CHAPTER 2

WHERE ARE COMMODITY EXPORTERS HEADED? OUTPUT GROWTH IN THE AFTERMATH OF THE COMMODITY BOOM

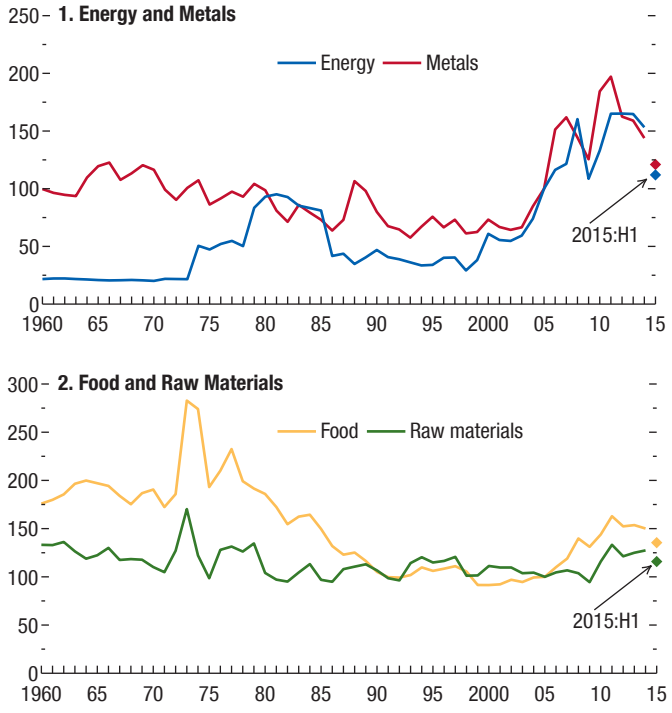
Commodity prices have declined sharply over the past three years, and output growth has slowed considerably among those emerging market and developing economies that are net exporters of commodities. A critical question for policymakers in these countries is whether commodity windfall gains and losses influence potential output or merely trigger transient fluctuations of actual output around an unchanged trend for potential output. The analysis in this chapter suggests that both actual and potential output move together with the commodity terms of trade but that actual output comoves twice as strongly as potential output. The weak commodity price outlook is estimated to subtract almost 1 percentage point annually from the average rate of economic growth in commodity exporters over 2015–17 as compared with 2012–14. In exporters of energy commodities, the drag is estimated to be larger—about 2¼ percentage points on average over the same period. The projected drag on the growth of potential output is about one-third of that for actual output.

Introduction

After rising dramatically for almost a decade, the prices of many commodities, especially those of energy and metals, have dropped sharply since 2011 (Figure 2.1). Many analysts have attributed the upswing in commodity prices to sustained strong growth in emerging market economies, in particular those in east Asia, and the downswing to softening growth in these economies and a greater supply of commodities.[1] Commodity prices are notoriously difficult to predict, but there is general agreement among analysts that they will likely remain low, given ample supplies and weak prospects for global economic growth. Commodity futures prices also suggest that, depending on

Figure 2.1. World Commodity Prices, 1960–2015
(In real terms; index, 2005 = 100)

After a dramatic rise in the 2000–10 period, the prices of many commodities have been dropping sharply. The cycle has been especially pronounced for energy and metals.



Sources: Gruss 2014; IMF, Primary Commodity Price System; U.S. Energy Information Administration; World Bank, Global Economic Monitor database; and IMF staff calculations.
Note: The real price index for a commodity group is the trade-weighted average of the global U.S. prices of the commodities in the group deflated by the advanced economy manufacturing price index and normalized to 100 in 2005. The commodities within each group are listed in Annex 2.1. The values for the first half of 2015 are the average of the price indices for the first six months of the year.

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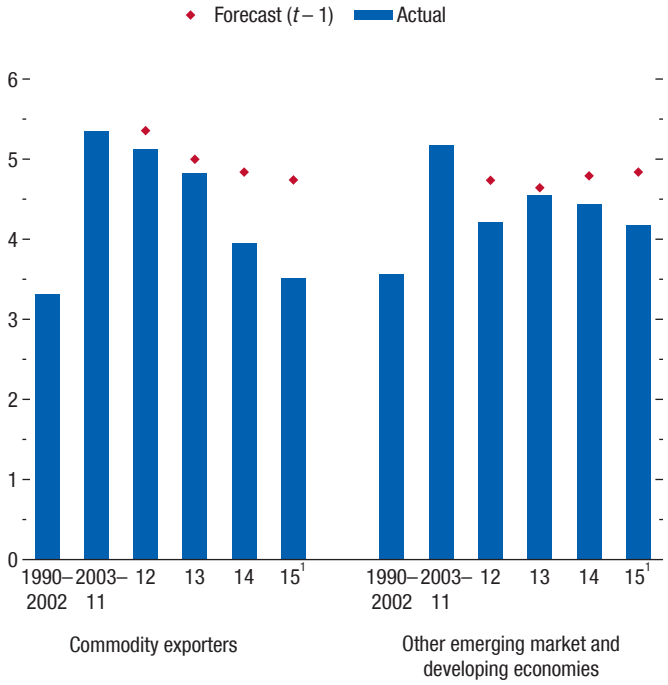
[1]The role of global and emerging market demand in driving the surge in commodity prices in the first decade of the 2000s is discussed in Erten and Ocampo 2012, Kilian 2009, and Chapter 3 of the October 2008 *World Economic Outlook*. On the impact of slowing emerging market growth on commodity prices, see "Special Feature: Commodity Market Review" in Chapter 1 of the October 2013 *World Economic Outlook*. Roache 2012 documents the increase in China's share in global commodity imports in the 2000s.

Figure 2.2. Average Growth in Commodity-Exporting versus Other Emerging Market and Developing Economies, 1990–2015
(Percent)

The recent drop in commodity prices has been accompanied by pronounced declines in real GDP growth rates, much more so in commodity-exporting countries than in other emerging market and developing economies.



Source: IMF staff estimates.
Note: "Commodity exporters" are emerging market and developing economies for which gross exports of commodities constitute at least 35 percent of total exports and net exports of commodities constitute at least 5 percent of exports-plus-imports on average, based on the available data for 1960–2014. "Other emerging market and developing economies" are defined as the emerging market and developing economies that are not included in the commodity exporters group. Countries are selected for each group so as to have a balanced sample from 1990 to 2015. Outliers, defined as economies in which any annual growth rate during the period exceeds 30 percent (in absolute value terms), are excluded.
[1]Average growth projected for 2015 in the July 2015 *World Economic Outlook Update*.

the commodity, future spot prices will remain low or rebound only moderately over the next five years.

The decline in commodity prices has been accompanied by stark slowdowns in economic growth among commodity-exporting emerging market and developing economies, most of which had experienced high growth during the commodity price boom (Figure 2.2). Besides the decline in growth, commodity exporters have also seen downgrades in their medium-term growth prospects: almost 1 percentage point has been shaved off the average of their five-year-ahead growth forecasts since 2012, while the medium-term growth forecasts of other emerging market and developing economies have remained broadly unchanged.

Weaker commodity prices raise key questions for the outlook in commodity-exporting economies. One that looms large is whether commodity-price-related fluctuations in growth are mostly cyclical or structural. The flip side of this question is whether the faster rate of output growth during the commodity boom reflected a cyclical overheating as opposed to a higher rate of growth in potential output.[2] Distinguishing between the cyclical and structural components of growth is not straightforward in any business cycle; it is particularly challenging during prolonged commodity booms, when a persistent pickup in incomes and demand makes it harder to estimate the underlying trend in output.[3]

The diagnosis of how actual and potential growth is influenced by commodity price fluctuations is crucial for the setting of macroeconomic policies in commodity exporters. Price declines that lead to a mostly cyclical slowdown in growth could call for expansionary macroeconomic policies (if policy space is available) to pick up the slack in aggregate demand. In contrast, lower growth in potential output would tend to imply a smaller amount of slack and, therefore, less scope for stimulating the economy using macroeconomic policies. In countries where the decline in commodity prices leads to a loss in fiscal revenues, weaker potential output growth would also require fiscal adjustments to ensure public debt sustainability.

This chapter contributes to the literature on the macroeconomic effects of booms and downturns in the commodity terms of trade (the commodity price cycle) in net commodity exporters.[4] Using a variety of empirical approaches, it makes a novel contribution

[2]Potential output is defined in this chapter as the amount of output in an economy consistent with stable inflation. Actual output may deviate from potential output because of the slow adjustment of prices and wages to changes in supply and demand. In most of the empirical analysis, potential output is proxied by trend output—based on an aggregate production function approach and using the growth rates of the capital stock as well as smoothed employment and total factor productivity series. Chapter 3 of the April 2015 *World Economic Outlook* includes a primer on potential output (pp. 71–73).

[3]See the discussion in De Gregorio 2015.

[4]A country's "terms of trade" refers to the price of its exports in terms of its imports. The concept of "commodity terms of trade" as used in this chapter refers to the price of a country's commodity exports in terms of its commodity imports. It is calculated as a country-specific weighted average of international commodity prices, for which the weights used are the ratios of the net exports of the

by analyzing changes in the cyclical versus structural components of output growth in small open net commodity-exporting economies during the commodity price cycle.[5] The empirical analysis focuses on emerging market and developing economies that are net exporters of commodities, with the exception of case studies that examine the sectoral reallocation resulting from commodity booms in Australia, Canada, and Chile. The chapter also uses model-based simulations to analyze the impact of the commodity price cycle on income, domestic demand, and output; that investigation draws on the IMF's Global Economy Model (GEM), which has a full-fledged commodities sector and is hence uniquely suited to this analysis.[6]

Specifically, the chapter seeks to answer the following questions about the effects of the commodity price cycle:

- *Macroeconomic effects:* How do swings in the commodity terms of trade affect key macroeconomic variables—including output, spending, employment, capital accumulation, and total factor productivity (TFP)? How different are the responses of actual and potential output? Do the economies of commodity exporters overheat during commodity booms?
- *Policy influences:* Do policy frameworks influence the variation in growth over the cycle?
- *Sectoral effects:* How do swings in the commodity terms of trade affect the main sectors of the economy—commodity producing, manufacturing, and nontradables (that is, goods and services not traded internationally)?
- *Growth outlook:* What do the empirical findings imply for the growth prospects of commodity-exporting economies over the next few years?

The main findings of the chapter are as follows:

Macroeconomic effects

- Swings in the commodity terms of trade lead to fluctuations in both the cyclical and structural components of output growth, with the former tending to be about twice the size of the latter. In previous prolonged terms-of-trade booms, annual actual output growth tended to be 1.0 to 1.5 percentage points higher on average during upswings than in downswings, whereas potential output growth tended to be only 0.3 to 0.5 percentage point higher. These averages mask considerable diversity across episodes, including in regard to the underlying changes in the terms of trade.
- The strong response of investment to swings in the commodity terms of trade is the main driver of changes in potential output growth over the cycle. In contrast, employment growth and TFP growth contribute little to the variations in potential output growth.

Policy influences, sectoral effects, and growth outlook

- Certain country characteristics and policy frameworks can influence how strongly output growth responds to the swings in the commodity terms of trade. Growth responds more strongly in countries specialized in energy commodities and metals and in countries with a low level of financial development. Less flexible exchange rates and more procyclical fiscal spending patterns (that is, stronger increases in fiscal spending when the commodity terms of trade are improving) also tend to exacerbate the cycle.
- Case studies of Australia, Canada, and Chile suggest that investment booms in commodity exporters are mostly booms in the commodity sector itself. Evidence of large-scale movements of labor and capital to nontradables activities is mixed.
- All else equal, the weak commodity price outlook is projected to subtract about 1 percentage point annually from the average rate of economic growth in commodity-exporting economies over 2015–17 as compared with 2012–14. In energy exporters the drag is estimated to be larger, about 2¼ percentage points on average.

relevant commodity to the country's total commodity trade. Details of the calculation are provided in Annex 2.1.

[5]The literature has mostly focused on the comparative longer-term growth record of commodity exporters. Surveys can be found in van der Ploeg 2011 and Frankel 2012. Other major topics in the literature include the contribution of terms-of-trade shocks to macroeconomic volatility (for example, Mendoza 1995 and Schmitt-Grohé and Uribe 2015), the comovement between the commodity terms of trade and real exchange rate (for example, Chen and Rogoff 2003 and Cashin, Céspedes, and Sahay 2004), the impact of natural resource discoveries on activity in the nonresource sector (Corden and Neary 1982; van Wijnbergen 1984a, 1984b), and the relationship between terms-of-trade movements and the cyclical component of output (Céspedes and Velasco 2012). Chapter 1 of the October 2015 *Fiscal Monitor* discusses the optimal management of resource revenues, a topic that has also been the subject of a large literature (for example, IMF 2012).

[6]This chapter is a sequel to Chapter 3 of the April 2015 *World Economic Outlook*, which provides estimates of potential output for 16 major economies for the past two decades, and to Chapter 4 of the April 2012 *World Economic Outlook*, which examines the growth implications of commodity price movements driven by global production versus global demand and the optimal fiscal management of commodity windfalls.

The findings of the chapter suggest that, on average, some two-thirds of the decline in output growth in commodity exporters during a commodity price downswing should be cyclical. Whether the decline in growth has opened up significant economic slack (that is, has increased the quantity of labor and capital that could be employed productively but is instead idle) and the degree to which it has done so are likely to vary considerably across commodity exporters. The variation depends on the cyclical position of the economy at the start of the commodity boom, the extent to which macroeconomic policies have smoothed or amplified the commodity price cycle, the extent to which structural reforms have bolstered potential growth, and other shocks to economic activity. Nevertheless, a key takeaway for commodity exporters is that attaining growth rates as high as those experienced during the commodity boom will be challenging under the current outlook for commodity prices unless critical supply-side bottlenecks that constrain growth are alleviated rapidly.

The rest of the chapter is structured as follows. First it discusses the macroeconomic implications of a terms-of-trade windfall in a commodity-exporting economy and presents illustrative model simulations. It then presents two sets of empirical tests of whether the evidence conforms to the model-based predictions, namely, event studies and regression-based estimates. The event studies cover a large sample of prolonged upswings and subsequent downswings in the commodity terms of trade to document the key regularities in the data; by design, they do not control for contextual factors. To isolate the effects of the terms-of-trade movements, regression-based estimates of the responses of key macroeconomic variables to terms-of-trade shocks are also presented. In addition, case studies examine the sectoral implications of terms-of-trade booms. The chapter concludes with a summary of the findings and a discussion of their policy implications.

Commodity Terms-of-Trade Windfalls: A Model-Based Illustration

How would commodity price cycles be expected to affect small open economies that are net exporters of commodities (hereafter, commodity-exporting economies)? This section first reviews the concept of potential output and then turns to simulations of a calibrated model that illustrate the response of a typical commodity-exporting economy to a terms-of-trade boom.

Preliminaries

The model-based analysis focuses on a commodity cycle in which a surge in prices—driven by stronger global demand—is followed by a partial, supply-driven correction. This assumption is consistent with how most analysts view the commodity price boom of the 2000s. The correction is partial given the exhaustible nature of commodities and because income levels in emerging markets are considered to have increased permanently (with higher demand for commodities), even if the increase in income may have been smaller than what had been expected.[7]

Potential Output

The following discussion of the macroeconomic implications of a terms-of-trade windfall distinguishes between temporary effects on potential output (those over a commodity cycle) and permanent effects (beyond a commodity cycle). Over a commodity cycle, potential output is defined as the level of output consistent with stable inflation—in the model, this is captured by the path of output under flexible prices. The short-term divergence of actual output from potential output—resulting from the slow adjustment in prices—is referred to as the output gap. These two components of output fluctuations can also be called the "structural" and "cyclical" components. Beyond the commodity cycle, potential output in a commodity-exporting economy is driven by changes in global income, the implied change in the relative price of commodities, and any durable effects of the commodity price boom on domestic productive capacity (as discussed next). All else equal, a permanent increase in the commodity terms of trade would lead to an increase in potential output.

With a growth-accounting framework (which measures the contribution to growth from various factors), potential output can be decomposed into capital, labor, and the remainder unexplained by those two—TFP. Terms-of-trade booms can affect the path of potential

[7]The empirical analysis in the next section shows that this pattern of commodity cycles also characterizes the average commodity cycle during the past five decades, in which an initial price boom is followed by a partial correction. The model captures the exhaustibility of commodities with land as a unique and important production input for commodities but not for other goods.

output through each of these three components. More durable changes in potential growth are possible to the extent that productivity growth is affected.

Capital. A commodity terms-of-trade boom that is expected to persist for some time will increase investment in the commodity sector and in supportive industries.[8] A broader pickup in investment could be facilitated by a lower country risk premium and an easing of borrowing constraints that coincide with better commodity terms of trade. Higher investment rates in the commodity and noncommodity sectors, in turn, will raise the economy's level of productive capital and hence raise the level (but not the permanent growth rate) of its potential output.

Labor supply. Large and persistent terms-of-trade booms may also affect potential employment. Structural unemployment may decline following a period of low unemployment through positive hysteresis effects. Lower unemployment rates may also encourage entry into the labor force as well as job search, raising the trend participation rate. As with investment, the labor supply channels have an effect on the level of potential output, but not on its permanent growth rate.

Total factor productivity. Terms-of-trade booms can raise TFP by inducing faster adoption of technology and higher spending on research and development. The sectoral reallocation of labor and capital during a terms-of-trade boom could also influence economy-wide TFP, but the sign of the effect is uncertain beforehand (because factors of production may be reallocated from high- to low-productivity sectors and vice versa).

Although the increases in productive capital and the labor force during a commodity price boom translate into increased potential output, this increase may not be sustainable. For example, investment may no longer be viable at lower commodity prices (once the boom has abated); thus the growth rate of aggregate investment may fall along with the terms of trade.

Transmission Channels for Commodity Cycles

Upswings in the commodity terms of trade affect the macroeconomy through two main channels, income and investment.

Income. The commodity price boom generates an income windfall, as existing levels of production yield greater revenues. Higher income boosts domestic demand and thereby stimulates domestic production. Because the income windfall is generated by more favorable terms of trade, the response of real domestic output is more subdued than that of income and domestic demand.[9] This was indeed the case during the most recent commodity boom (2000–10) (Figure 2.3). Consistent with the Dutch disease effect, the domestic supply response to higher domestic income occurs disproportionately in the nontradables sector because demand for tradables can be met in part by a rise in imports.[10] In the process, the prices of the relatively scarce nontradable goods and services increase relative to the prices of tradables, and the real exchange rate appreciates.

Investment. In addition, commodity price booms heighten incentives to invest in the commodity sector and supporting industries—such as construction, transportation, and logistics. The resulting increase in economic activity ultimately generates spillovers to the rest of the economy and raises incomes further. Moreover, in the medium term, the increase in the supply of commodities can reverse the commodity price boom, contributing to the commodity cycle itself.[11]

The income and investment channels are interrelated. The income gain in the domestic economy will be higher and more broadly based if investment and activity in the commodity sector respond more strongly to the increase in the terms of trade. Likewise, a greater income windfall will make higher investment more likely.

[8]See also the discussion in Gruss 2014.

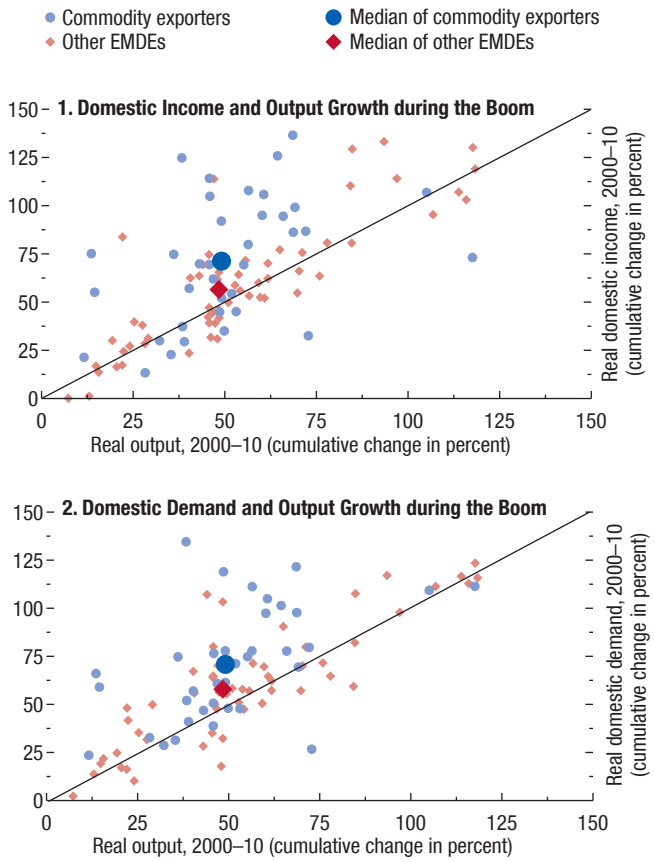
[9]Kohli (2004) and Adler and Magud (2015) show that real GDP tends to underestimate the increase in real domestic income when the terms of trade improve. In addition, Adler and Magud (2015) provide estimates of the income windfall during commodity terms-of-trade booms during 1970–2012.

[10]An extensive theoretical and empirical literature studies the Dutch disease effect (see Box 2.1 for an overview).

[11]The strength of the supply response in the commodity sector depends on the sector's maturity. That is, output in the sector will respond more to a boom the more potential there is for new resource discoveries and the less costly it is to ramp up production volumes. Anecdotal evidence from some countries in the 2000s boom illustrates the case of a relatively more mature sector: boosting or even just maintaining production required extractive companies to dig deeper, use more sophisticated technology, and incur higher costs than in the past; thus, the boom in commodity sector investment was associated with only a relatively modest rise in commodity output.

Figure 2.3. Real Income, Output, and Domestic Demand, 2000–10

The 2000–10 commodity price boom sharply improved the terms of trade for commodity exporters and induced an income windfall. Real domestic income and demand in the median commodity-exporting economy increased considerably more than real output.



Source: IMF staff calculations.
Note: Real income is calculated by deflating nominal GDP using the domestic consumer price index. Countries with a decline in real GDP, income, or domestic demand over 2000–10 or those with greater than 150 percent growth over the same period are excluded. EMDEs = emerging market and developing economies.

Model-Based Illustrations

The effects of a commodity price cycle on a commodity-exporting economy are illustrated here using GEM.[12]

[12]GEM is a micro-founded multicountry and multisector dynamic general equilibrium model of the global economy. Its key features are a commodities sector with land as a major nonreproducible production factor; conventional real and nominal frictions, such as sticky prices and wages; adjustment costs for capital and labor; habit formation in consumption; a fraction of liquidity-constrained consumers; and a financial accelerator mechanism. For a detailed description of GEM, see Lalonde and Muir 2007 and Pesenti 2008.

In the simulations, the commodity boom is induced by a temporary pickup in growth in east Asia.[13] The discussion in this section focuses on model responses to the boom in a typical Latin American economy, as the region exemplifies net commodity exporters.[14]

The Upswing

The growth pickup in east Asia is calibrated so that the commodity price index in the commodity-exporting country gradually increases by 20 percent over a 10-year period (Figure 2.4).[15] The more favorable terms of trade boost income and consumption in the exporter's economy. Meeting the surge in demand from domestic supply requires front-loading an increase in investment, which is followed by an increase in output. In response to higher demand, to capital deepening (that is, an increase in capital per worker), and to the resulting increase in real wages, the other factor of production—labor—also increases during the boom.

An important question that the model can help clarify relates to the relative contributions of cyclical and structural factors in the supply boom. In the model, increases in output during the commodity cycle are decomposed into the structural and cyclical contributing factors. First, under flexible prices the income windfall gives rise to an increase in demand and output (the structural component). Second, a slow adjustment in prices (in the presence of "sticky prices" given nominal rigidities) exacerbates the response of economic activity in the short term (the cyclical component—the deviation of actual output from potential output). The flexible- and sticky-price versions of the model are used to decompose the response in actual output and labor into contributions from these two factors (Figure 2.4, panels 2 and 4).

[13]This choice is motivated by the broad agreement among market analysts that fast growth in east Asia was a major force behind the surge in commodity prices between the late 1990s and 2008 (for a list of references on this topic, see note 1). The assumed duration of the pickup in east Asian growth in the model is selected to match this episode.

[14]Latin America, one of the six regions included in the model, accounts for about 6¼ percent of world output. The region is parameterized as a net exporter of commodities, with the commodities sector accounting for 11 percent of output. The commodities sector in the model is further divided into oil and non-oil commodities of approximately equal size, with a lower price elasticity of demand in the oil sector. All results reported in this section refer to the aggregate commodities sector.

[15]Figure 2.4 reports the responses of the model to the boom in the relative price of commodities (baseline scenario), presented as percentage deviations from the no-boom case.

The results show that both structural and cyclical components contribute to the supply response following the commodity price boom; that is, the slow adjustment in prices and wages leads actual output to increase more than potential output. The cyclical component—reflected in a positive output gap—drives a pickup in inflation during the boom. A key takeaway from this exercise is that an important component of the boom is structural—in the sense that a commodity boom generates a gradual and significant increase in capital, output, and employment even in the absence of sticky prices.[16]

The income windfall increases demand in all sectors. However, domestic supply increases more in the nontradables sector than in the tradables sector because domestic tradable goods can more readily be substituted with imported tradable goods than nontradables can be substituted with tradables.[17] Whether supply in the tradables sector increases or decreases depends on the degree of substitutability between domestic tradables and imports and whether the commodity exporter is also a net exporter of tradables to east Asia, where the global demand boom originates.

Partitioning the economy into three sectors—commodities, nontradables, and tradables—yields a distinct pattern of resource reallocation (Figure 2.4, panels 5–8). Investment rises relative to the no-boom case in all three sectors but more so in the commodities and nontradables sectors. Employment is correspondingly reallocated away from tradables and into commodities and nontradables. Consistent with these sectoral shifts, the relative price of nontradables to tradables increases, and the real effective exchange rate appreciates. The reproducible production factor—the capital stock—grows in all sectors, including in tradables, because the boom unambiguously increases demand in all sectors (even if in relative terms, the increase is larger for nontradables). Notably, in the model simulations, the sectoral shares in real value added are little changed because the fastest-growing commodities sector is small (about 10 percent of GDP in the model), and the

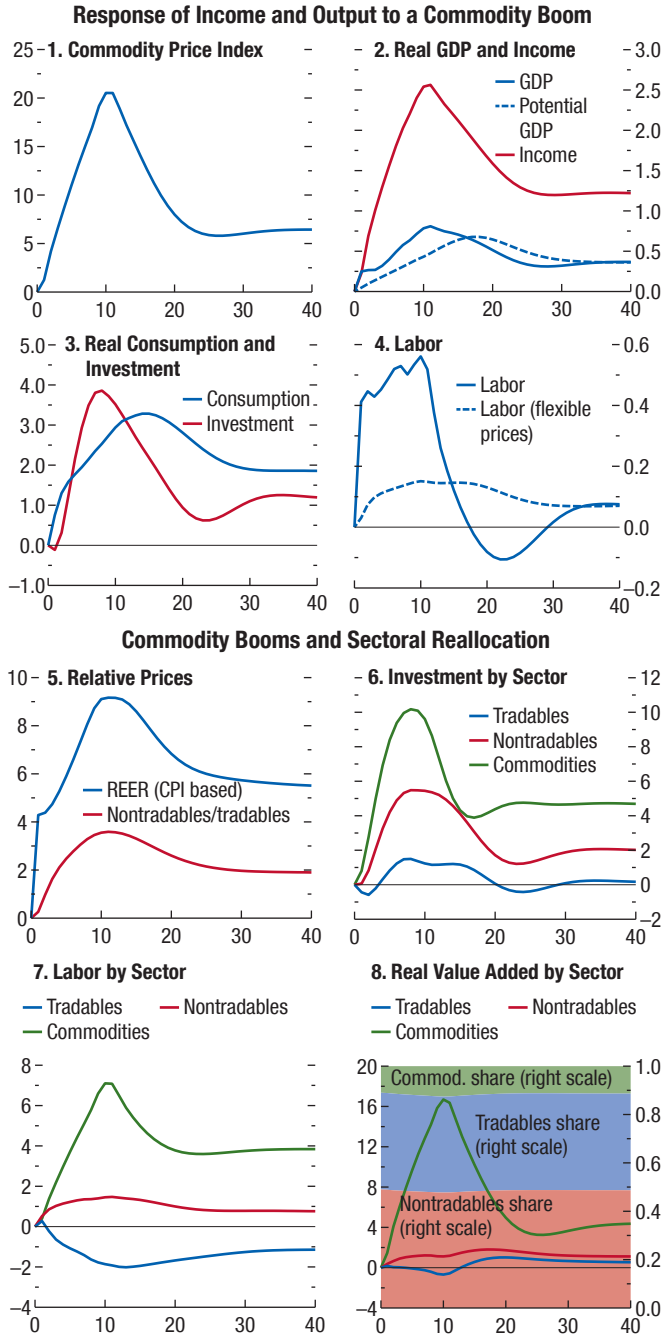
[16]The gradual nature of the increase in potential output and consumption is driven by real frictions, such as adjustment costs in production factors, liquidity-constrained consumers, and habit formation in consumption.

[17]That is, the elasticity of substitution is parameterized to be larger within sectors than across sectors. The cross-sectoral shifts will be largest if, within the tradables sector, domestic goods and imports are perfect substitutes.

Figure 2.4. Model Simulations: Macroeconomic Effects of a Commodity Boom

(Percent deviation, unless noted otherwise; years on x-axis)

The IMF's Global Economy Model predicts that a commodity price boom should induce higher investment, consumption, output, and labor effort in commodity-exporting economies. The gains in output and labor effort have cyclical and structural components. The model also predicts that these economies' factors of production will shift toward the nontradables and commodities sectors and that the currency will appreciate in real terms.



Source: IMF staff estimates.
Note: Potential output is given by the path of output under flexible prices. All variables except shares in real value added are shown in percentage deviations from their paths in the absence of a commodity boom. Commod. = commodities; CPI = consumer price index; REER = real effective exchange rate.

noncommodity parts of the economy get a boost from the income windfall.

The Downswing

In the medium term (after year 10 in the model simulations) the boom in commodity prices is partially reversed by the dissipation of the growth pickup in east Asia and the rise in the global supply of commodities in response to higher prices. The price reversal sets in motion a downswing phase for the economy. As income falls, all the forces outlined previously for the upswing phase occur in reverse. The drop in demand lowers supply. Actual output temporarily falls below potential output. Labor is reallocated from the commodities and nontradables sectors back into the tradables sector. Value added drops most in the commodities sector and grows more in the tradables sector than it does in the nontradables sector.

In the absence of permanent changes in the terms of trade, the boom produces no lasting gains in potential output. Put differently, potential output rises temporarily above a no-boom path and then returns to it. In contrast, if the terms of trade remain higher than their preboom level, as in the model simulations, the boom leads to a permanent gain in potential output.

Additional Factors Affecting the Commodity Cycle

The baseline scenario suppresses numerous factors that could influence the commodity cycle and its effect on the commodity-exporting economy. Four such factors are expectations about the price of the commodity, the reaction of fiscal policy to higher revenues, the easing of financial frictions due to the commodity boom, and sectoral reallocation of capital and labor.

Commodity price expectations. Expectations are central to the commodity cycle. Consumption and investment in the commodity-exporting economy increase only if the boom is expected to be long lasting. Overly optimistic expectations regarding the persistence of the boom can therefore aggravate the boom-bust cycle by generating a greater boom in domestic demand during the upswing, which in turn requires a greater correction in spending during the downswing. Overoptimism is more likely in the case of persistent upswings in commodity prices, like those experienced in the early 2000s. It can be global, rather than country specific; for example, the prices embedded in commodity futures may not materialize.

To illustrate how overly optimistic expectations can aggravate the cycle, the simulation compares the baseline scenario with a case in which the commodity price is initially expected to increase gradually for more than 10 years. Up to year 10, these expectations are validated; then, expectations are corrected downward, and the increase in the commodity price comes to a halt (Figure 2.5). As a result, income is less than initially expected. This scenario implies a more pronounced initial boom in the commodity-exporting economy because the expected wealth gain from the commodity price boom is larger than in the baseline case. In the aftermath of the boom, demand and supply dip below the responses in the baseline to correct for the excessive initial boom.

Fiscal policy. Much of the commodity price windfall accrues to the government in commodity-producing economies—especially in energy exporters. Thus, the terms-of-trade boom may loosen the government budget constraint and allow the government to finance a higher level of spending. Moreover, the government's use of the income windfall can substantially affect the economy's response to the commodity price cycle.[18] For example, if the government pursues a procyclical fiscal policy during the boom, using the additional revenues to reduce taxes on households or increase consumption spending, it can aggravate the boom-bust cycle in economic activity. Such a scenario is examined in detail in Chapter 4 of the April 2012 *World Economic Outlook*. In contrast, if the government invests in productivity-enhancing capital (whether infrastructure or human capital), productive capacity and income can benefit over the longer term. The implications of such a scenario—using a model calibrated to a low-income developing country—are examined in Box 2.2.

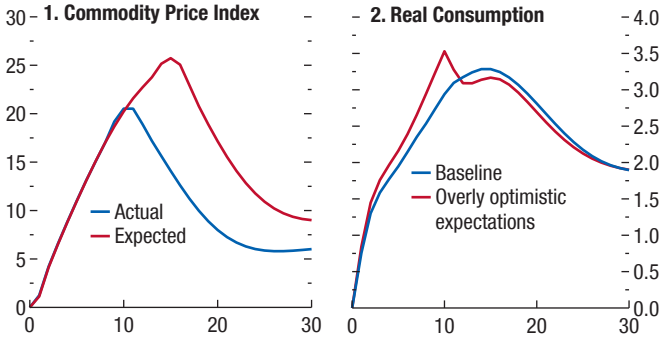
Financial frictions. The commodity boom increases returns, thereby improving companies' net worth and reducing their leverage. Reduced leverage, in turn, decreases both the premium firms pay to obtain financing and their cost of capital. The result is to reduce the economy's financial frictions, broadly defined. Increased global risk appetite during the boom can further magnify this channel. The effect can be illustrated with one summary measure of the cost of external financing—sovereign bond yield spreads—for a sample of commodity-exporting economies

[18]See the discussion in Chapter 1 of the October 2015 *Fiscal Monitor*.

Figure 2.5. Consumption Dynamics with Overly Optimistic Commodity Price Expectations

(Percent deviation; years on x-axis)

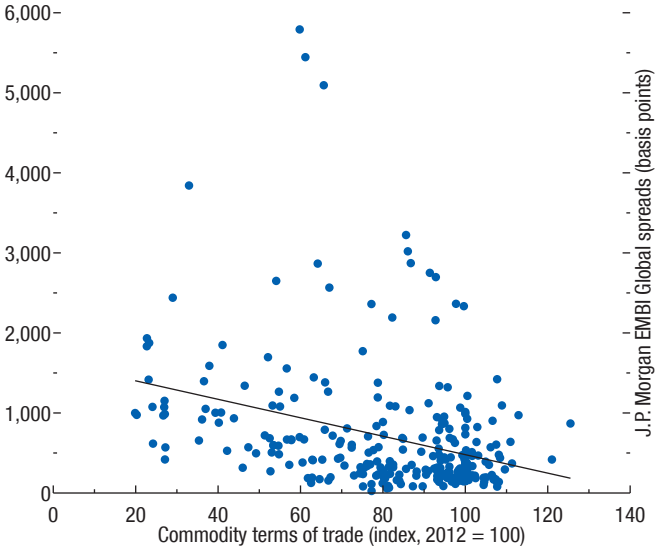
The IMF's Global Economy Model predicts that overestimating the ultimate size and persistence of a commodity price boom will yield a more pronounced initial increase in consumption that is followed by a dip in growth rates to levels below those in the baseline scenario.



Source: IMF staff estimates.
Note: All variables are shown in percentage deviations from their paths in the absence of a commodity boom.

Figure 2.6. Sovereign Bond Yield Spreads and the Commodity Terms of Trade

During 1997–2014, commodity-exporting economies had lower spreads on sovereign bond yields when their commodity terms of trade were higher, which meant lower financing costs during the boom phase of the commodity cycle.



Sources: Thomson Reuters Datastream; and IMF staff calculations.
Note: Data are for commodity-exporting emerging market and developing economies for which J.P. Morgan Emerging Markets Bond Index Global (EMBI Global) spreads are available. See Annex 2.1 for the definition of the commodity terms-of-trade index.

from 1997 to 2014 (Figure 2.6). The negative relationship between the country-specific terms of trade and spreads implies that the cost of financing decreases for exporters during commodity booms and increases during downswings.

The reduction in the cost of financing and the easing of financial frictions further boosts income and potential output during the upswing; its effects reverse during the downswing. The effect of the commodity price cycle on financial frictions is therefore another channel that aggravates the boom-bust dynamics in a commodity-exporting economy. Such effects are unlikely to affect the economy beyond the horizon of the commodity cycle unless they lead to a sustained improvement in financial sector development.

Sectoral reallocation. The responses in the baseline scenario feature a shift of labor and capital away from the noncommodity tradables sector toward the commodity and nontradables sectors as part of the equilibrium adjustment to the windfall. The sectoral reallocation of factors raises additional issues. If manufacturing is associated with positive externalities for the broader economy (such as learning-by-doing externalities), the shrinking of the relative size of the manufacturing sector can raise concerns.[19] In addition, the reallocation could change the weights of the different sectors in the overall economy and thus affect measured aggregate TFP growth. Most applied macroeconomic models, including GEM, assume balanced growth across sectors and thus abstract from such considerations. The case studies in the following section investigate this issue by examining whether sectoral shifts in activity during commodity booms have altered aggregate TFP growth.

Five Decades of Evidence: Commodity Terms-of-Trade Cycles and Output

How do actual and potential output respond to commodity windfall gains and losses? This section analyzes the question in two steps with data for a sample of 52 commodity-exporting emerging market and developing economies.[20] In the first step, event

[19]Box 2.1 provides a discussion of this issue.

[20]A country is classified as a commodity exporter (using data available for 1962–2014) if (1) commodities constitute at least 35 percent of its total exports and (2) net exports of commodities are

studies are carried out to shed light on how actual and potential output growth have behaved during and after prolonged upswings in the commodity terms of trade. The event study findings provide an overview of the main regularities in the data. However, event studies do not control for contextual factors (such as the broader effects of global demand booms that often accompany prolonged upswings in international commodity prices). Therefore, in the second step, the analysis uses a regression approach to isolate the impact of changes in the terms of trade by controlling for relevant contextual factors, such as output growth in trading partners.

To capture the country-specific impact of global commodity price movements, the analysis focuses on the commodity terms of trade by weighting the global prices of individual commodities according to country-specific net export volumes.[21] This approach has two advantages compared with a focus on the changes in the global price of a country's most important export commodity. First, few of the non-oil commodity exporters are so specialized that focusing on the price of a single commodity would be representative of the changes in their terms of trade. Second, the approach recognizes that fluctuations in commodity prices affect countries differently depending on the composition of both their exports and their imports. For instance, despite the upswing in food and raw materials prices in the 2000s, many agricultural commodity exporters did not experience terms-of-trade windfalls given the even stronger surge in their oil import bills.

Event Studies of Commodity Cycles with Pre-2000 Peaks

Since the recent declines in commodity prices have occurred after an unusually prolonged boom phase, the event studies focus on past episodes of *persistent* upswings in the commodity terms of trade (Figure 2.7).[22] Event studies are carried out for the cycles with peaks before 2000 because the end of the downswing phase cannot yet be identified for the post-2000 upswings. In this sample, the commodity terms of trade increased by 63 percent on average during upswings and declined by 24 percent on average over the subsequent downswings. On average, upswings are eight years long for extractive commodities and five years long otherwise.

The event studies confirm that output and domestic spending tend to grow faster during upswings in commodity terms of trade than in downswings. The variation in investment growth—both private and public—is particularly pronounced (Figure 2.8, panel 1).[23] Investment and consumption contribute about equally to the difference in the growth of real GDP, as the stronger response of investment makes up for its smaller share in overall spending.

Factors supporting domestic demand, such as credit to the private sector and overall government spending, tend to expand more strongly in upswings than in downswings (Figure 2.8, panel 2).[24] Somewhat surprisingly, the real effective exchange rate in the identified episodes did not appreciate during the average pre-2000 upswing.[25] However, breaking the sample into episodes involving countries with fixed versus flexible

at least 5 percent of its gross trade (exports plus imports) on average. A list of the countries and their shares of commodity exports is provided in Annex Table 2.1.2. Exporters of energy commodities and metals represent slightly more than 70 percent of the countries in the sample.

[21]See Annex 2.1 for details. This approach follows Gruss 2014 and builds on earlier work on gross country-specific commodity export price indices in Deaton and Miller 1996, IMF 2006, and Spatafora and Tytell 2009. Previous studies have used either price indices of individual commodities or standard terms-of-trade measures (exceptions include Deaton and Miller 1996, Dehn 2000, Cashin, Céspedes, and Sahay 2004, Céspedes and Velasco 2012, and Gruss 2014). Most of the previous studies have focused on price changes of at least a given magnitude, rather than a given duration, and on samples of disjointed price increases or decreases.

[22]Commodity price cycles are identified using an asymmetric Bry-Boschan Quarterly algorithm, following Harding and Pagan 2002 (Figure 2.7 presents three examples). Details of the algorithm are in Annex 2.2. Annex 2.3 provides further details of the event study analysis.

[23]During upswings, real GDP has grown about 1.5 percentage points more a year than in downswings, real consumption about 2.0 to 2.5 percentage points more, and investment about 8.0 to 8.5 percentage points more. Differences are statistically significant at the 5 percent level for all of these variables.

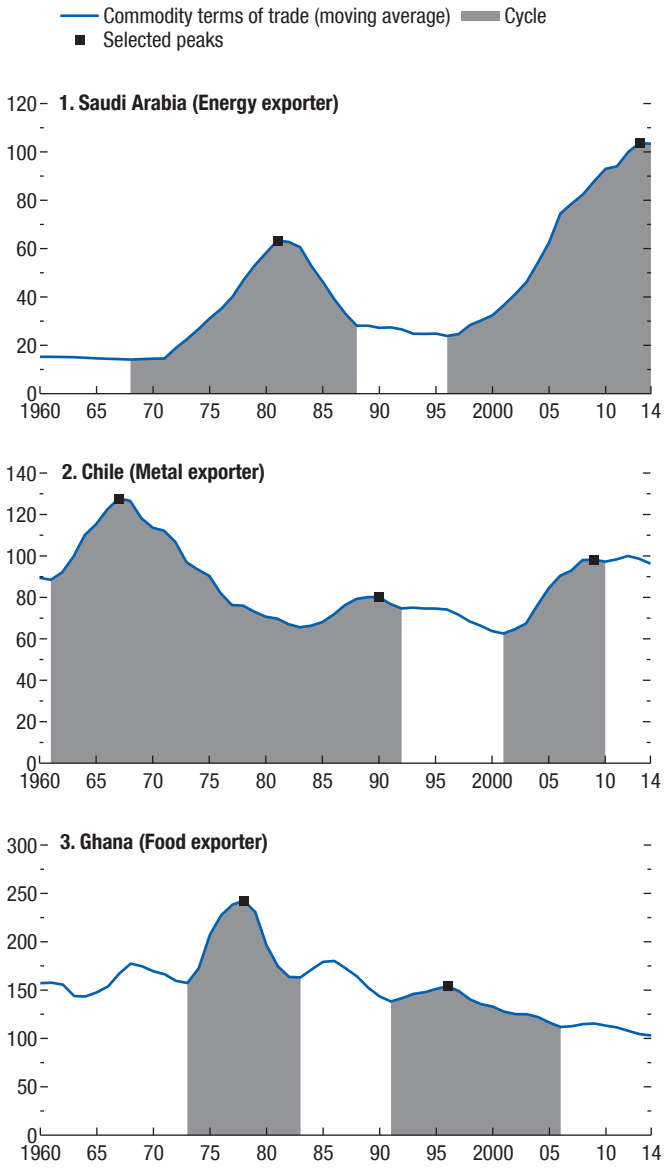
[24]Husain, Tazhibayeva, and Ter-Martirosyan (2008) examine a sample of 10 oil exporters and find that oil price changes affect the economic cycle only through their impact on fiscal policy. Their results are particularly stark for Gulf Cooperation Council countries, in which all oil income accrues to the state. An interesting question is whether governments use the windfall gains to invest in human as well as physical capital. In the absence of consistently measured cross-country data on education and health spending, Box 2.3 examines whether terms-of-trade booms are associated with improved education and health outcomes.

[25]This pattern, however, holds only for the cycles with peaks before 2000. During the pre-2000 upswings, factors other than the commodity terms of trade appear to have dominated the movements in the real exchange rate. By contrast, the most recent upswing is more in line with priors, showing about 2.0 to 2.5 percent average real appreciation a year. Regression analysis presented in Box 2.1 using data for 1970–2007 finds that the real exchange rate appreciates following increases in the commodity terms of trade.

Figure 2.7. Identification of Cycles in the Commodity Terms of Trade: Three Country Examples

(Index, 2012 = 100)

The event studies focus on the behavior of variables during commodity terms-of-trade cycles with prolonged upswings that peaked before 2000. On average, those upswings were eight years long for exporters of extractive commodities and five years long otherwise, and the commodity terms of trade improved by 63 percent.

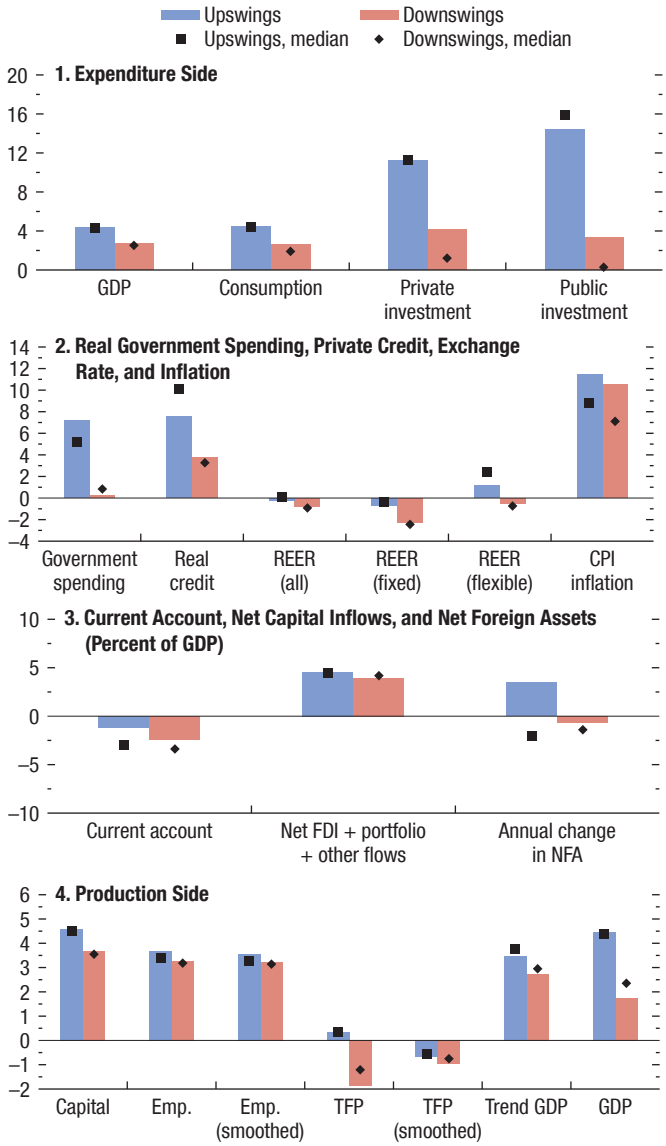


Sources: Gruss 2014; IMF, Primary Commodity Price System; U.S. Energy Information Administration; World Bank, Global Economic Monitor database; and IMF staff calculations.
Note: The definition of the commodity terms of trade is given in Annex 2.1. The algorithm for selecting the cycles is described in Annex 2.2. The portion of a cycle before (after) the peak is referred to as an upswing (downswing).

Figure 2.8. Event Studies: Average Annual Growth Rates of Key Macroeconomic Variables during Commodity Terms-of-Trade Upswings and Downswings

(Percent, unless noted otherwise)

Output and domestic spending tend to grow faster during upswings in the commodity terms of trade than in downswings. The growth of trend output tends to vary as well, as capital accumulation comoves with the terms of trade. Credit to the private sector and government spending expand faster during upswings, and net capital inflows tend to be higher.



Sources: External Wealth of Nations Mark II data set (Lane and Milesi-Ferretti 2007 and updates thereafter); IMF, Balance of Payments Statistics database; IMF, Fiscal Monitor database; IMF, International Financial Statistics database; Penn World Table 8.1; and IMF staff calculations.
Note: Samples consist of cycles with peaks before 2000. They are balanced across upswings and downswings, but differ across panels depending on data availability. See Annex 2.2 for the cycle identification methodology. The exchange rate classification is based on Reinhart and Rogoff 2004. See Annex 2.3 for details. CPI = consumer price index; Emp. = employment; FDI = foreign direct investment; NFA = net foreign assets; REER = real effective exchange rate; TFP = total factor productivity.

exchange rate regimes reveals that flexible regimes have been associated with currency appreciations during upswings (and depreciations during downswings), as would be expected, whereas depreciations have occurred in fixed regimes during both upswings and downswings.

The behavior of external accounts provides some additional evidence that financing constraints loosen during upswings. Even though outflows in the form of official reserves and foreign direct investment rise when commodity prices are high, net commodity exporters have received, on average, slightly higher net capital inflows during upswings than during downswings (Figure 2.8, panel 3). Given the higher net inflows, no general tendency toward improved net foreign asset positions has been observed for upswings, even though, as expected, current account balances have been stronger in those episodes. Specifically, the average ratio of net foreign assets to GDP has tended to rise during upswings, a result driven by a few oil exporters, while the median ratio has tended to decline more in upswings than in downswings.

A growth-accounting perspective highlights the key supply-side factors behind the cycle in output growth. Aggregate production factors (capital and labor) and TFP have tended to move in tandem with the changes in the commodity terms of trade (Figure 2.8, panel 4). The comovement is particularly strong for the rate of change in the capital stock, which is consistent with the substantially faster growth in investment spending during upswings. The variation in employment growth is driven by Latin America, where employment has grown 1.5 percentage points more during upswings than in downswings.

The growth rate of trend output—calculated using estimates of the actual capital stock and smoothed employment and TFP series—is considerably smoother than that of actual output.[26] In line with the model-based predictions, trend output growth weakens during downswings relative to upswings, but it does so with less vigor than actual output growth. Annual actual output growth has tended to be 1.0 to 1.5 percentage points higher on average during upswings than in downswings, whereas potential output growth has tended to be only 0.3 to 0.5 percentage point higher. The fact that inflation tends to be higher during upswings than in downswings (Figure 2.8, panel 2) corroborates the notion of a smaller amount of slack in the economy during upswings. As discussed in Box 2.4, the experience of six commodity exporters provides evidence of increasing output gaps during the uninterrupted phase of the commodity boom in the first decade of the 2000s.

The exchange rate regime, cyclicality of fiscal policy, and depth of financial markets have a bearing on the difference in growth between upswings and downswings (Figure 2.9). Countries with fixed exchange rates tend to experience stronger variation in growth relative to countries with flexible exchange rates. This is consistent with the notion that a more flexible exchange rate tends to act as a shock absorber and cushion the domestic effects of terms-of-trade shocks. Likewise, the difference in the growth rate of output between upswings and downswings is larger in countries with more procyclical fiscal spending.[27] Countries with a lower level of credit to the private sector (relative to GDP) also exhibit stronger variation in growth. The growth slowdown in these countries is sharper during downswings, probably because they experience a greater tightening of borrowing constraints when commodity prices decline than do countries with greater financial depth.[28]

Commodity exporters differ across many other dimensions—in terms of the weight of commodities in their aggregate production, the nature of the commodities they export (for example, exhaustible versus renewable resource bases), and their levels of economic and institutional development. As could be expected, the growth patterns described previously are more marked for economies that are less diversified, that is, those in which commodity exports account for a larger share of GDP. They are also clearer for exporters of extractive commodities, whose economies tend to be less diversified and face more persistent commodity terms-of-trade cycles. Low-income countries have less procyclical fiscal spending and a slightly lower degree of commodity intensity in production but also less flexible exchange rates and lower levels of financial development. They exhibit greater variability in their

[26]Employment and TFP are smoothed using a standard Hodrick-Prescott filter on annual data; the capital and labor shares are from Penn World Table 8.1.

[27]Some correlation between fiscal spending and commodity prices may be optimal. Cycles are classified here as having more procyclical fiscal policy if the correlation between the growth of real spending and the change in the commodity terms of trade is greater than the sample median.

[28]This result is not driven by the variation in the level of economic development, which tends to be correlated with financial depth.

growth rates for investment, employment, and TFP compared with emerging market economies, but the differences between the two groups are not statistically significant (Annex 2.3).

The Boom of the 2000s

The event studies of commodity price cycles with pre-2000 peaks provide evidence that is highly relevant for the current downswing in commodity exporters. Nevertheless, the most recent commodity price boom was different in a number of dimensions from the earlier booms. In particular, this boom entailed a larger upswing in the terms of trade, especially for commodity exporters specializing in energy and metals.[29] The main reason for the difference is the greater number of oil exporters in the recent upswing, for reasons of data availability or more recent oil discovery and development.

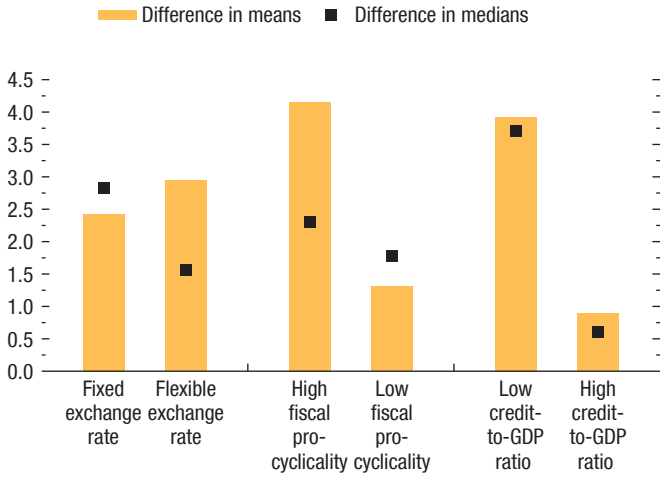
Nonetheless, the average annual growth rates of key macroeconomic variables during the most recent upswing were very similar to those in the pre-2000 upswings (Figure 2.10). However, investment and, accordingly, capital accumulation and trend growth were somewhat lower in the most recent upswing than in previous upswings. Increases in real credit and government spending were also slightly lower.

Improvements in their macroeconomic policy frameworks and financial depth since the earlier episodes have put commodity exporters in a better position to deal with a downswing. Fiscal policy was considerably less procyclical during the most recent upswing: the correlation of government spending growth with changes in the commodity terms of trade fell to half of what it was in the pre-2000 episodes. Reduced procyclicality is consistent with the finding of greater fiscal savings out of commodity-based revenues in the 2000s, as reported in Chapter 1 of the October 2015 *Fiscal Monitor*. Financial depth and the extent of exchange rate flexibility, which in past downswings were associated with a smaller drop in output growth, have also increased in most commodity exporters.

[29]For the sample of net exporters that experienced at least two upswings in our data sample—one in the 2000s and at least one in the 1960–99 period—the cumulative net terms-of-trade increase averaged slightly more than 70 percent in the 2000s, compared with 50 percent in past episodes. When all net exporters—not only those that recorded a pre-2000s upswing—are included, the average cumulative increase in the commodity terms of trade in the 2000s was even sharper, about 140 percent.

Figure 2.9. Variation in Average Output Growth between Upswings and Downswings: The Role of Policy Frameworks and Financial Depth
(Percentage points)

Commodity-exporting countries with more flexible exchange rates, less procyclical fiscal policy, and a higher level of credit to the private sector exhibit less growth variation over commodity price cycles.



Sources: IMF, Fiscal Monitor database; IMF, International Financial Statistics database; Penn World Table 8.1; and IMF staff calculations.
Note: The bars (blocks) show the difference between the average (median) growth rates during upswings and subsequent downswings. The exchange rate regime classification is based on Reinhart and Rogoff 2004. See Annex 2.3 for details. An episode is classified as having high fiscal policy procyclicality if the correlation between real government spending growth and the change in the smoothed net commodity terms of trade during the cycle is higher than the overall sample median (and having low fiscal policy procyclicality otherwise). A country is classified as having a high credit-to-GDP ratio if credit to the private sector (as a share of GDP) during the upswing is higher than the sample median (and having a low credit-to-GDP ratio otherwise).

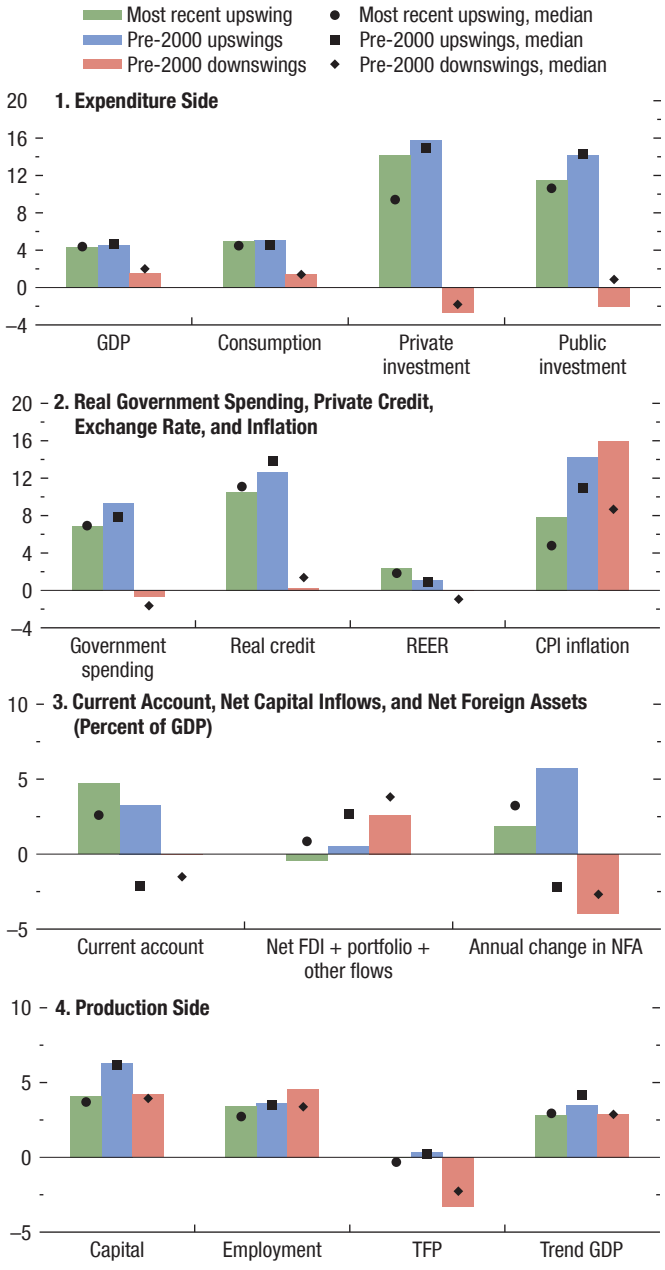
Commodity exporters are entering the current downswing with stronger external positions as well. The median annual current account balance and the average annual change in the net foreign asset position were 5 percentage points of GDP stronger in the 2000s upswings than earlier.

In sum, the larger increase in commodity prices in the 2000s could potentially presage sharper terms-of-trade downswings for some commodity exporters (beyond the decline already experienced) and therefore lead to sharper reductions in actual and potential growth. At the same time, stronger external positions, more robust policy frameworks, and more developed financial markets could help mitigate some of the growth impacts.

Figure 2.10. Most Recent Upswing: Average Real Growth Rates during Upswings and Downswings

(Percent, unless noted otherwise)

The most recent upswing in the commodity terms of trade was longer and larger than the upswings with pre-2000 peaks, notably for energy exporters, but it coincided with average annual growth rates in key macroeconomic variables that were similar to those in the earlier booms.



Sources: External Wealth of Nations Mark II data set (Lane and Milesi-Ferretti 2007 and updates thereafter); IMF, Balance of Payments Statistics database; IMF, Fiscal Monitor database; IMF, International Financial Statistics database; Penn World Table 8.1; and IMF staff calculations.

Note: Restricted samples of 17 (panel 1), 21 (panels 2 and 3), or 20 (panel 4) countries, each with one pre-2000 and one post-2000 cycle peak. See Annex 2.2 for the cycle identification methodology. CPI = consumer price index; FDI = foreign direct investment; NFA = net foreign assets; REER = real effective exchange rate; TFP = total factor productivity.

Regression Analysis

This subsection examines the responses of key macroeconomic variables to changes in the terms of trade.[30] The estimations control for global time effects and partner country GDP growth, as well as political regime change and conflict.

The estimation results suggest that terms-of-trade shocks have positive, statistically significant, and fairly long-lasting effects on output (Figure 2.11). A 10 percentage point increase in a country's commodity terms of trade is found to lead to a slightly more than 1 percentage point increase in GDP after three years. The effect gradually subsides, but remains statistically significant, over a horizon of up to five years. The estimates suggest that the effects of negative shocks are somewhat larger and more persistent than those of positive shocks. Nonetheless, the analysis cannot statistically reject the possibility that output responds symmetrically to positive and negative changes in the commodity terms of trade.

Turning to the spending side, both consumption and investment respond positively and with statistical significance to commodity terms-of-trade shocks over a seven-year period. The average response of total fixed investment is almost double that of consumption. The positive response of public investment is more immediate and long lasting than that of private investment.

On the production side, shocks to the commodity terms of trade raise capital accumulation over the medium term in line with the estimated persistent response of investment. The capital stock increases (or decreases) steadily for seven years after the shock by a cumulative 1 percentage point. In contrast, the impacts on labor supply and TFP are muted. The response of employment is not statistically significant. The impact on TFP is only weakly significant in the first two years after the shock, which could reflect a cyclical deterioration in the Solow residual relative to its underlying trend, as seen in the event studies. Overall, these results are consistent with the event study findings, which suggest that commodity terms-of-trade shocks affect potential output mainly by raising capital accumulation.[31]

[30]The analysis uses the local projection estimation method proposed in Jordà 2005. This method does not impose the dynamic restrictions embedded in vector autoregression specifications and is therefore suited to estimating nonlinearities in the dynamic response. Annex 2.4 provides details of the estimation methodology.

[31]The estimation does not distinguish between supply-driven and demand-driven changes in the commodity terms of trade. Chapter 3

The response of output to terms-of-trade shocks is stronger among low-income developing countries than in emerging market economies (Figure 2.12). Terms-of-trade shocks are estimated to have a more rapid effect on growth in countries specializing in extractive commodities. In contrast, they take longer to build but appear more persistent for countries specializing in nonextractive commodities. Given the smaller sample and more varied responses, the estimates for the latter group are not statistically significant.

What do the estimated responses of output growth to the commodity terms of trade imply for the growth outlook for commodity exporters? To answer this question, projections for the country-specific commodity terms-of-trade indices through 2020 were constructed using the forecasts for international commodity prices.[32]

On average, the weaker outlook for commodity prices implies that the annual growth of output for net commodity exporters will decline further, by almost 1 percentage point in 2015–17 compared with 2012–14. The results differ sizably among the different types of commodity exporters. Most notably, reflecting a relatively larger decline for energy prices, the reduction in growth for energy exporters is projected to be about 2¼ percentage points over the same period.[33] The effect of commodity prices on capital accumulation implies a reduction in the growth of potential output as well. Based on the estimated response of capital accumulation to the commodity terms of trade, the projected decline in the growth of potential output in 2015–17 compared with 2012–14 is about ⅓ percentage point on average and ⅔ percentage point for energy exporters.

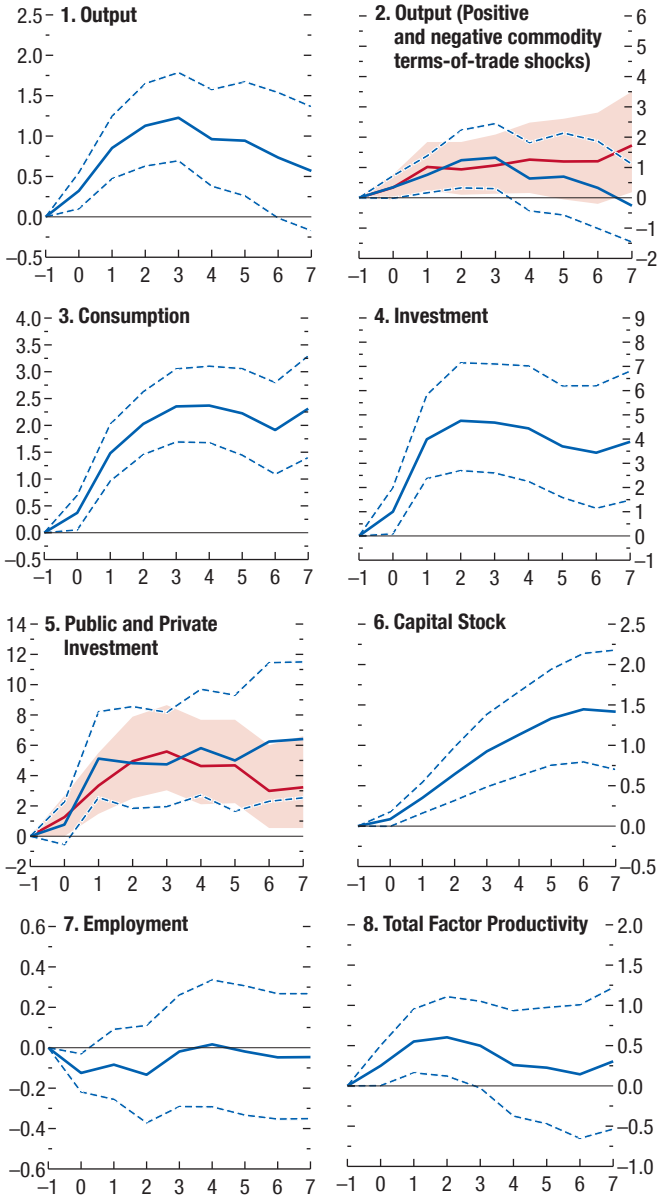
Sectoral Reallocation during Commodity Booms: Case Studies

Theoretical studies predict that the composition of economic activity will change following a boom

Figure 2.11. Macroeconomic Variables in the Aftermath of Commodity Terms-of-Trade Shocks

(Percentage points; years on x-axis)

Terms-of-trade shocks have positive, fairly long-lasting, and symmetric effects on output. Consumption and investment respond positively to an increase in the terms of trade. On the production side, capital accumulation rises, whereas the responses of labor supply and total factor productivity are muted.



Source: IMF staff estimates.
Note: $t = 0$ is year of the shock; dashed lines and shaded areas denote 90 percent confidence bands. In panels 1 and 3–8, solid lines represent the response of the variable to an exogenous 10 percentage point increase in the commodity terms of trade. In panel 2, the blue (red) solid line denotes the response to an exogenous positive (negative) 10 percentage point change in the commodity terms of trade. In panel 5, the blue (red) solid line denotes the response of public (private) investment. See Annex 2.4 for the estimation methodology.

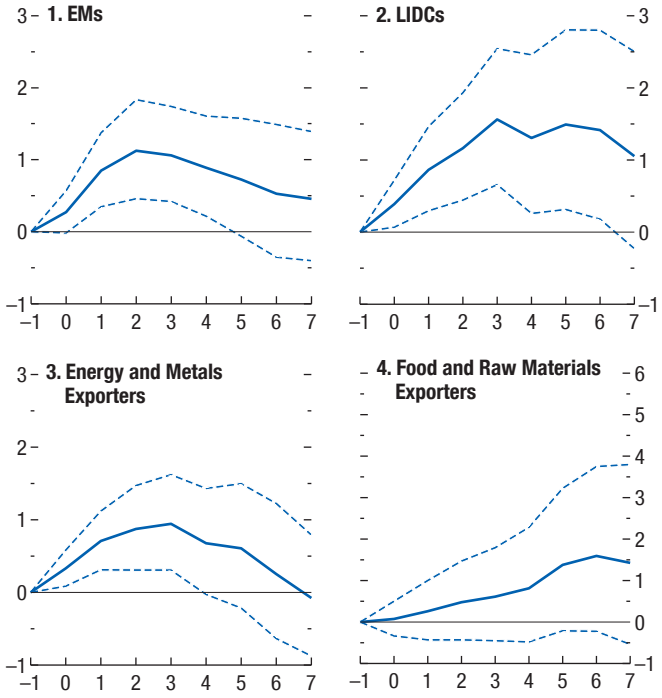
of the April 2012 *World Economic Outlook* finds the output responses to demand-driven commodity price shocks to be somewhat larger than the responses to supply-driven shocks, but with no statistically significant difference.

[32]Output projections for all the countries in the sample were then generated, feeding the relevant historical data and the forecasts for the terms of trade into the impulse response functions for output under the main specification.

[33]These projections assume that all other factors are unchanged and therefore are not equivalent to regular *World Economic Outlook* forecasts, which take other factors into account.

Figure 2.12. Output in the Aftermath of Commodity Terms-of-Trade Shocks: Role of Income Level and Type of Commodity
(Percentage points; years on x-axis)

Terms-of-trade shocks have stronger effects on output in low-income developing countries than in emerging market economies. The shocks are estimated to have a more rapid effect on output in countries specializing in the export of extractive commodities.



Source: IMF staff estimates.
Note: $t = 0$ is year of the shock; dashed lines denote 90 percent confidence bands; solid lines represent the response of the variable to an exogenous 10 percentage point increase in the commodity terms of trade. EM = emerging market; LIDC = low-income developing country.

in the commodity terms of trade, with a reallocation of output and factors from the manufacturing sector toward the commodity and nontradables sectors.[34] These predictions of the Dutch disease effect are also borne out in the model simulations presented earlier in this chapter. The sectoral reallocation could shift the share of sectors in overall output; to the extent that TFP levels and growth rates differ across sectors, the change in sectoral shares could affect the economy's overall TFP growth rate. The sectoral reallocation patterns are thus relevant to country growth prospects in the aftermath of the boom, but data constraints make them challenging to examine for a large set of countries.

This section uses data from the Latin America KLEMS and World KLEMS data sets to examine patterns of sectoral reallocation and their implications for aggregate TFP growth in three commodity exporters with well-established macroeconomic policy frameworks—Australia, Canada, and Chile—during the commodity boom of the 2000s.[35] The analysis seeks to answer the following questions:

- How did the growth rates of sectoral capital and labor stocks change during the boom period (2000–10) relative to the preboom period (1990–99)? Which sectors contributed the most to changes in the growth rates of aggregate investment and employment?
- Were the shifts in the relative shares of nontradables and manufacturing in economy-wide output and factor stocks different from those in commodity importers over the same period?
- Did the reallocation of output across sectors during the boom have an effect on the growth rate of TFP?

Background

The surge in global commodity prices in the first decade of the 2000s led to commodity terms-of-trade gains for Australia, Canada, and Chile given their relatively large extractive industries: coal and iron ore in Australia, oil and natural gas in Canada, and copper in Chile. Among these three countries, the relative share of the commodity sector is largest in Chile, closely followed by Australia, and is the smallest in Canada (Table 2.1). Australia and Chile enjoyed larger terms-of-trade gains over the decade than Canada (Figure 2.13). Chile experienced the smallest real appreciation of its currency over the boom period, while Canada's real appreciation was the largest relative to its terms-of-trade gain.

In line with the model-based predictions, the rate of income growth exceeded the rate of output growth in all three countries during the boom. Domestic demand grew in line with incomes, if not more than incomes. Invest-

[34]Recent case studies of sectoral change among commodity exporters include Francis 2008; Steenkamp 2014; Bjørnland and Thorsrud, forthcoming; and Fornero, Kirchner, and Yany 2014.

[35]The analysis uses case studies and focuses on the most recent boom because comparable data on sectoral output, capital, and labor stocks are available for only a very small subset of commodity-exporting emerging market and developing economies for limited periods. KLEMS databases have been set up to promote and facilitate the analysis of growth and productivity patterns around the world, based on a growth-accounting framework at a detailed industry level.

Table 2.1. Commodity Exports

	Period	Australia	Canada	Chile
Share of Total	1990–2000	44.3	24.3	52.1
	2000–10	47.1	27.8	56.6
Share of GDP	1990–2000	7.3	7.9	13.3
	2000–10	8.8	9.5	21.1

Source: IMF staff calculations.

ment as a share of GDP rose strongly in all three cases, surpassing the change in savings as a share of GDP.

Did Capital and Labor Reallocate toward the Commodity and Nontradables Sectors?

In all three countries, there was a clear pickup in the growth rates of both capital and labor in the extractive sector during the boom period.[36] Higher investment in the sector accounted for the bulk of the increase in economy-wide investment in Australia and Chile. But the broader changes in investment and employment growth across the commodity, manufacturing, and nontradables sectors did not always conform to the model-based predictions. Contrary to those predictions, in Australia the pace of capital accumulation in manufacturing picked up during the boom period, reflecting in part strong demand from export markets (mainly east Asia), while it declined in the nontradables sector.[37] In Chile, manufacturing employment growth increased during the boom, while capital accumulation slowed in nontradables. Canada is the only case among the three countries in which the sectoral factor accumulation patterns consistently favored the extractive and nontradables sectors: both the pace of capital accumulation and employment levels fell in the Canadian manufacturing sector during the boom, while those in the extractive and nontradables sectors increased (Figure 2.14).

Were the Shifts between Manufacturing and Nontradables Different from Those in Commodity Importers?

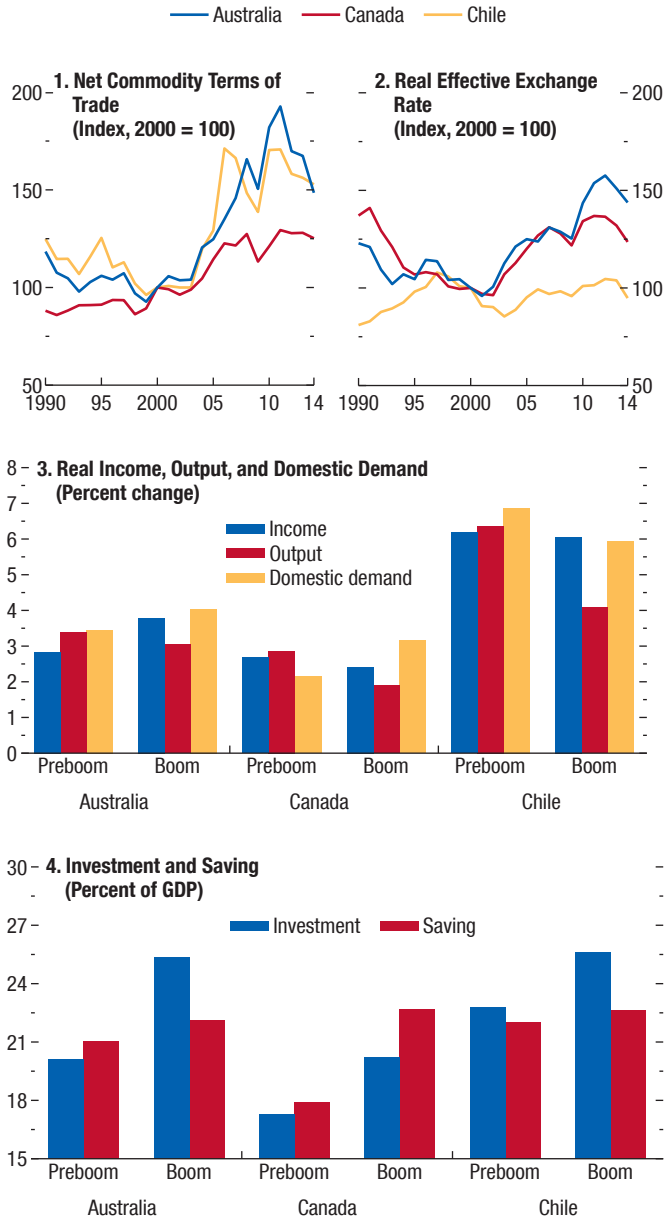
The reallocation of activity from manufacturing toward nontradables in the 2000s was not unique to

[36]To analyze sectoral shifts arising from the commodity boom, the economy is disaggregated into three sectors: extractive industries (fuels and mining), manufacturing, and nontradables. Agriculture is omitted for simplicity—it accounts for 2 to 4 percent of aggregate value added in the three countries studied.

[37]In the 2000s, manufacturing exports to east Asia accounted for more than one-third of total manufacturing exports in Australia, about 15 percent in Chile, and about 5 percent in Canada.

Figure 2.13. Commodity Booms and Macroeconomic Indicators in Australia, Canada, and Chile

Australia, Canada, and Chile experienced commodity terms-of-trade booms in the first decade of the 2000s. In that period, the three countries differed in the extent of their real currency appreciation, but in all three, real incomes grew faster than real output, and investment picked up strongly.

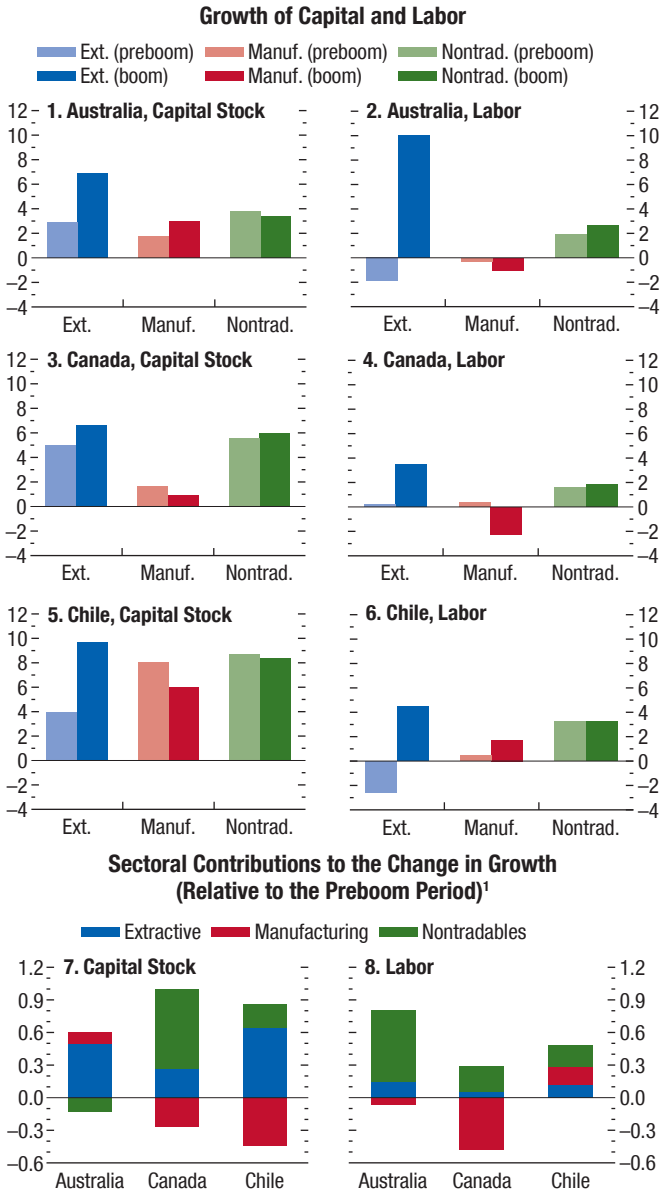


Source: IMF staff calculations.
Note: Preboom is 1990–2000; boom is 2000–10. In panel 3, bars show annualized average growth rates during the specified periods. In panel 4, bars are annual averages over the specified periods.

Figure 2.14. Growth of Capital and Labor by Sector: Boom versus Preboom Periods

(Average annual percent change)

In Australia, Canada, and Chile, the 2000–10 commodity boom period coincided with a clear increase in both capital and labor in the extractive sector; in Australia and Chile, that sector accounted for the bulk of economy-wide capital accumulation in the period. Labor and capital in the three countries did not shift notably into the nontradables sector.



Sources: Hofman and others 2015; Latin America KLEMS; World KLEMS; and IMF staff calculations.

Note: Preboom is 1990–2000; boom is 2000–10. The contributions of the agriculture sector are small and not shown. Ext. = extractive; Manuf. = manufacturing; Nontrad. = nontradables.

[1]The change in the growth of capital and labor relative to the preboom period is decomposed into sectoral contributions. A sector's contribution to the change in growth is calculated as the annual growth of capital or labor multiplied by the weight of that sector in the total capital and labor stock and averaged across the 10-year period.

the commodity-exporting economies; many advanced economies have experienced a similar shift during the past three decades. Thus, to draw definitive conclusions on whether the boom of the 2000s accelerated the reallocation of activity toward nontradables in commodity exporters, it is useful to examine whether the shift was stronger than in commodity importers. The data indeed suggest that the three commodity exporters considered here saw a faster reallocation of output shares toward nontradables during the boom relative to importers (Figure 2.15, panel 1). But only in Canada did this represent a change relative to the preboom years; in Australia and Chile, the faster reallocation toward nontradables represented a continuation of a preexisting trend. Data on factors of production paint an even more mixed picture: only in the case of labor in Canada is there a steepening in the trend relative to importers during the boom period (Figure 2.15, panels 2 and 3). In sum, benchmarking against the experience of commodity importers suggests little evidence of a faster shift from manufacturing toward nontradables activities during the boom among the three countries studied, except in Canada. The evolution of house prices offers a slightly different view: in all three countries, especially Canada, real house prices rose faster than the average real house price in commodity importers, providing some evidence of relative strength in nontradables activities during the boom period (Figure 2.15, panel 4).

The different patterns of sectoral reallocation across the three countries can be attributed in part to the destination of their export manufacturing products. Among the countries, Australia—which saw a pickup in manufacturing investment during the boom period—sent a relatively larger share of its manufacturing exports to east Asia, particularly China, on the eve of the boom. In contrast, the majority of Canada's manufacturing exports went to the United States, where manufacturing output growth slowed in the 2000s. As highlighted in Box 2.1, to the extent that booms in commodity prices coincide with strong global activity, Dutch disease effects in commodity exporters could be offset, especially if the manufacturing sector has trade linkages with the faster-growing regions.

Did the Reallocation of Activity Hamper Aggregate TFP Growth?

The evidence on sectoral growth rates of output, capital, and labor points to unambiguous shifts toward

the commodity sector as well as shifts—though not as consistent—toward nontradables activities. To examine whether these changes had an impact on economy-wide TFP growth, the latter is decomposed into within-sector and between-sector effects, applying the decomposition in Dabla-Norris and others 2015.[38]

Data from Latin America KLEMS and World KLEMS indicate that aggregate TFP growth declined in all three case study countries during the commodity boom relative to the previous decade and even turned negative in Australia and Chile. The decomposition indicates that this decline was entirely due to the within-sector effect (Figure 2.16, panels 1, 3, and 5). The between-sector effect in fact attenuated the decline in TFP. This finding of a negative contribution from the within-sector effect holds more broadly for Latin American economies (Aravena and others 2014; Hofman and others 2015).

Declining TFP growth in extractive industries and manufacturing appears to be a common factor behind the weak within-sector TFP performance in all three cases (Figure 2.16, panels 2, 4, and 6). A marked decline in TFP growth in nontradables was also a key driver in Australia and Chile. The weak TFP growth in the extractive sectors during the boom is likely to have resulted from the time-to-build associated with large-scale mining investments and the tapping of less efficient mines (Figure 2.17) (see Francis 2008). The remoteness of extractive production sites may have contributed to higher marginal costs in the supporting nontradables service industries.

In summary, the case studies point to substantial heterogeneity across countries in terms of sectoral reallocation patterns during commodity booms. While all three countries under study experienced a flow of factors of production into the commodity sector, they experienced varying degrees of reallocation between the manufacturing and nontradables sectors. The fact that the countries were exposed to different manufacturing export destinations (that were experiencing different

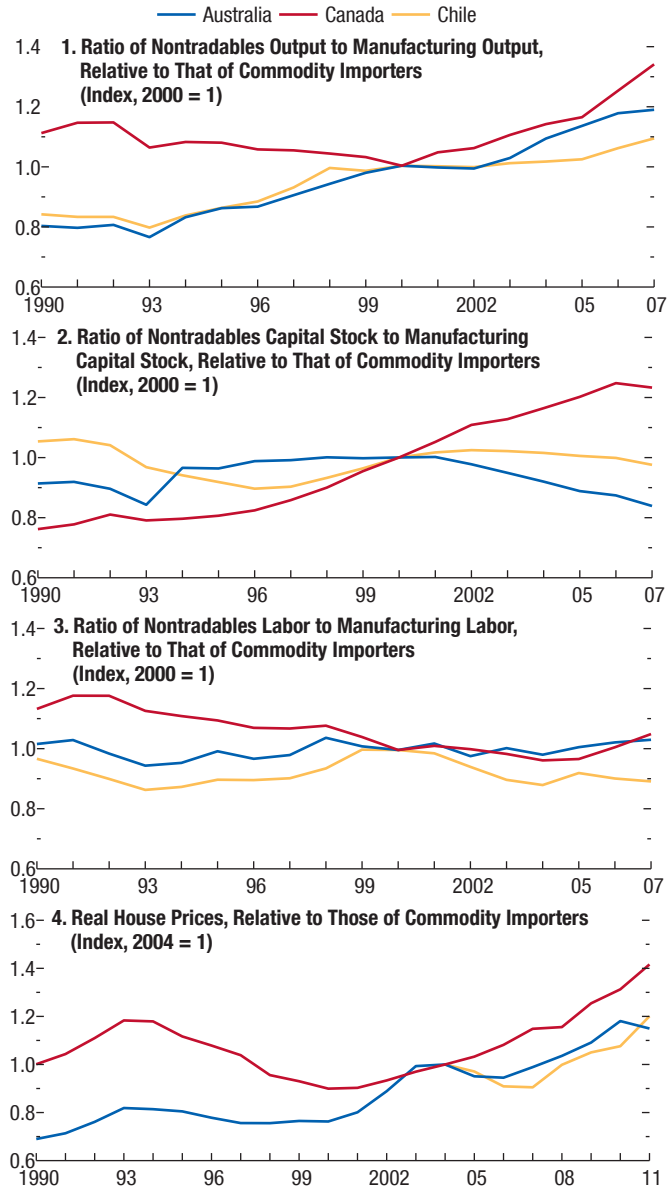
[38]The decomposition is based on the following specification:

$$tfp_t - tfp_{t-1} = \sum_i \omega_{i,t-1}(tfp_{i,t} - tfp_{i,t-1}) + \sum_i tfp_{i,t}(\omega_{i,t} - \omega_{i,t-1}),$$

in which i refers to the sectors of the economy (here, extractive commodities, manufacturing, and nontradables); tfp_t and $tfp_{i,t}$ refer to economy-wide and sectoral TFP, respectively; and $\omega_{i,t}$ is the share of real value added of sector i. The first term on the right side is the within-sector effect given by the weighted sum of TFP growth in each sector. The second term is the between-sector effect, which captures the effect of the sectoral reallocation of real value added on aggregate TFP growth.

Figure 2.15. Evolution of Activity in Nontradables Relative to Manufacturing, Commodity Exporters Relative to Commodity Importers

In Australia and Chile, the 2000–10 commodity boom did not accelerate the shift of output, capital, and labor shares from manufacturing into nontradables. House prices, however, grew more strongly in Australia, Canada, and Chile than in their commodity-importing peers.

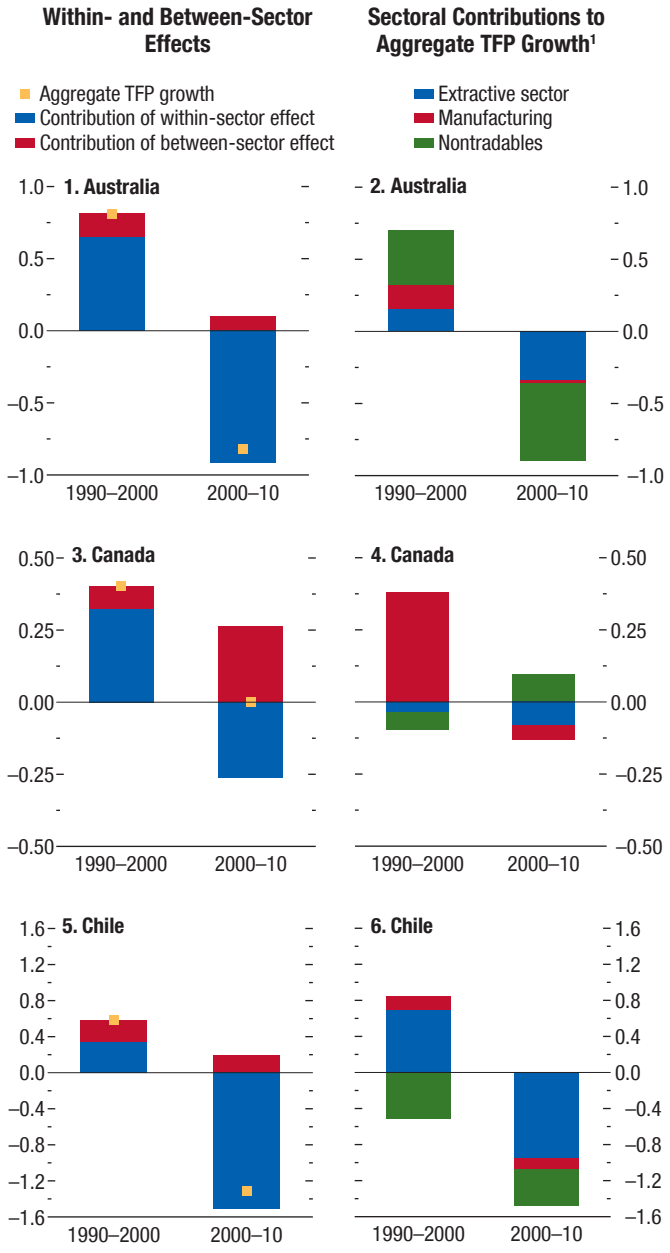


Sources: Haver Analytics; Hofman and others 2015; Latin America KLEMS; national authorities; World KLEMS; and IMF staff calculations.
Note: Panels 1–3 show the evolution in commodity exporters of the ratios of output, capital, and labor in nontradables to those in manufacturing, scaled by the average ratio across a sample of commodity importers in the same year. An increase in the trend of a ratio beginning in 2000 relative to the pre-2000 trend indicates that the reallocation from manufacturing to nontradables in commodity exporters intensified relative to that in importers during the commodity boom. Panel 4 shows the evolution of real house prices in commodity exporters scaled by the average real house prices across commodity importers. The sample of commodity importers comprises Denmark, Finland, Germany, Japan, Sweden, the United Kingdom, and the United States.

Figure 2.16. Total Factor Productivity Growth Decompositions

(Percent)

Economy-wide total factor productivity (TFP) growth slowed in Australia, Canada, and Chile during the 2000–10 commodity boom, with weak TFP growth in the extractive sector a common contributor to the economy-wide decline.

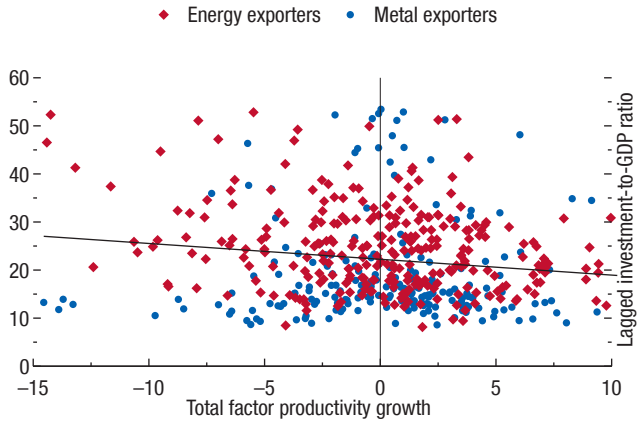


Sources: Hofman and others 2015; Latin America KLEMS; World KLEMS; and IMF staff calculations.
Note: The within-sector effect captures the contribution of TFP growth within the subsectors (extractive, manufacturing, and nontradables). The between-sector effect captures the contribution of sectoral reallocation.
[1]The contributions of the agriculture sector are small and not shown.

Figure 2.17. Investment and Total Factor Productivity Growth

(Percent)

In exporters of energy and metals, large increases in the investment-to-GDP ratio tend to be followed by weaker total factor productivity growth. This correlation is likely to partly reflect underutilized capital during the gradual buildup of large-scale projects in extractive industries.



Sources: Penn World Table 8.1; and IMF staff calculations.
Note: Sample of 18 commodity-exporting emerging market and developing economies. The data are Winsorized at the 1 percent level to reduce the influence of outliers. The correlation between the lagged investment-to-GDP ratio and total factor productivity growth is statistically significant at the 5 percent level.

rates of expansion) seems to have been a factor behind the varying intensity of sectoral reallocation; countries with trading linkages to faster-growing countries had more limited Dutch disease symptoms. Decompositions of economy-wide TFP growth do not suggest that sectoral reallocation hindered TFP growth during the commodity boom of the 2000s but instead point to a marked decline in productivity growth within sectors. Understanding the mechanisms behind the drop in TFP growth in these economies is an important area for future research.[39]

Conclusions

The evidence presented in this chapter suggests that fluctuations in international commodity prices, through their impact on domestic spending, can lead to sizable output fluctuations in commodity exporters. In exporters of energy and metals, the comovement between output and the commodity terms of trade tends to be particularly strong. It is also stronger in countries with lower levels of financial develop-

[39]Studies of this issue include Parham 2012 for Australia and Baldwin and others 2014 for Canada.

ment, more procyclical fiscal policies, and less flexible exchange rates.

The strong investment response to changes in the commodity terms of trade means that the latter affect not only actual output, but also potential output. As a result, the growth of potential output can be expected to decline during downswings in commodity prices. The change in the cyclical component of output is, however, about twice the size of the change in potential output, the structural component.

Against the backdrop of the recent declines in the commodity prices, the findings of this chapter suggest that the growth slowdown in commodity exporters mirrors experiences during earlier downswings. The slowdown could even be larger than those experienced in past episodes, since the terms-of-trade upswings that many exporters experienced in the first decade of the 2000s were much larger than earlier ones. As a result, they may have led to much larger increases in actual and potential output growth than in the past upswings analyzed in the chapter. If the terms-of-trade downswings are now also larger, the declines in growth would likely be correspondingly larger as well.

The chapter's regression-based analysis indeed suggests that the recent commodity price declines, together with the weak commodity price outlook, could subtract about 1 percentage point on average from the growth rate of commodity exporters in 2015–17 relative to 2012–14. For energy exporters, the reduction in growth could be even larger—about 2¼ percentage points on average. The projected drag on the growth of potential output is about ⅓ percentage point on average for commodity exporters and ⅔ percentage point on average for energy exporters.

At the same time, many commodity exporters have moved toward policy frameworks and structural characteristics that are more conducive to smoothing the macroeconomic effects of terms-of-trade fluctuations—less procyclical fiscal policies, more flexible exchange rates, and deeper financial systems. These changes could mitigate some of the growth impact of commodity price downswings.

The analysis in the chapter suggests that policymakers must avoid overestimating output gaps and the scope for expansionary macroeconomic policies to support demand. As commodity-exporting economies are likely to overheat toward the end of a prolonged surge in commodity prices, the growth slowdown in the immediate aftermath of the boom most likely reflects a cooling of output toward potential, which may itself be growing at a reduced pace, given a slowdown in investment. If indicators of slack show few signs of output having fallen below potential, expansionary monetary and fiscal policies are more likely to raise inflation than to sustainably raise investment and employment.

In countries where output has fallen below potential, supportive domestic demand policies could help avoid a costly underutilization of resources. But two considerations suggest that the drop in the commodity terms of trade may itself limit the scope to ease macroeconomic policies. First, in economies with some exchange rate flexibility, currency depreciation may have led to an easing of monetary conditions without a change in the stance of monetary policy; thus, any easing in the stance could risk further depreciation and unwelcome increases in inflation. In other economies, declining resource-based fiscal revenues may call for fiscal adjustment to secure debt sustainability. As also emphasized in Chapter 1 of the October 2015 *Fiscal Monitor*, these trade-offs highlight the need, during upswings, to build fiscal buffers that will help support the economy during downswings.

Although the comovement of potential output with the commodity terms of trade tends to be less pronounced than that of actual output, the analysis in this chapter suggests that declining growth of potential output exacerbates the postboom slowdowns. The challenge for policymakers in commodity exporters, therefore, is to implement targeted structural reforms to alleviate the most binding supply-side bottlenecks and restore stronger growth potential.

Annex 2.1. Data Sources, Index Construction, and Country Groupings

Variables and Sources

The primary data sources for this chapter are the IMF's World Economic Outlook database, Haver Analytics, Penn World Table 8.1, UN Comtrade International Trade Statistics, the United Nations Industrial Development Organization, the World Bank's *World Development Indicators*, the IMF's *International Financial Statistics*, Latin America KLEMS, and World KLEMS. Sources for specific data series are listed in Annex Table 2.1.1.

Construction of Commodity Terms-of-Trade Indices

For each country, commodity terms-of-trade indices are constructed, following Gruss 2014, as a

Annex Table 2.1.1. Data Sources

Variable	Source
Cross-Country Variables	
Capital Stock	Penn World Table 8.1
Commodity Export Prices	Gruss 2014; IMF, Primary Commodity Price System; U.S. Energy Information Administration; World Bank, Global Economic Monitor database
Commodity Export Weights	UN Comtrade; IMF, World Economic Outlook database
Conflict	Correlates of War Project, New Correlates of War Data, 1816–2007, v4.0 (2011)
Consumer Price Index	IMF, International Financial Statistics database; IMF, World Economic Outlook database
Consumption	Penn World Table 8.1; IMF, World Economic Outlook database
Credit to the Private Sector	IMF, International Financial Statistics database; IMF, World Economic Outlook database
Current Account	Penn World Table 8.1; IMF, World Economic Outlook database
EMBI Global Spread	Thomson Reuters Datastream
Employment	Penn World Table 8.1; IMF, World Economic Outlook database
Exchange Rate Classifications	Reinhart and Rogoff 2004
Government Expenditure	IMF, Fiscal Monitor database; IMF, World Economic Outlook database
House Price Index	Haver Analytics
Human Development Indicators	Barro and Lee 2010, April 2013 update; United Nations Development Programme; United Nations Department of Economic and Social Affairs, Statistics Division
Infant Mortality (0–1 Year) per 1,000 Live Births	United Nations Department of Economic and Social Affairs, Statistics Division, UNdata
Investment (Private and Public)	Haver Analytics; IMF, Fiscal Monitor database; Organisation for Economic Co-operation and Development; IMF, World Economic Outlook database
Life Expectancy	World Bank, World Development Indicators database
Manufacturing Exports	UN Comtrade
National Saving	Penn World Table 8.1; IMF, World Economic Outlook database
Net Financial Assets	External Wealth of Nations Mark II data set (Lane and Milesi-Ferretti 2007 and updates thereafter)
Net Financial Flows	IMF, Balance of Payments Statistics database (sum of net foreign direct investment, portfolio equity, and other investment flows)
Real and Nominal GDP	Penn World Table 8.1; IMF, World Economic Outlook database
Real Domestic Demand	Penn World Table 8.1; IMF, World Economic Outlook database
Real Domestic Income	Nominal gross domestic output deflated by the consumer price index, both from the IMF's World Economic Outlook database
Real Effective Exchange Rate (CPI Based)	IMF, International Financial Statistics; IMF staff calculations based on the April 2010 *World Economic Outlook,* Chapter 4
Regime Transition	Polity IV Project, Political Regime Characteristics and Transitions, 1800–2013
Secondary School Attainment	Barro and Lee 2010, April 2013 update
Total Factor Productivity	Penn World Table 8.1; IMF, World Economic Outlook database; IMF staff calculations (Solow residual)
Trading-Partner Country Output Growth	IMF, World Economic Outlook database
Case Studies	
Capital Stock	Haver Analytics; Hofman and others 2015; Latin America KLEMS; national authorities; World KLEMS
Employment	Haver Analytics; Hofman and others 2015; Latin America KLEMS; national authorities; World KLEMS
Total Factor Productivity	Haver Analytics; Hofman and others 2015; Latin America KLEMS; national authorities; World KLEMS; IMF staff calculations (Solow residual)
Value Added	Haver Analytics; Hofman and others 2015; Latin America KLEMS; national authorities; World KLEMS

Source: IMF staff compilation.
Note: CPI = consumer price index; EMBI = J.P. Morgan Emerging Markets Bond Index.

trade-weighted average of the prices of imported and exported commodities. The annual change in country i's terms-of-trade index ($CTOT$) in year t is given by

$$\Delta \log CTOT_{i,t} = \sum_{j=1}^{J} \Delta \log P_{j,t}\, \tau_{i,j,t},$$

in which $P_{j,t}$ is the relative price of commodity j at time t (in U.S. dollars and divided by the IMF's unit value index for manufactured exports) and Δ denotes the first difference. Country i's weights for each commodity price, $\tau_{i,j,t}$, are given by

$$\tau_{i,j,t} = \frac{x_{i,j,t-1} - m_{i,j,t-1}}{\sum_{j=1}^{J} x_{i,j,t-1} + \sum_{j=1}^{J} m_{i,j,t-1}},$$

in which $x_{i,j,t-1}$ ($m_{i,j,t-1}$) denote the average export (import) value of commodity j by country i between $t-1$ and $t-5$ (in U.S. dollars). This average value of net exports is divided by total commodity trade (exports plus imports of all commodities).

The commodity price series start in 1960. Prices of 41 commodities are used, sorted into four broad categories:

1. *Energy:* coal, crude oil, and natural gas
2. *Metals:* aluminum, copper, iron ore, lead, nickel, tin, and zinc
3. *Food:* bananas, barley, beef, cocoa, coconut oil, coffee, corn, fish, fish meal, groundnuts, lamb, oranges, palm oil, poultry, rice, shrimp, soybean meal, soybean oil, soybeans, sugar, sunflower oil, tea, and wheat
4. *Raw materials:* cotton, hardwood logs and sawn wood, hides, rubber, softwood logs and sawn wood, soybean meal, and wool

The price of crude oil is the simple average of three spot prices: Dated Brent, West Texas Intermediate, and Dubai Fateh. The World Bank's Global Economic Monitor database has been used to extend the price series of barley, iron ore, and natural gas from the IMF's Primary Commodity Price System back to 1960. The price of coal is the Australian coal price, extended back to 1960 using the World Bank's Global Economic Monitor database and U.S. coal price data from the U.S. Energy Information Administration.

Forecasts of the country-specific commodity terms of trade are constructed in the same manner, using the prices of commodities futures for the 41 commodities, where available, through 2020.

Commodity-Exporting Country Groupings

A country is classified as a commodity exporter if it meets the following two conditions:

- Commodities constituted at least 35 percent of the country's total exports, on average, between 1962 and 2014.
- Net commodity exports accounted for at least 5 percent of its gross trade (exports plus imports), on average, between 1962 and 2014.

Among emerging market and developing economies, 52 satisfy these criteria, 20 of which are low-income developing countries (according to the classification in the *World Economic Outlook*'s Statistical Appendix). For a list of the 52 economies and their shares of commodity exports, see Annex Table 2.1.2.

Annex Table 2.1.2. Commodity-Exporting Emerging Market and Developing Economies

	Commodity Exports (percent of total exports)					Net Commodity Exports (percent of total exports-plus-imports)
	Total Commodities	Extractive		Nonextractive		
		Energy	Metals	Food	Raw Materials	
Emerging Markets						
Algeria	89.2	87.9	0.7	0.5	0.2	37.6
Angola	81.1	47.8	5.5	26.2	3.2	34.6
Argentina	49.8	5.7	1.5	30.0	12.7	20.1
Azerbaijan	76.7	73.2	0.7	0.8	1.9	35.9
Bahrain	60.4	35.5	24.1	0.7	0.1	12.4
Brazil	45.3	3.3	9.5	23.5	8.9	8.3
Brunei Darussalam	90.0	89.9	0.0	0.1	0.0	55.5
Chile	61.2	0.8	48.0	7.0	5.5	20.9
Colombia	58.5	21.7	0.3	34.7	1.9	20.8
Costa Rica	36.2	0.4	0.4	34.9	0.5	8.4
Ecuador	79.0	40.1	0.2	38.8	0.7	32.6
Gabon	78.4	66.3	1.2	0.5	10.8	44.4
Guatemala	45.4	2.4	0.3	36.6	6.1	8.1
Guyana	66.3	0.0	21.5	41.9	2.9	14.4
Indonesia	64.4	40.8	5.0	8.5	10.1	24.9
Iran	81.5	78.9	0.6	0.4	1.6	41.4
Kazakhstan	70.5	53.3	11.7	4.3	1.3	35.5
Kuwait	72.2	71.7	0.1	0.4	0.1	42.4
Libya	96.8	96.7	0.0	0.1	0.0	58.2
Malaysia	45.0	12.7	6.3	8.2	17.8	15.3
Oman	79.8	77.8	1.4	1.0	0.0	42.3
Paraguay	65.4	0.2	0.4	36.6	28.5	12.4
Peru	60.6	7.4	32.8	18.0	2.3	17.5
Qatar	82.5	82.4	0.0	0.1	0.0	49.2
Russia	60.5	50.3	6.6	1.0	2.5	34.0
Saudi Arabia	85.8	85.5	0.1	0.1	0.1	47.3
Syria	54.3	45.8	0.1	2.7	6.2	8.2
Trinidad and Tobago	64.2	60.9	1.2	2.0	0.2	19.8
Turkmenistan	58.9	45.5	0.4	0.2	12.8	19.7
United Arab Emirates	49.6	36.8	13.4	2.4	0.1	12.6
Uruguay	37.0	0.6	0.2	22.5	13.7	5.5
Venezuela	87.1	82.1	4.1	0.8	0.1	46.6

Annex 2.2. Methodology for Dating Commodity Price Cycles

Cycles in country-specific commodity terms-of-trade indices are identified using the Bry-Boschan Quarterly algorithm, which is standard in the business cycle literature (Harding and Pagan 2002). The algorithm as used here differs from the standard version in two ways: (1) it is applied to a smoothed (five-year centered moving-average) version of the price index because the underlying series are choppy, making it difficult for standard algorithms to identify meaningful cycles, and (2) it allows for asymmetry between upswings and downswings, as the focus here is on cycles in which the upswing was at least five years long, even if the subsequent downswing was sudden.

The algorithm identifies 115 cycles since 1960 (78 with peaks before 2000 and 37 with peaks after 2000). There are approximately two cycles a country. Upswings are slightly longer than downswings, with a mean (median) of seven (six) years for upswings and six (five) years for downswings (Annex Figure 2.2.1, panel 1). The duration of phases and the amplitude of price movements are correlated (Annex Figure 2.2.1, panels 3 and 4). Most peaks were in the 1980s and the most recent years, particularly for extractive commodities (Annex Figure 2.2.1, panel 2).

Upswings are defined trough to peak (excluding the trough year, but including the peak year); downswings are defined peak to trough (excluding the peak year, but including the trough year).

Annex 2.3. Stylized Facts and Event Studies

The event studies presented in the chapter use the following definitions:

Annex Table 2.1.2. Commodity-Exporting Emerging Market and Developing Economies *(continued)*

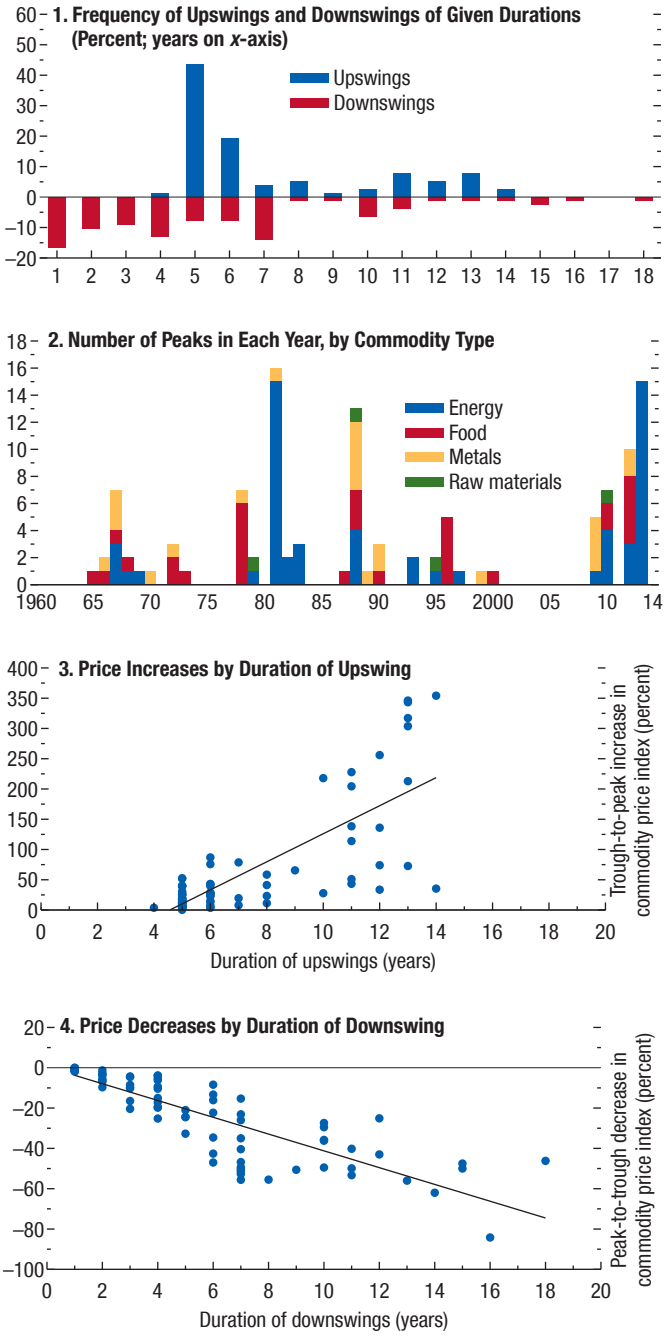
	Commodity Exports (percent of total exports)					Net Commodity Exports (percent of total exports-plus-imports)
	Total Commodities	Extractive		Nonextractive		
		Energy	Metals	Food	Raw Materials	
Low-Income Developing Countries						
Bolivia	65.9	25.3	27.7	6.0	6.8	28.4
Cameroon	71.3	16.1	6.6	34.7	13.9	22.6
Chad	91.6	4.5	0.0	15.6	71.5	8.6
Republic of Congo	61.3	52.6	0.2	1.8	6.7	30.6
Côte d'Ivoire	70.9	11.9	0.2	44.7	14.0	26.7
Ghana	66.0	5.4	7.0	50.2	3.3	12.3
Guinea	67.3	0.5	61.4	3.9	1.5	9.3
Honduras	66.6	1.3	2.8	60.0	2.5	14.1
Mauritania	75.9	9.2	47.2	23.8	0.0	12.2
Mongolia	59.2	4.6	35.6	1.9	17.2	12.4
Mozambique	46.1	4.7	26.7	10.9	3.9	5.1
Myanmar	52.8	36.1	0.7	6.1	9.8	24.4
Nicaragua	55.9	0.6	0.5	42.7	12.2	7.2
Niger	65.8	2.1	38.0	23.2	2.5	10.2
Nigeria	88.4	79.5	0.7	6.2	2.0	46.8
Papua New Guinea	58.0	6.7	24.5	20.7	6.1	15.7
Sudan	69.4	56.5	0.3	11.8	9.8	11.3
Tajikistan	63.4	0.0	51.6	0.2	11.6	21.5
Yemen	82.5	79.6	0.2	2.4	0.4	20.8
Zambia	77.0	0.4	72.4	2.7	1.6	30.4
Memorandum						
Number of Economies	52	52	52	52	52	52
Maximum	96.8	96.7	72.4	60.0	71.5	58.2
Mean	67.1	34.6	11.6	14.5	6.7	24.2
Median	65.9	30.4	1.3	6.2	2.7	20.8
Standard Deviation	14.5	32.6	18.2	16.5	11.0	14.5

Sources: UN Comtrade; and IMF staff calculations.

Note: Countries listed are those for which gross commodity exports as a share of total exports were greater than 35 percent and net commodity exports as a share of total trade (exports plus imports) were greater than 5 percent, on average, between 1962 and 2014. Commodity intensities are determined using a breakdown of the first criterion into the four main commodity categories: energy, food, metals, and raw materials.

- *Growth rates:* Average growth rates over upswings (downswings) are computed by first averaging for a given country over all upswing (downswing) years, then taking simple averages of these across countries. Samples are fully balanced, that is, they include the same country cycles for upswings and downswings.
- *Exchange rate regimes:* Exchange rate regimes are categorized as fixed or flexible according to the classification set out by Reinhart and Rogoff (2004). Regimes of countries in their coarse categories 1 and 2 are classified as fixed, and those in their coarse categories 3 and 4 are categorized as flexible. Countries in categories 1 and 2 have no separate legal tender or variously use currency boards, pegs, horizontal bands, crawling pegs, and narrow crawling bands. Countries in categories 3 and 4 variously have wider crawling bands, moving bands, and managed floating or freely floating arrangements. As very few countries maintain the same regime over an entire cycle, the exchange rate regime in the peak year is used to classify the cycle. The sample includes 34 cycles with fixed exchange rates but only 8 cycles with flexible exchange rates. Regimes classified as free-falling are dropped.
- *Type of fiscal policy:* Cycles are classified as being subject to either a high or low degree of fiscal policy procyclicality. The classification depends on whether the correlation between real spending growth and the change in the smoothed commodity terms-of-trade series is above or below the median for the overall sample during the cycle.
- *Cycles and credit ratio:* Cycles are classified as having a high (low) ratio of credit to GDP depending on whether average domestic credit to the private sector as a share of GDP during the upswing is above (below) the sample median.

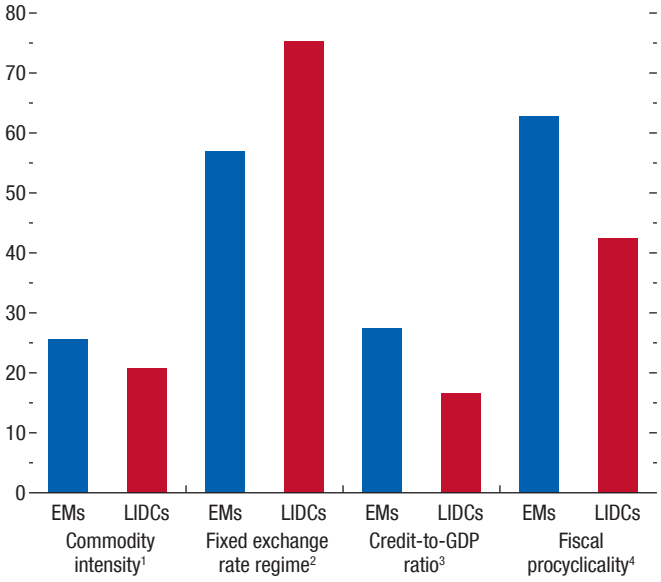
Annex Figure 2.2.1. Characteristics, Amplitudes, and Durations of Cycles



Sources: Gruss 2014; IMF, Primary Commodity Price System; U.S. Energy Information Administration; World Bank, Global Economic Monitor database; and IMF staff calculations.
Note: The cycles shown are for the country-specific commodity terms-of-trade indices. See Annexes 2.1 and 2.2 for the data definitions and cycle-dating methodology.

Annex Figure 2.3.1. Commodity Intensity, Policy Frameworks, and Financial Depth: Commodity-Exporting Emerging Markets versus Low-Income Developing Countries

(Percent)



Sources: IMF, Fiscal Monitor database; IMF, International Financial Statistics database; World Bank, *World Development Indicators*; and IMF staff calculations.
Note: Figures are the averages of data for all available years across all commodity exporters within each group. EM = emerging market; LIDC = low-income developing country.
[1]Average of commodity exports as a share of GDP.
[2]Share of commodity-exporting emerging markets and low-income developing countries with a fixed exchange rate regime as defined in Annex 2.3.
[3]Average of bank credit to the private sector as a share of GDP.
[4]Determined by whether the correlation between real spending growth and the change in the smoothed commodity terms of trade is greater or less than the sample median.

Among the commodity-exporting countries, emerging market economies can be differentiated from low-income developing countries along four key dimensions: commodity intensity, exchange rate regime, credit ratio, and fiscal procyclicality (Annex Figure 2.3.1). Emerging markets tend to have a greater degree of commodity intensity (GDP share of gross commodity exports). A greater share of low-income developing countries operate fixed exchange rates. Emerging markets tend to have greater financial depth, as captured by higher credit-to-GDP ratios. And emerging markets tend to have a more procyclical fiscal stance.

The comovement between the commodity terms-of-trade cycle and investment (and hence capital) is particularly marked in extractive commodity exporters (Annex Figure 2.3.2, panels 1 and 2), in line with the longer, more pronounced cycles in their terms of trade.

As extractive commodity exporters represent almost three-fourths of the emerging market economies in the sample, but less than half of low-income developing countries, differences across commodity types thus also translate into distinctions across country groups (Annex Figure 2.3.2, panels 3 and 4). GDP, spending, and production factors as well as trend GDP are less procyclical (or even countercyclical) in low-income developing countries.

Annex 2.4. Local Projection Method

Methodology and Data

The estimations of baseline impulse responses presented in the chapter follow the local projection method proposed by Jordà (2005) and developed further by Teulings and Zubanov (2014). This method provides a flexible alternative to traditional vector autoregression techniques and is robust to misspecification of the data-generating process. Local projections use separate horizon-specific regressions of the variable of interest (for example, output, investment, capital) on the shock variable and a series of control variables. The sequence of coefficient estimates for the various horizons provides a nonparametric estimate of the impulse response function.

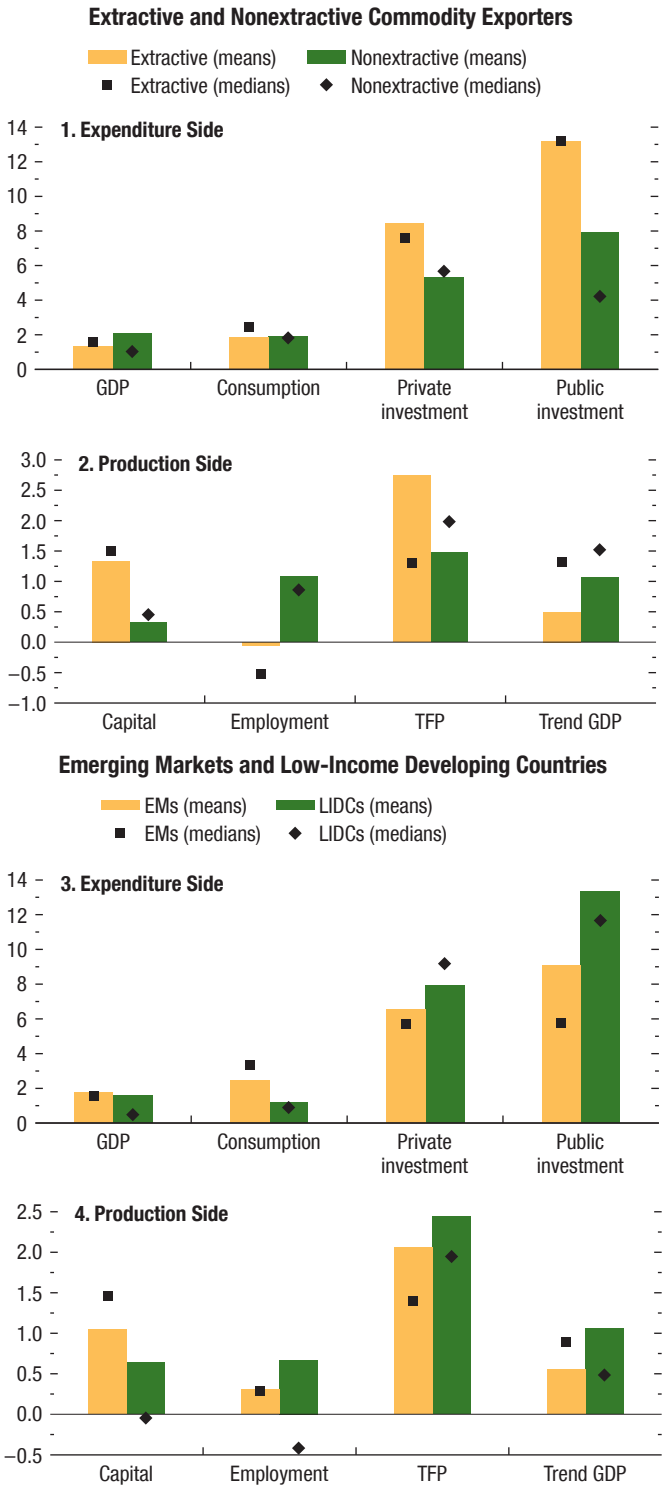
The estimated baseline specification is as follows:

$$y_{i,t+h} - y_{i,t-1} = \alpha_i^h + \gamma_t^h + \beta_1^h \Delta s_{i,t} + \sum_{j=1}^{p} \beta_2^h \Delta s_{i,t-j} + \sum_{j=1}^{h-1} \beta_3^h \Delta s_{i,t+h-j} + \sum_{j=1}^{p} \theta_1^h \Delta y_{i,t-j} + \sum_{j=0}^{p} \theta_2^h x_{i,t-j} + \sum_{j=1}^{h-1} \theta_3^h x_{i,t+h-j} + \varepsilon_{i,t}^h,$$

in which the i subscripts index countries; the t subscripts index years; the h superscripts index the horizon of the projection after time t; p is the number of lags for each variable; $y_{i,t}$ is the natural logarithm of the variable of interest (for example, output); and $s_{i,t}$ is the natural logarithm of the commodity terms of trade, the shock variable of interest. The equation also includes controls for additional factors, $x_{i,t}$, such as the trade-weighted output growth of trading partners, political regime transition, and conflict in the domestic economy. Regressions include country fixed effects, α_i^h, and time fixed effects, γ_t^h.

A balanced panel for the period 1960–2007 is used for the baseline regression (Annex Table 2.4.1). The period of the global financial crisis and its aftermath is thus omitted. However, because of differences in data availability, the number of economies included differs

Annex Figure 2.3.2. Average Differences in Real Growth Rates between Upswings and Downswings
(Percentage points)



Sources: IMF, Fiscal Monitor database; Penn World Table 8.1; and IMF staff calculations.
Note: The bars show the average differences between growth rates during upswings and downswings. EM = emerging market; LIDC = low-income developing country; TFP = total factor productivity.

Annex Table 2.4.1. Sample of Commodity Exporters Used in the Local Projection Method Estimations, 1960–2007

Emerging Markets		Low-Income Developing Countries	
Argentina	Iran	Bolivia	Mongolia
Brazil	Libya	Cameroon	Mozambique
Chile	Malaysia	Chad	Niger
Colombia	Paraguay	Republic of Congo	Nigeria
Costa Rica	Peru	Côte d'Ivoire	Zambia
Ecuador	Syria	Ghana	
Gabon	Trinidad and Tobago	Guinea	
Guatemala	Uruguay	Honduras	
Indonesia	Venezuela	Mauritania	

Sources: IMF, Fiscal Monitor database; Penn World Table 8.1; and IMF staff calculations.

Annex Table 2.4.2. Country Coverage for Key Macroeconomic Variables in the Local Projection Method Estimations

	Commodity Exporters		
Variable	Emerging Markets	Low-Income Developing Countries	Total
Real GDP	18	14	32
Real Consumption	16	14	30
Real Total Fixed Investment	17	16	33
Real Capital Stock	16	14	30
Employment	14	9	23
Real Total Factor Productivity	14	5	19

Sources: IMF, Fiscal Monitor database; Penn World Table 8.1; and IMF staff calculations.
Note: The sample length for all variables is 1960–2007.

by variable. For example, for real GDP, the sample spans 32 commodity-exporting emerging market and developing economies (Annex Table 2.4.2). However, the results are robust to the minimum sample of economies available for total factor productivity.

Robustness Tests

The chapter's baseline regression analysis focuses on the macroeconomic impact of terms-of-trade shocks and thus excludes economies for which data are not available until the 1970s. Repeating the analysis using data starting a decade later, in 1970, brings in 13 additional commodity exporters, including the oil exporters of the Gulf region (Kuwait, Oman, Qatar, Saudi Arabia, United Arab Emirates). The findings are broadly robust to the addition of these economies. Furthermore, starting the estimation from 1980 (thereby omitting the 1970s oil shocks) marginally boosts the GDP response in the outer years.

In addition, investment and consumption respond more strongly and with greater persistence to shocks that occur during a persistent commodity terms-of-trade cycle than to other shocks. This is consistent with the idea that successive commodity terms-of-trade gains can generate perceptions of a more persistent income windfall and therefore boost the incentive to invest (and consume), which in turn supports aggregate activity.

Box 2.1. The Not-So-Sick Patient: Commodity Booms and the Dutch Disease Phenomenon

In the "Dutch disease" phenomenon, a boom in the commodity-producing sector of an economy puts downward pressure on the output of the (noncommodity) tradable goods sector—essentially manufacturing. An extensive theoretical literature, starting with Corden 1981 and Corden and Neary 1982, examines the patterns and optimality of factor reallocation between sectors following booms in commodity production (linked to the discovery of natural resources). The models presented in these studies predict that an improvement in the commodity terms of trade and the subsequent spending of the income windfall in the domestic economy will drive up the real exchange rate and divert capital and labor from manufacturing toward the commodity and nontradables sectors.[1]

Despite some evidence of a positive association between the terms of trade and the real exchange rate of commodity exporters, empirical research on whether commodity booms hinder manufacturing performance has been mixed, even among studies that focus on the same countries or similar episodes:[2]

- *No Dutch disease effects found:* Studies of the 1970s oil price boom, such as Gelb and Associates 1988 and Spatafora and Warner 1995, estimate that higher oil prices led to real exchange rate appreciations but had no adverse effect on manufacturing output in oil-exporting economies. Sala-i-Martin and Subramanian (2003) find both the real exchange rate and manufacturing activity to be insensitive to oil price movements in Nigeria, an oil exporter. Bjørnland (1998) argues that evidence of Dutch disease following the United Kingdom's oil boom is weak and that manufacturing output in Norway actually benefited from oil discoveries and higher oil prices.
- *Support for Dutch disease effects:* Studies that have found support for Dutch disease effects are more recent. Ismail (2010) uses disaggregated data for manufacturing subsectors for a sample of oil exporters for the 1977–2004 period and shows that manufacturing output was negatively associated with the oil price, especially in subsectors with a relatively higher degree of labor intensity in production. Harding and Venables (2013) use balance of payments data for a broad sample of commodity exporters for 1970–2006 and find that an increase of $1 in commodity exports tends to be accompanied by a fall of about 75 cents in noncommodity exports and an increase of almost 25 cents in noncommodity imports.

Some indirect evidence of the Dutch disease effect can be gleaned by looking at the evolution of country shares in global manufacturing exports, which tend to be lower on average for commodity exporters than for other emerging market and developing economies. Although both groups have increased their market shares over time (relative to advanced economies), commodity exporters have seen a smaller increase in their global manufacturing export shares than the others, and the gap between the average market shares of the two groups has widened since the early 1990s (Figure 2.1.1, panel 1).

Formal tests of whether terms-of-trade booms hurt manufacturing export performance yield varied results, however. The real exchange rate appreciates gradually following an increase in the commodity terms of trade (with the increase becoming statistically significant only after the fifth year), but the impact on manufacturing exports is not significant, which points to a wide range of experiences across episodes (Figure 2.1.1, panels 2 and 3).

Numerous explanations have been offered for the absence of major Dutch disease symptoms following commodity terms-of-trade booms. These include policy-induced production restraints in the oil sector (especially in the 1970s), the "enclave nature" of the commodity sector (that is, its limited participation in domestic factor markets), limited spending of the windfall on nontradables (with a ramping up of imports instead), and government protection of the manufacturing sector.[3]

A further explanation could be linked to the pickup in global economic activity that, in some episodes,

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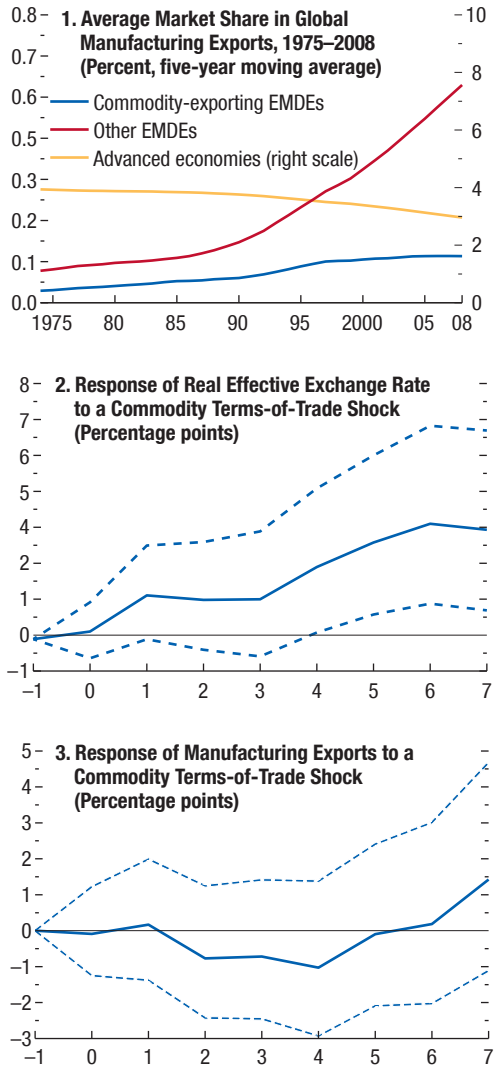
[1]There are two effects at work: a "resource movement" effect, in which the favorable price shock in the commodity sector draws factors of production out of other activities, and a "spending effect," which draws factors of production out of tradables (to be substituted with imports) into the nontradables sector.

[2]For instance, Chen and Rogoff (2003) show that the currencies of three advanced economy commodity exporters—Australia, Canada, and New Zealand—have comoved strongly with their terms of trade. Cashin, Céspedes, and Sahay (2004) find a long-run relationship between the real exchange rates and commodity terms-of-trade indices in about one-third of a sample of 58 commodity exporters. Arezki and Ismail (2013) argue that delays in the response of nontradables-intensive government spending to declines in commodity prices could weaken the empirical correlation between the latter and the real exchange rate.

[3]See Ismail 2010, Sala-i-Martin and Subramanian 2003, and Spatafora and Warner 1995.

Box 2.1 *(continued)*

Figure 2.1.1. Manufacturing Export Performance



Sources: UN Comtrade; United Nations Industrial Development Organization; and IMF staff estimates.
Note: Impulse responses are estimated using the local projection method; $t = 0$ is year of the shock; solid lines denote response of variables to a 10 percentage point increase in the shock variable; dashed lines denote 90 percent confidence bands. For panel 2, sample of 27 commodity-exporting emerging market and developing economies (EMDEs) from 1970 through 2007. For panel 3, sample of 45 commodity-exporting EMDEs from 1970 through 2007. See Annexes 2.1 and 2.4 for data definitions and estimation methodology.

could be contributing to the booms in world commodity prices. Stronger global activity could lead to stronger foreign demand for manufactured goods in all countries, commodity exporters included, and provide some offset to the loss of competitiveness associated with an appreciating real exchange rate. This explanation seems consistent with the varying findings in the empirical literature. Dutch disease symptoms appear to be stronger in studies that examine the performance of the manufacturing sector over longer time periods, which would include episodes of resource discoveries and consequent increases in commodity production volumes. Such country-specific episodes would not necessarily be expected to coincide with episodes of strong growth in global demand.

A question that has received much attention among policymakers is whether commodity boom effects on the manufacturing sector weigh on longer-term growth. In principle, commodity booms could compromise the longer-term outlook for the economy if they weaken features of the manufacturing sector that support longer-term growth—such as increasing returns to scale, learning by doing, and positive technological externalities.[4] However, the evidence is inconclusive.[5] One explanation for the lack of an apparent correlation between Dutch disease symptoms and longer-term growth could be that learning-by-doing externalities are not necessarily exclusive to manufacturing; the commodity sectors could also benefit from that effect (Frankel 2012). Another explanation proposes that a manufacturing sector that contracts and shifts toward greater capital intensity as a result of a commodity boom—and that, in turn, uses higher-skilled labor—may generate more positive externalities for the economy than a larger manufacturing sector using low-skilled labor (Ismail 2010).

[4]Theoretical models that incorporate learning-by-doing externalities in the manufacturing sector include Matsuyama 1992, van Wijnbergen 1984a, Krugman 1987, and Benigno and Fornaro 2014. Rodrik (2015) also argues that premature deindustrialization can reduce the economic growth potential of developing economies by stifling the formal manufacturing sector, which tends to be the most technologically dynamic sector.

[5]A comprehensive survey of the literature on this topic is in Magud and Sosa 2013. Rodrik (2008) analyzes the effect of the real exchange rate on economic growth and the channels through which this link operates; he concludes that episodes of undervaluation are associated with more rapid economic growth. Eichengreen (2008), however, notes that the evidence of a positive growth effect from a competitive real exchange rate is not overwhelming.

Box 2.2. Commodity Booms and Public Investment

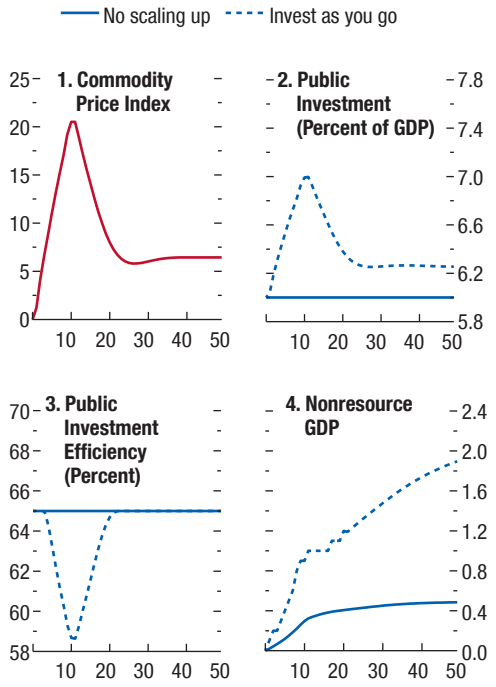
A commodity resource windfall can support economic development in low-income developing countries where potential returns to public investment are high and access to international and domestic credit markets is limited. When managed well, investments in productivity-enhancing public capital, such as infrastructure, can help raise output and living standards over the long term (Collier and others 2010; IMF 2012, 2015).[1]

A model calibrated to a low-income developing country is presented here to illustrate how a commodity windfall can raise public investment and boost income levels over the long term if capital is scarce and credit is constrained.[2] The model captures the key trade-offs in public investment decisions.[3] In particular, public investment in low-income developing countries has the potential for high returns but exhibits low levels of efficiency.[4] The long-term effects of the boom on the growth of output depend on the rate of return of public capital (relative to the cost of funding), the efficiency of public investment, and the response of private investment to the increase in public capital.

The analysis examines the behavior of nonresource GDP in two scenarios—"no scaling up" (the baseline) and "invest as you go"—both of which feature a 20 percent increase in commodity prices followed by a 15 percent drop after year 10 (consistent with the scenario discussed in the chapter) (Figure 2.2.1):

- *No scaling up:* In the baseline case, the public investment ratio stays constant at 6 percent of GDP.
- *Invest as you go:* In the alternative scenario, all royalties from the commodity boom are spent on public investment, whose share of GDP increases 1 percentage point, to 7 percent, during the boom (the initial 10 years) and subsequently falls in tandem with the commodity price. Nevertheless, it stays elevated in the long term in line with the permanent gain in the commodity price.

Figure 2.2.1. Long-Term Effects of Heightened Public Investment during Commodity Booms
(Percent deviation, unless noted otherwise; years on x-axis)



Source: IMF staff calculations.
Note: "Public investment efficiency" refers to the share of investment that ends up embedded in the capital stock.

The authors of this box are Rudolfs Bems and Bin Grace Li.

[1]For example, public investment can help close infrastructure gaps, which are an important impediment to trade integration and total factor productivity catch-up (see Chapter 3 of the April 2015 *Regional Economic Outlook: Sub-Saharan Africa*).

[2]Berg and others (forthcoming) find that low levels of efficiency may be correlated with high rates of return because the low efficiency implies very scarce public capital. In this situation, the rate of return to investment spending may not depend on the level of efficiency. *Increasing* efficiency would nonetheless increase the return to public investment spending.

[3]The model extends the work of Berg and others (2013) and Melina, Yang, and Zanna (2014). A detailed presentation of the model calibration is provided by Gupta, Li, and Yu (2015). The modeled economy features the same structure as the commodity exporter in the IMF's Global Economy Model (GEM) used in the chapter, including three sectors: tradables, nontradables, and commodities. However, it excludes some of the real and nominal frictions featured in the GEM, which makes it more suitable for studying long-term effects rather than fluctuations over the commodity cycle. The calibration of the model pays particular attention to the lower levels of public investment efficiency and limited absorptive capacity in low-income countries.

[4]Albino-War and others 2014 and IMF 2015 discuss the definition and measurement of public investment efficiency. These papers also highlight possible reforms that could help make public investments more efficient, such as steps to strengthen project appraisal, selection, and budget planning.

Box 2.2 *(continued)*

As in the model simulation shown in the chapter's second section, nonresource GDP increases by 0.5 percent over the long term if the government maintains an unchanged investment ratio. Under invest as you go, the additional public investment increases long-term nonresource output by about 2 percent because of the direct impact of a higher stock of public capital and the crowding-in of private investment.[5] The magnitude of this positive impact on output is broadly consistent with the empirical findings for developing economies in Chapter 3 of the October 2014 *World Economic Outlook*.

The gains from higher public investment in low-income developing countries depend crucially on efficiency levels, which vary across the two scenarios (Figure 2.2.1). In the baseline case, 35 percent of public investment is lost. In the alternative scenario, the ramping up of public investment reduces the efficiency level by about 6 percentage points—about 41 percent is lost. The decline in efficiency in the scenario highlights the trade-off between the need for public investment and investment efficiency, with the latter calibrated to match levels reported in empirical studies.[6]

In sum, a ramping up of public investment in response to a commodity boom can bring long-term benefits to commodity exporters. But considering the limited absorptive capacity of many developing economies, a more gradual investment profile can yield higher efficiency levels and lead to more favorable long-term outcomes. The more gradual pace can also curb the demand pressures during the boom phase of the commodity cycle.

[5]While the increase in the long-term output under this alternative scenario might appear small, it should be considered against the relatively small size of the increase in public investment (1 percent of GDP at the peak). In comparison, Chapter 3 of the October 2014 *World Economic Outlook* finds that in a typical public investment boom, the increase is about 7 percentage points of GDP. However, a large scaling up of public investment may also result in the implementation of inframarginal projects, lowering its impact (see Warner 2014).

[6]These levels are consistent with the cost overruns in low-income developing countries in Africa, as reported by development agencies (see Foster and Briceño-Garmendia 2010). Gupta and others (2014) document the decrease in public investment efficiency during the 2000–08 boom.

Box 2.3. Getting By with a Little Help from a Boom: Do Commodity Windfalls Speed Up Human Development?

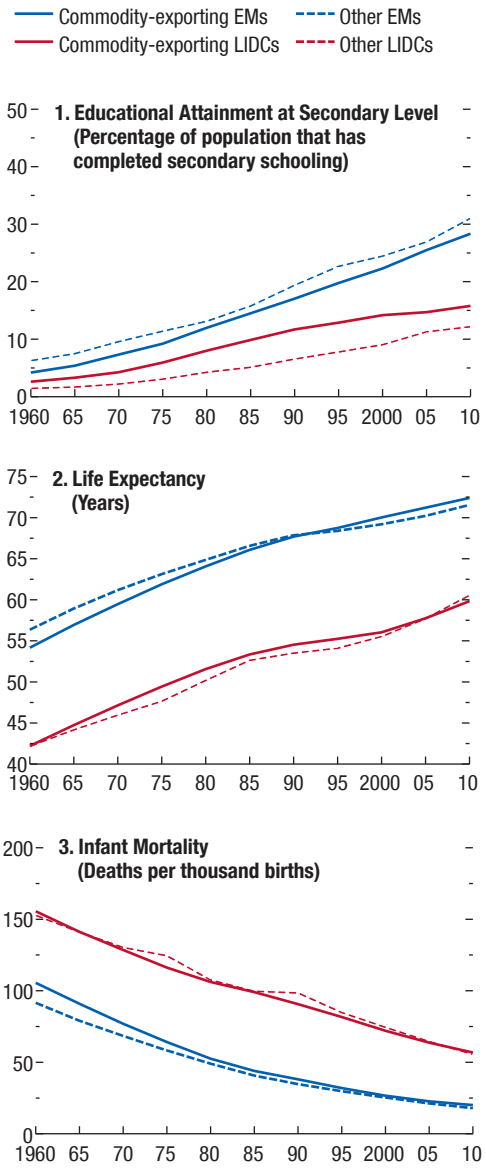
Improvements in education and health help a country increase its economic potential over time by building larger and more-skilled pools of human capital. Increasing their investments in human development is therefore one way in which commodity-exporting emerging market and developing economies can use commodity windfall gains to boost their longer-term living standards. The following discussion considers whether commodity exporters have had an advantage in boosting human development.[1]

Does Being a Commodity Exporter Matter for Human Development?

To set the stage, it is useful to investigate whether being a commodity exporter matters for the level and pace of improvement in human development. Examination of the average levels of key human development indicators over the past five decades reveals no clear pattern across exporters and others (Figure 2.3.1).[2] For instance, in terms of educational attainment at the secondary school level, commodity-exporting low-income developing countries have on average had better outcomes than noncommodity exporters, while commodity-exporting emerging market economies on average have had poorer outcomes than their noncommodity-exporting peers. For life expectancy and infant mortality, levels of indicators have been similar across the two different types of economies, but the relative pace of improvement has varied between the groups over time.

Controlling for basic country characteristics—including initial conditions, population size, GDP, and political variables—does not reveal statistically significant differences between commodity exporters and other similar emerging market and developing economies in terms of educational attainment, life expectancy, or infant mortality (Figure 2.3.2).[3]

Figure 2.3.1. Human Development Indicators



Sources: Barro and Lee 2010, April 2013 update; United Nations Department of Economic and Social Affairs, UNdata; United Nations Development Programme; World Bank, *World Development Indicators*; and IMF staff calculations.
Note: Simple averages are taken over balanced samples for each group. EM = emerging market; LIDC = low-income developing country.

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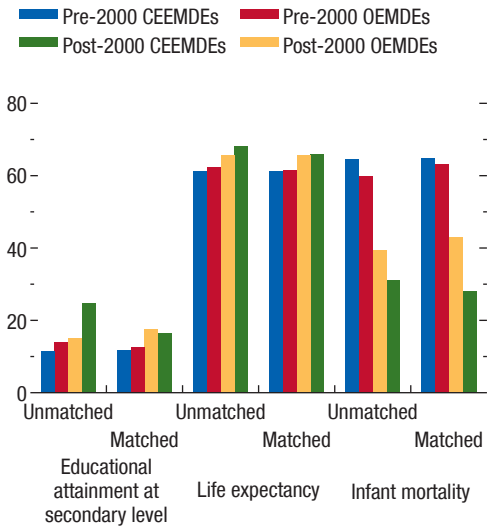
[1]McMahon and Moreira (2014) find that in the 2000s, human development improved more rapidly in extractive commodity exporters than in countries that are not dependent on extractive industries. Gylfason (2001) suggests that education levels were inversely related to resource abundance in the 1980–97 period.

[2]These particular indicators of human development have been shown to have an impact on the quality of human capital (for example, Kalemli-Özcan, Ryder, and Weil 2000 and Oster, Shoulson, and Dorsey 2013).

[3]These results are obtained using propensity score matching (Rosenbaum and Rubin 1983). This estimation technique tests for statistically significant differences between commodity exporters and noncommodity exporters while ensuring that they

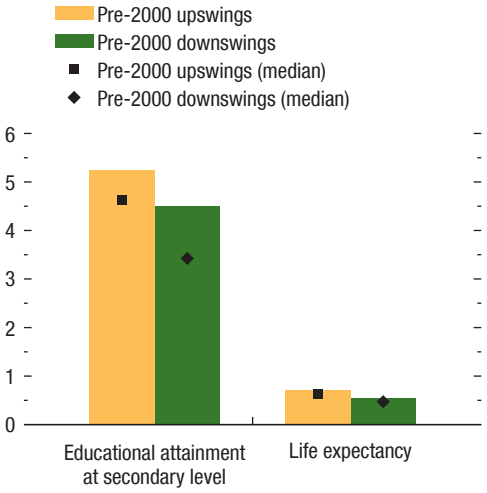
Box 2.3 *(continued)*

Figure 2.3.2. Comparing the Performance of Commodity and Noncommodity Exporters
(Percent)



Sources: Barro and Lee 2010, April 2013 update; United Nations Department of Economic and Social Affairs, UNdata; United Nations Development Programme; World Bank, *World Development Indicators*; and IMF staff calculations.
Note: CEEMDEs = commodity-exporting emerging market and developing economies; OEMDEs = other emerging market and developing economies. None of the differences between matched samples are statistically significant at the 10 percent level.

Figure 2.3.3. Event Studies: Average Changes in Human Development Indicators during Upswings and Downswings
(Percent)



Sources: Barro and Lee 2010, April 2013 update; United Nations Department of Economic and Social Affairs, UNdata; United Nations Development Programme; World Bank, *World Development Indicators*; and IMF staff calculations.
Note: Sample includes only cycles with peaks before 2000. See Annex 2.2 for the cycle dating methodology. Infant mortality is omitted from the event studies because data are available only in five-year intervals and interpolation would confound the effects.

Do Changes in the Commodity Terms of Trade Predict Changes in the Pace of Human Development?

Like the macroeconomic variables examined in the chapter, key human development indicators tend to move in tandem with the commodity terms of trade. Educational attainment and life expectancy rise faster during commodity terms-of-trade upswings than during downswings (Figure 2.3.3). This comovement is not surprising, since education and health outcomes are likely to benefit from higher social spending by the public sector and a faster-growing economy during a commodity boom. However, the differences between average changes in educational attainment and life expectancy during upswings and downswings are not statistically significant, which is probably attributable to other contextual factors affecting these variables during these episodes.

Using the local projection method allows some contextual factors such as the output growth of trading partners, domestic conflict, and political

are otherwise comparable in terms of key characteristics such as population, level of GDP, political factors (regime change, conflict), and lagged measures of human development. Figure 2.3.2 illustrates how commodity exporters compare with noncommodity exporters in both an unmatched and a matched sample. The former provides a simple comparison across groups without controlling for any differences between them, whereas in the latter, commodity exporters are compared with (hypothetical) noncommodity exporters similar to them in regard to a number of key characteristics.

Box 2.3 *(continued)*

regime change to be controlled for. Estimates from that method show that the responses of educational attainment are barely statistically significant following changes in the net commodity terms of trade; those of life expectancy are not statistically significant.

Infant mortality has a statistically significant negative response, but this result appears sensitive to the inclusion of data from the 1970s and early 1980s, when commodity windfalls allowed commodity exporters to catch up with their noncommodity-exporting peers—infant mortality among commodity exporters fell by 30 to 50 percent over that period. The result weakened during later decades, when the pace of improvement slowed for both commodity exporters and noncommodity exporters. During those years upswings no longer brought statistically significant reductions, as marginal improvements appear to have become progressively more difficult to achieve.

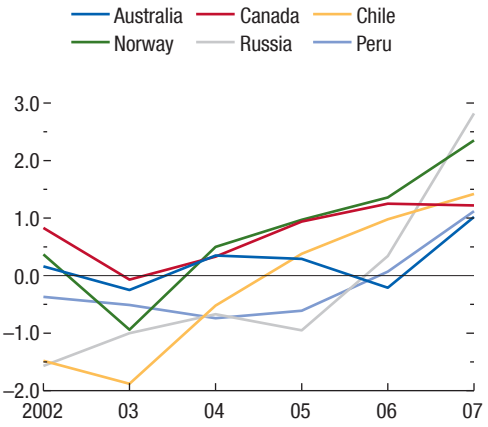
Box 2.4. Do Commodity Exporters' Economies Overheat during Commodity Booms?

The model simulations presented in this chapter predict that commodity booms will tend to be accompanied by overheating: if prices and wages adjust only slowly to higher demand, the volume of output will overreact and rise above its potential level (defined as the level of output consistent with stable inflation). The event studies presented in the chapter provide indirect evidence of overheating during booms, documenting that actual output tends to grow faster than trend output during prolonged upswings in the commodity terms of trade (Figure 2.8, panel 4). Such a growth differential would be likely to push actual output above potential output over the duration of the boom.

The discussion here presents direct evidence of overheating in six net commodity exporters during the global commodity boom of the 2000s. Multivariate filtering is used to estimate potential output and the output gap, both of which are unobserved. The technique combines information on the relationship between unemployment and inflation (Phillips curve) on the one hand, and between unemployment and the output gap (Okun's law) on the other.[1] It is based on the notion that a positive (negative) output gap will be correlated with excess demand (slack) in the labor market and lead to increases (decreases) in inflation.

The six net exporters of commodities are Australia, Canada, Chile, Norway, Peru, and Russia.[2] The inflation process in these countries largely conforms to that predicted by economic theory, with a broadly stable relationship between inflation and unemployment.

Figure 2.4.1. Output Gaps in Six Commodity Exporters
(Percent)



Source: IMF staff calculations.
Note: Output gaps are estimated using the multivariate-filter technique.

The discussion focuses on the period 2002–07: the uninterrupted phase of the boom in world commodity prices ahead of the volatility associated with the 2008–09 global financial crisis.

The analysis finds that the six economies moved into excess demand as the commodity boom progressed (Figure 2.4.1). The results are striking in that all six economies show positive output gaps toward the end of the prolonged commodity price boom. Moreover, the changes in the output gap exhibit a positive correlation with the commodity terms of trade, even if the estimation does not incorporate information on the latter variable (Figure 2.4.2). That result underscores the important role of the commodity terms of trade in driving cyclical fluctuations in net commodity exporters.

However, estimates of output gaps based on multivariate filtering benefit from hindsight, in the

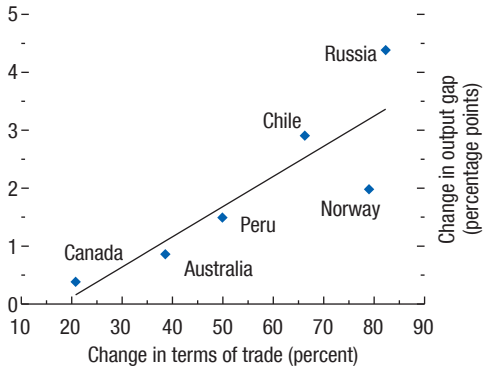
The authors of this box are Oya Celasun, Douglas Laxton, Hou Wang, and Fan Zhang.

[1]Chapter 3 of the April 2015 *World Economic Outlook* uses the multivariate-filter methodology to estimate potential output for 16 countries. A detailed description of the methodology can be found in Annex 3.2 of that report and in Blagrave and others 2015.

[2]The countries and time period chosen for the analysis reflect the data requirements. Reliable unemployment series are not available for a large number of commodity exporters, nor do many countries show a broadly stable relationship between inflation and unemployment. To ensure a focus on the link between the terms of trade and the output gap, estimates are shown for the uninterrupted phase of the commodity boom prior to the 2008–09 global financial crisis.

Box 2.4 *(continued)*

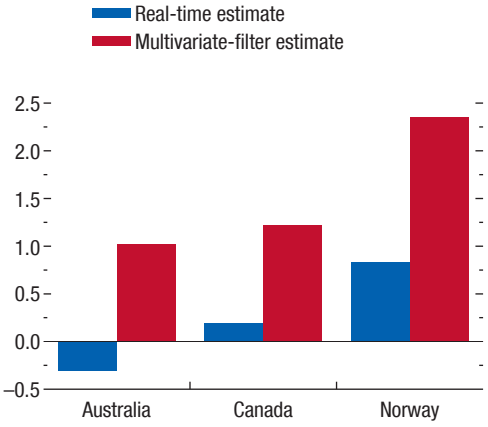
Figure 2.4.2. Changes in the Output Gap and Terms of Trade



Source: IMF staff calculations.
Note: The definition of the commodity terms of trade is given in Annex 2.1. The trend line is estimated by regressing the change in the output gap during 2002–07 on the change in the terms of trade over the same period.

Figure 2.4.3. Real-Time and Multivariate-Filter Estimates of 2007 Output Gaps

(Percent)



Source: IMF staff calculations.
Note: Real-time estimates of output gaps are from the September 2007 World Economic Outlook database.

sense that the estimation of output gaps for 2002–07 incorporates information on the actual behavior of output, inflation, and unemployment in the aftermath of the period. Disentangling the cyclical versus structural components of output is more challenging in real time.[3] Available real-time estimates of output gaps in the September 2007 World Economic Outlook database are lower than the multivariate-filter-based estimates obtained with data through 2014, suggesting that the structural component of output was overestimated in real time (Figure 2.4.3).[4]

[3]Grigoli and others (2015) document the wide range of uncertainty surrounding real-time estimates of the output gap. They find that initial assessments of an economy's cyclical position tend to overestimate the amount of slack in the economy, especially during recessions.

[4]For advanced economies, the World Economic Outlook database contains estimates and projections of output gaps from 1991 onward. For emerging market and developing economies, estimates start in 2008.

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