energy Exporters	–0.9	0.7	–1.3	–0.7
Net Metal Exporters	–1.8	0.8	–0.4	–0.9
Net Food Exporters	–3.4	–2.1	–2.1	–1.8
Net Raw Material Exporters	–2.6	–2.4	–2.3	–2.1
		Cyclically Adjusted Fiscal Balance (percent of potential GDP)		
Net Energy Exporters	2.5	0.3	–2.2	–0.9
Net Metal Exporters	0.8	–0.2	–3.1	–1.6
Net Food Exporters	–3.2	–2.6	–2.6	–3.2
Net Raw Material Exporters	–4.8	–1.6	–3.1	–2.6
		Inflation (percentage points)		
Net Energy Exporters	4.9	7.4	4.7	7.5
Net Metal Exporters	8.4	7.9	6.9	8.6
Net Food Exporters	5.7	7.2	4.8	7.7
Net Raw Material Exporters	5.1	6.9	5.3	7.0
		Change in Log Real Effective Exchange Rate (times 100)		
Net Energy Exporters	3.2	1.5	0.3	1.5
Net Metal Exporters	1.3	2.9	1.5	0.8
Net Food Exporters	1.6	2.2	–2.1	0.9
Net Raw Material Exporters	1.6	0.4	–2.8	1.0

Source: IMF staff calculations.

Note: Unless indicated otherwise, numbers represent the median value within the sample for the relevant year. Commodity exporters are those whose share of net exports of a particular commodity group in total goods exports is at least 10 percent.

Economic Performance during Shorter Commodity Price Swings

With some evidence of a positive correspondence between macroeconomic performance and commodity price booms and slumps, we now turn to the consequences of shorter-term commodity price cycles. To do this, we identify turning points in real prices within each commodity group from 1957 to October 2011.[16] This exercise yields more than 300 completed cycles for 46 commodities, with a median (average)

with studies that assess the procyclicality of fiscal policy with output cycles). See Chapter 3 in the September 2011 *Regional Economic Outlook—Western Hemisphere*; Medina (2010); and Kaminsky (2010) for procyclicality in Latin American commodity producers' fiscal policies, especially among lower- and middle-income economies. Céspedes and Velasco (2011), however, find that fiscal policies in commodity exporters (encompassing a wider group) have become less procyclical in the 2000s.

[16]Drawing on Cashin, McDermott, and Scott (2002), we use the Harding and Pagan (2002) methodology to identify peaks and troughs in the time path of real commodity prices. A candidate turning point is identified as a local maximum or minimum if the price in that month is either greater or less than the price in the two months before and the two months after. The sequence of resulting candidate turning points is then required to alternate between peaks and troughs. Furthermore, each phase defined by

upswing duration of 2 (2½) years and a median (average) downswing of 2½ (3) years. An average downswing entails a decline in real prices (from peak to trough) of 38 to 52 percent, with price changes sharper for energy and metal prices (see Appendix 4.2). The relationship between key economic indicators during commodity price upswings and downswings is summarized below.

With few exceptions, indicators of commodity exporters' domestic economic performance tend to move with commodity price cycles—improving during upswings and deteriorating during downswings. This pattern is observed for each of the four commodity groups. Moreover, the difference in economic performance across downswings and upswings tends to be amplified when cycles last longer and/or when they entail sharper price changes than average. Specifically:[17]

- *Real GDP* (Figure 4.3, panels 1 and 2): Across the four groups of commodity exporters, median real GDP growth is ½ to 1¼ percentage points lower during downswings than during upswings.
- *Credit growth* is 1 to 2 percentage points lower during typical downswings than during upswings for energy and metal exporters, while the difference is sharper for food exporters at 6 percentage points (Figure 4.3, panels 3 and 4).[18]
- *External balances* (Figure 4.3, panels 5 and 6): The current account balance deteriorates during downswings compared with upswings. The sharpest difference is for energy exporters, whose current account falls from a surplus of ¾ percent of GDP in an upswing to a deficit of 2¼ percent of GDP in a downswing. For all commodity exporters, the differences are larger when the underlying price phase lasts longer or price changes are sharper than during a typical phase. Thus, weaker terms of trade resulting from lower commodity export prices more than offset any positive demand effect from the lower price of the commodity.
- *Fiscal balances* (Figure 4.3, panels 9–12): The fiscal position is weaker in downswings compared with upswings. We present two measures of the fiscal position—change in the public-debt-to-GDP ratio and the overall fiscal balance.[19] These measures point to a deterioration in fiscal balance of ½ to 4 percentage points of GDP in downswings relative to upswings, with greater variation in energy and metal exporters.
- *Financial stability:* More commodity price downswings than upswings are associated with banking crises in commodity exporters (Table 4.3).
- *The real effective exchange rate (REER)* is generally stronger in the course of a commodity price upswing compared with a downswing (Figure 4.3, panels 7 and 8). The cumulative percentage change in the REER during an upswing (from trough to peak) is typically greater than during a downswing (from peak to trough). This variation is particularly remarkable for energy and metal exporters, whereas the pattern is not observed for food exporters.[20]

The pattern of cyclical synchronization in macroeconomic indicators and commodity prices becomes muddier for individual commodities within the commodity groups (Figure 4.4).

- *Activity:* Procyclical behavior in real GDP growth is more prominent for oil and copper exporters compared with coffee and cotton exporters. The stronger comovement of economic activity and commodity price cycles could reflect the greater

the turning points (upswing or downswing) is required to be at least 12 months in length. See Appendix 4.2 for details.

[17]The macroeconomic variables are studied for each phase (upswing or downswing) using three characteristics—cross-country median for the entire phase, median when the phase is in the top quartile in terms of duration (long swings), and median when the phase is in the top quartile in terms of amplitude (sharp swings). We also compared mean values (instead of median values) for the macroeconomic indicators across alternative commodity price swings. The pattern is the same, with slightly larger differences in variation between upswings and downswings.

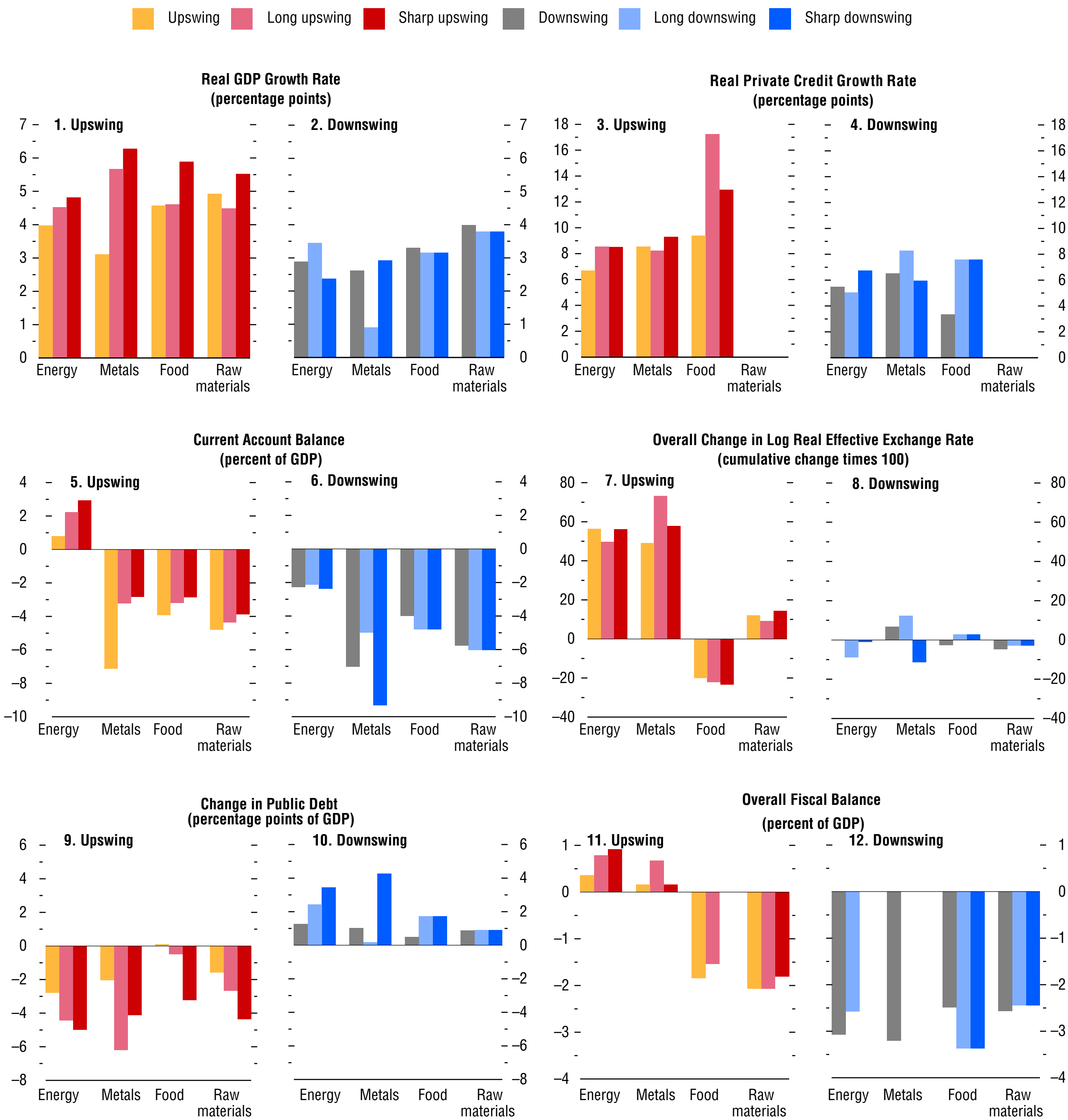
[18]We do not have sufficient data on credit growth for raw materials exporters.

[19]The data coverage for the change in public debt is more comprehensive than for the overall fiscal balance.

[20]This is consistent with the empirical literature. For instance Chen, Rogoff, and Rossi (2010) find that commodity exporters' real exchange rates are higher during periods of increasing commodity prices. However, the average growth in the REER during a commodity price upswing is not always greater than its average growth in a downswing (not shown here), which is a bit puzzling. We offer two possible explanations. First, the REER (like the other variables analyzed) is affected not only by changes in commodity prices but also by underlying policies and other factors, none of which are identified or controlled for in this exercise. Second, there may be some overshooting of the REER in the beginning of an upswing, which unwinds somewhat during the rest of the phase, resulting in average growth of the REER that is not necessarily stronger in an upswing relative to a downswing.

Figure 4.3. Macroeconomic Performance of Commodity Exporters during Commodity Price Swings

Commodity exporters' economic performance moves in tandem with commodity price swings.



Source: IMF staff calculations.

Note: Each bar shows the median value of the economy-level averages within the relevant sample for each variable. Long swings are in the top quartile by duration, and sharp swings are in the top quartile by amplitude. Bars appear only if there are at least three years of data for at least three economies, and therefore bars are missing when these criteria are not met. See Appendix 4.1 for a full description of the underlying data.

Table 4.3. Relationship between Commodity Price Swings and Banking Crises in Commodity Exporters

(Number of observations)

	Net Energy Exporters		
	No Banking Crisis	Banking Crisis	Total
Upswing	409	67	476
Downswing	399	77	476
Total	808	144	952
	Net Metal Exporters		
	No Banking Crisis	Banking Crisis	Total
Upswing	262	25	287
Downswing	340	49	389
Total	602	74	676
	Net Food Exporters		
	No Banking Crisis	Banking Crisis	Total
Upswing	433	83	516
Downswing	825	168	993
Total	1,258	251	1,509
	Net Raw Material Exporters		
	No Banking Crisis	Banking Crisis	Total
Upswing	520	46	566
Downswing	492	105	597
Total	1,012	151	1,163

Source: IMF staff calculations.

Note: The table shows the cross tabulation of the indicated commodity price index phase with banking crises in the associated group of net commodity exporters. Observations are economy-years. The banking crisis indicator comes from Laeven and Valencia (2008, 2010). See Appendix 4.1 for a full description of the data.

importance of oil and copper in their exporters' economic activity—average net exports of oil to GDP are more than 20 percent and more than 10 percent for copper. For exporters of coffee and cotton, net exports to GDP average between 3 and 4 percent.

- *External balance:* The current account balance is procyclical in all commodity exporters, and the differences between upswings and downswings are amplified when the underlying cycle is longer or the price changes are sharper.
- *Fiscal balance:* The comovement of fiscal balances and commodity cycles is more prominent for exporters of crude oil and copper than for exporters of food and raw materials.

Commodity Price Cycles and Policy Regimes

Having established that domestic commodity exporters' economic conditions move with commodity price cycles, we next examine whether this comovement is dampened or accentuated under alternative policy regimes in commodity exporters. In particular, we focus on the nature of the exchange rate regime (pegged versus nonpegged) and the degree of capital account openness (relatively high versus low). As before, these basic correlations should not be misinterpreted as a causal link between structural characteristics and comovement of economic conditions and commodity price swings.

Exchange rate regime

The cyclical variability in macroeconomic indicators is slightly stronger with pegged exchange rate regimes relative to flexible regimes, especially for energy and metal exporters (Figure 4.5). Under pegged regimes, output growth falls more sharply during downswings for all except raw material exporters, while the current account balance differences are sharper for exporters of metals and energy. Conceptually, a fixed exchange rate can reduce economic volatility by limiting exchange rate fluctuations, but it is also unable to absorb external shocks, including changes in real commodity prices. We find weak evidence of the latter effect dominating for energy and metal exporters.[21]

Capital account openness

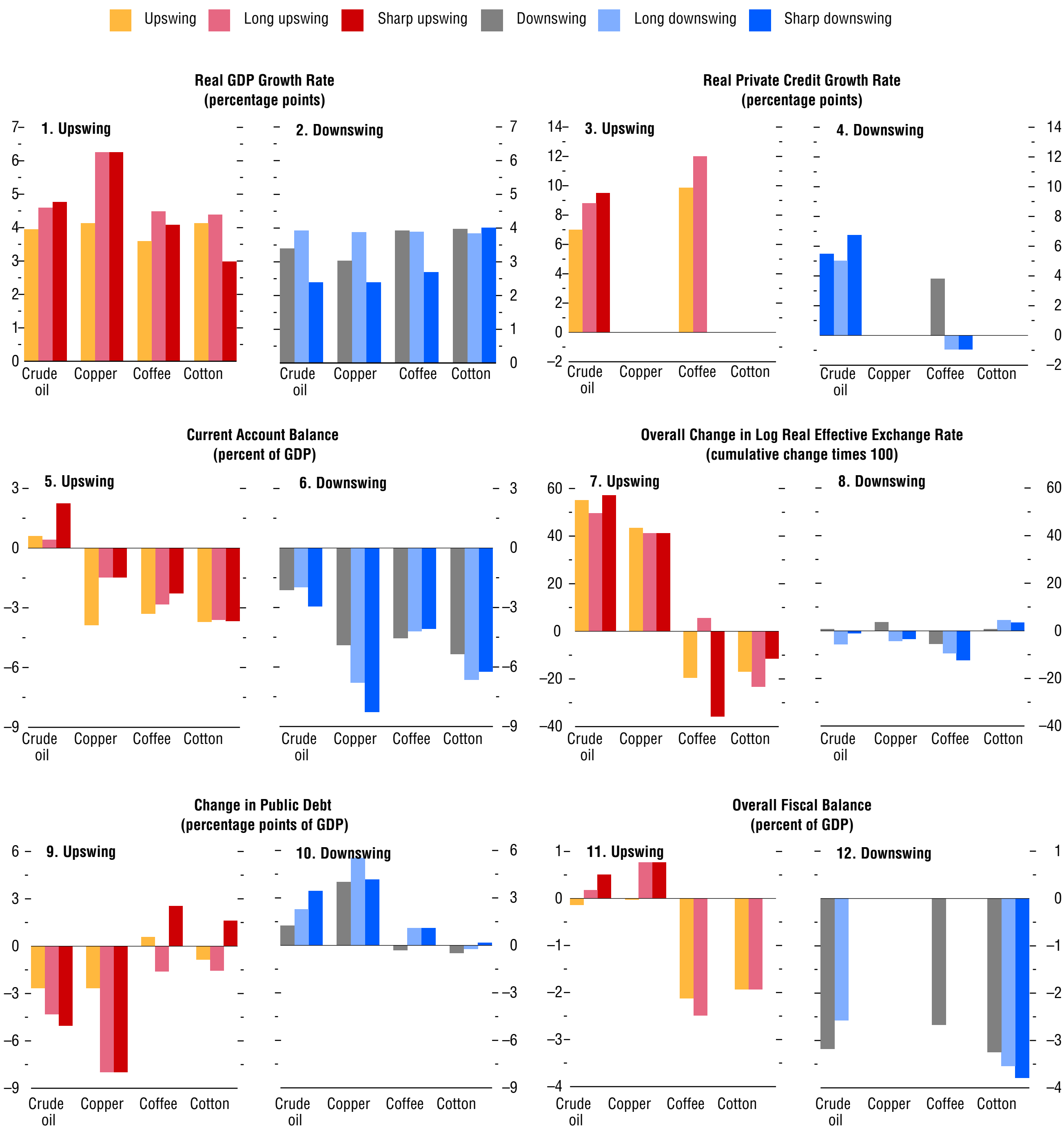
There is more comovement of macroeconomic indicators with commodity price cycles under greater capital account openness for energy and metal exporters but not for other commodity exporters (Figure 4.6). Overall, there may be offsetting forces at play. Economies with greater access to international capital markets should be better able to smooth output volatility when commodity prices fluctuate—for instance, by borrowing in international markets during downswings. Markets may, however, be procyclical for some—with capital flows increasing during commodity price upswings and declining during downswings.[22] The latter force appears to dominate for energy and

[21]See Rafiq (2011) for evidence from the Gulf Cooperation Council oil exporters, and Adler and Sosa (2011) for Latin American commodity exporters.

[22]Adler and Sosa (2011) find evidence of this procyclicality for Latin American commodity exporters.

Figure 4.4. Macroeconomic Performance of Exporters of Four Major Commodities during Commodity Price Swings

The comovement with commodity price cycles of domestic economic indicators is stronger for exporters of oil and copper than of coffee and cotton.

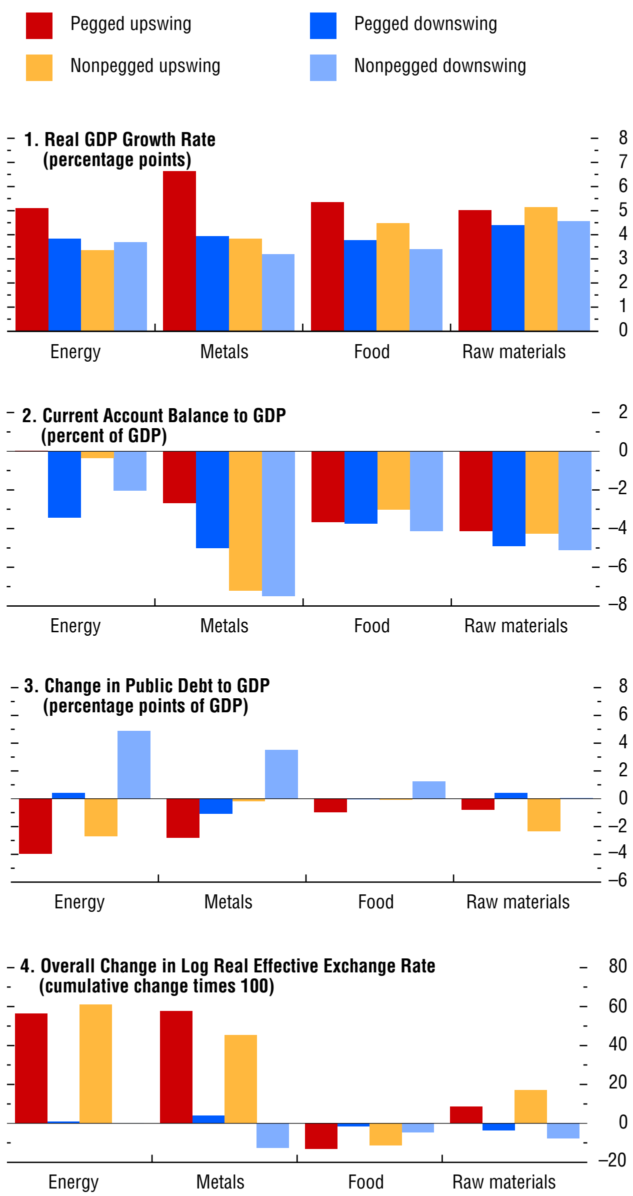


Source: IMF staff calculations.

Note: Each bar shows the median value of the economy-level averages within the relevant sample for each variable. Long swings are in the top quartile by duration, and sharp swings are in the top quartile by amplitude. Bars appear only if there are at least three years of data for at least three economies, and therefore bars are missing when these criteria are not met. See Appendix 4.1 for a full description of the underlying data.

Figure 4.5. The Exchange Rate Regime and Exporter Performance during Commodity Price Swings

The comovement of economic indicators with commodity price cycles is greater under pegged exchange rates for energy and metal exporters.



Source: IMF staff calculations.

Note: Each bar shows the median value of the economy-level averages within the relevant sample for each variable. Bars appear only if there are at least three years of data for at least three economies. Exchange rate regimes are from the "coarse" classification system in Ilzetzki, Reinhart, and Rogoff (2008), updated to 2010. See Appendix 4.1 for a full description of the underlying data.

metal exporters, but not for exporters of food and raw materials.

To sum up, the macroeconomic performance of commodity exporters is closely related to commodity price swings. This procyclical behavior with respect to commodity prices is accentuated when commodity price swings last a long time or involve sharp price changes. There are, however, considerable differences among commodity exporters. Energy and metal exporters are typically more synchronized with commodity price swings than exporters of food and raw materials, and their macroeconomic variation with commodity price swings tends to be more pronounced under fixed exchange rate regimes and greater capital account openness.

The generally sharper differences in macroeconomic performance between upswings and downswings for energy and metal exporters compared with food and agricultural commodities exporters may reflect in part steeper price changes for energy and metals compared with food and agricultural raw materials. But more generally, the above correlations do not control for policies that may dampen or accentuate the comovement between economic conditions and commodity price cycles. For instance, energy and metals generally carry larger royalties than other commodities, which, if spent during upswings, would reinforce the comovement of economic indicators with commodity price swings.

Commodity Market Drivers and Their Macroeconomic Effects

How does an unanticipated deterioration in the global economic outlook affect commodity prices and commodity exporters? To answer this question, this section first identifies how shocks to global economic activity affect commodity prices and then estimates the macroeconomic effects on commodity exporters.

Commodity Market Drivers

Using a structural vector autoregression (VAR) model of the global commodity markets for crude oil, copper, cotton, and coffee, we identify the contribution of global economic activity and commodity production shocks to commodity price fluctuations. The remaining (unaccounted for) fluctuations in the price reflect other factors that cannot be precisely identified but are likely a combination of commodity-specific demand factors and expectations about future global production and demand.[23]

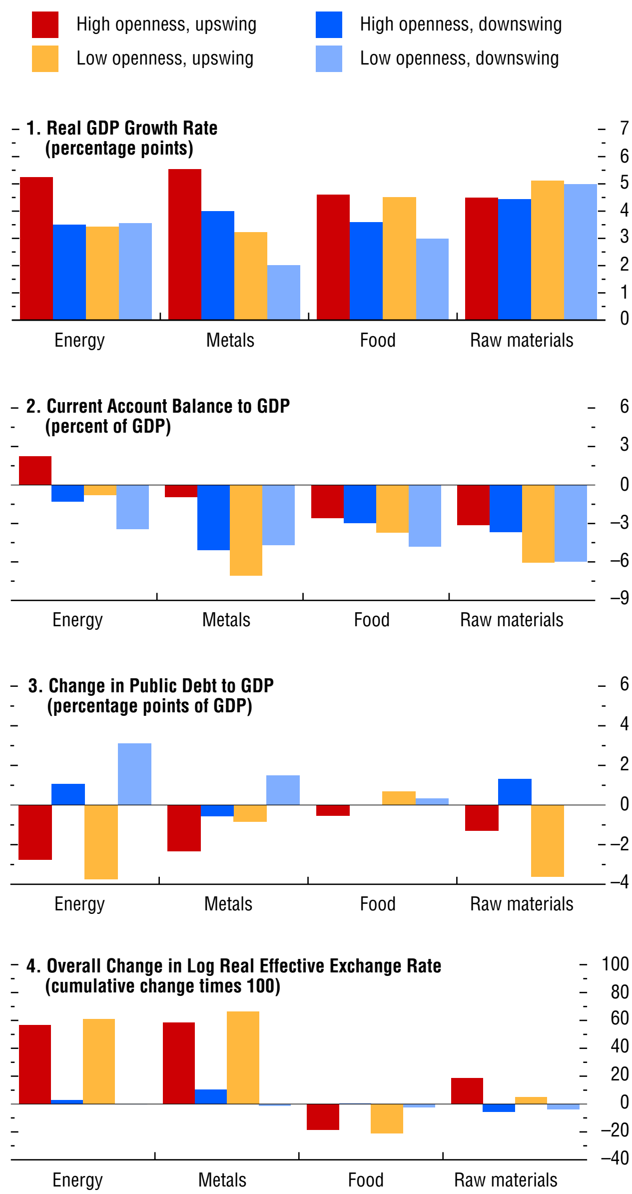
Global demand shocks have a positive effect on the prices of all commodities except coffee (Table 4.4). A 1 standard deviation positive global demand shock (equal to a 0.6 percent rise in the monthly global industrial production index for oil and a 0.75 percent rise for copper) increases the real price in the impact year by 3.5 percent for oil and 2.4 percent for copper. For cotton, a 1 standard deviation rise in global demand, proxied by an increase in global real GDP of 0.8 percent, increases cotton prices by 0.7 percent. The positive effect of the global demand shock remains significant even after three years following the impact for crude oil and cotton prices.

In contrast, although global production shocks result in price movements in the opposite direction, the effect is not significant for any commodity except coffee. A 1 standard deviation positive production shock increases annual production by 7 percent for coffee and 4 percent for cotton in the same year. The average increases in monthly production for oil and copper are 0.5 and 1 percent, respectively. The negative price effect of this production increase is significant for coffee only,

[23]The VARs for oil and copper are estimated at monthly frequency, while those for coffee and cotton use annual data due to data limitations. See Appendix 4.3 for details on the baseline model and robustness checks. Examples of production shocks include unpredictable weather events, such as floods and droughts that adversely impact yields (for food and raw materials); production disruptions from unanticipated equipment breakdowns or work stoppages (for energy and metals); and unexpected technological breakthroughs that boost production. An example of a global activity shock includes a sudden fall in global activity due to an unanticipated hard landing in a systemically important country. Conversely, examples of commodity-specific shocks include a preference shift for coffee over tea (as happened over the past decade), gradual improvements in the intensity of commodity usage, and changes in expectations about future production and global activity. Thus, production or activity changes that are either wholly or partially anticipated would be in the unexplained component of the price, matched to the time at which the news about the forthcoming change is first received rather than at the time it actually occurs. An example of such an anticipated production shock might include the recent case of Libya, where political turmoil was expected to disrupt oil production and thereby the global oil supply, which pushed oil prices up in advance. Similarly, an anticipated increase in demand for commodities because of an ongoing real-estate-driven growth boom in China would push up commodity prices in advance.

Figure 4.6. Capital Account Openness and Exporter Performance during Commodity Price Swings

There is some evidence of greater comovement between economic indicators and commodity price cycles under greater capital account openness for energy and metal exporters.



Source: IMF staff calculations.
Note: Each bar shows the median value of the economy-level averages within the relevant sample for each variable. Bars appear only if there are at least three years of data for at least three economies. An economy is classified as having high openness if its Chinn and Ito (2006, 2008) capital account openness measure is greater than or equal to the grand median of the sample. Otherwise, it is classified as having low openness. See Appendix 4.1 for a full description of the underlying data.

Table 4.4 Dynamic Effects of Global Commodity Market Shocks

		Commodity Production		Global Activity		Real Commodity Price	
Commodity	Shock	On Impact	At 3 Years	On Impact	At 3 Years	On Impact	At 3 Years
Oil	Production	0.488†	0.263	0.024	0.059	–1.098	1.975
	Global Activity	0.128†	–0.080	0.610†	0.215	3.526†	3.693†
Copper	Production	0.949†	0.696†	–0.031	–0.076	–0.873	–2.106
	Global Activity	0.305†	0.229	0.752†	0.475†	2.414†	0.693
Coffee	Production	6.933***	1.767	–0.144	–0.163	–1.050*	–1.481
		(0.731)	(1.175)	(0.156)	(0.321)	(0.557)	(1.252)
	Global Activity	. . .	2.393*	1.041***	1.162***	0.517	–1.466
		. . .	(1.263)	(0.110)	(0.328)	(0.544)	(1.319)
Cotton	Production	4.149***	0.095	0.370***	0.425	–0.038	–0.296
		(0.437)	(1.059)	(0.132)	(0.345)	(0.369)	(0.536)
	Global Activity	. . .	–3.005**	0.848***	1.320***	0.693*	1.410**
		. . .	(1.178)	(0.089)	(0.373)	(0.361)	(0.614)

Source: IMF staff calculations.

Note: Since the oil and copper commodity market models are at monthly frequency, the average effect over the corresponding year is shown for these commodities. A dagger is placed next to the statistic if at least 50 percent of the underlying statistics are individually significant at the 10 percent level. Standard errors are in parentheses underneath their corresponding estimate for the results from the annual frequency vector autoregression. *, **, and *** denote significance at the 10 percent, 5 percent, and 1 percent levels, respectively. The thought experiment is a 1 standard deviation rise in the commodity's global production shock or a 1 standard deviation rise in the global activity shock at the relevant frequency. No value is shown when the indicated shock is restricted to have no contemporaneous effect. See Appendix 4.3 for further details.

whose price falls by 1 percent on impact, and is not significant for the others. The result is contrary to the literature for oil, which argues that historical oil price shocks are largely underpinned by global supply.[24] This likely implies that historical supply disruptions in oil markets were mostly anticipated in advance. Conversely, weather-related supply shocks may be harder to predict than shocks to energy and metal supplies, resulting in more significant effects on prices of agricultural commodities, such as coffee.[25]

These findings demonstrate that not all commodity price effects are alike, and much depends on the source of the shock and the type of commodity. More important, changes in commodity prices driven by unexpected movements in global activity can be significant.

Domestic Macroeconomic Effects of Global Commodity Market Shocks

How do global-activity-driven commodity market shocks affect commodity exporters? We answer this question by estimating a dynamic panel model of the economic effects of alternative commodity market drivers for exporters of each commodity.[26] As described above, we are able to identify two types of underlying shocks that drive commodity price changes—shocks to global activity (demand) and shocks to global production of the commodity (supply). The following panel model is estimated by commodity for each set of exporters:[27]

$$Y_{i,t} = \alpha_i + \delta Y_{i,t-1} + \sum_{k=0}^{1} \sum_{j=0}^{2} (\beta_{k,j} u_{t-k,j} + \theta_k W_{i,t-k} + \varphi_{k,j} W_{i,t-k} u_{t-k,j}) + \eta_{i,t}, \quad (4.1)$$

where $Y_{i,t}$ is the macroeconomic variable of interest for economy i at time t. We focus on real GDP, current account balance as a ratio of GDP, and change in public debt to GDP. α_i is an economy-specific fixed effect, $u_{t,j}$ is the jth commodity market shock of interest at time t, $W_{i,t}$ is economy i's commodity exposure at time t, expressed as a lagged three-year moving average of net exports of the commodity to the economy's total GDP, and $\eta_{i,t}$ is a mean-zero error term. The interaction terms allow for the possibility

[24]See for instance Hamilton (2011). However, Kilian (2009) and Kilian and Murphy (2010) hold the opposite view.

[25]The fact that global demand does not significantly affect coffee prices may reflect their greater sensitivity to beverage-related preferences as well as low income elasticity (Bond, 1987).

[26]Commodity price movements can also have serious implications for commodity importers, many of which are low-income countries (LICs). While the chapter mainly focuses on exporters, Box. 4.1 provides a synopsis of the varying effects of food and fuel price increases on LICs.

[27]In the sample, each net commodity exporter's average share of net exports of the commodity to total goods exports over the entire sample period is at least 10 percent.

that the effects of commodity market variables vary with the economy's reliance on commodity exports.

The results confirm that global demand-driven commodity shocks have significant economic effects on commodity exporters (Figure 4.7; Table 4.5). This is not surprising, as global activity surprises may affect the demand for all goods. A diversified exporter of commodities will therefore face an increase in demand for all its exports. Specifically:

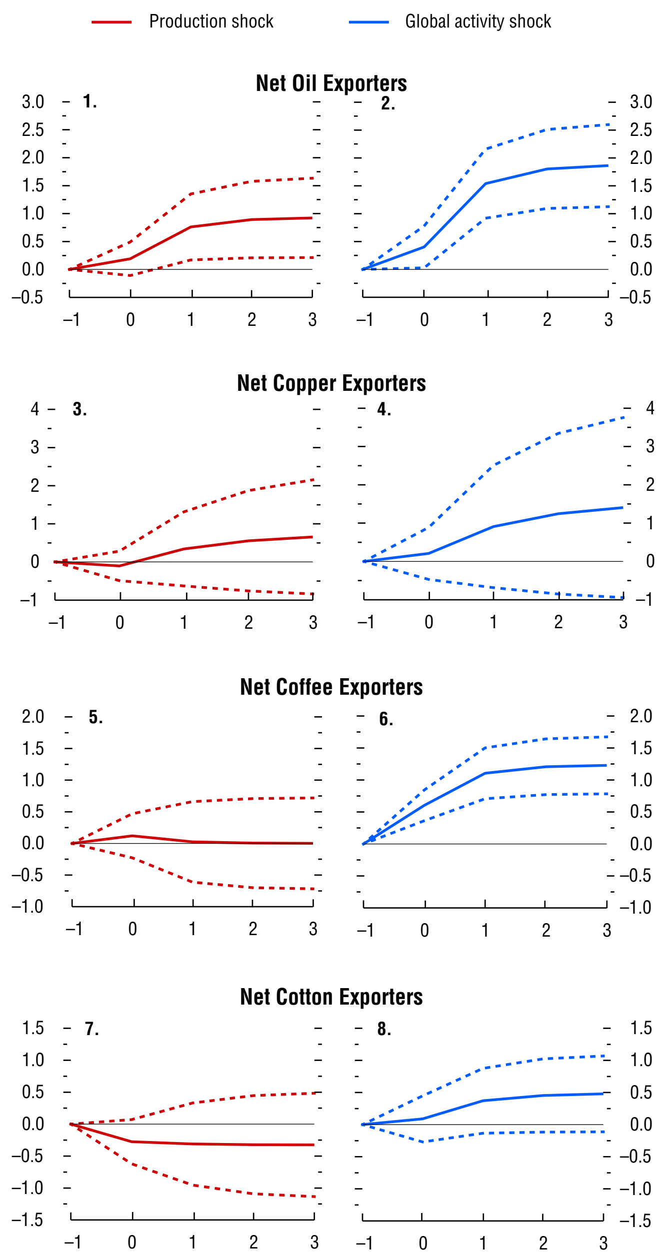
- A positive global activity shock improves economic conditions for all commodity exporters via real GDP growth or external balances or both. For oil, a typical global demand shock that increases the price of oil increases real GDP of net oil exporters by close to 0.4 percent in the impact year, while for coffee the increase is 0.6 percent (Table 4.5).[28] The real GDP effects for oil and coffee grow over the next three years, remaining positive and significant. For the remaining cases, the growth effects of demand shocks are not significant. However, there are significant improvements in the current account balance for all commodity exporters, and this effect remains significant even after three years for exporters of all commodities. Global demand shocks improve fiscal balances only for oil exporters, with the effect growing over a three-year horizon.
- In contrast, it is not surprising that a negative global production shock for the commodity, which increases its price, does not always have a significant economic effect. This is because a negative global production shock can be partially driven by a negative domestic production shock, or can result in a fall in global GDP, which could partly or fully offset the positive effect from the stronger terms of trade (as observed for copper and cotton).

How do the above economic effects of global activity versus global production manifest themselves over the entire phase of a commodity price upswing or downswing? To find out, we draw on the VAR model to separate the oil price upswings that are

[28]Note that a typical global demand (or production) shock for the case of oil and copper prices represents the annual average of the monthly structural shocks in the monthly VAR model. See Appendix 4.3 for details on using these results to obtain an estimate of the implied elasticities of real GDP with respect to price increases at an annual frequency.

Figure 4.7. Real Output Effects of Commodity Market Shocks
(Percent response)

Global demand-driven commodity price shocks can have significant economic effects on commodity exporters.



Source: IMF staff calculations.
Note: The *x*-axis shows the number of years elapsed, where time zero is the year that the shock occurs. The sample consists of net commodity exporters, where net exports of the commodity to total goods exports is at least 10 percent. Dashed lines denote 90 percent confidence bands. Shock magnitudes are a 1 standard deviation annual global production shock decline or annual global activity shock increase. See Appendix 4.3 for a description of the vector autoregression model used to estimate the underlying global activity and production shocks.

Table 4.5. Domestic Macroeconomic Effects of Global Commodity Market Shocks

		Real GDP		Current Account to GDP		Change in Public Debt to GDP	
Commodity	Shock	On Impact	At 3 Years	On Impact	At 3 Years	On Impact	At 3 Years
Oil	Production	0.191	0.923**	0.510	2.802	–1.990***	–4.316***
		(0.182)	(0.432)	(0.329)	(1.851)	(0.671)	(1.043)
	Global Activity	0.404*	1.862***	0.840***	5.458***	–1.333***	–3.269***
		(0.228)	(0.448)	(0.230)	(0.980)	(0.395)	(0.433)
Copper	Production	–0.104	0.658	0.098	–1.253**	0.984	–0.094
		(0.235)	(0.908)	(0.287)	(0.576)	(0.675)	(1.077)
	Global Activity	0.210	1.406	1.049**	2.486***	0.338	–0.851
		(0.412)	(1.428)	(0.549)	(0.952)	(0.752)	(1.191)
Coffee	Production	0.121	0.001	0.220	0.532	2.873*	0.860
		(0.212)	(0.437)	(0.237)	(0.560)	(1.657)	(1.090)
	Global Activity	0.603***	1.229***	0.364*	1.589*	4.579	6.128
		(0.146)	(0.270)	(0.217)	(0.915)	(4.192)	(5.895)
Cotton	Production	–0.275	–0.325	–0.399	–1.153	2.854	1.697
		(0.210)	(0.491)	(0.324)	(1.124)	(3.718)	(2.176)
	Global Activity	0.090	0.479	1.258*	4.110***	0.469	–0.435
		(0.218)	(0.359)	(0.648)	(1.588)	(2.074)	(1.464)

Source: IMF staff calculations.

Note: Standard errors are in parentheses underneath their corresponding estimate. *, **, and *** denote significance at the 10 percent, 5 percent, and 1 percent levels, respectively. The thought experiment is a 1 standard deviation annual global production shock decline of the commodity or a 1 standard deviation annual global activity shock rise. For oil and copper, the shocks are the average of the monthly shocks within a year, as taken from the model underlying Table 4.4, described in Appendix 4.3. The dynamic effects shown here are evaluated at the sample average value of the commodity exposure measure (net exports of the commodity of interest to GDP): for oil, this is 22.9 percent; for copper, 10.3 percent; for coffee, 4.2 percent; and for cotton, 3.2 percent.

driven predominantly by global demand from those that are driven primarily by changes in global production.[29] The results are summarized in Figure 4.8.

- The cyclical economic effect of oil price swings is somewhat larger when driven by global demand. The difference in real GDP growth between a typical upswing and a downswing is 1 percentage point for a demand-driven oil price cycle, compared with about 0.5 percent for all oil price cycles on average. The variation in the current account balance and the cumulative REER appreciation under a demand-driven oil price upswing relative to a downswing is similar to that observed in all oil price cycles on average.
- The fiscal position improves less during demand-driven oil price upswings relative to downswings. The fiscal balance proxied by the annual change in the public-debt-to-GDP ratio improves by about 2½ percentage points of GDP during a global demand-driven upswing (compared with an improvement of close to 4 percentage points of GDP for all oil price cycles on average). This may reflect a tendency for oil exporters to have a less countercyclical (or more procyclical) fiscal response to global demand shocks than to other shocks, which in turn could explain the greater domestic economic variation in response to demand-driven oil price cycles.

Distinguishing between the underlying sources of commodity price swings does matter, as these drivers have different price and macroeconomic effects for different commodity exporters. Overall, the economic effects of global activity shocks are significant for commodity exporters. These effects are strongest for crude oil, but also hold for other exporters. Oil exporters experience somewhat greater variation in real activity from global demand-driven oil price cycles than from other types of oil price cycles. These findings do not, however, shed light on how commodity exporters should respond to global commodity shocks to minimize their domestic economic effects. These questions are addressed in the next section.

Optimal Fiscal Policy Responses to Commodity Market Shocks

How should commodity exporters respond to commodity price fluctuations? The role of macroeconomic policies in lowering economic volatility may be more important for commodity exporters given the persistence and volatility of commodity price swings. As noted, a typical downswing in oil and metal prices

[29]Such a clear separation of demand-driven from production-driven price cycles is not possible for the other commodities. See Appendix 4.3 for details.

can last two to three years, can entail a real price decline from peak to trough of 40 to 50 percent, and can induce a setback in real GDP growth of ½ to 1 percentage point. In this regard, the role of fiscal policy may be crucial, given the direct effect of commodity prices on government coffers, and through the latter's actions, on the rest of the economy.[30]

This section focuses on the optimal fiscal policy response to commodity price fluctuations in a small, open commodity exporter and its interaction with monetary policy through the choice of exchange rate regime. Although the model is calibrated for oil, as discussed below, the qualitative results are equally applicable to other commodities. The section analyzes how the optimal fiscal policy choice is affected by the source of commodity price fluctuations, differences in underlying macroeconomic conditions, and structural characteristics of the commodity exporter. Recognizing some of the limitations of the model-based analysis, we also discuss possible trade-offs between optimal policies at the country versus the global level for the case of large commodity exporters, given the possibility for spillover of their policies. We also consider the optimal fiscal response to permanent commodity price changes. Finally, we consider how commodity exporters can best design their policies in light of prevailing uncertainty about the future direction of commodity prices.

The Setting

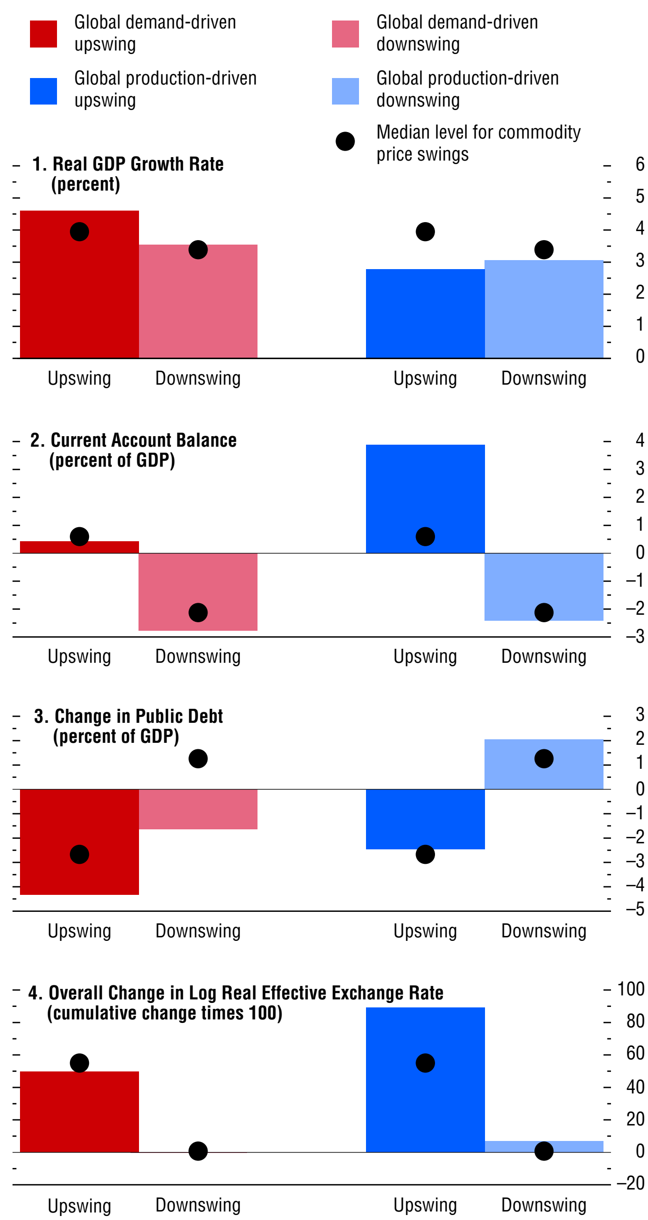
We use a two-region version of the Global Integrated Monetary and Fiscal model (GIMF) comprising a small, open oil exporter and the rest of the world, which is a *net* oil importer.[31] The small, open oil exporter takes the global oil price as given. It exports the bulk of its oil production, with net oil exports equivalent to 18 percent of its GDP and

[30]The empirical evidence, however, points to fiscal policies being procyclical, thereby exacerbating domestic volatility. For instance, Husain, Tazhibayeva, and Ter-Martirosyan (2008) find that fiscal policy reactions to oil price shocks raise real domestic volatility. As noted, Frankel (2011) argues that commodity exporters are too procyclical in their macroeconomic policies, while Céspedes and Velasco (2011) find that there may have been a decline in procyclical fiscal policies in commodity exporters in recent years.

[31]See Appendix 4.4 for details.

Figure 4.8. Oil Price Drivers, Cycles, and Performance in Net Oil Exporters

Global demand-driven oil price cycles lead to greater macroeconomic volatility.



Source: IMF staff calculations.
Note: The black circles denote the sample median level during upswings and downswings, without taking into account their underlying driver. There are two production-driven oil price swings: a downswing (1996:M1–1998:M12) and an upswing (1999:M1–2000:M9). There are four demand-driven price swings: two downswings (1990:M10–1993:M12 and 2000:M10–2001:M12) and two upswings (1994:M1–1996:M10 and 2002:M1–2008:M7). See Appendix 4.1 for a full description of the underlying data. See Appendix 4.3 for a description of the vector autoregression model used to estimate the underlying global activity and production shocks.

representing 45 percent of its total exports.[32] This structure implies that a global demand-driven shock would affect the oil exporter not only through a change in the price of oil, but also through a change in the demand for other goods it exports (thereby allowing for Dutch-disease-type effects). The exporter is populated by households with overlapping generations as well as liquidity-constrained households, to more realistically capture the effects of fiscal policy. The government can borrow in international capital markets but faces a risk premium that is increasing with the level of its net external debt.[33] In the baseline, we also assume that (1) oil production is largely controlled by the government, which accrues most of the associated rent (through "commodity royalties"); (2) net public debt is relatively small, and the sensitivity of the sovereign risk premium to its changes is low; and (3) monetary policy follows an inflation-targeting regime, with a floating nominal exchange rate. These assumptions are relaxed in subsequent robustness analyses.

The fiscal policy stance is modeled through rules that target the government budget balance to minimize output and inflation volatility. Specifically, in each period the fiscal policy authority sets a fiscal instrument in response to deviations of non-oil tax receipts relative to their long-term level and deviations of commodity royalties from their long-term level. For example, if the global oil price and tax receipts temporarily rise unexpectedly, commodity royalties temporarily increase above their long-term levels and the fiscal authority may adjust the fiscal instrument in response. The specific instrument used is the labor tax rate, which is chosen for simplicity and does not constitute a policy recommendation. Also, policy conclusions do not depend on this choice. We consider three broad stances:

- *A balanced budget rule:* Under such a rule, the government budget is balanced in every period, so all exceptional commodity royalties and tax revenues are redistributed immediately to households through lower tax rates. This rule is procyclical by design but maintains fiscal balance and net debt at long-term targets.
- *A structural surplus rule:* Under this rule, exceptionally high commodity royalties and tax revenues are saved, while exceptionally low royalties and revenues result in dissavings (thereby avoiding increases in tax rates to offset the loss). This rule results in a one-for-one change in the overall fiscal balance and government debt in response to deviations of royalties and tax revenues from their long-term values. It is cyclically neutral, since it does not add to or subtract from aggregate demand.
- *A countercyclical rule:* Under this rule, the fiscal authority not only saves exceptionally high commodity royalties and tax revenues, but also increases taxes to dampen the stimulus to aggregate demand from higher oil revenue accruing to the private sector. In the case of exceptionally low royalties and tax revenues, taxes are lowered temporarily. This rule implies larger changes in budget surpluses and government debt in response to oil price changes. However, it acts countercyclically, increasing (reducing) the structural balance during periods of strong (weak) oil prices and/or economic activity.

In practice, fiscal policy behavior in a number of commodity exporters has been broadly influenced by rules of this kind. Chile and Norway have even adopted specific rules along the lines of those used in the model simulations. Chile follows a structural surplus rule, which allows for the presence of automatic stabilizers. Norway's rule targets a structural non-oil balance and also allows for the possibility of countercyclical responses over the business cycle.[34]

Response to Temporary Commodity Price Shocks

To compare the effects of the three fiscal policy stances, we analyze the results from simulations based on two oil-price-shock scenarios. In the first, the oil

[32]This is similar to the average shares for oil exporters in the sample (see Appendix 4.1).

[33]Net debt takes into account any positive foreign asset position (such as a sovereign wealth fund).

[34]Over the past two decades, there has been a marked increase in the adoption of rules-based fiscal policy, expressed through some concept of the fiscal balance or its components (revenue and/or expenditure) and/or the debt level. Fiscal rules are currently in use in some form in more than 65 countries. See IMF (2009).

price increases in response to unexpected increases in global activity. In the second, the increase is due to a negative shock to global oil production. In both scenarios, the shocks are calibrated to result in comparable oil price increases (close to 20 percent after one year). Also, the persistence of the oil price increases is about three years—within the distribution of the duration of oil price cycles in the empirical analysis.

We find that the effects of oil price increases on the domestic economy differ according to whether they are driven by external demand or external supply conditions, in line with the empirical results.

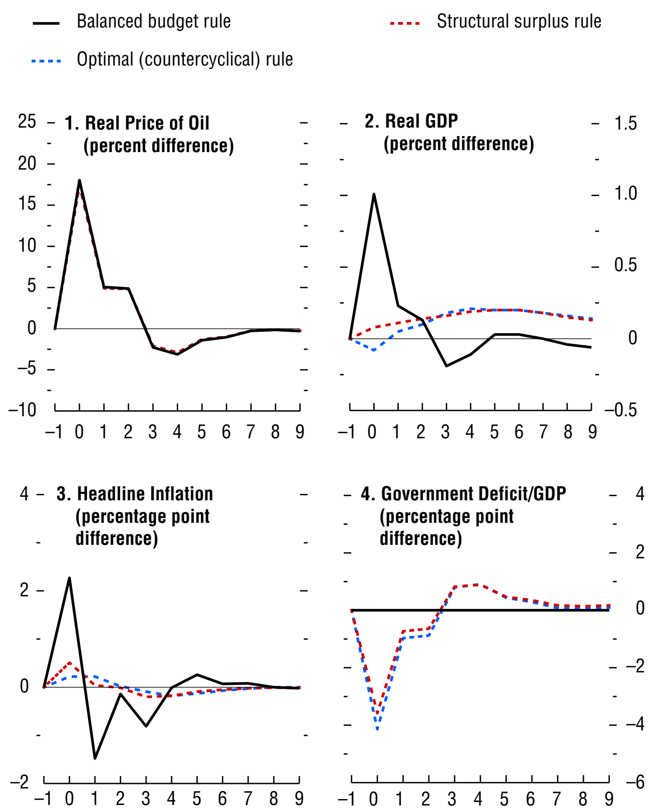
For the external supply-driven oil price increase, a temporary decline in oil supply in the rest of the world increases the real price of oil by 20 percent in the first year. The price gradually falls over the next two years (Figure 4.9). As the rest of the world's GDP declines so does real external demand for all goods exported by the small, open oil exporter. However, the fall in external demand is offset by an increase in the real value of the economy's oil exports, which improves its trade balance. Despite the increase in headline inflation resulting from higher oil prices, depressed global demand reduces the real price of final goods and in fact causes core inflation to fall. This is mitigated in part by slightly more stimulative monetary policy.

For the external demand-driven oil price increase, a temporary increase in liquidity in the rest of the world boosts global demand, driving up the real price of oil by about 20 percent in the first three years, after which global demand unwinds. Oil prices also experience a boom-bust cycle. Unlike a supply-driven oil price shock, the global demand boom drives up the demand and prices of *all* the small, open economy's exports.

For both shocks, a fiscal policy stance that aims at a balanced budget exacerbates macroeconomic volatility relative to the structural and countercyclical stances (Figures 4.9 and 4.10). Under a balanced budget rule, the excess tax revenues and oil royalties obtained during the boom are spent via a decline in labor taxes. Conversely, when the oil price increase unwinds, the fall in tax revenues and royalties is offset by an increase in labor taxes. In either direction, there is an increase in the output gap and in inflation volatility. With a structural surplus rule, the excess

Figure 4.9. Dynamic Effects of a Temporary Reduction in Oil Supply in the Rest of the World on a Small, Open Oil Exporter

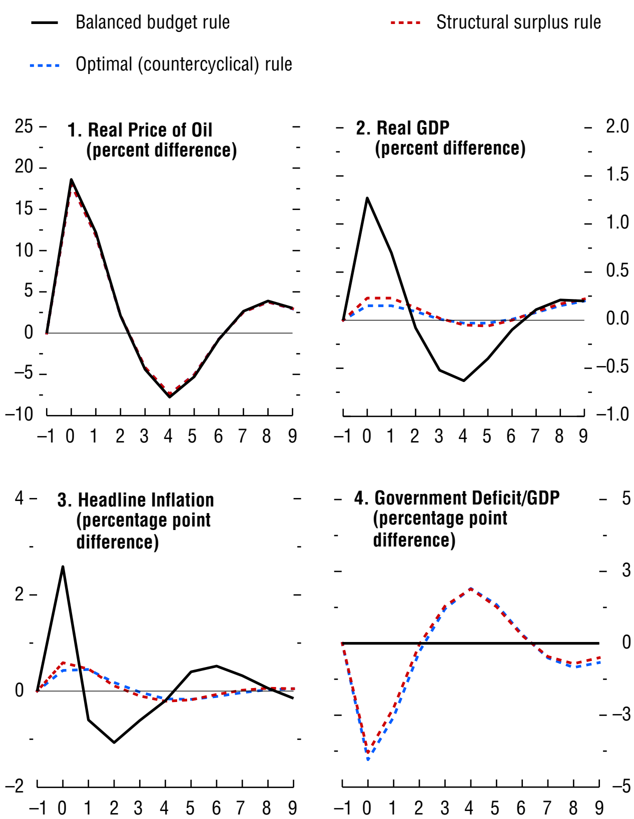
A balanced budget fiscal policy in response to a global supply-driven oil price increase elevates domestic macroeconomic volatility in the oil exporter. A countercyclical fiscal response is the best way to reduce this volatility.



Source: IMF Global Integrated Monetary and Fiscal Model.
Note: The *x*-axis shows the number of years elapsed, where time zero is the year that the shock occurs. See Appendix 4.4 for a description of the model.

Figure 4.10. Dynamic Effects of a Temporary Increase in Liquidity in the Rest of the World on a Small, Open Oil Exporter

Domestic economic volatility induced by a global demand-driven oil price increase is even greater than that of a global supply-driven increase. In either case, a countercyclical fiscal policy dominates the balanced budget policy in terms of minimizing the volatility.



Source: IMF Global Integrated Monetary and Fiscal Model.
Note: The *x*-axis shows the number of years elapsed, where time zero is the year that the shock occurs. See Appendix 4.4 for a description of the model.

revenues and royalties during the price boom are saved, resulting in no change in labor taxes and a fall in the debt-to-GDP ratio. Conversely, these revenues are allowed to fall short of their potential levels when the boom unwinds. In either direction, the structural surplus rule helps dampen inflation and output volatility relative to a balanced budget rule.[35] Under a countercyclical rule, the labor tax rate rises with the boom, helping further dampen demand and inflation. Conversely, the labor tax rate is reduced when the boom unwinds, mitigating the fall in demand. Thus, a countercyclical rule reduces the output gap and inflation volatility more than a structural surplus rule under both types of cyclical commodity price shocks and constitutes the optimal fiscal response to them both. In the simulations, the size of countercyclical responses to the temporarily high royalties is quite small. This largely reflects the assumption that most of the oil royalties accrue to the government, which in turn implies that insulating the economy from changes in government oil revenues is broadly sufficient for macroeconomic stabilization.

Alternative Policy Frameworks and Structural Characteristics

The result that a countercyclical fiscal policy stance is optimal is generally robust to alternative assumptions about policy regimes and structural characteristics. Nevertheless, there are some nuances to consider (Figure 4.11).

Fixed exchange rate regime

Under a fixed exchange rate regime, the fiscal authority's countercyclical response to oil price shocks must be more aggressive. The main reason is that it lacks the support of the monetary authority, which, unlike under an inflation-targeting regime, is not complementary but procyclical in its response to commodity price shocks. For example, in the case of an unexpected oil price increase, the monetary policy stance is relaxed to offset the upward pressure on the nominal exchange rate. This feature is reminiscent of the empirical regularity that the comovement of the

[35]This is consistent with the findings of Kumhof and Laxton (2010), who find that a structural surplus rule can reduce macroeconomic volatility for a small copper exporter such as Chile.

domestic economy with the commodity price cycle is stronger with pegged exchange rates, as discussed earlier.[36]

Initial debt levels

The size of the countercyclical response might also reflect initial public net debt levels, depending on how strongly the sovereign risk premium reacts to changes in the level of net debt. In an alternative simulation with an initial net debt level of 100 percent of GDP (compared with the baseline of 30 percent), changes in the net debt level due to countercyclical policy responses can lead to a substantial change in the sovereign risk premium and hence domestic interest rates. In the case of an unexpected oil price drop, for example, a strong countercyclical response would result in a substantial increase in the risk premium due to higher public net debt, which would induce a sharp contraction in private domestic demand. This latter effect could be strong enough to fully offset the initial expansionary fiscal policy response.[37] Thus, at high levels of net debt, a higher priority is placed on reducing debt and building fiscal credibility prior to adopting a countercyclical fiscal response.

Different ownership structure in the oil sector

If there is a higher share of domestic private ownership in the oil sector, the saving behavior of households matters.[38] Assuming that a higher share of private sector oil royalties goes to households that can smooth their consumption by saving more (compared with the case of public sector ownership, when the government distributes revenues in a broadly similar way across households that smooth their consumption and those that do not), the ensuing output and inflation volatility is lower than in the baseline case. However, it is still optimal to have

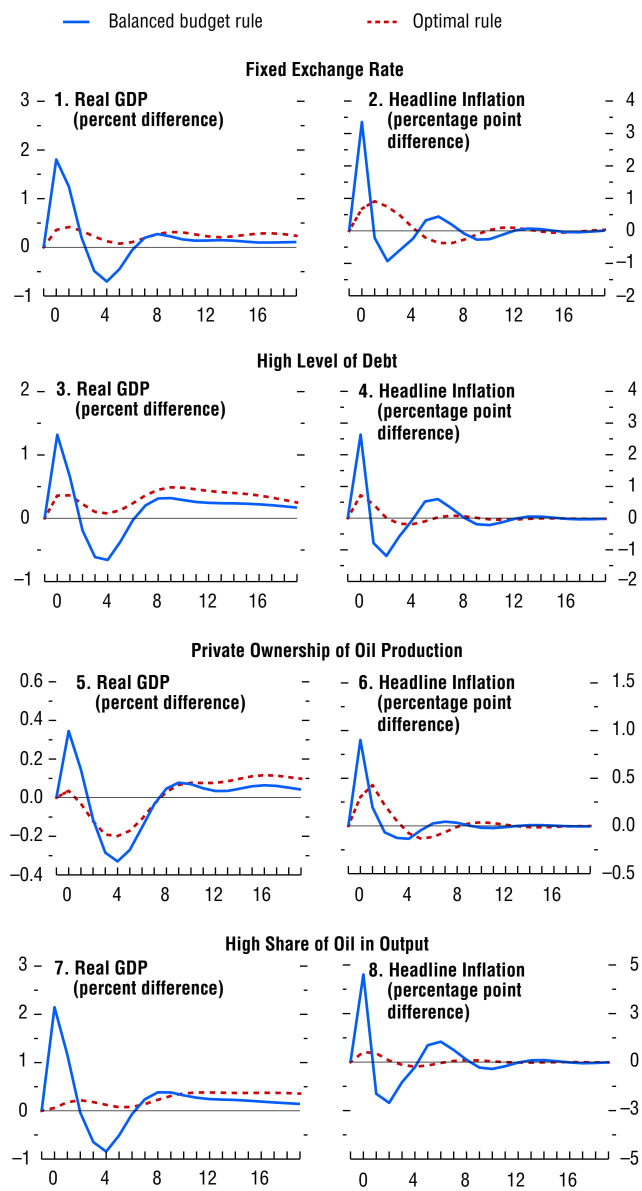
[36]See also Broda (2004) or Rafiq (2011).

[37]See also Demirel (2010), who finds that optimal fiscal and monetary policies are procyclical (countercyclical) in the presence (absence) of the country spread. IMF (2009) finds that for a sample of Organization for Economic Cooperation and Development (OECD) countries, fiscal rules were more effective when public debt ratios were below a certain threshold.

[38]In this scenario, the private sector is assumed to own 90 percent of the oil production, compared with the baseline case, in which it owned only 10 percent.

Figure 4.11. Optimal Fiscal Policy Stance under Alternative Policy Frameworks and Structural Characteristics

This figure compares the optimal fiscal rule to the balanced budget rule for a temporary increase in global liquidity (similar to Figure 4.10). A countercyclical fiscal policy is consistently optimal for alternative macroeconomic conditions or different characteristics of commodity exporters. The exception is when the risk premium is highly sensitive to the level of sovereign debt, in which case the optimal fiscal response is closer to a structural surplus rule.



Source: IMF Global Integrated Monetary and Fiscal Model.
Note: The *x*-axis shows the number of years elapsed, where time zero is the year that the shock occurs. Panels 1 and 2 show the case when the exchange rate regime is fixed. Panels 3 and 4 show the case where net public debt is 100 percent of GDP. Panels 5 and 6 show the case where the share of private ownership in total oil production is 90 percent. Panels 7 and 8 show the case where the ratio of net oil exports to GDP is 36 percent.

a countercyclical fiscal response, which mitigates output and inflation volatility more than the other fiscal rules.

Higher share of oil in production

If the oil sector accounts for a larger share of output,[39] it is optimal to have a countercyclical fiscal response only to the changes in tax revenues, while saving the changes in oil royalties. Even though there are spillovers from the oil revenues into the non-oil sector, the non-oil sector contributes less to overall demand fluctuations relative to the baseline. Also, given the much larger share of the oil sector in the economy, a more countercyclical fiscal response to the increase in oil royalties can cause output to fall. Thus, saving the difference in government oil royalties may be enough for macroeconomic stabilization.

Subsidies for oil consumption

Many oil producers implicitly subsidize gasoline consumption and oil in domestic production. Such subsidies reduce the pass-through of changes in the price of oil into headline inflation. However, output fluctuations are similar to those considered in the baseline model because of changes in oil royalties and their effect on the non-oil economy. Thus, a countercyclical fiscal rule is still preferred to a structural rule for smoothing output volatility. A full analysis of the desirability of these subsidies should take into account the long-term viability of these subsidies, which is beyond the scope of this chapter.

Non-oil commodities

The results of the model are easily applicable to commodities other than oil. Although specific parameter values in the simulations have been chosen to replicate features of oil exporters, there is nothing about the structure of the model that makes it relevant only for oil.[40] For example, our results are broadly similar to those of Kumhof and Laxton (2010) for the case of copper in Chile. The main difference is that oil price shocks might have larger effects on headline inflation compared with copper and other industrial raw materials, since oil is more important in the consumption basket. In contrast, for food, the difference in headline inflation might be even more pronounced. Intuitively, the optimal size of the countercyclical fiscal response therefore increases with a higher share of the commodity in the consumption basket.

These findings underscore the importance of countercyclical fiscal policy in commodity exporters to ameliorate domestic volatility induced by temporary global commodity price shocks. A countercyclical fiscal stance is preferred under both fixed and flexible exchange rate regimes but needs to work harder under fixed rates when monetary policy becomes procyclical. Moreover, for a countercyclical policy to be effective and credible, public net debt levels should be low. When commodity production comprises a large share of an economy's value added, the size of the countercyclical fiscal response is closer to that of a structural surplus rule.

Where do commodity exporters stand vis-à-vis the policy lessons above? In general, they have been moving in the right direction by reducing their debt levels and strengthening their fiscal balances, especially over the past decade. However, economies vary greatly when it comes to macroeconomic and institutional readiness to implement fiscal policies aimed at macroeconomic stabilization. Some effectively now operate under a structural or countercyclical fiscal rule or fiscal responsibility laws (Botswana, Chile) and/or have moved toward further enhancement of their monetary policy frameworks by adopting inflation targeting (Indonesia, South Africa, and many Latin American economies). Some have achieved large debt reductions over the past decade (many OPEC members) or are in the process of

[39]In this scenario, the share of net oil exports in total GDP is 36 percent, as in some members of the Organization of Petroleum Exporting Countries (OPEC), compared with the baseline of 18 percent.

[40]When it comes to quantifying the optimal fiscal policy response to cyclical commodity price fluctuations, the structure of commodity exporters matters, of course, because of differences in demand and supply price elasticities across commodities, the heterogeneity of commodity prices across regions, and the level of production rents. In addition, economies that are more diversified across commodities are less inclined to experience domestic fluctuations from global supply shocks compared with broad-based global demand shocks. Moreover, structural characteristics such as high commodity intensity in total production and public ownership are more applicable to metal and oil production than to agricultural commodities.

formalizing fiscal institutions.[41] For those that have yet to initiate policy reforms, the current strength of commodity prices offers a good opportunity to build additional fiscal buffers and to ready fiscal and monetary institutions for any unexpected cyclical downturn in commodity prices.

Global Spillovers from Domestic Policies in Commodity Exporters

Could there be trade-offs between the optimal response to temporary commodity price shocks from the perspective of individual economies and the optimal response from the perspective of global economic stability? The analysis of optimal policies in this chapter was based on the assumption that commodity exporters are small and their policies do not affect economic activity in the rest of the world, including commodity markets. While this is a reasonable assumption for most commodity exporters and commodities, it may not be realistic for some large exporters. For instance, some oil exporters account for a substantial share of global absorption, wealth, and spare oil production capacity. When a commodity exporter is large, its policies can generate spillovers to other economies. Similarly, broadly identical policy responses by a group of relatively large commodity exporters may also generate important spillovers. This, in turn, raises the question of whether such spillovers could change the advice about optimal responses to commodity price changes.

A comprehensive analysis of optimal policies for large commodity exporters is beyond the scope of this chapter since it would need to consider not only the type of shock but also policies of other large economies, including commodity importers. Instead, this section touches on the possible conflicts between policies that are optimal for large oil exporters from a domestic perspective and policies that are optimal from a global perspective in the case of a temporary oil supply shock. The backdrop to this discussion is the current concern about increased geopolitical risks to the supply of oil as a source of downside risks to the global economy. Policy responses of large oil exporters are thus an important consideration in the global response to such shocks (see Chapter 1).

A temporary oil supply shock would have asymmetric effects on oil exporters for whom oil is a dominant source of exports compared with oil importers as well as other oil exporters. For exporters whose main export is oil, the terms-of-trade gains from the increase in oil prices in response to a supply shock would dominate any negative effect from a fall in external demand. The optimal domestic fiscal response to the windfall revenue gain in a small, open oil exporter (that does not experience the supply shock) would be a countercyclical one. Such a response by large exporters, however, would not be helpful in offsetting the negative direct effects of the shock on aggregate demand of oil importers. As a result, global output growth could slow or fall further than it would without such policies in oil exporters.[42] However, in normal times, the increased saving by large oil exporters could lower global real interest rates and boost interest-sensitive components of aggregate demand in importers.

Do such spillovers from large oil exporters' policies change the policy advice? Not necessarily. In many cases, the countercyclical fiscal response for oil exporters is still likely to be optimal. Importers can respond to the supply shock with countercyclical policies of their own. Nevertheless, there could be circumstances where other policy choices might be more relevant—for example, when the policy room in importers is limited or when the global economic downturn is so deep or protracted that the ensuing falloff in global demand can ultimately depress prices for all commodities, including oil. Under such circumstances, the countercyclical response may not be optimal in the first place for large exporters.

What are the policy options under these circumstances? The best option (from a global perspective) would be increased oil production by oil exporters

[41]See Céspedes and Velasco (2011), IMF (2009), De Gregorio and Labbé (2011), Ossowski and others (2008), and Roger (2010).

[42]This trade-off between domestic and global economic stability arises only when the effects of commodity market shocks are asymmetric across different economies. Therefore, there is no relevant trade-off when commodity prices are driven by global activity, which affects commodity exporters and the rest of the world in similar ways.

unaffected by the initial supply disruption, if they have spare capacity. This would offset the shock and stabilize global oil markets. If oil supply increases are not feasible, a less countercyclical policy response in large oil exporters combined with supportive economic policies in major importers (where possible) could also help alleviate the negative effect of the oil price increase on global output. How large could this effect be? If major oil exporters opted to spend all of their revenue windfalls from a 50 percent hike in the price of oil on imports, then real demand in the rest of the world could rise by up to ¾ percentage point, not a negligible amount.[43]

Fiscal Response to a Permanent Increase in the Price of Oil

Besides cyclical fluctuations, commodity prices also display long-term trends. While these trends are difficult to forecast, they nevertheless point to the possibility that some price shocks may have a permanent component. The main difference with respect to temporary price rises is the fact that a permanent oil price increase will have a permanent effect on potential royalties and possibly even on potential output. This naturally leads to the question of how a permanent windfall in oil royalties should be used most efficiently to maximize potential output and overall welfare.

A permanent oil price increase raises many policy issues, including those related to equity across generations, and an exhaustive analysis of these issues is beyond the scope of the chapter.[44] Nevertheless, using the GIMF, we can examine which fiscal instrument is most effective in maximizing output and welfare. By exploring a relatively wide array of fiscal instruments, we complement previous work on this topic, which has focused primarily on the desirability of investing savings in foreign assets (Davis and others, 2001; Barnett and Ossowski, 2003; Bems and de Carvalho Filho, 2011) or domestic government investment (Takizawa, Gardner, and Ueda, 2004; Berg and others, forthcoming). It should be emphasized that this analysis is conducted for an oil exporter, but as noted, the results also apply to other commodities.

The fiscal policy options in response to a permanent increase in oil royalties are increases in public investment (such as public infrastructure), increases in household transfers, reductions in distortionary tax rates (such as those on labor and capital income), and reductions in debt levels or increases in sovereign wealth invested abroad. The key features of this model are the assumption that higher investment and lower taxes boost labor demand and that higher transfers lower the supply of labor, which is in line with the empirical evidence.[45] To evaluate these options, we analyze their effects on the new long-term equilibrium in the model, compared with the long-term equilibrium before the shock. Because the speed of the transition to the new equilibrium differs depending on the fiscal policy options, the results also include the net present value of each option in terms of household utility (Table 4.6). It is important to bear in mind, however, that the results depend on the choice of underlying model parameters. The parameters used in this model closely follow those in the literature, but the results could vary according to economy-specific characteristics.

Increased public investment has the strongest effect on output (see also Takizawa, Gardner, and Ueda, 2004). However, it is important to stress that the simulations do not account for low-quality governance and production bottlenecks, which could substantially impede the efficient conversion of resources into public capital (see Box 4.2). In addition, the benefits of public investment accrue only slowly because it takes time to build up public

[43]These calculations present an upper bound on the positive effects from spending increases by large oil exporters that account for more than one-third of global oil production (such as a majority of the OPEC producers together). We assume that these oil exporters' fiscal revenues increase proportionately with the oil price increase and that they channel all the windfall fiscal revenues back to the rest of the world via increased import demand. See Beidas-Strom (2011) for a related analysis of global spillover effects of fiscal spending by Saudi Arabia.

[44]Among these questions are resource exhaustibility, Dutch disease effects, bequest objectives, and exporting economies' institutional and development needs. See Box 4.2 for a discussion of some of these issues.

[45]See Eissa and Hoynes (2004) and Keane (2010). Another implicit assumption is that the original equilibrium was not already at the optimal capital and output levels due to prevailing distortions in the economy, a reasonable assumption for most developing economies.

Table 4.6. Comparison of Policy Instruments for Permanent Increases in Oil Royalties

	Real GDP (percent)	Real Consumption (percent)	Current Account (percent of GDP)	Debt-to-GDP Ratio (percent of GDP)	NPV of Utility (percent)
Reduction in Labor Taxes	1.7	9.7	0.8	0.0	24.6
Reduction in Capital Taxes	12.2	11.9	–0.6	0.0	25.1
Increase in General Transfers	–0.6	6.5	0.2	0.0	21.8
Increase in Government Investment	53.7	31.6	0.3	0.0	19.0
Reduction in Net Debt from Low Initial Debt Position	4.1	12.6	5.5	–109.0	12.8
Reduction in Net Debt from High Initial Debt Position	15.4	21.5	7.6	–109.0	20.1

Source: IMF Global Integrated Monetary and Fiscal Model.

Note: The first four columns show the difference between the new long-term level and the old long-term level of each variable. The last column shows the net present value (NPV) of household utility evaluated over the transition to the new steady state.

capital. As a result, the net present value of the expected utility flow is lower than under some other options, although this result depends on how much policymakers discount the future. The more patient a country's policymakers and citizens, the more beneficial the public investment option becomes.[46] An increase in general transfers to households—even though it raises household income and, thus, private consumption—negatively affects labor supply, thus reducing the total hours worked and output in the long term.

However, there are trade-offs between maximizing output and maximizing welfare, with the ultimate choice of the instrument depending on country-specific preferences. For instance, an increase in general transfers to households raises the net present value of utility (from increases in consumption and leisure) by more than an increase in public investment, even though the former has less of an output effect. The public welfare benefits of using resource revenues to pay off debt are significant only when a country's initial debt level is high and debt reduction significantly lowers the sovereign risk premium. In this case, the main benefit is to lower sovereign risk, which means the government can borrow at lower interest rates to finance investment and service its debt (see, for example, Venables, 2010). Lower borrowing costs stimulate demand, while the lower cost of servicing the debt increases fiscal room. In contrast, paying off a low amount of debt and then accumulating assets (for example, via a sovereign wealth fund) yields a relatively small return—namely, investment income from safe international assets. This might be a good option in response to prudential and intergenerational equity demands, but in this model context, where there is no uncertainty, accumulating low-yielding foreign asset positions offers lower benefits in terms of both output and welfare.

The effects of various fiscal policy instruments are almost the same whether prices rise or fall. This would argue for a cut in general transfers to minimize the output effects under a permanent decline in oil prices, as the model assumes that increases in transfers reduce the labor supply. However, if optimizing the net present value of utility by meeting social needs were a concern, then cutting transfers would not be optimal. Another option, if the economy started at a relatively low net debt position, would be to reduce holdings of assets, with relatively small negative effects on both output and household welfare. Conversely, cutting public infrastructure investment would be the least desirable fiscal response if the objective were to minimize the output shortfall from permanently lower commodity prices.

Conclusions and Policy Lessons

This chapter presents evidence of commodity exporters' vulnerability to swings in commodity prices. Historically, exporters' macroeconomic performance has fluctuated with commodity price cycles—improving during upswings and deteriorating during downswings. The comovement of domestic economic conditions with commodity

[46]We assume a 5 percent discount factor.

price cycles is amplified when the underlying cycles are longer or deeper than usual. When the underlying drivers of commodity price changes are identified, we find that global demand-driven commodity market shocks have a positive and significant effect on exporters' activity and external balances. For oil exporters, domestic economic indicators tend to vary with global demand-driven oil price cycles.

What are the policy implications for commodity exporters? If all commodity price swings were temporary, the optimal fiscal policy response for a small commodity exporter would be a countercyclical one—save the windfall fiscal revenue and royalties during price upswings and spend them during downswings to ameliorate the macroeconomic volatility induced by commodity price cycles. These policies are desirable under both fixed and flexible exchange rate regimes but are more effective under a flexible exchange rate combined with inflation targeting, when monetary policy complements fiscal policy by reducing inflation volatility. When public debt levels are high, however, the priority should be on lowering debt and sovereign risk premium to build credibility prior to adopting countercyclical fiscal policies. For large commodity exporters whose policies generate spillovers for others, the optimal policy response may depend on the nature of the shock and the state of the global economy. Thus, when global demand is weak and policy room in the rest of the world is limited, there may be a case for a less countercyclical fiscal policy response.

Under a permanent increase in the commodity price, the key challenge is how best to use the permanently higher royalties to maximize welfare. Changes in public investment expenditures give the strongest output effect by raising private sector productivity (for instance, via improvements in education, health, and infrastructure) and subsequently by increasing private capital, labor and corporate incomes, and consumption. Conversely, if prices were to fall permanently, cutting general transfers could best limit the output shortfall, although the social welfare impact of such cuts must be taken into account.

What messages do these findings provide for commodity exporters? In the near term they face a weak global economy. If downside risks to the global outlook materialize, commodity prices could decline further. Over the longer term, commodity prices are even more unpredictable. They may stay at their current levels in real terms if rapid commodity-intensive growth continues in emerging and developing economies. On the other hand, prices may decline in response to increasing user efficiency and the unwinding of earlier supply constraints. In light of the unusually high uncertainty and the difficulty of forecasting prospects for commodity markets in real time, a cautious approach is the best option. This involves upgrading policy frameworks and institutions and building buffers to address cyclical volatility while gradually incorporating new information to smooth the adjustment to potentially permanently higher prices.

Appendix 4.1. Data Description

Real Commodity Prices

Monthly data on commodity prices come mainly from the IMF's Primary Commodity Price System. All prices are period averages and are representative of the global market price because they are determined by the largest exporter of a given commodity. The key exception is the monthly oil price, which is the U.S. Energy Information Administration (EIA) import price of crude oil to refiners between January 1974 and August 2011. The price is extended backward through 1973 with Barsky and Kilian's (2002) imputed series value. All prices are denominated in U.S. dollars and, in line with other work (such as Cashin, McDermott, and Scott, 2002), deflated by the U.S. consumer price index (CPI) to obtain a real commodity price (CPI is taken from the St. Louis Federal Reserve Economic Data database, series CPIAUCSL). These real prices are then normalized such that the average real price in 2005 is equal to 100. Annual data on real commodity prices are calculated by taking the mean of the data at a monthly frequency for the corresponding year.

Exports and Imports by Commodity

Annual data on imports and exports used in the chapter are taken from the UN-NBER bilateral country and commodity-level merchandise trade flows database, which covers the period 1962–2000 (Feenstra and others, 2005). These data are extended with the United Nations COMTRADE data from 2001–10, following the methodology described in Feenstra and others (2005) and using the Standard International Trade Classification (SITC) Version 2 to define trade in each commodity. These data are then aggregated to compute country-level total exports and imports and country-level exports and imports by commodity.

Commodity Price Indices

The four commodity group price indices (energy, metals, food and beverages, raw materials) are weighted averages of the real prices of the commodities within a group. The weight for each commodity is its once-lagged three-year moving average of total world exports of the commodity divided by total world exports of all commodities in the group.

Economy-Level Macroeconomic Variables

These data come largely from the World Economic Outlook (WEO) database: real output (series NGDP_R), nominal output in U.S. dollars (series NGDPD), the current account in current U.S. dollars (series BCA), the overall fiscal balance (GGXOFB), and the cyclically adjusted fiscal balance as a percent of potential GDP (series GGCB). The change in the public-debt-to-GDP ratio is taken from the Historical Public Debt database (Abbas and others, 2010). The real effective exchange rate is series EREER from the IMF's Information Notice System (INS) database, from 1980 to the present. We construct a comparable series for the years prior to 1980 by combining the INS weights with historical nominal, bilateral exchange rates. We take the growth rate of this constructed series and splice the original INS series using this growth rate as far back as possible. The underlying data for real private credit growth are the level of bank credit to the private sector in current local currency units, taken from line 22 of the IMF's International Financial Statistics (IFS) database. This private credit series is releveled whenever a level shift or break is observed in the series. These data are deflated using the economy's CPI to construct a real private credit level. The exchange rate regime indicator is taken from Ilzetzki, Reinhart, and Rogoff (2008). We collapse their coarse classification into a binary indicator, mapping their classes 1 and 2 to "fixed" and 3 and 4 to "flexible." To extend this indicator to the present, we take the 2008 value for the indicator by economy and assume that it is the same during 2009–11. The capital account openness indicator (high versus low) is calculated using Chinn and Ito's (2006, 2008) capital openness measure, KAOPEN. To extend this indicator to the present, we take the last value for the indicator by economy and carry it forward to the present. We then take the grand median of this measure and categorize an observation as high if it is above this grand median and low if it is below it. The banking crisis indicator comes from Laeven and Valencia (2008, 2010). It takes a value of 1 if the economy is deemed to be experiencing a systemic banking crisis and zero otherwise.

Commodity Production and Inventories

The four major commodities explored in this chapter are crude oil, copper, coffee, and cotton. Production data for these commodities came from various sources.

Monthly oil production data come from the EIA's *International Energy Statistics* for world petroleum production (thousands of barrels a day), from January 1974 to August 2011. These data are extended backward through 1973 with Barsky and Kilian's (2002) imputed value of the series. The monthly global inventory level for oil is proxied by total OECD inventories, taken from the EIA's *International Energy Statistics* for the total petroleum stock in the OECD, measured on an end-of-period basis in millions of barrels. For data prior to 1988, we follow the approach of Kilian and Murphy (2010) and splice the total OECD stock back to 1970 using the monthly growth rate of the U.S. stock (also taken from the EIA).

Monthly copper production data come from two sources. From January 1995 onward, world copper production comes from the World Bureau of Metal Statistics—WBMS (originally sourced from the U.S. Geological Survey). To recover a monthly measure of world copper production prior to 1995 requires two steps. First, we calculate the growth rate of monthly U.S. copper production—which goes back to 1955—from the Commodity Research Bureau (CRB). This growth rate series is then used to extend the WBMS U.S. series backward. Second, we add this resulting extended series to the "Outside of the U.S." production series from the CRB, starting in 1955 (originally sourced from the American Bureau of Metal Statistics). We then calculate the growth rate of the resulting world production series and use it to extend the WBMS world copper production series backward from 1995 to 1955. Monthly global copper inventories are the sum of copper inventory stocks recorded by the London Metal Exchange, COMEX (part of the New York Mercantile Exchange), and the Shanghai Metals Market. Data are in thousands of metric tons and were kindly shared with us by the Comisión Chilena del Cobre.

Yearly coffee and cotton production data are from the U.S. Department of Agriculture (USDA) Foreign Agricultural Service. We match the harvest year to the calendar year during which most of the production occurred. Inventories for these commodities are end-of-year amounts and are also from the USDA.

Global Activity

At the monthly frequency, global activity is measured as the change in the natural logarithm of a global industrial production index. This global industrial production index comes from the Netherlands Bureau for Economic Policy Analysis (CPB) for 1991 to the present. Prior to 1991, the growth rate of the advanced economies' industrial production index from the IFS was used to splice the CPB data backward. At the annual frequency, global activity is measured as the change in the natural logarithm of global real GDP, which is taken from the WEO database. In a robustness check for the vector autoregression at the monthly frequency, we used the global activity index of Kilian (2009). This is an index of detrended real shipping freight costs around the world.

Oil Price Forecast Error

The oil price forecasts used in Appendix 4.3 are the 12-month-ahead forecasts for the U.S. dollar price of West Texas Intermediate (WTI) crude oil, taken from the March/April survey of Consensus Economics. The forecast error is calculated as the difference between the log of this forecast and the actual log average spot price of WTI crude oil in March/April of the following year.

Global GDP Forecast Error

The global GDP growth forecast used in Appendix 4.3 is the weighted average of the GDP growth forecasts for the G7 economies plus Brazil, China, India, and Russia. The growth forecasts are the 12-month-ahead Consensus Economics forecasts from March/April. The weights are purchasing-power-parity GDP weights for 2011 from the WEO database. The forecast error is calculated as the difference between this forecast and the similarly weighted average of the actual growth rates of these economies.

Sample

The sample consists of emerging and developing economy commodity exporters with populations of at least 1 million, and each economy with a ratio of net commodity exports (for the relevant commodity group or commodity) to total goods exports that averages at least 10 percent over all available years (Table 4.7).

Table 4.7. Commodity Intensity in Exports

(Net exports of commodities over total goods exports times 100)

	International Financial Statistics Code	World Bank Code	All Commodities	Commodity Groups				Major Commodities			
				Energy	Metals	Food	Raw Materials	Oil	Copper	Coffee	Cotton
Islamic Republic of Afghanistan	512	AFG					23.5				
Algeria	612	DZA	60.5	68.4				53.7			
Angola	614	AGO	80.9	65.6		15.5		68.0		13.4	
Argentina	213	ARG	37.3			35.3					
Azerbaijan	912	AZE	27.8	38.1			13.5	45.2			13.0
Benin	638	BEN	27.7				32.5				31.3
Bolivia	218	BOL	61.4	22.0	26.1						
Brazil	223	BRA	29.0			29.4				14.4	
Burkina Faso	748	BFA	33.6				47.1				43.0
Burundi	618	BDI	70.7			64.4				63.2	
Cambodia	522	KHM					25.2				
Cameroon	622	CMR	78.8	22.8		33.5	19.4	33.0		13.7	
Central African Republic	626	CAF	43.8			15.8	28.5			15.9	12.9
Chad	628	TCD	83.0	13.9			70.0	68.2			68.5
Chile	228	CHL	51.2		48.5				48.9		
Colombia	233	COL	56.1	16.7		42.3		12.0		36.2	
Democratic Republic of Congo	636	COD	58.9	11.7	34.7			14.3	32.8		
Republic of Congo	634	COG	75.9	54.5			17.2	56.2			
Costa Rica	238	CRI	48.4			51.9				20.2	
Côte d'Ivoire	662	CIV	61.9			49.6	19.6			17.5	
Dominican Republic	243	DOM	19.8			17.9					
Ecuador	248	ECU	74.3	28.8		49.7		29.6			
Egypt	469	EGY	29.4	31.1			12.7	30.2			15.6
El Salvador	253	SLV	39.4			39.9				39.1	
Ethiopia	644	ETH	38.7			40.5				53.9	
Georgia	915	GEO			12.7						
Ghana	652	GHA	62.8			46.9					
Guatemala	258	GTM	44.6			41.2				29.2	
Haiti	263	HTI	12.9			14.7				17.8	
Honduras	268	HND	56.8			50.3				15.4	
India	534	IND				10.6					
Indonesia	536	IDN	49.1	32.1			10.6	24.3			
Islamic Republic of Iran	429	IRN	77.8	85.4				85.0			
Iraq	433	IRQ	61.1	89.8				93.5			
Kazakhstan	916	KAZ	69.0	44.1	19.0			42.8			
Kenya	664	KEN	30.2			39.8				23.6	
Kuwait	443	KWT	67.0	69.5				67.7			
Kyrgyz Republic	917	KGZ					12.0				
Lao People's Democratic Republic	544	LAO					32.6			13.8	
Latvia	941	LVA	15.4				13.2				
Liberia	668	LBR	19.4				14.5				
Libya	672	LBY	88.1	90.2				88.9			
Madagascar	674	MDG	26.7			29.1				20.4	
Malawi	676	MWI	23.2			25.0					
Malaysia	548	MYS	36.0				25.5				
Mali	678	MLI	43.4				57.5				55.0
Mauritania	682	MRT	49.8		26.0	22.5					
Mauritius	684	MUS	37.5			42.2					
Mexico	273	MEX	23.5	15.0				16.1			
Moldova	921	MDA			13.8						
Mongolia	948	MNG	34.0		16.3		12.7		15.8		
Mozambique	688	MOZ	40.3		15.9	13.6	10.2				
Myanmar	518	MMR	59.6			26.2	28.8				
Nicaragua	278	NIC	56.0			41.1	17.9			21.1	16.6
Niger	692	NER	19.0			10.7					

Table 4.7. Commodity Intensity in Exports *(continued)*

	International Financial Statistics Code	World Bank Code	All Commodities	Commodity Groups				Major Commodities			
				Energy	Metals	Food	Raw Materials	Oil	Copper	Coffee	Cotton
Nigeria	694	NGA	87.8	80.5				79.1			
Oman	449	OMN	85.1	89.3				86.4			
Panama	283	PAN	12.2			27.7					
Papua New Guinea	853	PNG	72.7		22.7	24.3	11.5	19.9	25.6	11.3	
Paraguay	288	PRY	58.5			40.1	22.8				13.3
Peru	293	PER	54.3		31.2	16.0			18.6		
Philippines	566	PHL	12.2			10.2					
Russia	922	RUS	55.5	34.8	12.1			28.7			
Rwanda	714	RWA	63.6			57.0				51.5	
Saudi Arabia	456	SAU	82.6	86.3				84.0			
Sierra Leone	724	SLE	11.4			12.5					
South Africa	199	ZAF	24.1		12.5						
Sri Lanka	524	LKA	26.3			24.4					
Sudan	732	SDN	47.9	14.3			33.8	39.0			32.3
Syrian Arab Republic	463	SYR	49.7	50.5			10.1	51.0			
Tajikistan	923	TJK	65.3		43.1		30.3				29.9
Tanzania	738	TZA	34.9			24.1	13.5			20.1	11.7
Thailand	578	THA	16.0			20.6					
Togo	742	TGO	27.1			18.9	10.3			11.1	
Tunisia	744	TUN	12.6	12.2				14.5			
Turkmenistan	925	TKM	68.8	48.2			23.9				23.3
Uganda	746	UGA	77.5			69.1	10.3			65.8	
Ukraine	926	UKR	15.4		34.9						
United Arab Emirates	466	ARE	65.5	67.7				69.9			
Uruguay	298	URY	35.6			26.3					
Uzbekistan	927	UZB	53.6	11.1			41.8				41.7
Venezuela	299	VEN	59.5	58.1				57.3			
Vietnam	582	VNM						16.1			
Republic of Yemen	474	YEM	67.0	80.4				79.4			
Zambia	754	ZMB	72.3		71.7				72.9		
Zimbabwe	698	ZWE	33.3		19.0						
Maximum			88.1	90.2	71.7	69.1	70.0	93.5	72.9	65.8	68.5
Mean			47.9	47.8	27.1	31.8	23.5	50.1	35.8	26.8	29.2
Median			49.4	46.2	22.7	28.4	19.5	51.0	29.2	20.2	26.6
Standard Deviation			21.8	28.0	15.9	15.5	14.4	26.6	21.7	17.2	17.6
Number of Economies			78	30	17	40	32	29	6	22	14

Source: IMF staff calculations.

Note: Entries are not shown if the share is less than 10 since this is the criterion used to define the sample. The table shows the averages of each share over the period 1962–2010 using all available data. For the commodity groups, the average share is calculated for each component and then these averages are added together. All Commodities includes gold and silver. See Appendix 4.1 for details on the source data.

Appendix 4.2. Statistical Properties of Commodity Price Cycles

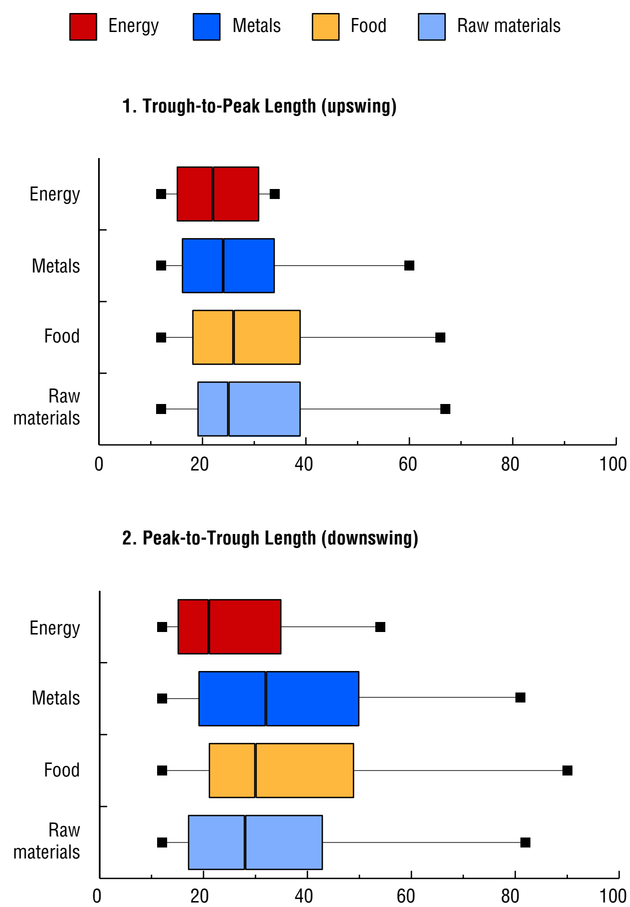
We adopt the Harding and Pagan (2002) methodology used for dating business cycles to identify turning points (peaks and troughs) in the time path of real commodity prices.[47] A full cycle in real commodity prices comprises one upswing phase—the period from trough to peak—and one downswing phase—the period from peak to trough. Drawing on Cashin, McDermott, and Scott (2002), a candidate turning point is identified as a local maximum or minimum if the price in that month is either greater or less than the price in the two months before and the two months after. The set of resulting candidates is then required to alternate peaks and troughs. Furthermore, each phase defined by the turning points (either upswing or downswing) must be at least 12 months long, and thus a complete cycle must be at least 24 months.

This exercise gives us over 300 completed cycles for 46 commodities with an average duration of five years (Table 4.8). Among upswings and downswings, the average (median) duration of the former is about 2½ (2) years, and of the latter about 3 (2½) years (Figure 4.12). However, there are significant variations in the distribution within and across commodity groups. For instance, an average downswing in crude oil lasted 31 months compared with upswings of 33 months. Among nonfuel commodities, downswings typically lasted longer than upswings, especially for food and raw material prices. The latter could be affected by some persistent negative factors, related to weather, plant disease, and so forth, that do not generally affect the prices of energy and metals. With the exception of crude oil and a few metals' prices, the amplitude

[47]The business cycle literature has traditionally distinguished between classical cycles and growth cycles. In the former case, variables of interest are not pretreated or transformed before turning points are identified. In the latter case, variables are filtered prior to the dating analysis—for example, turning points are chosen to capture periods of above- or below-trend growth. Since we are agnostic about the presence of any trend in commodity prices, we focus on commodity prices in levels, distinguishing between periods of expansion and contraction. Even more important, this classical cycle approach avoids the need to choose between alternative filtering or detrending methods, which are known to introduce potentially spurious phase shifts, confounding the turning points algorithm.

Figure 4.12. Duration of Commodity Price Upswings and Downswings
(Months)

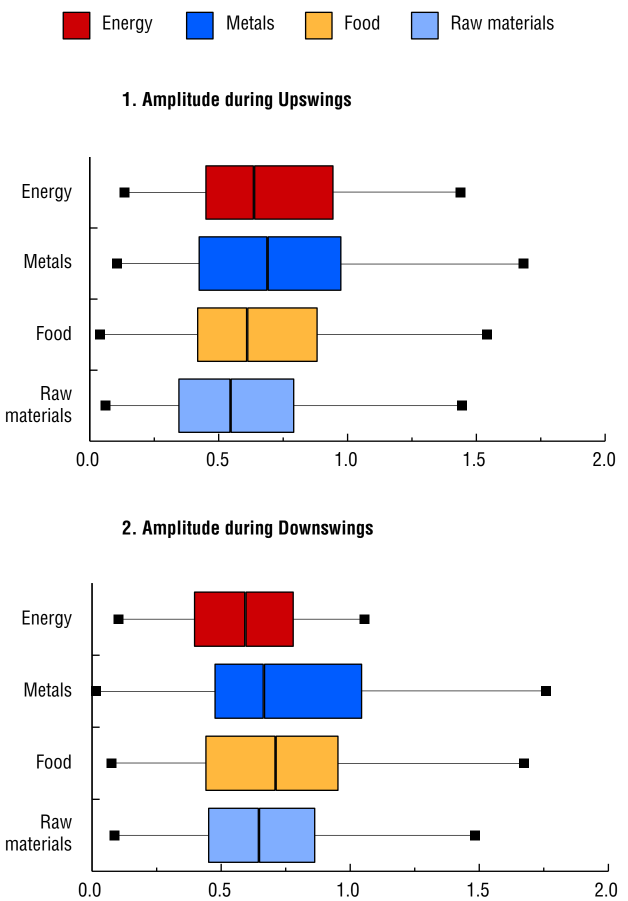
Downswings last somewhat longer than upswings for most commodity groups except energy.



Source: IMF staff calculations.
Note: The vertical line inside each box is the median duration within the group; the left and right edges of each box show the top and bottom quartiles. The distance from the black squares (adjacent values) on either side of the box indicates the range of the distribution within that commodity group, excluding outliers. See Appendix 4.2 for a description of the algorithm used to identify peaks and troughs.

Figure 4.13. Amplitude of Commodity Price Upswings and Downswings
(Change in log real price)

With the exception of energy prices, the amplitude of commodity price downswings is generally greater than that of upswings.



Source: IMF staff calculations.
Note: The vertical line inside each box is the median amplitude within the group; the left and right edges of each box show the top and bottom quartiles. The distance from the black squares (adjacent values) on either side of the box indicates the range of the distribution within that commodity group, excluding outliers. See Appendix 4.2 for a description of the algorithm used to identify peaks and troughs.

of price downswings is slightly greater than that of upswings (Figure 4.13).

The above findings support the related literature (Cashin, McDermott, and Scott, 2002) and earlier literature that found long periods of doldrums punctuated by shorter upward spikes to be characteristic of agricultural commodity prices (Deaton and Laroque, 1992). However, for coffee and cotton, the differences in the length of upswings and downswings are small. This could be related to the fact that both are storable commodities, and therefore inventories may play an important role in smoothing prices in either direction.

Appendix 4.3. Description of the Vector Autoregression Model

In this appendix, we describe the global commodity market model used to determine the sources of commodity price fluctuations described in the section Commodity Market Drivers and Their Macroeconomic Effects.

A Structural Vector Autoregression (VAR) Model for Global Commodity Markets

Drawing on Kilian's (2009) insights into the global oil market, we estimate a structural VAR model of the global commodity market for each of four major commodities: crude oil, copper, coffee, and cotton. Each VAR includes the following set of variables:

$$z'_{i,t} = (\Delta q_{i,t}, \Delta y_t, \Delta k_{i,t}, \Delta s_t, \Delta p_{i,t}), \qquad (4.1)$$

where t indexes time, $\Delta q_{i,t}$ is the change in log global production of commodity i, Δy_t is a proxy for the changes in global economic activity, $\Delta k_{i,t}$ is the change in log global inventories of commodity i, Δs_t is the change in the log U.S. real effective exchange rate (REER), and $\Delta p_{i,t}$ is the change in the log real price of commodity i.[48] The structural VAR for each commodity i takes the following form:

[48]For the copper and oil monthly VARs, we take the global industrial production index as a measure of global activity. For agricultural commodities, we use the growth rate of global GDP, since the VARs are estimated at annual frequency. In a robustness check of the results at monthly frequency, we try as an alternative measure of global activity the one proposed by Kilian (2009).

Table 4.8. Statistical Properties of Real Commodity Prices

Commodity	Series Start Date (year: month)	Number of Peak-to-Trough Episodes	Number of Trough-to-Peak Episodes	Peak-to-Trough Average Length	Trough-to-Peak Average Length	Peak-to-Trough Average Amplitude	Trough-to-Peak Average Amplitude	Average Cycle Length	Amplitude between Latest Available Observation and Latest Trough/Peak	Length of the Latest Period
Energy	1973:M2	7	6	31.0	33.0	0.7	0.9	65.3	0.1	17
Coal	1993:M12	4	5	25.0	20.4	0.6	0.7	45.0	–0.1	9
Crude Oil	1973:M2	7	6	31.3	32.7	0.8	0.9	65.3	0.2	15
Natural Gas	1992:M1	6	6	16.7	18.5	0.4	0.5	36.6	0.6	25
Food	1970:M1	7	8	37.9	26.0	0.5	0.4	60.9	–0.2	8
Cocoa	1957:M1	9	10	38.8	28.5	0.9	0.8	63.2	–0.3	22
Coffee	1957:M1	7	8	36.1	40.0	0.9	0.8	77.6	–0.2	6
Tea	1957:M1	10	10	35.7	29.0	0.7	0.6	65.3	0.1	6
Barley	1975:M1	7	8	34.0	24.5	0.7	0.6	57.1	0.0	3
Maize	1957:M1	9	10	39.2	27.9	0.6	0.6	66.6	–0.2	6
Rice	1957:M1	9	8	40.7	33.6	0.8	0.8	76.0	0.2	16
Wheat	1957:M1	10	10	35.6	26.8	0.6	0.5	64.0	0.6	16
Beef	1957:M1	7	7	58.6	31.7	0.5	0.5	81.9	–0.1	6
Lamb	1957:M1	7	8	39.4	39.5	0.5	0.4	72.1	–0.1	11
Poultry	1980:M1	6	6	21.5	40.2	0.2	0.2	67.2	0.0	8
Pork	1980:M1	6	7	37.0	22.1	1.1	0.9	46.3	–0.1	2
Fish	1979:M1	4	5	64.5	25.2	0.9	0.6	82.5	–0.7	6
Shrimp	1957:M1	12	11	24.3	31.2	0.6	0.5	49.5	0.2	18
Coconut Oil	1957:M1	12	13	25.8	25.5	0.9	0.9	51.0	–0.6	8
Olive Oil	1978:M9	4	4	34.5	44.3	0.6	0.5	84.5	–0.8	79
Palm Oil	1957:M1	10	11	27.6	27.7	0.8	0.8	53.7	–0.3	8
Soy Meal	1965:M1	9	10	32.6	25.4	0.7	0.7	55.6	–0.1	4
Soy Oil	1957:M1	9	10	37.3	27.9	0.8	0.7	65.4	–0.1	8
Soybeans	1965:M1	8	8	41.3	25.5	0.7	0.7	70.3	0.2	20
Sunflower Oil	1960:M7	6	7	51.8	39.0	1.0	0.9	89.8	–0.1	4
Bananas	1975:M1	6	6	40.0	31.5	0.8	0.8	69.3	–0.1	8
Fishmeal	1957:M1	9	10	28.4	37.2	0.7	0.7	67.1	–0.4	18
Groundnuts	1980:M1	5	6	37.6	26.5	0.8	0.6	62.0	0.0	3
Oranges	1978:M1	6	5	43.7	23.2	0.9	0.9	69.6	0.3	10
Sugar	1957:M1	7	7	52.9	39.4	1.3	1.2	87.1	–0.1	9
Metals	1970:M1	8	8	33.0	28.5	0.7	0.6	60.1	–0.1	8
Aluminum	1972:M5	6	7	37.5	33.6	0.8	0.7	56.0	–0.2	6
Copper	1957:M1	8	9	42.8	32.8	0.7	0.7	69.0	–0.3	8
Lead	1957:M1	9	10	35.1	26.9	0.9	0.9	59.1	–0.3	6
Nickel	1979:M12	5	6	34.6	27.8	1.1	1.2	57.4	–0.4	8
Steel	1987:M1	4	5	37.3	27.6	0.6	0.7	65.3	–0.1	8
Tin	1957:M1	8	9	44.3	25.0	0.6	0.6	68.0	–0.4	6
Uranium	1980:M1	4	4	39.0	34.0	0.8	1.0	81.0	0.2	19
Zinc	1957:M1	10	11	34.0	26.7	0.7	0.7	58.7	–0.3	8
Gold	1968:M4	6	5	39.0	30.4	0.6	0.7	61.2	1.6	126
Silver	1976:M1	7	7	27.3	32.4	0.8	0.9	57.3	–0.3	6
Raw Materials	1970:M1	5	6	48.6	40.3	0.6	0.5	56.4	–0.3	8
Hardwood Logs	1980:M1	6	6	21.7	32.7	0.6	0.7	59.0	0.5	18
Hardwood, Sawed	1980:M1	5	6	23.2	37.3	0.5	0.6	61.2	0.0	4
Softwood Logs	1975:M1	5	6	45.4	32.3	0.6	0.4	70.4	–0.1	5
Softwood, Sawed	1975:M1	6	6	35.7	34.0	0.5	0.4	72.6	0.1	8
Cotton	1957:M1	12	13	24.9	24.8	0.6	0.5	48.7	–0.7	7
Hides	1957:M1	7	7	58.1	33.9	1.0	1.0	55.7	–0.1	7
Rubber	1957:M1	8	9	41.1	33.9	0.8	0.8	55.3	–0.4	8
Wool	1957:M1	9	9	42.4	29.8	0.7	0.7	69.7	–0.3	4

Source: IMF staff calculations.

Note: All series end in October 2011 (2011:M10) except Crude Oil, which ends in August 2011 (2011:M8). Peaks and troughs are determined according to the Harding and Pagan (2002) algorithm, as described in Appendix 4.2. The length or duration of a phase is quoted in months. The amplitude or height of a phase is expressed in natural log units. See Appendix 4.1 for a full description of the underlying data.

$$z_{i,t} = \alpha_i + \sum_{m=1}^{M_i} A_{m,i}\, z_{i,t-m} + e_{i,t}, \qquad (4.2)$$

where $e_{i,t}$ is a mean-zero serially uncorrelated (5×1) vector of innovations, α_i is a (5×1) vector of constants, and $A_{m,i}$ is a (5×5) coefficient matrix for variables at lag m for a total of M_i lags. We assume that the innovations may be expressed as $e_{i,t} = A_{0,i}\, \varepsilon_{i,t}$, where $\varepsilon_{i,t}$ is a vector of mutually and serially uncorrelated structural shocks with variance 1, and $A_{0,i}$ is a coefficient matrix mapping the structural shocks to the contemporaneous reduced-form shocks. To identify production and global demand shocks, we make some assumptions about the structure of the matrix $A_{0,i}$.

Specifically, we assume that the change in a commodity's global production ($\Delta q_{i,t}$) does not respond to other shocks contemporaneously, but only with a lag. This means that the estimated innovation from the production equation represents the structural production shock. In other words, shifts in the demand curve for the commodity due to global activity shocks or other factors do not affect production in the same period, although they may in the next and future periods. This assumption seems justifiable with monthly data, which we have for both crude oil and copper. For coffee and cotton, only annual data on global production are available, but the assumption still seems justifiable, since the production cycles of these commodities are relatively long.[49] Examples of production shocks are unpredictable weather events, such as floods or droughts that adversely impact yields (for agricultural commodities), production disruptions due to unanticipated equipment breakdowns or work stoppages (for oil and metal commodities), or unexpected technological breakthroughs that boost production.

We further assume that global activity (Δy_i) may be contemporaneously affected by the structural production shock, but only with a lag by the other shocks. This means that the estimated innovation from the global activity equation, once the effect of the production shock is accounted for, represents the structural global activity shock. Again, these assumptions seem justifiable at a monthly frequency. Even when the underlying data are annual, it still seems reasonable so long as the commodity in question makes a relatively small contribution to global GDP. Nevertheless, the results for agricultural commodities should be interpreted with caution.[50]

Taken together, these assumptions imply that:

$$e_{i,t} = A_{0,i}\, \varepsilon_{i,t}$$

$$\begin{pmatrix} e_{i,t}^{\Delta q} \\ e_{i,t}^{\Delta y} \\ e_{i,t}^{\Delta k} \\ e_{i,t}^{\Delta s} \\ e_{i,t}^{\Delta p} \end{pmatrix} = \begin{bmatrix} \cdot & 0 & 0 & 0 & 0 \\ \cdot & \cdot & 0 & 0 & 0 \\ \cdot & \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot & \cdot \end{bmatrix} \begin{pmatrix} \varepsilon_{i,t}^{\Delta q} \\ \varepsilon_{i,t}^{\Delta y} \\ \varepsilon_{i,t}^{3} \\ \varepsilon_{i,t}^{4} \\ \varepsilon_{i,t}^{5} \end{pmatrix}, \qquad (4.3)$$

where 0 indicates that the structural shock does not influence the corresponding reduced-form shock, and a dot indicates that the relationship is unrestricted. Again, under the restrictions shown here, we are able to recover only the structural shocks to production and global activity ($\varepsilon_{i,t}^{\Delta q}$ and $\varepsilon_{i,t}^{\Delta y}$).

Notice that we include changes in a commodity's inventories and in the log U.S. REER in our model, since both variables are known to improve the forecasts of prices and production of oil, metals, and other commodities.[51] Moreover, because they are able to react quickly to new information, these variables likely incorporate forward-looking information about the specific commodity market (in the case of inventories) and global activity (in the case of both inventories and the REER) beyond what is contained in production, activity, and prices themselves. This means that the flow production and global demand shocks identified are more precise in our five-variable VAR than those that are recovered in a three-variable VAR without REER and inventories.

Price fluctuations that are not explained by either demand or production shocks result from a combination of factors we cannot disentangle. Those factors

[49]New coffee trees take about five years to mature (Wellman, 1961). For cotton the assumption might not be as clear cut, since it has a harvest cycle of about a year (Smith and Cothren, 1999).

[50]At annual frequency, a greater concern is that real commodity price changes may correlate with other factors that do drive global GDP but that are not included in the VAR system. This could give rise to an omitted variable bias that would influence the interpretation of the results.

[51]See De Gregorio, González, and Jaque (2005) for the role of the U.S. REER in determining copper prices, and Kilian and Murphy (2010) for the role of crude oil inventories in determining oil prices.

include commodity-specific shocks, but also news about future commodity market developments.[52] This implies that production changes that are either wholly or partly anticipated will show up in the unaccounted-for component of the price, matched to the time the news of the forthcoming change becomes known rather than the time the change actually occurs. An example of such an anticipated production shock might include the recent case of Libya, where political turmoil was expected to disrupt oil production, and thereby the global oil supply, hiking prices in advance.[53] Our results mainly confirm those of Kilian (2009) for the other commodities as well. This means that demand shocks are more important in explaining commodity price fluctuations than unanticipated production shocks.

An alternative exercise we performed also suggests the greater relevance of demand over production shocks, corroborating our VAR results (for the case of oil). We find a positive and significant correlation between revisions in commodity price forecasts and in global real GDP forecasts, suggesting that on balance oil prices are driven by global activity (Figure 4.14). In fact, if forecast revisions in oil prices were more strongly associated with negative commodity production shocks, which adversely affect global GDP, then the commodity price forecast revisions should correlate negatively with global economic activity revisions. We were unable to conduct this analysis for other commodities because of the lack of time series data on Consensus Economics forecasts for other commodity prices.

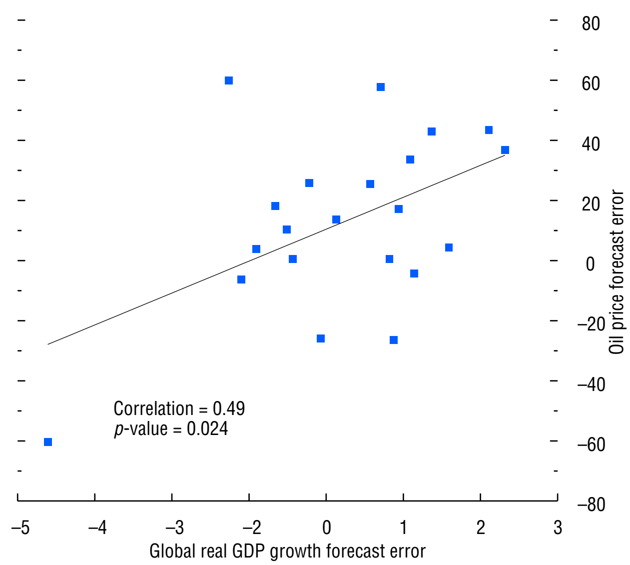
How much can commodity exporters' GDP be expected to move with changes in the real commodity price driven by global demand or production shocks? To answer this question for copper and oil, we need to make the global demand and production shocks in

[52]There are various examples of commodity-specific shocks. A preference shift for coffee over tea (as has happened in the past decade) is an example of a shock that is captured by our residual component. Other examples are technological improvements that affect oil intensity, an alternative source of energy, or a global housing boom/bust that affects demand for copper.

[53]The financialization of commodity markets may have exacerbated commodity price sensitivity to news about market prospects (see Chapter 1 in the September 2011 *World Economic Outlook* for a discussion of the role of financialization in influencing commodity prices).

Figure 4.14. Correlation of Global Real GDP Growth and Oil Price Forecast Errors

Surprises in global oil price movements correlate positively with surprises in global activity.



Sources: Consensus Economics and IMF staff calculations.
Note: Forecast errors are calculated as the actual value minus the forecast value. The global real GDP growth forecast error is in percentage points, while the oil price forecast error is in log units times 100. The line shows the least squares line of best fit. See Appendix 4.1 for a full description of the underlying data.

the monthly VAR model comparable with the shocks used in the panel regression, which are at an annual frequency. To do this, we assume that there are a series of shocks for the first 12 months, each equal to the size of the 1 standard deviation shock used in the annual regression. For oil, this results in a 12.2 percent increase in the real price of oil over the year from an annual global demand shock and a 3.8 percent increase from a (negative) global oil production shock. For copper, this is about an 8 percent increase in the real price of copper from a global demand shock and a 3 percent increase from a (negative) global copper production shock. Thus, the elasticity of real GDP for exporters in response to price changes can now be obtained by drawing on the real GDP effects of such commodity price changes over a year (see Table 4.5). For instance for oil, the implied elasticity of real GDP with respect to a global demand-driven oil price change is 0.03 in the impact year and 0.15 three years after the impact year. Although the elasticity with respect to a global production-driven oil price change is comparable in size (0.05 on impact, and –0.14 three years after impact), the effect of the shock on an exporter's GDP is not statistically significant (as seen in Table 4.4).

Robustness

We undertook several robustness checks of our baseline VAR model. These include (1) using the log real commodity price and log U.S. REER in levels instead of differences, since there is no self-evident reason why these variables should be nonstationary; (2) using the real global activity index of Kilian (2009) in the VARs with monthly data instead of the change in log global industrial production; (3) using an alternative deflator for commodity prices based on the SDR basket-weighted wholesale price index instead of the U.S. CPI. Broadly speaking, the results are qualitatively unchanged for all commodities.

Identifying global demand- and production-driven phases

We define a phase as a global demand-driven phase if the contribution to the amplitude of that phase made by the global demand component is at least 25 percent and is bigger than the contribution of the global production component—and vice versa for a production-driven phase. For oil, this results in the identification of four global demand-driven phases, with two downswings (October 1990–December 1993 and October 2000–December 2001) and two upswings (January 1994–October 1996 and January 2002–July 2008). These phases are shown in Figure 4.8. The production-driven phases include one downswing (January 1996–December 1998) and one upswing (January 1999–September 2000).

Appendix 4.4. The Basic Features of the GIMF and Its Application to a Small, Open Oil Exporter

The Global Integrated Monetary and Fiscal model (GIMF) is a microfounded, multicountry, multisector dynamic general equilibrium model that features a wide array of real and nominal types of friction considered relevant in recent macroeconomic literature.[54] For the purposes of this chapter, we use a two-region version of the GIMF comprising a small, open economy oil exporter and the rest of the world, which is a *net* oil importer. The oil sector is modeled along the lines described in Chapter 3 of the April 2011 *World Economic Outlook*. International borrowing by this small, open oil exporter is modeled such that the sovereign risk premium rises with the level of total net debt. In the calibration here—a debt level of 100 percent of GDP—a 20 percentage point decrease (increase) in the debt level would generate a 53 (103) basis point decrease (increase) in the risk premium. In contrast, at a debt level of 30 percent of GDP, a 20 percentage point decrease (increase) in the debt level would generate an 11 (16) basis point decrease (increase) in the risk premium.

Fiscal Policy

The fiscal policy rule is defined by a simple numerical target for the government fiscal-balance-to-GDP ratio that aims to stabilize debt around its long-term target while minimizing output and inflation volatility. It takes the following form:

[54]A full description of the GIMF can be found in Kumhof and others (2010) and Kumhof and Laxton (2009a).

$$gs_t = gs^* + d^{tax}\frac{(\tau_t - \tau_t^{pot})}{GDP_t} + d^{com}\frac{(c_t - c_t^{pot})}{GDP_t}, \qquad (4.4)$$

where gs_t is the fiscal-surplus-to-GDP ratio; gs^* is its long-term target; τ_t and c_t are the actual non-oil tax revenues and oil royalties, respectively; and τ_t^{pot} and c_t^{pot} are the *potential* level of tax revenue and oil royalties.[55] Differences between actual and potential values are *gaps*. The coefficients d^{tax} and d^{com} determine the type of rule that is adopted.[56] The choice of d^{tax} and d^{com} provides a continuum of rules, of which three calibrations are discussed in this chapter: (1) a balanced budget rule when d^{tax} and d^{com} are equal to zero, (2) a structural surplus rule when d^{tax} and d^{com} are equal to 1, and (3) a countercyclical rule when d^{tax} and d^{com} are greater than 1.[57]

To implement the surplus-to-GDP ratio prescribed by the rule, the government, in principle, has a menu of fiscal instruments that can be used. However, for simplicity, we assume that the government satisfies the fiscal rule by changing the labor income tax rate. As mentioned, the qualitative results do not change if a different fiscal instrument is used to satisfy the fiscal rule. To determine the optimal rule, alternative calibrations of the fiscal rule parameters are evaluated to find the minimum loss function of the standard deviations of inflation and output. We evaluate the net present value of discounted household utility for the analysis of permanent changes in the price of oil.

[55]More precisely, tax revenues are given by the sum of labor and capital revenues raised in the non-oil sector, plus consumption taxes and transfers. Potential tax revenues are defined as current tax rates times tax bases at the long-term equilibrium. Potential oil revenues are calculated based on long-term values of commodity output and price.

[56]By construction the fiscal surplus and debt-to-GDP ratios are guaranteed to return to their long-term targets because eventually all *gaps* close after the temporary shocks unwind. Kumhof and Laxton (2009b) have shown that this class of rules is particularly well suited to capturing periods of relatively strong (weak) economic conditions and is therefore effective for stabilizing business cycle fluctuations.

[57]For a more detailed discussion of the fiscal rule and the government sector, see Snudden (forthcoming).

Box 4.1. Macroeconomic Effects of Commodity Price Shocks on Low-Income Countries

Commodity price shocks can have large economic, social, and political effects on low-income countries (LICs), whether they are commodity importers or exporters. Most LICs are net importers of food and fuel, and many face substantial import bills for oil products in particular. At the same time, commodities account for more than half of total goods exports for about a third of LICs, implying that swings in commodity prices can lead to large swings in LICs' external balances, creating winners and losers, depending on their trade structure and the specific commodities involved. Global commodity price shocks also tend to create strong inflation and social pressures in LICs because food prices, which account for nearly half of the consumption basket in LICs, are highly correlated with other commodity prices.[1] The resulting squeeze on real household incomes can increase poverty and exert political pressure for mitigating fiscal measures, which in turn could have a negative impact on public finances.

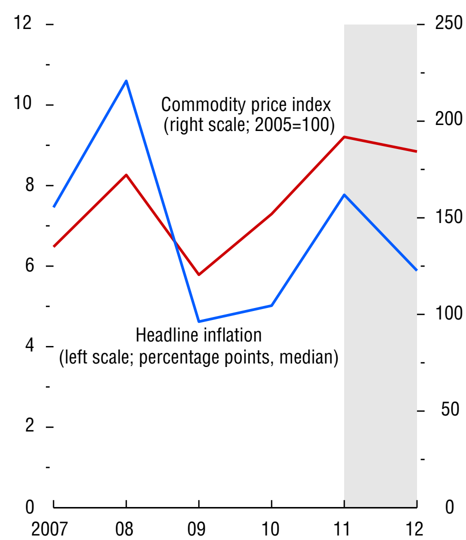
Recent experience highlights the significance of commodity prices for LICs. The spike in food and fuel prices during 2007–08 created significant inflation pressure (Figure 4.1.1) until 2009, when commodity prices slumped during the global financial crisis. In late 2010 and early 2011, LICs faced a renewed surge in global commodity prices. This time, global price increases were more synchronized across commodities than during 2007–08, softening the impact on LICs that export nonfuel commodities. Inflation pressures were also more contained in most LICs, in some cases due to good local harvests. Moreover, about half of LICs took fiscal measures to mitigate the social and inflation impact of the shock, with a median budgetary cost estimated at more than 1 percent of GDP. Measures included food and/or fuel price subsidies (with only a few explicitly targeted to the poor), safety net expenditure measures, and reductions in taxes and import tariffs.

The author of this box is Julia Bersch. It is based on IMF (2011a). The set of low-income countries in this box includes all countries eligible for concessional financing from the IMF under the Poverty Reduction and Growth Trust, except Somalia, which has been excluded due to a lack of data.

[1]This compares with a food share of less than 20 percent in the consumption baskets of Organization for Economic Cooperation and Development countries.

Figure 4.1.1. Headline Inflation in Low-Income Countries and the World Commodity Price Index

Most low-income countries experienced only a modest uptick in headline inflation in 2011.



Sources: September 2011 *World Economic Outlook*; and IMF staff estimates.

Simulating the Macroeconomic Effects of Another Spike in Global Commodity Prices

We examine the possible implications of a further global commodity price shock using the IMF's newly developed vulnerability exercise framework for LICs.[2] The scenario is constructed using market expectations embedded in commodity futures options, and the shocks for different commodities are aligned with the prices at the top 7 percent of the expected probability distribution.[3] The impact of the shock is then simulated on a country-by-country basis, taking into account the

[2]Details are in IMF (2011a).

[3]Under this specific scenario, food prices are assumed to increase by 25 percent in 2011 and 31 percent in 2012 relative to the baseline forecast; fuel prices by 21 percent in 2011 and 48 percent in 2012; and metal prices by 21 percent in 2011 and 36 percent in 2012.

Box 4.1. *(continued)*

experience of past shock episodes and countries' different trade structures and consumption baskets.

The scenario analysis illustrates that a further spike in commodity prices could have severe macroeconomic and social consequences. Even though the impact on growth would be modest, the price shock would push 31 million people below the poverty line, mainly because of higher inflation and the absence of efficient social safety nets (Figure 4.1.2). Countervailing fiscal measures, modeled on the basis of past experience, could worsen the median fiscal balance by more than 1 percent of GDP in 2012, with about three-quarters arising from higher oil prices, and the other quarter from higher food prices (Figure 4.1.3).

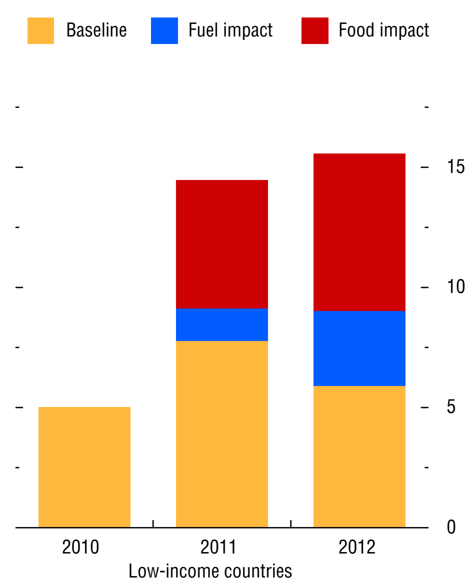
The external impact of the commodity price scenario would be negative for a large majority of LICs, with a median deterioration in the trade balance of almost 3 percent of GDP (Figure 4.1.4). This deterioration would be driven mainly by higher oil prices, with a smaller impact from higher food prices. Only net oil exporters would benefit from higher prices. Net food exporters would fare only slightly better than net food importers, as both would be negatively affected by higher oil prices. For LICs experiencing a negative terms-of-trade shock, external financing needs could increase by about $9 billion, much of which would be accounted for by a small number of large noncommodity exporters.

Policy Responses to Commodity Price Shocks and Policies to Build Resilience

Many LICs used their macroeconomic policy buffers during the recent crisis, so another global commodity price shock may present difficulties.[4] The standard "first-best" fiscal policy advice of passing on higher prices to consumers may not be feasible in most LICs because they lack comprehensive social safety nets to support the vulnerable. It is also challenging to find pragmatic and cost-effective "second-best" solutions given limited fiscal room. Conducting monetary policy in response to commodity price shocks, in particular food price shocks, also poses significant challenges because policymakers need to choose between accommodating higher inflation and tightening policies that exacerbate real costs. However, even though the direct impact of higher food prices on headline inflation is usually much larger in LICs than in more advanced economies, inflation inertia is relatively low. Hence, an accommodative monetary policy stance is less likely to lead to persistent inflation.[5]

Figure 4.1.2. Inflationary Impact of Higher Commodity Prices in Low-Income Countries in 2011 and 2012
(Percentage points, median)

Under the higher global commodity price scenario, inflation in low-income countries could double relative to the baseline projection, driven mainly by higher food prices.



Sources: September 2011 *World Economic Outlook*; and IMF staff estimates.
Note: The scenario gauges the impact of increases in global food and fuel prices compared with the baseline. For food, the price increases used were 25 percent in 2011 and 31 percent in 2012; for fuel, 21 percent and 28 percent, respectively.

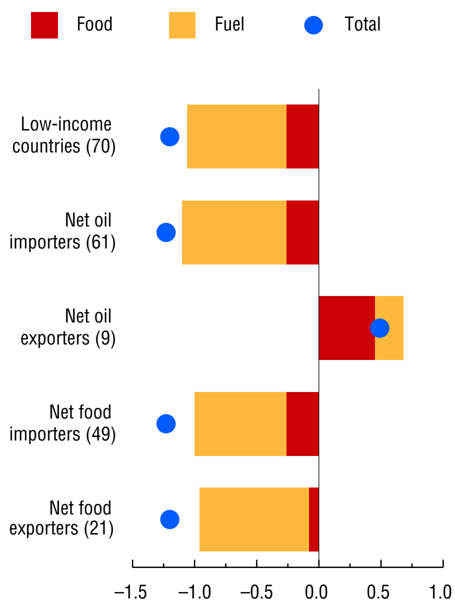
[4]For a detailed analysis of how LICs fared during the global crisis, see IMF (2010).

[5]See Chapter 3 of the September 2011 *World Economic Outlook* for an analysis of monetary policy implications of commodity-price-induced inflation in advanced and emerging market economies. This work underscores the importance of "targeting what you can hit" as a way of building monetary policy credibility and delivering better macroeconomic outcomes.

Box 4.1. *(continued)*

Figure 4.1.3. Impact of Higher Commodity Prices on the Fiscal Balance for Low-Income Countries in 2012
(Percent of GDP, median)

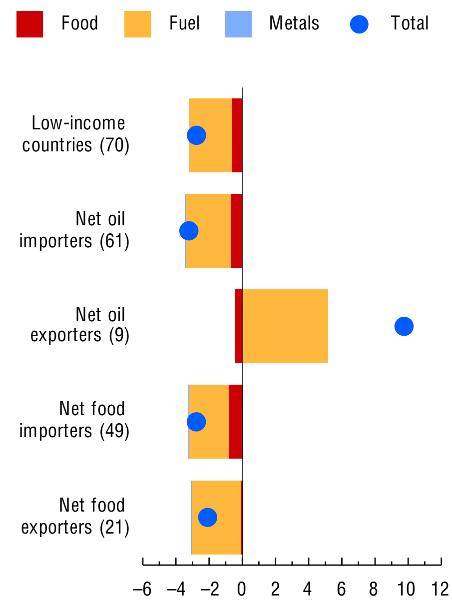
The fiscal balance of the median low-income country would deteriorate by more than 1 percent of GDP in 2012, mainly due to higher global fuel prices.



Sources: September 2011 *World Economic Outlook*; and IMF staff calculations.
Note: The estimates of the fiscal impact are calculated using revenue and expenditure elasticities to changes in global food and oil prices. The policy response is assumed to be similar to that in the 2007–08 episode of high global food and oil prices. The calculations are based on the median of differences, so the sum of the components may differ from the total. The numbers in parentheses indicate the sample size (number of economies).

Figure 4.1.4. Impact of Higher Commodity Prices on the Trade Balance for Low-Income Countries in 2012
(Percent of 2010 GDP, median)

Although some countries would gain from higher global commodity prices, for the median low-income country the 2012 trade balance would worsen by almost 3 percent of GDP, with most of the impact coming from oil.



Sources: September 2011 *World Economic Outlook*; and IMF staff calculations.
Note: The scenario simulated the impact of global price increases for food, metal (except gold and uranium), and fuel (31, 36, and 48 percent above the baseline, respectively). The calculations are based on the median of differences, so the sum of the components may differ from the total. The numbers in parentheses indicate the sample size (number of economies).

While coping well with shocks is important, countries can take steps before a crisis occurs to reduce their exposure or create space to prepare for future shocks. Besides building policy buffers during good times, LICs can (1) make their budgets more structurally robust, (2) put in place stronger and more flexible social safety net systems, (3) pursue reforms to encourage domestic saving and deepen their financial sectors, and (4) explore policies to encourage greater diversification in their production and exports.

Box 4.2. Volatile Commodity Prices and the Development Challenge in Low-Income Countries

Recent discoveries of natural resources in many low-income countries (LICs) combine with volatile commodity prices to pose both great opportunities and great challenges for these countries. In many cases, the production horizon is short, meaning that there is only a small window of opportunity to translate resource windfalls into development gains.[1] At the same time, trying to do too much too fast creates its own challenges.

The difficulties are partly analytic. The conventional recommendation, based on the permanent income hypothesis (PIH), is to save most resource income in a sovereign wealth fund, consisting of low-yielding financial assets (for example, Davis and others, 2001; Barnett and Ossowski, 2003; Bems and de Carvalho Filho, 2011). This helps preserve resource wealth, ensure intergenerational equity, and maintain stability.

However, this approach overlooks the longer-term development needs in these capital-scarce, credit-constrained countries. The above analyses generally combine the PIH with an assumption that the capital account is open and that the return to capital—including to public capital—is equal to world interest rates. Substantial empirical evidence, however, indicates that the rate of return to public capital investment in LICs may be well above world interest rates.[2] Limited access to world capital markets and weak domestic tax systems may leave many LICs unable to exploit this opportunity prior to a boom in natural resource exports. Indeed, several studies using models with investment find that front-loading productive public investment can be optimal (Takizawa, Gardner, and Ueda, 2004; van der Ploeg and Venables, 2011; Araujo and others, 2012).

Despite the theoretical appeal of LICs investing their resource income, historical evidence does not generally support the idea that natural resource abundance promotes economic growth—the so-called natural resource curse.[3] For example, the experience of four Latin American countries (Bolivia, Ecuador, Mexico, Venezuela) in the 1970s shows no obvious supply-side effects of growth beyond the resource windfall period (Sachs and Warner, 1999).

All this suggests that LICs should attempt to invest resource income, but with caution. Given the volatile nature of commodity prices, spending resource income as it accrues implies a highly volatile government spending path that aggravates economic instability and makes it harder to execute investment plans efficiently. Moreover, spending a large foreign exchange windfall domestically can lead to real appreciation, which can hurt the traded-goods sector (Dutch disease). Because LICs often suffer from poor governance and production bottlenecks, ramping up public investment is also likely to run into inefficiencies related both to converting resource income to public capital and to absorptive capacity constraints.

To address these potential problems, Berg and others (forthcoming) propose a "sustainable investing" approach, which involves using an investment fund to save some resource income and any increase in nonresource tax receipts.[4] Public investment is scaled up gradually, in line with institutional and absorptive capacity constraints. This approach can minimize the impact of volatile commodity prices in the domestic economy, mitigate Dutch disease effects, and reduce the costs of absorptive capacity constraints. When the magnitude of investment scaling-up is beyond the annuity value of the investment fund, further fiscal adjustments are required.

The author of this box is Susan Yang.

[1]For example, Ghana started to produce oil in 2011, and its reserve from the recent discovery is expected to run out by early 2020 (IMF staff projection).

[2]For example, the median annual rate of return among all the World Bank's projects has risen from about 12 percent during 1987–88 to 24 percent during 2005–07 (World Bank, 2010).

[3]As surveyed by van der Ploeg (2011), although an average negative correlation exists between growth and the export share of natural resources, many countries, such as Botswana and Chile, have escaped the curse.

[4]Collier and others (2010) also propose investing through a sovereign liquidity fund, which mainly aims to smooth the government investment path with resource income. The creation of a separate fund can be thought of as an intellectual construct to help identify the dynamics of an appropriate fiscal policy. In practice, while institutional factors may argue against fragmentation in the form of a separate fund, the insights as far as the trajectory for government saving and spending would remain valid.

Box 4.2. *(continued)*

This approach in effect preserves exhaustible natural resource wealth in the form of public capital that can increase the productivity of private production. Because consumption is also raised permanently, the approach is largely consistent with the PIH principle.

Recent experience among LICs suggests that the vast majority have not followed the PIH-based approach in managing natural resource income (see Appendix II in Baunsgaard and others, forthcoming). For example, during the recent oil price surge, domestically financed capital spending in Chad increased from 2.1 percent of non-oil GDP in 2003 to 12.6 percent during 2008–10 (IMF, 2011b). Timor-Leste, on the other hand, has followed the PIH-based approach for a sustained period. Since oil production began in early 2000, it has built a sizable petroleum fund that reached 886 percent of non-oil GDP in 2011 (IMF, 2012). Capital expenditure remained low before 2011, but the government recently launched a strategic development plan that includes large infrastructure spending to be partially financed by withdrawals from the petroleum fund.

References

Abbas, S. M. Ali, Nazim Belhocine, Asmaa A. ElGanainy, and Mark A. Horton, 2010, "A Historical Public Debt Database," IMF Working Paper 10/245 (Washington: International Monetary Fund).

Adler, Gustavo, and S. Sebastián Sosa, 2011, "Commodity Price Cycles: The Perils of Mismanaging the Boom," IMF Working Paper 11/283 (Washington: International Monetary Fund).

Araujo, Juliana, Bin Grace Li, Marcos Poplawski-Ribeiro, and Luis-Felipe Zanna, 2012, "Current Account Norms in Natural Resource Rich and Capital Scarce Economies" (unpublished; Washington: International Monetary Fund).

Barnett, Steven, and Rolando Ossowski, 2003, "Operational Aspects of Fiscal Policy in Oil-Producing Countries," in *Fiscal Policy Formulation and Implementation in Oil-Producing Countries*, ed. by Jeffrey M. Davis, Rolando Ossowski, and Annalisa Fedelino (Washington: International Monetary Fund).

Barsky, Robert B., and Lutz Kilian, 2002, "Do We Really Know That Oil Caused the Great Stagflation? A Monetary Alternative," *NBER Macroeconomics Annual 2001,* pp. 137–83.

Batini, Nicoletta, and Douglas Laxton, 2005, "Under What Conditions Can Inflation Targeting Be Adopted? The Experience of Emerging Markets," paper presented at "Monetary Policy Under Inflation Targeting," Ninth Annual Conference of the Central Bank of Chile (Santiago), October 20–21.

Baunsgaard, M. Thomas, Mauricio Villafuerte, M. Marcos Poplawski-Ribeiro, and C. Christine Richmond, forthcoming, "Fiscal Frameworks for Natural-Resource-Intensive Developing Countries," IMF Staff Discussion Note (Washington: International Monetary Fund).

Beidas-Strom, Samya, 2011, "Economic Policy Spillovers: Saudi Arabia in the Global Economy," Chapter 6 in *Gulf Cooperation Council Countries: Enhancing Economic Outcomes in an Uncertain Global Economy,* ed. by Samya Beidas-Strom, Tobias N. Rasmussen, and David O. Robinson (Washington: International Monetary Fund), pp. 81–93.

Bems, Rudolfs, and Irineu de Carvalho Filho, 2011, "The Current Account and Precautionary Savings for Exporters of Exhaustible Resources." *Journal of International Economics*, Vol. 84, No. 1, pp. 48–64.

Berg, Andrew, Rafael Portillo, Susan Yang, and Luis-Felipe Zanna, forthcoming, "Public Investment in Resource Abundant, Low-Income Countries," IMF Working Paper (Washington: International Monetary Fund).

Bond, Marion E., 1987, "An Econometric Study of Primary Commodity Exports from Developing Country Regions to the World," *IMF Staff Papers,* Vol. 34, No. 2, pp. 199–227.

Broda, Christian, 2004, "Terms of Trade and Exchange Rate Regimes in Developing Countries," *Journal of International Economics,* Vol. 63, No. 1, pp. 31–58.

Cashin, Paul, C. John McDermott, and Alasdair Scott, 2002, "Booms and Slumps in World Commodity Prices," *Journal of Development Economics*, Vol. 69, No. 1, pp. 277–96.

Céspedes, Luis Felipe, and Andrés Velasco, 2011, "Was This Time Different? Fiscal Policy in Commodity Republics," BIS Working Paper No. 365 (Basel: Bank for International Settlements).

Chen, Yu-Chin, Kenneth S. Rogoff, and Barbara Rossi, 2010, "Can Exchange Rates Forecast Commodity Prices?" *Quarterly Journal of Economics,* Vol. 125, No. 3, pp. 1145–94.

Chinn, Menzie, and Hiro Ito, 2006, "What Matters for Financial Development? Capital Controls, Institutions, and Interactions," *Journal of Development Economics*, Vol. 81, No. 1, pp. 163–92.

———, 2008, "A New Measure of Financial Openness," *Journal of Comparative Policy Analysis*, Vol. 10, No. 3, pp. 307–20.

Collier, Paul, and Benedikt Goderis, 2007, "Commodity Prices, Growth, and the Natural Resource Curse: Reconciling a Conundrum," CSAE Working Paper No. 2007–15 (Oxford: University of Oxford, Center for the Study of African Economies).

Collier, Paul, Frederick van der Ploeg, Michael Spence, and Anthony J. Venables, 2010, "Managing Resource Revenues in Developing Economies," *IMF Staff Papers*, Vol. 57, No. 1, pp. 84–118.

Davis, Jeffrey, Rolando Ossowski, James Daniel, and Steven Barnett, 2001, *Stabilizing and Saving Funds for Non-Renewable Resources: Experience and Fiscal Policy Implications,* IMF Occasional Paper No. 205 (Washington: International Monetary Fund).

Deaton, Angus, 1999, "Commodity Prices and Growth in Africa," *Journal of Economic Perspectives*, Vol. 13, No. 3, pp. 23–40.

———, and Guy Laroque, 1992, "On the Behaviour of Commodity Prices," *Review of Economic Studies,* Vol. 59, No. 1, pp. 1–23.

De Gregorio, José, Hermann González, and Felipe Jaque, 2005, "Fluctuations in the Dollar, Copper Price, and Terms of Trade," Working Paper No. 310 (Santiago: Central Bank of Chile).

De Gregorio, José, and Felipe Labbé, 2011, "Copper, the Real Exchange Rate, and Macroeconomic Fluctuations in Chile," in *Beyond the Curse: Policies to Harness the Power of Natural Resources,* ed. by Rabah Arezki, Amadou N. R. Sy, and Thorvaldur Gylfason (Washington: International Monetary Fund).

Demirel, Ufuk Devrim, 2010, "Macroeconomic Stabilization in Developing Economies: Are Optimal Policies Procyclical?" *European Economic Review,* Vol. 54, No. 3, pp. 409–28.

Eissa, Nada, and Hilary Williamson Hoynes, 2004, "Taxes and the Labor Market Participation of Married Couples: The Earned Income Tax Credit," *Journal of Public Economics,* Vol. 88, Nos. 9–10, pp. 1931–58.

Erten, Bilge, and José Antonio Ocampo, 2012, "Super-Cycles of Commodity Prices Since the Mid-Nineteenth Century," DESA Working Paper No. 110 (New York: United Nations Department of Economic and Social Affairs, February).

Eyzaguirre, Nicolás, Martin Kaufman, Steven Phillips, and Rodrigo Valdés, 2011, "Managing Abundance to Avoid a Bust in Latin America," IMF Staff Discussion Note 11/07 (Washington: International Monetary Fund).

Feenstra, Robert, Robert Lipsey, Haiyan Deng, Alyson Ma, and Hengyong Mo, 2005, "World Trade Flows: 1962–2000," NBER Working Paper No. 11040 (Cambridge, Massachusetts: National Bureau of Economic Research).

Frankel, Jeffrey, 2011, "How Can Commodity Exporters Make Fiscal and Monetary Policy Less Pro-Cyclical?" Harvard Kennedy School Faculty Research Working Paper No. 11-015 (Cambridge, Massachusetts: Harvard Kennedy School).

Hamilton, James D., 2011, "Historical Oil Shocks," in *Handbook of Major Events in Economic History,* ed. by Randall E. Parker and Robert M. Whaples (New York: Routledge).

Harding, Don, and Adrian Pagan, 2002, "Dissecting the Cycle: A Methodological Investigation, *Journal of Monetary Economics,* Vol. 49, No. 2, pp. 365–81.

Heap, Alan, 2005, *China—The Engine of a Commodities Super-Cycle* (New York: Citigroup Smith Barney).

Heenan, Geoffrey, Marcel Peter, and Scott Roger, 2006, "Implementing Inflation Targeting: Institutional Arrangements, Target Design, and Communications," IMF Working Paper 06/278 (Washington: International Monetary Fund).

Husain, Aasim M., Kamilya Tazhibayeva, and Anna Ter-Martirosyan, 2008, "Fiscal Policy and Economic Cycles in Oil-Exporting Countries," IMF Working Paper 08/253 (Washington: International Monetary Fund).

Ilzetzki, Ethan, Carmen M. Reinhart, and Kenneth S. Rogoff, 2008, "The Country Chronologies and Background Material to Exchange Rate Arrangements in the 21st Century: Which Anchor Will Hold?" (unpublished; College Park, Maryland: University of Maryland).

International Monetary Fund (IMF), 2009, "Fiscal Rules—Anchoring Expectations for Sustainable Public Finances," SM/09/274 (Washington). blog-pfm.imf.org/files/paper.pdf

———, 2010, "Emerging from the Global Crisis: Macroeconomic Challenges Facing Low-Income Countries," Policy Paper (Washington).

———, 2011a, *Managing Global Growth Risks and Commodity Price Shocks—Vulnerabilities and Policy Challenges for Low-Income Countries,* Policy Paper (Washington).

———, 2011b, *Chad: Staff Report for the 2011 Article IV Consultation*, IMF Country Report No. 11/302 (Washington).

———, 2012, *Democratic Republic of Timor-Leste: 2011 Article IV Consultation*, IMF Country Report No. 12/24 (Washington).

Kaminsky, Graciela L., 2010, "Terms of Trade Shocks and Fiscal Cycles," NBER Working Paper No. 15780 (Cambridge, Massachusetts: National Bureau of Economic Research).

Keane, Michael P., 2010, "Labor Supply and Taxes: A Survey," Working Paper No. 160 (Sydney: University of Technology, School of Finance and Economics).

Kilian, Lutz, 2009, "Not All Oil Price Shocks Are Alike: Disentangling Demand and Supply Shocks in the Crude Oil Market," *American Economic Review,* Vol. 99, No. 3, pp. 1053–69.

Kilian, Lutz, and Dan Murphy, 2010, "The Role of Inventories and Speculative Trading in the Global Market for Crude Oil," CEPR Discussion Paper No. 7753 (London: Centre for Economic Policy Research).

Kilian, Lutz, Alessandro Rebucci, and Nikola Spatafora, 2009, "Oil Shocks and External Balances," *Journal of International Economics,* Vol. 77, No. 2, pp. 181–94.

Kumhof, Michael, and Douglas Laxton, 2009a, "Fiscal Deficits and Current Account Deficits," IMF Working Paper 09/237 (Washington: International Monetary Fund).

———, 2009b, "Simple, Implementable Fiscal Policy Rules," IMF Working Paper 09/76 (Washington: International Monetary Fund).

———, 2010, "Chile's Structural Fiscal Surplus Rule: A Model-Based Evaluation," *Journal Economía Chilena* (The Chilean Economy), Vol. 13, No. 3, pp. 5–32.

———, Dirk Muir, and Susanna Mursula, 2010, "The Global Integrated Monetary Fiscal Model (GIMF)—Theoretical Structure," IMF Working Paper No. 10/34 (Washington: International Monetary Fund).

Laeven, Luc, and Fabian Valencia, 2008, "Systemic Banking Crises: A New Database," IMF Working Paper No. 08/224 (Washington: International Monetary Fund).

———, 2010, "Resolution of Banking Crises: The Good, the Bad, and the Ugly," IMF Working Paper 10/146 (Washington: International Monetary Fund).

Medas, Paulo, and Daria Zakharova, 2009, "A Primer on Fiscal Analysis in Oil-Producing Countries," IMF Working Paper 09/56 (Washington: International Monetary Fund).

Medina, Leandro, 2010, "The Dynamic Effects of Commodity Prices on Fiscal Performance in Latin America," IMF Working Paper 10/192 (Washington: International Monetary Fund).

Ossowski, Rolando, Mauricio Villafuerte, Paolo A. Medas, and Theo Thomas, 2008, *Managing the Oil Revenue Boom: The Role of Fiscal Institutions,* IMF Occasional Paper No. 260 (Washington: International Monetary Fund).

Radetzki, Marian, 2006, "The Anatomy of Three Commodity Booms," *Resources Policy,* Vol. 31, No. 1, pp. 56–64.

Rafiq, M. Sohrab, 2011, "Sources of Economic Fluctuations in Oil-Exporting Economies: Implications for Choice of Exchange Rate Regimes," *International Journal of Finance and Economics,* Vol. 16, No. 1, pp. 70–91.

Roger, Scott, 2010, "Inflation Targeting Turns 20," *Finance & Development*, Vol. 47, No. 1, pp. 46–49.

Sachs, Jeffrey D., and Andrew M. Warner, 1999, "The Big Push, Natural Resource Booms and Growth," *Journal of Development Economics*, Vol. 59, No. 1, pp. 43–76.

Smith, C. Wayne, and J. Tom Cothren, eds., 1999, *Cotton: Origin, History, Technology, and Production* (New York: Wiley).

Snudden, Stephen, forthcoming, "Designing Fiscal Rules for Oil-Exporting Countries," IMF Working Paper (Washington: International Monetary Fund).

Takizawa, Hajime, Edward Gardner, and Kenichi Ueda, 2004, "Are Developing Countries Better Off Spending Their Oil Wealth Upfront?" IMF Working Paper 04/141 (Washington: International Monetary Fund).

van der Ploeg, Frederick, 2011, "Natural Resources: Curse or Blessing?" *Journal of Economic Literature*, Vol. 49, No. 2, pp. 366–420.

———, and Anthony J. Venables, 2011, "Harnessing Windfall Revenues: Optimal Policies for Resource-Rich Developing Economies," *Economic Journal,* Vol. 121, No. 551, pp. 1–30.

Venables, Anthony J., 2010, "Economic Geography and African Development," *Papers in Regional Science,* Vol. 89, No. 3, pp. 469–83.

Wellman, Frederick L., 1961, *Coffee: Botany, Cultivation, and Utilization* (London: Leonard Hill, and New York: Interscience Publishers).

World Bank, 2010, *Cost-Benefit Analysis in World Bank Projects* (Washington).