CHAPTER 5

THE BOOM IN NONFUEL COMMODITY PRICES: CAN IT LAST?

Over the past four years, fuel and nonfuel commodity prices have risen significantly. Developments in fuel markets (especially oil) have dominated the attention of policymakers so far, although the increase in nonfuel commodity prices has also had considerable consequences for trade balances and growth in many countries.

Nonfuel commodities have a higher share in world trade (about 14 percent during 2000–04) than fuel commodities (7 percent). As in the case of oil, many developing countries are highly dependent on nonfuel commodities as a source of export earnings—36 countries have a ratio of nonfuel commodity exports to GDP of over 10 percent, and in 92 countries the ratio is over 5 percent (Figure 5.1). Indeed, in many low-income countries, a large share of export receipts are generated by just a few commodities (see Table 5.1 for selected examples). Moreover, prices of some nonfuel commodities have increased more than oil prices—for example, the IMF metals index has risen by 180 percent in real terms since 2002, while oil prices increased by 157 percent.

Given the significant exposure of many countries to fluctuations in nonfuel commodity prices, the future dynamics of commodity markets have important policy implications. Some observers have suggested that the rise of China and other large emerging markets may have led to a fundamental change in long-term price trends, and that the world has now entered a period of sustained high prices, particularly of metals (see Barclays Capital, 2006a). In contrast, others believe that speculative forces have largely decoupled metals prices from market fundamentals (Societe Generale, 2006), and that prices will inevitably fall back and continue to decline gradually in real terms, as during most of the past century.

This chapter examines these issues by:

- identifying the underlying causes of the recent increases in nonfuel commodity prices and putting them in historical perspective;
- assessing the roles of rising commodity demand from large emerging market countries (especially China) and of financial investors in pushing up prices; and
- evaluating whether the current high price levels are likely to be temporary or lasting.

Long-Term Trends in Commodity Prices and Volatility

Despite recent increases, the prices of most nonfuel commodities remain below their historical peaks in real terms. Over the past five decades, commodity prices have fallen relative to consumer prices at the rate of about 1.6 percent a year (Figure 5.2).[1] This downward trend is usually attributed to large productivity gains in the agricultural and metals sectors relative to other parts of the economy.[2] Compared with the prices of manufactures, however, commodity prices stopped falling in the 1990s as the growing globalization of the manufacturing sector slowed producer price inflation.[3]

The main author of this chapter is Martin Sommer with consultancy support from Christopher Gilbert. Angela Espiritu provided research assistance.

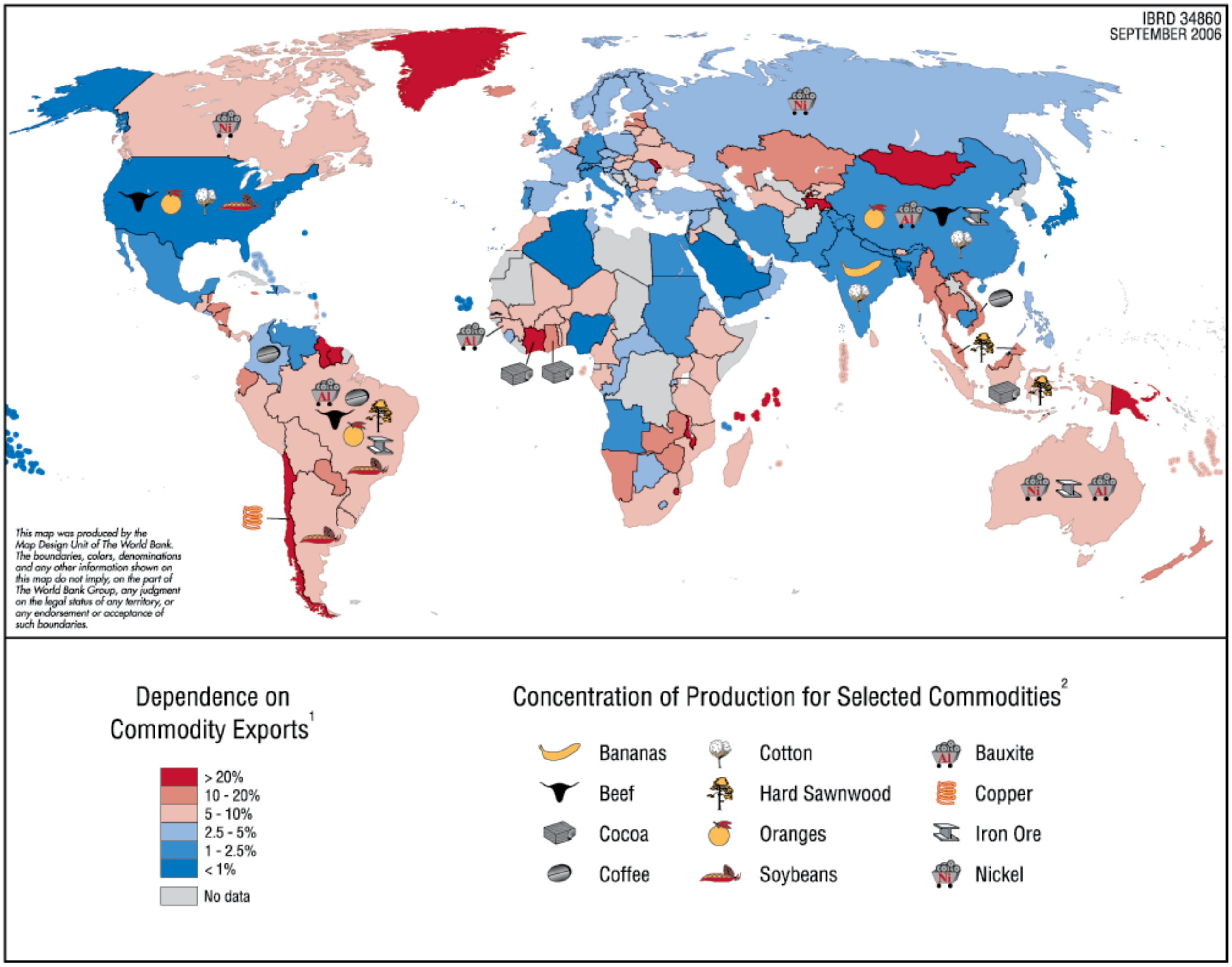
[1]This long-term trend has been apparent for most of the past century and was highlighted by Prebisch (1950) and others in the 1950s. See Cashin and McDermott (2002); Deaton and Laroque (2003); Grilli and Yang (1988); and Borensztein and others (1994) for a detailed discussion. Due to data deficiencies and inherent volatility in commodity prices, the academic literature does not uniformly share the view that real commodity prices are falling—see Cuddington (1992) for an alternative account.

[2]See Tilton (2003) for a review of the recent literature and Barnett and Morse (1963) for a historical assessment of productivity gains.

[3]See Chapter III, "Globalization and Inflation," in the April 2006 *World Economic Outlook*.

Figure 5.1. Dependence on Exports of Nonfuel Commodities and Geographical Concentration of Production

Many developing countries and emerging markets continue to be highly dependent on exports of nonfuel commodities (these countries are marked in red). Production of some commodities is highly geographically concentrated, potentially making world prices sensitive to country-specific events.



Sources: British Geological Survey, *World Mineral Statistics 1998/2002* (2004); FAOSTAT data (2006); Foreign Agricultural Service, Official USDA estimates (2006); World Bank, World Integrated Trade Solution Database; World Bureau of Metal Statistics, *World Metal Statistics Yearbook 2006* (2006); and IMF staff calculations.

[1] Share of nonfuel commodity exports in gross domestic product. See Appendix 5.1 for details.

[2] Symbols are assigned to the countries whose share of world production is over 10 percent. For metals, the production shares refer to mining output. Bauxite is the raw material most widely used in the production of aluminum.

Table 5.1. Dependence on Exports of Selected Nonfuel Commodities

(2000–04; in percent)

	Country	Share in Total Exports
Aluminum	Suriname	47
	Tajikistan	46
	Guinea	36
	Mozambique	26
Cocoa	Côte d'Ivoire	34
Coffee	Burundi	43
Copper	Zambia	41
	Chile	31
	Mongolia	20
Cotton	Burkina Faso	42
	Benin	28
Fish	Iceland	30
	Seychelles	30

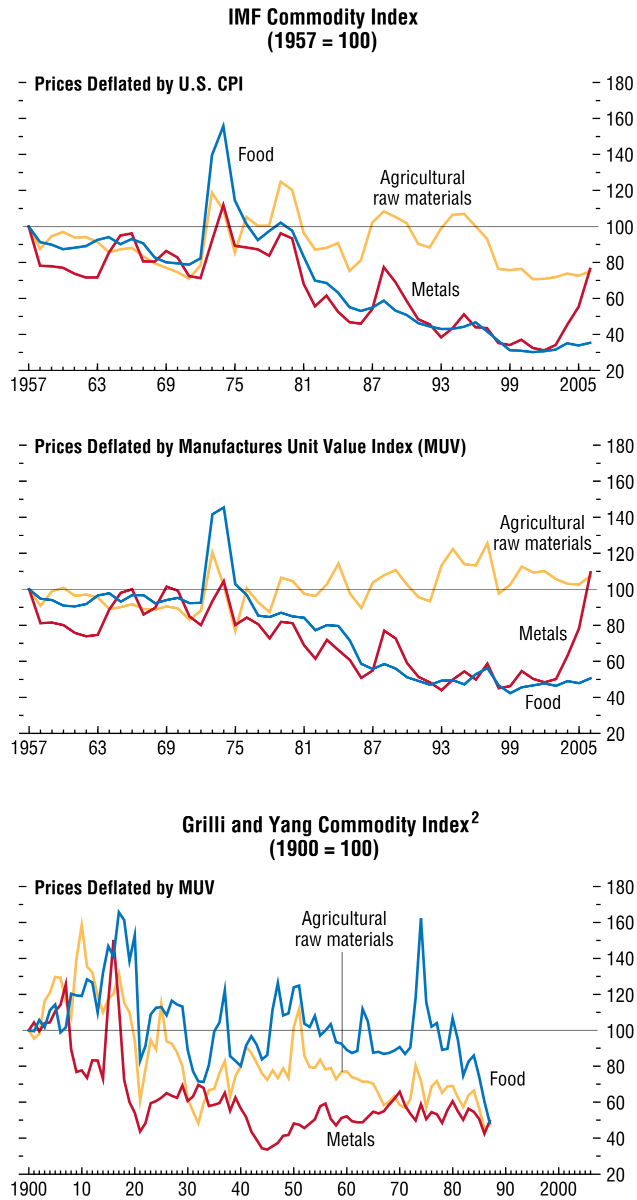
Sources: World Bank, World Integrated Trade Solution database; and IMF staff calculations.

On a year-to-year basis, commodity prices can significantly deviate from the long-term downward trend, as price volatility is much higher than the average real price decline (one standard deviation of annual price changes is about 11.5 percent, compared with the long-term price decline of 1.6 percent a year; see Figure 5.3). The current volatility in nonfuel commodity markets is not unusual by historical standards. In fact, the volatility of food and raw agricultural material prices seems to have fallen on average over the past couple of decades, as growing geographical diversification of production and technological advances have reduced the sensitivity of prices to supply shocks, such as bad weather or natural disasters (FAO, 2004b).[4]

[4]For example, the emergence of major new exporters of coffee such as Vietnam has helped to reduce the dependence of coffee prices on weather in Brazil. The aggregate volatility figures, however, mask significant variability in the price behavior of individual food commodities. The median correlation between annual price changes of two randomly selected food commodities is 15 percent, compared with 33 percent for metals. See Cashin, McDermott, and Scott (2002) and Gilbert (2006) for analysis of volatility in commodity prices. Dehn, Gilbert, and Varangis (2005) discuss the policies to manage the negative consequences of volatile commodity markets.

Figure 5.2. Long-Term Price Trends[1]

Prices of many nonfuel commodities have been falling in real terms relative to the consumer price index (CPI) for at least the last 50 years. Globalization has slowed price increases in the manufacturing sector and as a result commodity prices stopped declining relative to the prices of manufactures in the early 1990s. However, commodity prices exhibit significant volatility and prices can deviate from trend for long periods.



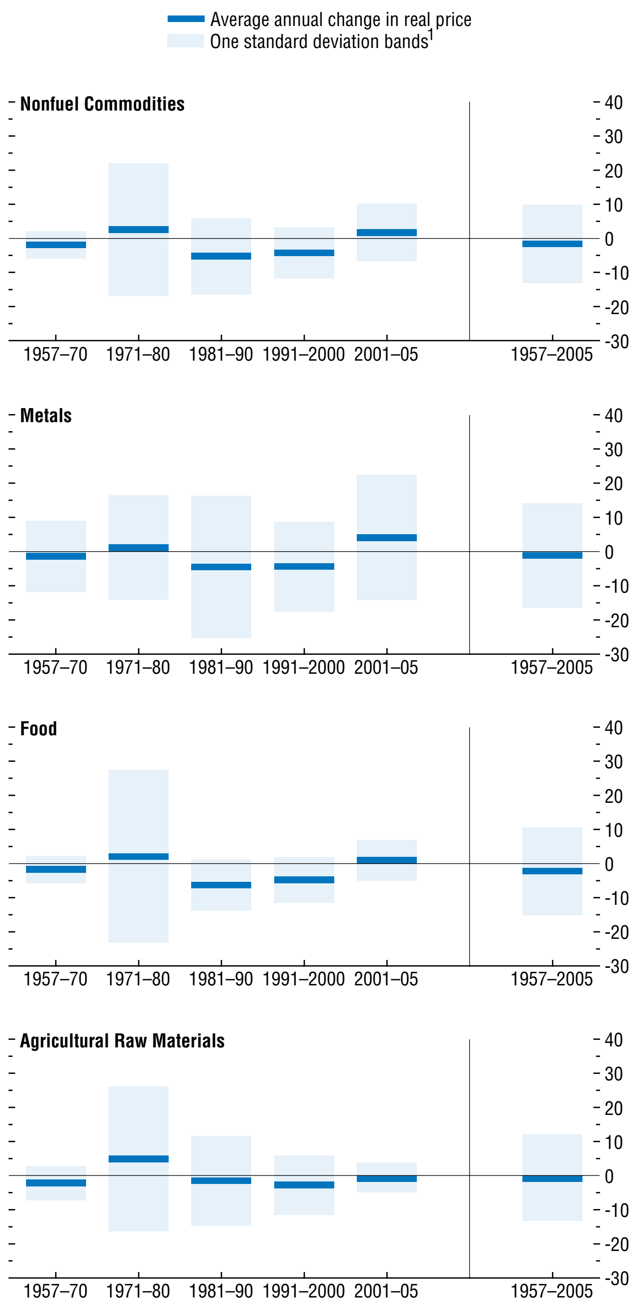
Sources: Cashin, Liang, and McDermott (2000); Grilli and Yang (1988); IMF, Commodity Price System database; UNCTAD, Handbook of Statistics database; and IMF staff calculations.

[1]Price data for 2006 are based on the average of January–June.

[2]Grilli and Yang indexes are only available for the period 1900–87. See Appendix 5.1 for details.

Figure 5.3. Volatility in Nonfuel Commodities Prices
(Percent)

Recent volatility in the nonfuel commodity markets is not unusual by historical standards. In fact, the volatility of food and agricultural raw materials prices has fallen over the past couple of decades as a result of technological advances and geographical diversification of production.



Sources: IMF, Commodity Price System database; and IMF staff calculations.
[1]Standard deviation of annual real price changes.

Nonfuel commodity prices—especially metals—have a strong business-cycle component (Figure 5.4). The correlation between world growth and annual changes in real metals prices is about 50 percent. Moreover, almost all periods of large upward movements in metals prices have been associated with strong world growth. Prices of agricultural commodities also tend to rise during cyclical upturns, but their response is much more muted than in the case of metals because of more flexible supply and the low income elasticity of demand.

Assessment of Recent Developments

Over the past four years, commodity prices have evolved very differently across various subgroups of the nonfuel index (Figure 5.5). Metals prices have risen sharply since 2002 to the present (by 180 percent in real terms), while food and agricultural raw materials prices have increased much less (by 20 and 4 percent, respectively). As a result, metals contributed almost 90 percent to the cumulative 60 percent real increase in the IMF nonfuel commodity index since 2002 (Table 5.2).

The current price dynamics of food and agricultural raw material prices are similar to earlier cyclical episodes (Figure 5.6). In fact, some of the increase in food prices accumulated since 2001 can be attributed to the depreciation of U.S. dollar—real food prices expressed in the IMF's special drawing right (SDR) are now only 9 percent higher than four years ago, and the SDR prices of agricultural raw materials are lower than their 2002 level.

Until recently, metals prices have also tracked historical patterns[5]—but the continued run-up in metals prices this year has made the cumulative price increase significantly larger than usual. A part of the unusually strong run-up in metals prices can be attributed to low invest-

[5]Metals prices have increased by over 75 percent during previous cyclical upturns, reflecting long gestation lags for increasing capacity in the industry and the low price elasticity of demand.

Table 5.2. Decomposition of IMF Nonfuel Commodities Price Index, 2002–06[1]

(Prices expressed as real changes; contributions to growth in percent)

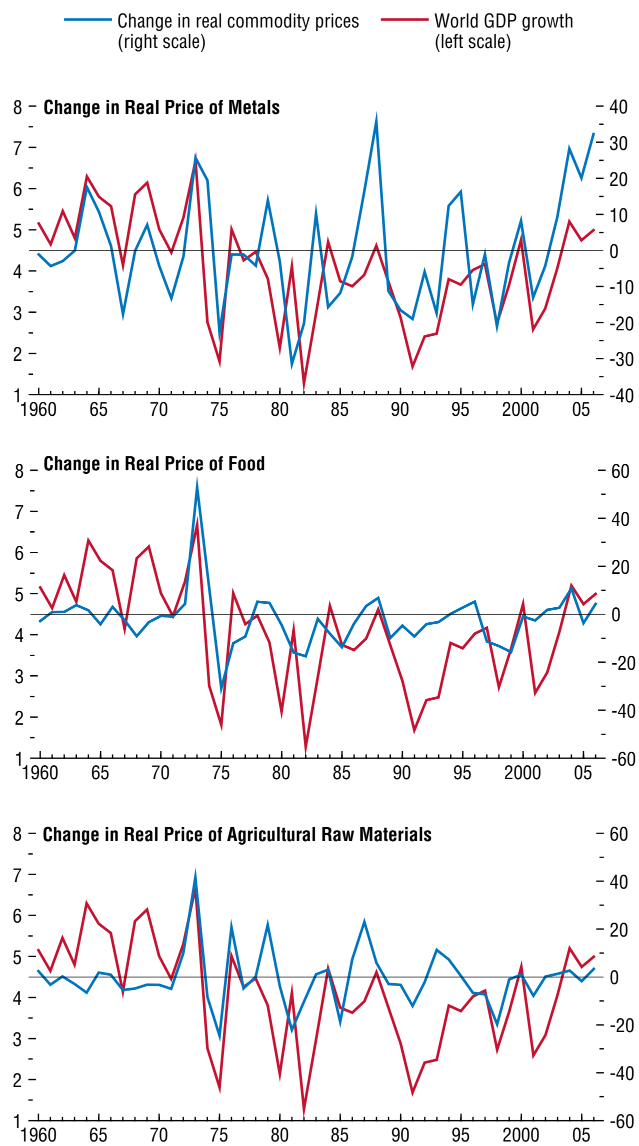
	Prices in U.S. Dollars[2]		Prices in Special Drawing Rights (SDRs)[3]	
	Increase	Contributions to increase	Increase	Contributions to increase
All nonfuel commodities	60.1	100.0	45.3	100.0
Metals	179.7	87.5	153.5	99.3
Food	19.9	7.7	8.9	4.6
Beverages	21.5	1.8	10.4	1.1
Agricultural raw materials	4.3	3.1	–5.3	–5.0

Sources: IMF, Commodity Price System database; and IMF staff calculations.
[1]Data for 2006 refer to July 2006.
[2]Prices deflated using U.S. consumer prices.
[3]Prices deflated using the weighted average of consumer prices in SDR basket countries.

Figure 5.4. Commodity Prices over the Business Cycle[1]

(Annual percent change; prices deflated by U.S. CPI)

Nonfuel commodity prices are correlated with global growth. However, the response of food and agricultural raw materials prices to cyclical conditions is much more muted than in the case of metals.



Sources: IMF, Commodity Price System database; and IMF staff calculations.
[1]Price data for 2006 are based on the average of January–June.

ment in the metals sector in the late 1990s and the early 2000s that followed a period of earlier price declines. Some analysts have also suggested that the intensity of the price upswing in this cycle has been amplified by new factors—the increasing weight of rapidly growing emerging markets (especially China) in the world economy and investment activity of financial investors in commodity markets.[6] All these potential explanations are further examined below.

Role of Emerging Markets

China has become a key driver of price dynamics in the metals markets. During 2002–05, China contributed almost all of the increase in the world consumption of nickel and tin (Table 5.3). In the cases of lead and zinc, China's contribution even exceeded net world consumption growth. For the two most widely traded base metals (aluminum and copper) and for steel, the contribution of China to world consumption growth was about 50 percent.[7] These

[6]The September 2006 edition of the IMF's *Global Financial Stability Report* discusses the growing allocation of investors' portfolios in commodities markets.

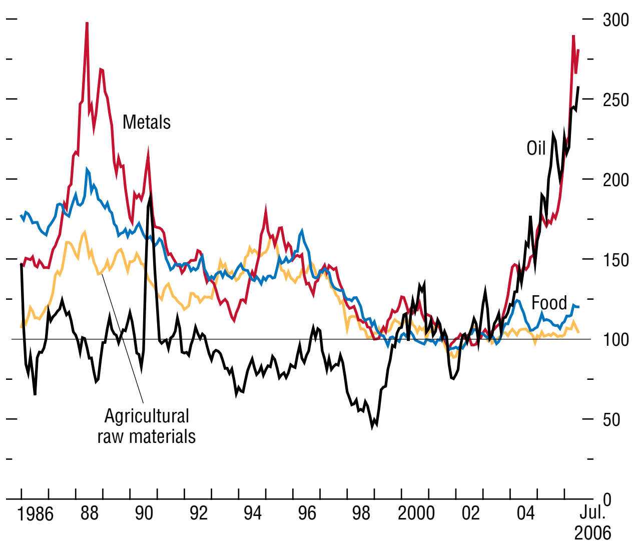
[7]Interestingly, Chinese demand made up a higher proportion of world demand growth for metals than for oil.

figures exceed China's 29 percent contribution to world PPP-adjusted GDP growth and are much higher than the current 15 percent share of China in world output. Compared with the last decade, the relative contribution of China to global demand for commodities has increased considerably, as a result of both its rising weight in the world economy and its particularly rapid industrial production growth—including industrial exports—which is closely linked to the demand for metals.[8] Other emerging market countries have also contributed significantly to demand in specific metals markets but, overall, their contribution was not as broad-based as China's (Table 5.3).[9]

Is the strength of Chinese demand for metals temporary or permanent? Historical patterns suggest that consumption of metals typically grows together with income until about $15,000–$20,000 per capita (in purchasing power parity, or PPP, adjusted dollars) as countries go through a period of industrialization and infrastructure building (Figure 5.7). At higher incomes, growth typically becomes more services-driven and, therefore, the use of metals per capita starts to stagnate.[10] So far, China (with its current PPP-adjusted real income of about $6,400 per capita) has generally tracked the patterns of Japan and Korea during their initial development phase. For some metals, China's per capita consumption at a given income level is higher than in the other emerging markets, partly because it has a much greater share of industry in its gross domestic product than is

Figure 5.5. Recent Developments in Commodity Prices
(2002 = 100; monthly data; prices deflated by U.S. CPI)

During the past four years, metals prices have increased more than oil prices and have contributed heavily to the overall rise in the index of nonfuel commodity prices.



Sources: Haver Analytics; IMF, Commodity Price System database; and IMF staff calculations.

[8]China has become the largest consumer of several key metals, generating about one-quarter of the total world demand for aluminum, copper, and steel. For comparison, China contributes 8–25 percent of the world industrial value added, depending on whether current or PPP-adjusted exchange rates are used for currency conversion.

[9]For example, Russia accounted for 25 percent of the increase in world copper demand during 2002–05, but only 0.5 percent of the rise in aluminum consumption.

[10]Demand for metals can continue to rise even at higher income levels if metal-intensive industrial sectors continue to grow strongly (such as, for example, in Korea).

typical for other countries at a similar stage of development (Figure 5.8; see also Chapter 3). This outcome reflects historical antecedents[11] as well as the strong competitiveness of the Chinese economy and relocation of manufacturing production from advanced economies and other emerging markets to China.

Looking ahead, rapid industrial output growth, construction activity, and infrastructure needs could sustain the growth of demand of emerging markets for metals at high rates in the medium term. That said, some of the current demand strength could be temporary—especially as the Chinese government is aiming at a rebalancing of growth from investment to consumption over the medium term. Moreover, China's size and heavy concentration in industry make it somewhat a special case. India's industrial sector, for example, has a considerably lower share in the economy, and India's continued rapid growth would in the medium term have a less pronounced impact on metals markets than growth in China.

The impact of emerging markets on agricultural prices is less clear-cut. China and other fast-developing countries have often contributed significantly to world demand growth (e.g., in the cases of cotton and beef; see Table 5.4).[12] However, this has not necessarily led to rising prices—the price of cotton, for example, fell by almost 20 percent during 2004–05. Generally, food consumption in developing countries shifts gradually toward high-protein commodities such as meats, dairy products, and oils (FAO, 2004b). But this type of substitution has started at a much lower level of income in China and other countries—for example, meat consumption growth was particularly fast in China when its per capita income was below $3,000 in PPP

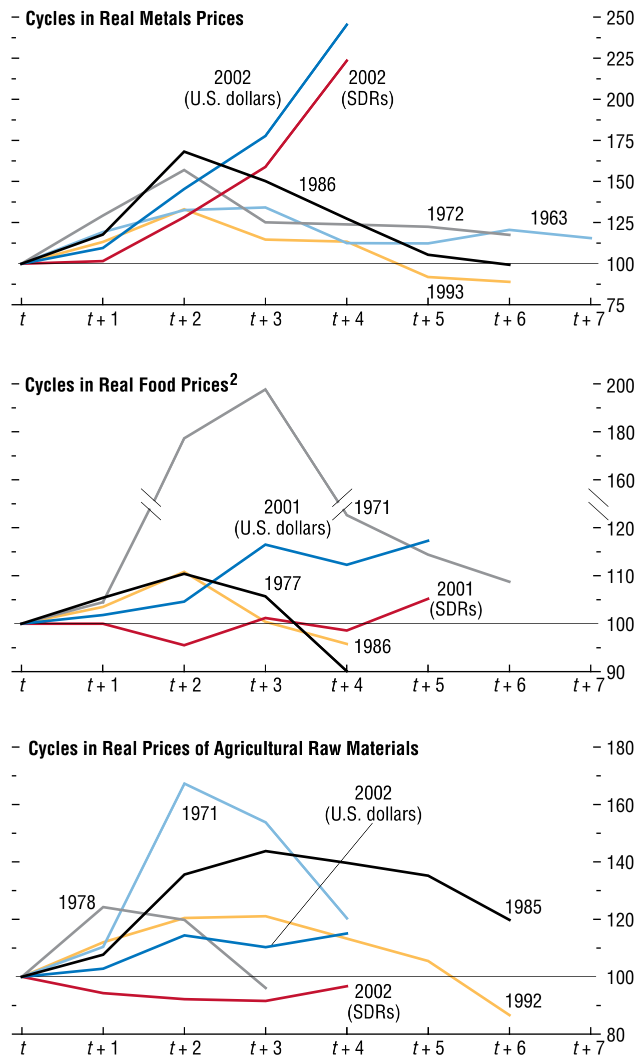
[11]A high degree of industrialization was common in many former centrally planned economies.

[12]The contribution of China to food consumption growth tends to be lower than in the cases of metals and other intermediate commodities, such as cotton. As discussed above, the more prominent role of China in the intermediate commodity markets reflects the very strong growth of industrial production in China.

Figure 5.6. Perspective on the Recent Price Developments, 1957–2006[1]

(Bottom of the cycle at time t = 100)

The current dynamics of real food and agricultural raw materials prices expressed in U.S. dollars are similar to earlier cyclical episodes. After accounting for exchange rate changes, both food and raw materials prices are very close to their levels from four years ago. Until recently, metals prices have also tracked historical patterns, but the continued run-up in metals prices this year has made the cumulative price increase significantly larger than usual.



Sources: IMF, Commodity Price System database; and IMF staff calculations

[1]Commodity prices are expressed in constant U.S. dollars and are indexed such that cyclical troughs have a value of 100. The most recent episode of rising commodity prices is also expressed in constant special drawing rights (SDRs). Price data for 2006 are based on the average of January–June.

[2]Double slash denotes a break in the scale of the vertical axis.

Table 5.3. Consumption of Industrial Metals and Oil
(Consumption expressed as real annual percent change; contributions to growth in percent)

	1993–2002			2002–05[1]		
	World consumption growth	Contribution to growth of: China	Contribution to growth of: Other major emerging markets[2]	World consumption growth	Contribution to growth of: China	Contribution to growth of: Other major emerging markets[2]
Metal						
Aluminum	3.8	38	9	7.6	48	9
Copper	3.5	43	15	3.8	51	41
Lead	3.0	42	15	4.3	110	–7
Nickel	4.4	12	–11	3.6	87	–11
Steel	3.4	38	11	9.2	54	8
Tin	1.3	34	16	8.1	86	2
Zinc	3.4	42	10	3.8	113	7
Oil	1.5	21	18	2.2	30	7

	1993–2000	2002–05
	(In percent)	
Memorandum items:		
World GDP growth	3.5	4.8
China's share in world GDP	10	13
China's industrial production growth	10.5	16.2

Sources: International Energy Agency; International Iron and Steel Institute, *Steel Statistical Yearbook* (various issues); World Bureau of Metal Statistics, *World Metal Statistics Yearbook* (various issues); and IMF staff calculations.
[1]The sample is selected to match the recent period of rising real metal prices. Due to limited data availability, figures for steel are over the period 2002–04.
[2]Brazil, India, Mexico, and Russia. Due to missing data for 2005, Russia is not included in the group for oil.

terms. The contribution of China to consumption growth in some key commodity markets such as bananas, beef, corn, and cotton was higher than its population share during much of the past decade without any noticeable break in the trend of falling real prices (Table 5.4 and Figure 5.5). A similar point can also be made about India and other major emerging market countries.

Will the Recent Run-Up in Metals Prices Be Sustained?

A central question, especially for metal-exporting countries, is whether the recent run-up in prices will prove lasting, or whether the longer-term downward price trend discussed earlier will eventually reassert itself.

Commodities futures markets suggest that the current high prices may not be sustained in the medium term.[13] Over the next five years, the futures prices of metals retain only about one-half of the increase accumulated since 2002 (in real terms, metals prices fall by 45 percent from current levels; see Figure 5.9). This decline contrasts with oil futures prices, which remain very close to the current spot price. There are differences within the group of metals—for example, aluminum futures prices decline less over time (by 31 percent) than copper futures prices (49 percent in real terms). Against this background, Box 5.1 examines the role of financial investors in determining commodity prices. The analysis suggests that while the investors may have played a role in providing liquidity to the markets, there is little evidence that speculative investments have been a significant driver of nonfuel commodity price movements.

[13]While futures prices are not accurate predictors of future spot prices, they nevertheless reflect current beliefs of market participants about forthcoming price developments. Bowman and Husain (2004) find that futures-prices-based models produce more accurate forecasts than the models based on historical data or judgment, especially at long horizons.

The market price of base metals is typically close to the production costs of marginal (i.e., relatively less-efficient) producers—especially at the bottom of the cycle (Deutsche Bank, 2006; see Table 5.5). During booms, the market price can rise to a multiple of the production cost, although over the past couple of decades, the market price has tended to return to a little above costs within a few years. For aluminum, copper, and nickel, the current ratios of market price-to-cost in the range of 1½–2¾ are similar to, or somewhat higher than, those experienced during the cyclical peak in the late 1980s. Back then, it took approximately two years for the market price to come down from the peak to near the cost level. For aluminum, the market-to-cost price ratio is currently less elevated than for the other base metals, supporting the indications from the futures markets that price declines are likely to be less pronounced for this metal.

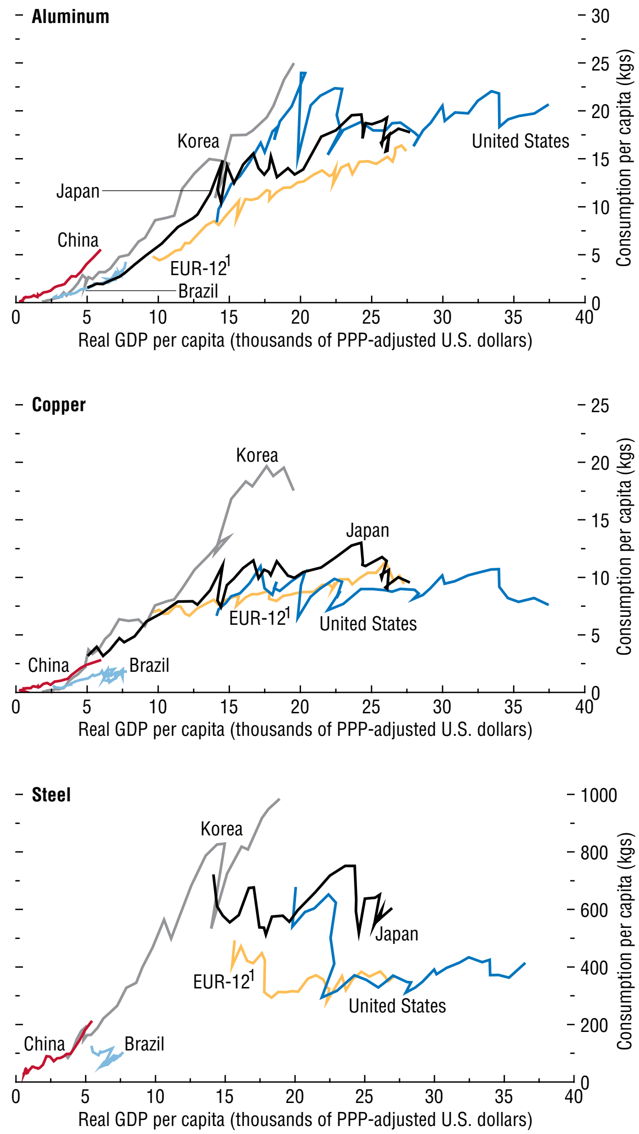
Production costs vary considerably over time, mainly reflecting energy prices, exchange rate changes, and cyclical factors, such as availability of skilled personnel and hardware. During 2002–05, production costs escalated for all metals reported in the table—by about 20–50 percent for the marginal producers—with rising energy costs playing a significant part.[14] It is clear, however, that the doubling to tripling of market prices over the past four years cannot be fully explained by the cost structure of the industry.

Since demand for metals seems to be rising due to higher global growth and rapidly increasing income and industrial production in large countries such as China, the speed and costs of supply additions will determine whether metals prices retreat from the current high levels in the medium term. To bring the demand and supply factors affecting the metals market together in a more complete framework, two parallel models were built for aluminum and copper

[14]According to Alcan (2006) and Alcoa (2004), energy costs account for about 30 percent of the cost structure of refined aluminum.

Figure 5.7. Consumption of Base Metals and Steel, 1960–2005

Per capita consumption of base metals and steel generally rises with income. Some countries reach saturation in their per capita consumption at income levels between 15,000–20,000 purchasing-power-parity (PPP) adjusted U.S. dollars. Demand for metals, however, can continue to grow even at higher income levels if industrial production and construction contribute significantly to growth.

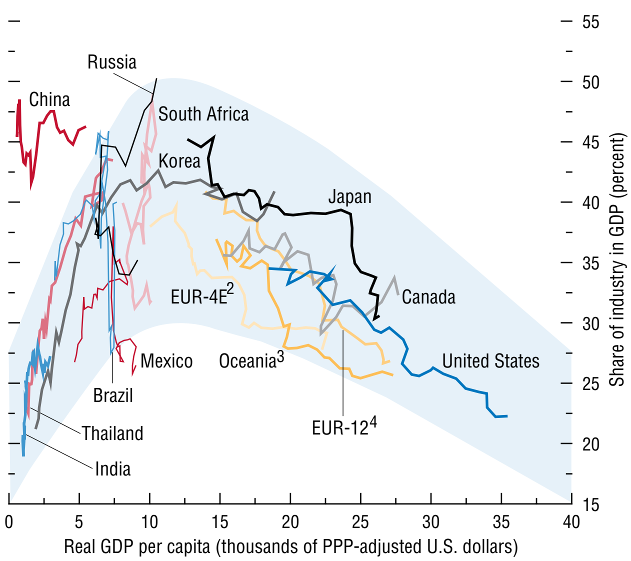


Sources: International Iron and Steel Institute, *Steel Statistical Yearbook* (various issues); World Bank, *World Development Indicators* (2006); World Bureau of Metal Statistics, *World Metal Statistics Yearbook* (various issues); and IMF staff calculations

[1]Austria, Belgium, Denmark, Finland, France, Germany, Italy, the Netherlands, Norway, Sweden, Switzerland, and the United Kingdom.

Figure 5.8. The Importance of Industry at Various Stages of Economic Development, 1965–2004[1]

At low income levels, countries tend to go through a period of industrialization and infrastructure building. At incomes of about 15,000 purchasing-power-parity (PPP) adjusted U.S. dollars per capita, growth becomes more services-driven and the share of industry in GDP starts to fall. China has an unusually large share of industry in its economy relative to its peers from the same income group.



Sources: World Bank, *World Development Indicators* (2006); and IMF staff calculations.
[1]Industry share for country groups were aggregated using 2004 PPP-adjusted real GDP values as weights.
[2]Greece, Ireland, Portugal, and Spain.
[3]Australia and New Zealand.
[4]Austria, Belgium, Denmark, Finland, France, Germany, Italy, the Netherlands, Norway, Sweden, Switzerland, and the United Kingdom.

that together account for over two-thirds of the IMF metals price index. Each model consists of four parts (the full model is described in Appendix 5.1).

- First, demand for each metal is estimated as a function of industrial production and the real price (relative to consumer prices) for 17 country groups that together make up about 90 percent of world metal consumption. The sample period is 1960–2005 and the estimated equations include a lagged endogenous variable.[15] By disaggregating consumption data into many country groups and using industrial production as an explanatory variable, the model broadly captures the nonlinearity between metals consumption and income illustrated in Figure 5.7. The estimated elasticity of demand with respect to industrial production is somewhat higher for emerging market and developing countries than for the advanced economies (for aluminum, 1.2 compared with 1.0; see Table 5.6). This reflects differences in the industrial structure and the lower efficiency of production in developing countries. The long-term price elasticity of demand is estimated at low levels, which is consistent with earlier studies (see, for example, Ghosh, Gilbert, and Hughes Hallett, 1987).[16]
- The second element of the model is a production function that incorporates information about planned increases in capacity as well as a price-elasticity term. Given the gestation lags of several years for building new capacity in the industry, information about the existing green field and brown field projects is critical for the assessment of medium-term supply prospects. The supply projection draws on the expert assessment of the Australian Bureau of Agricultural and Resource Economics (ABARE, 2006). In the model, the

[15]The sample is shorter for some countries due to limited availability of industrial production data.
[16]Substitution across metals is modest even in the medium term and, therefore, is not modeled explicitly. See Appendix 5.1 for details.

Table 5.4. Consumption of Selected Agricultural Commodities
(Consumption expressed as real annual percent change; contributions to growth in percent)

	1993–2001			2001–05[1]		
	World consumption growth	Contribution to growth of: China	Contribution to growth of: Other major emerging markets[2]	World consumption growth	Contribution to growth of: China	Contribution to growth of: Other major emerging markets[2]
Agricultural commodity						
Bananas	2.6	26	45	3.5	15	73
Beef	0.9	102	17	0.8	103	40
Corn	2.6	26	4	2.6	14	19
Cotton	1.1	52	54	5.4	90	12
Sugar	1.6	5	45	2.1	26	27
		1993–2001		2001–05		
			(In percent)			
Memorandum items:						
World GDP growth		3.7		4.4		
China's share in world population		22		21		

Sources: FAOSTAT data (2006); Foreign Agriculture Service official USDA estimates (2006); and IMF staff calculations.
[1]The sample is selected to match the recent period of rising real prices. Owing to limited data availability, figures for bananas are for the period 2001–03.
[2]Brazil, India, Mexico, and Russia.

supply of refined aluminum and copper is allowed to deviate from the ABARE forecast whenever the price projection is different from that assumed by ABARE (see Appendix 5.1 for details).

- Third, a price equation relates the current real price of metals to the market balance (the gap between demand and supply), the exchange rate of the U.S. dollar to SDR (as the metals prices are denominated in U.S. dollars), and other variables.
- Finally, for each of the 17 country groups, equations are estimated to build a link between industrial production and GDP growth rates. These equations are needed since the *World Economic Outlook* projects real GDP growth but not industrial production. The equations are estimated over a shorter sample, 1990–2005, because the relationship between industrial production and GDP changes over time (Figure 5.8).

The estimated model is used to prepare a forecast of demand, supply, and prices in aluminum and copper markets during 2006–10. The main inputs into the model are *World Economic Outlook* GDP forecasts (in turn, determining future demand for metals) and ABARE supply projections (which contain information about forthcoming supply).[17] The results suggest that:

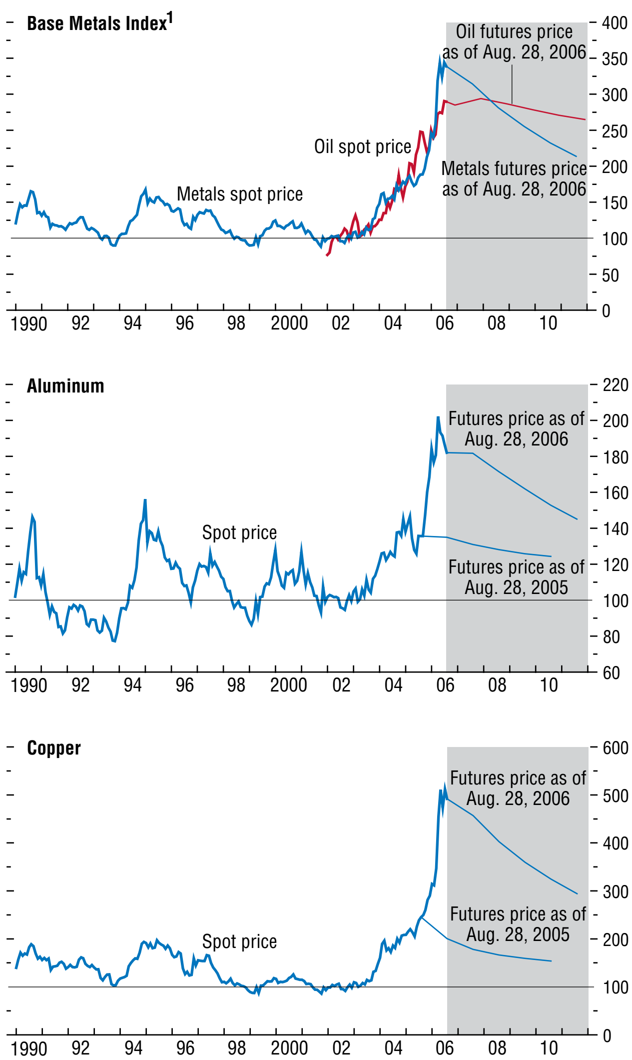
- Consumption of aluminum and copper will continue to grow fast—averaging 5.6 and 4.8 percent a year, respectively—given expected rapid expansion of industrial production in emerging markets, with China contributing about 50 percent to average future demand growth (Appendix 5.1 provides additional details on expected market developments).
- The real annual average price of aluminum and copper will decline from current levels by 35 and 57 percent, respectively, by 2010. In other words, rising supply will be able to meet robust demand growth at falling prices. The price decline is generated by a combination of factors: (1) recent accumulated price increases will have some dampening impact on demand; (2) considerable supply expansion is projected by ABARE in the next five years; and (3) some additional supply is expected to come on stream as the current

[17]The medium-term scenario presented in Chapter 1 of this *World Economic Outlook* expects continued robust world economic growth in the range of 4¾ to 5 percent a year. This represents an increase of ¾–1 percentage point over the average annual growth during 1995–2005.

Figure 5.9. Base Metal Prices on Futures Markets

(2002 = 100; monthly data in nominal terms)

At present, futures markets expect the price of metals to fall gradually to the middle of the range between the current prices and the trough of 2002 (in nominal terms). The expected price decline is smaller in the aluminum industry where the gap between market prices and production costs has been narrower than for the other metals.



Sources: Barclays Capital (2006b); Bloomberg Financial Markets, LP; IMF, Commodity Price System database; and IMF staff calculations.

[1]Weighted average of aluminum, copper, lead, nickel, tin, and zinc prices.

metals prices are higher than in the ABARE projections. In addition, the price forecast reflects the unwinding of the models' error terms, since the recent run-up in prices has been greater than the models would have predicted based on their explanatory variables.[18] Naturally, there is significant uncertainty around these central price projections, reflecting uncertainties about global growth, the speed of supply additions, and the econometric models (Figure 5.10).

- The price of copper is forecast to fall relatively more than the price of aluminum. This is consistent with prices in the futures markets and the fact that the market-price-to-cost ratio is currently much higher for copper than for aluminum (Table 5.5).

Considering price developments beyond 2010, the key issue is whether metals supply would be able to meet rising demand in an environment of continued strong growth. In this regard, several features of the metals markets are important:

- In contrast to hydrocarbons, overall reserves of base metals are practically unlimited (Tilton, 2003).[19]
- While output concentration is high (the top three producing countries account for about 46 percent of refined aluminum production and 41 percent of refined copper production), market structures are competitive and there is currently no formal attempt by producers to control prices. This stands in contrast with the oil industry, where the majority of reserves

[18]The model on average explains 80–90 percent of variability in real prices of aluminum and copper. However, it does not fully capture the price behavior during cyclical peaks. See Appendix 5.1 for details.

[19]Base metals are abundant—for example, aluminum and iron account for over 8 and 5 percent, respectively, of the earth's crust. The resource base for many metals could therefore last hundreds of years, although only a fraction of these supplies can be extracted profitably using the current technology (Tilton, 2003). Moreover, the metals are not destroyed when processed and used, and can be recycled, which would further increase the estimates of reserves life expectancy. For comparison, the International Energy Agency (2004) estimates that the remaining oil resources could cover 70 years of annual average consumption between 2003 and 2030.

Table 5.5. Cash Costs of Production for Selected Base Metals
(U.S. dollars per ton)

			Marginal Cost[1]			
	Year	Phase of Cycle	Typical producer[2]	Least-efficient producer[3]	Market Price	Ratio of Price to Marginal Cost[4]
Aluminum	1985	Trough	1,000	1,200	1,000	0.8
	1988	Peak	1,200	1,400	2,500	1.8
	2002	Trough	1,000	1,200	1,400	1.2
	2005	Upturn	1,500	1,800	1,900	1.1
	2006	Current	. . .	. . .	2,500[5]	1.4[6]
Copper	1985	Trough	1,000	1,400	1,400	1.0
	1989	Peak	1,300	1,800	2,800	1.6
	2002	Trough	1,000	1,500	1,600	1.1
	2005	Upturn	1,200	2,200	3,700	1.7
	2006	Current	. . .	. . .	6,100[5]	2.8[6]
Nickel	1985	Trough	3,400	5,300	4,900	0.9
	1988	Peak	4,000	7,400	13,800	1.9
	2002	Trough	3,700	6,100	6,800	1.1
	2005	Upturn	4,700	7,300	14,800	2.0
	2006	Current	. . .	. . .	17,400[5]	2.4[6]

Sources: Brook Hunt Metal Consultants; Deutsche Bank (2006); and IMF staff calculations.
[1]Operating cash cost of production rounded to the nearest hundred.
[2]50th percentile of the industry cost curve.
[3]90th percentile of the cost curve.
[4]Cost of the least-efficient producers.
[5]Average January–June.
[6]Relative to the 2005 marginal cost.

Table 5.6. Estimated Elasticities of Demand for Selected Base Metals

	Industrial Production	Price Deflated by CPI
Aluminum	1.1	–0.01
Advanced economies	1.0	–0.03
Emerging markets	1.2	0.00
Copper	1.1	–0.04
Advanced economies	0.7	–0.04
Emerging markets	1.6	–0.04

Source: IMF staff calculations.
Note: Elasticities are weighted using 2005 metal consumption shares. See Appendix 5.1 for the description of country groups.

are controlled by OPEC countries and there is a long tradition of attempted price management.[20]

- While investment gestation lags can reach three to five years in the sector (or more in case of green field investments), they are generally shorter than in the oil industry.

These supply-side factors tilt the long-term price risks for metals to the downside and clearly differentiate the metals sector from the oil market where prices are expected to remain high in the foreseeable future.[21]

Outlook for Food and Other Agricultural Commodities

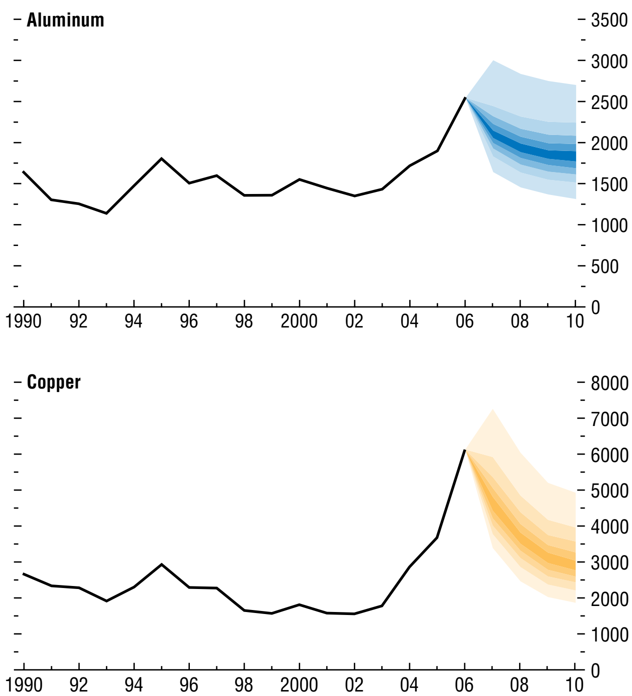
As noted above, rapid growth in emerging market economies has not had a noticeable

[20]Gilbert (1996) discusses several past attempts to control prices in nonfuel commodity markets. These have failed for a variety of reasons, including emergence of alternative supplies, coordination problems, and disagreement over the division of benefits.

[21]Oil prices are currently being kept high by robust oil demand, geopolitical developments, and limited spare production capacity (Appendix 1.1). Chapter IV, "Will the Oil Market Continue to Be Tight?," in the April 2005 *World Economic Outlook* documents frictions on the supply side of the oil industry that may prevent long-term oil prices from returning to the average levels of the 1990s. These include, among other factors, the limited potential for production growth in the non-OPEC region and the lack of incentives for OPEC countries to increase long-term output sufficiently to help lower oil prices to the levels typical during the previous decade.

Figure 5.10. Model-Based Forecasts of Aluminum and Copper Prices[1]
(U.S. dollars per ton)

The demand and supply analysis suggests that aluminum and copper prices should moderate by the end of this decade. However, the estimated price range is very wide, reflecting uncertainties about global growth, capacity expansion in the metal industry, and the econometric model.



Sources: IMF, Commodity Price System database; and IMF staff estimates.
[1]The fan chart corresponds to a 95 percent probability band for future metal prices. Each shade represents a 10 percent likelihood with the exception of the central band (represented by the darkest shade in the fan), which represents a 15 percent likelihood. See Appendix 5.1 for details.

impact on price trends for agricultural commodities. Prices of food and raw materials are also much less sensitive to cyclical conditions than metals. Clearly, the speed of supply response is significantly faster in the agricultural sector than in metals—for example, crops can be switched from harvest to harvest relatively quickly in response to price signals. Moreover, the demand for agricultural commodities is less cyclical and therefore more predictable.

Given these factors, long-term agricultural prices will mostly be determined by productivity gains, which are expected to continue in the future due to technological progress (FAO, 2004b). Prices of some agricultural commodities will be influenced—like metals—by rising input costs, especially fertilizers whose price is linked to oil. Baffes (2006) estimates that the average pass-through from higher oil prices to agricultural prices is about 0.18. This factor (together with exchange rate changes) can explain why the current food price cycle—while very benign—has exhibited some persistence (Figure 5.6). However, as the example of cotton illustrates, weather-related supply shocks are the main source of price volatility in the agricultural sector and year-to-year fluctuations in the harvest size can dominate the impact of higher input costs for specific commodities.

For a narrow group of commodities, the price pressures from higher energy costs may be more substantial. These are the commodities that have a particularly large exposure to the oil market—such as sugar (through ethanol production for flex-fuel cars in Brazil), natural rubber (substitute for synthetic rubber produced from oil), and possibly also corn (fuel for flex-fuel cars in the United States).

In the future, agricultural prices could also be affected by shifts in the agricultural support system in the advanced economies. Production subsidies and import tariffs in advanced economies have served to systematically lower world prices for agricultural products, and successful completion of a multilateral agreement to reduce this support system would be expected to raise prices of certain key commodi-

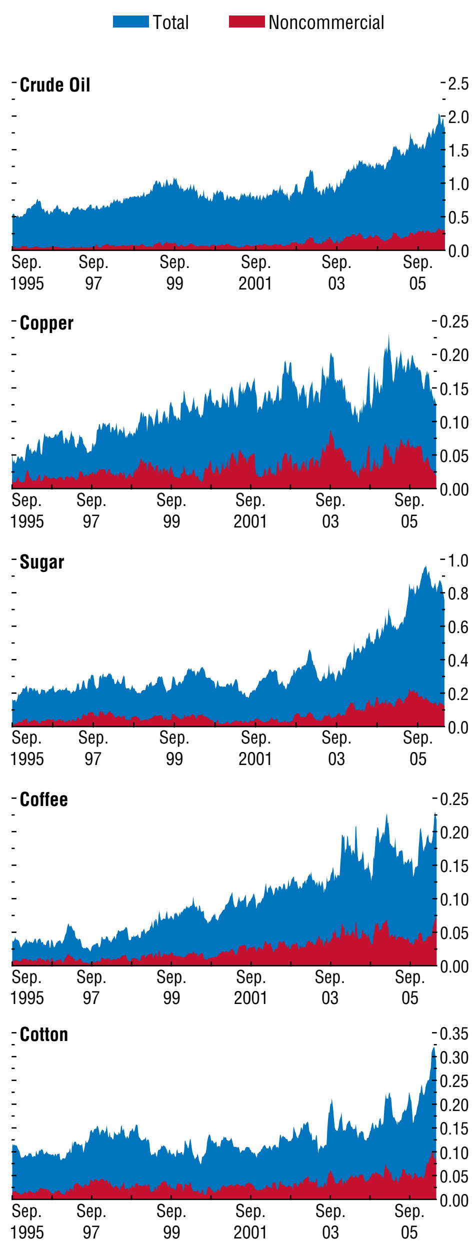
Box 5.1. Has Speculation Contributed to Higher Commodity Prices?

Investor interest in commodity futures as assets has increased significantly in recent years. For example, participation in the NYMEX oil futures market—as measured by the number of contracts reported by the U.S. Commodity Futures Trading Commission (CFTC)—has risen almost fourfold since 1995 (first figure). Furthermore, the share of noncommercial contracts (long plus short—or total open positions) has steadily increased over this period—from 9 percent to 16 percent of the total. A similar trend can be observed in other commodity markets. The value of noncommercial contracts, however, is not large relative to total transactions in the physical market over a comparable period.[1]

The increased investor interest has led some private analysts to suggest that speculative activity has been a major contributor to the recent surge in crude oil and metals prices and may have even caused a bubble (see, for example, Societe Generale, 2006). They argue that speculation has magnified the impact of changes in the fundamental determinants of supply and demand (which have been supportive of higher prices) to an extent that in some cases prices have risen far in excess of levels justified by fundamentals.[2] The Organization of the Petroleum Exporting Countries (OPEC) has also suggested that while geopolitical uncertainties have been a major force behind higher prices, speculation has also been a significant factor, given the organization's accommodative supply policies and the historically high level of inventories in OECD countries.[3] Despite

Number of Positions in Commodity Markets

(Long plus short; in millions of contracts)



Source: Commodity Futures Trading Commission.

Note: The authors of this box are Sergei Antoshin and Hossein Samiei.

[1]For example, the value of total crude oil non-commercial positions of all maturities (up to six years) in the NYMEX is currently only about 3 percent of the value of U.S. oil consumption over six years at current prices. Contracts up to one-year maturity are equivalent to about 10 percent of U.S. consumption over one year.

[2]Note that speculators may also appear to affect prices if they have additional information that helps them make better forecasts than the average trader.

[3]See, for example, OPEC's press release "OPEC reassures market of continuing commitment to stability," July 14, 2006 at http://www.opec.org.

Box 5.1 *(continued)*

the attractiveness of some of these arguments, however, the supporting evidence has often focused on correlations rather than tests of causality, and has tended to be anecdotal or circumstantial—based on, for example, the increased hedge fund activity accompanying the rise in prices or the deviation of prices from long-run marginal costs. The lack of solid evidence in part reflects data and definitional problems associated with defining and measuring speculation.

A price bubble is certainly a theoretical possibility and a periodic occurrence in financial and housing markets. Excessive speculation in the commodity futures market could, in principle, push up futures prices and (through arbitrage opportunities) spot prices above levels justified by fundamentals. However, an alternative view is that increased investor activity, by providing the necessary liquidity, is simply a vehicle to translate changing views about fundamentals into changing prices. In this case, higher prices would be the cause (rather than the effect) of increased investor participation. In the intermediate case, there could be a two-way causality between prices and speculation, so that higher prices induce an increase in speculation, which in turn pushes prices up further until a new equilibrium is achieved.

Note also that the supposed impact of speculation is sometimes confused with the so-called "security premium," which essentially reflects concerns about future fundamentals (e.g., potential shortages because of geopolitical developments). The security premium, in contrast to speculation, results from a genuine desire by consumers to hedge against risks. Such a precautionary desire could push up prices—for example, by raising demand for inventories—as has happened in the oil market where global inventories are at record levels, likely because of concerns about future supply (leading to higher precautionary demand) rather than (as argued by some commentators) genuine excess supply in the spot market.

To assess the empirical validity of the speculation hypothesis, this box provides an econometric assessment of the direction of causality between movements in spot and futures prices,[4] and changes in speculative positions in a sample of major commodities, comprising crude oil, copper, sugar, coffee, and cotton (Appendix 5.2 provides details of the approach taken). The objective is to test for the presence of a set of relationships between these three variables that goes beyond anecdotal evidence or one-off events.

A related issue of interest is whether speculation stabilizes or destabilizes prices—that is, whether speculation reduces or increases the amplitude of price fluctuations around equilibrium. While this issue is not the focus of this box, the causality tests carried out in the box can throw some light on the matter. Specifically, to the extent that the presence of stabilizing or destabilizing effects requires speculators to systematically influence price changes (as opposed to broader measures of volatility), the absence of causality from speculation to price levels could be taken to suggest that speculators are neutral as far as price fluctuations are concerned.

Two caveats/clarifications are in order before describing the results. First, a thorough analysis of price formation in the commodity markets would require a more complete model incorporating the role of current fundamentals (supply and demand factors) and perceptions about future fundamentals (including the fear factor). Such an exercise, however, is constrained by the lack of high-frequency data on most fundamental factors and given that the relationship between speculation and prices is most important in the short term.

Second, empirical analysis is hampered by definitional problems related to information on types of trader. The CFTC reports on a weekly basis the number of contracts for two categories of traders: commercial and noncommercial. Commercial traders are defined as those who use futures contracts for the purpose of hedging (e.g., oil producers, merchants, and major consumers, such as airlines). Other participants

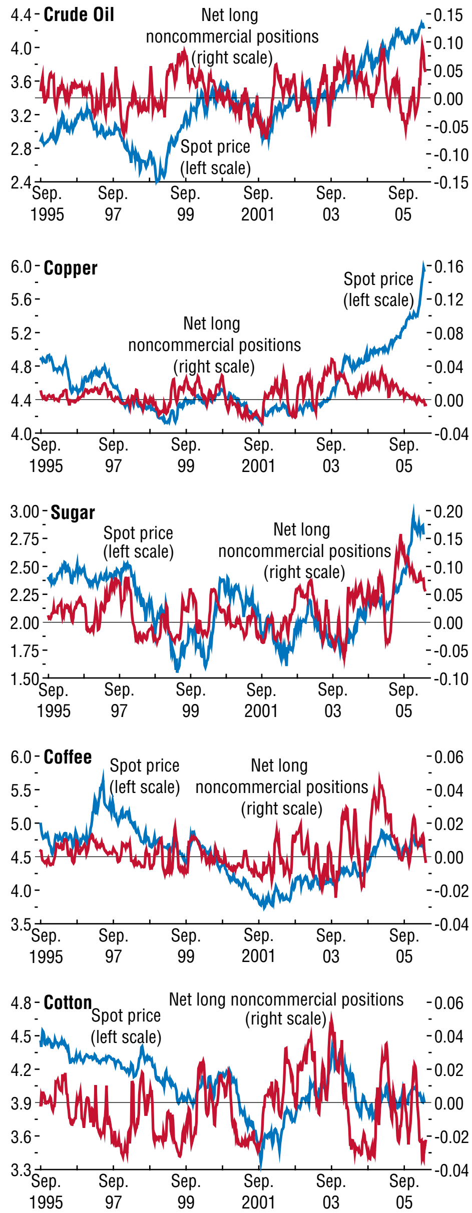
[4]One-year ahead futures prices are used since activity is the largest in this market. The results were broadly similar for longer-dated maturities.

are treated as noncommercial traders. Noncommercial traders are clearly speculators, as they take positions in the market to bet on price changes. However, some of the traders classified as commercial may also be engaged in speculative activity. For example, commodity index traders, who are classified as commercial, may take market positions that are driven by speculative motives from the clients' perspective. Since the CFTC only reports the data in an aggregated form, one cannot distinguish amongst trader types within the commercial category and isolate those that may potentially qualify as speculators. Nevertheless, a recent CFTC study using disaggregated unpublished data collected by the Commission suggests that, among commercial traders, the main groups that may potentially be involved in speculation (namely, managed money traders, including hedge funds) do not appear to impact price volatility and act largely as providers of liquidity (see Haigh, Hranaiova, and Overdahl, 2005). Note also that since data is weekly (measuring the activity on the Tuesday of each week), it is not possible to capture the impact of within-the-week activity, which could be significant.[5] Finally, CFTC data do not distinguish the contracts by maturity. Therefore, it is not possible to study the relationship between speculation and futures prices of different maturities. Subject to the above limitations and considerations, this box uses the number of net long noncommercial positions as a proxy for speculation.[6]

The second figure shows the behavior of spot prices and the number of speculative positions

Commodity Prices and Speculative Positions

(Spot prices in log scale; net long noncommercial positions in millions of contracts)



Sources: Bloomberg Financial, LP; and Commodity Futures Trading Commission.

[5]Note that in the following analysis, average weekly prices (Tuesday to Monday) are used to partly overcome this problem. Using prices for each Tuesday produced qualitatively similar results.

[6]Note that since each contract comprises a fixed volume, using the number of positions is equivalent to using volumes. Note also that the alternative of total open noncommercial positions (i.e., the sum of short and long positions) would not be a suitable measure because a rise in this variable could result from a rise in short or long positions, which have potentially opposite impacts on prices.

Box 5.1 *(concluded)*

for various commodities. This figure suggests two generalizations. First, prices appear less volatile than speculative positions across commodities, with no discernible common trend between prices and speculation. For example, in the crude oil market there has been no persistent pickup in net long noncommercial positions in recent years when oil prices have had a strong upward trend. More strikingly, in the copper market, net positions have actually fallen steadily over the past year, during which prices have reached record highs, suggesting that contrary to common perceptions, speculation may not have played a major role in the recent price run-up. Second, while the series do not appear to be correlated over the long run, for most commodities some correlation appears to be present over subperiods, as peaks and turning points seem to occur around the same time across the two series.[7] The key question then concerns the direction of causality.

The visual analysis suggests the relevance of distinguishing short- and long-run causality. To this end, and to account for the nonstationarity of the price and speculative positions series, a Vector Error Correction Model (VECM) is employed (see Appendix 5.2 for details). Furthermore, given that the relationships have varied over time, and to enhance the reliability of the results, the parameters are estimated using rolling regressions. This approach will, in particular, allow us to assess whether speculation has played a major role in the recent episode of rising prices.

The results from the regressions for the five commodities—summarized in Table 5.11 in Appendix 5.2—indicate that the short-run causality generally runs from spot and futures prices to speculation, and not vice versa.[8] This is true even when the long-run (error-correction) term is removed from the estimation.[9] This finding is rather consistent across commodities. For crude oil, speculation appears to have had a significant but very small effect on futures prices. However, this has not been translated into a causal impact on spot prices. This finding is consistent with previous work by IMF staff on the oil market (which tested for causality in the frequency rather than time domain and used longer-dated futures prices).[10]

Turning to the long run, while the estimated parameters vary considerably over time, the three series are mostly cointegrated, permitting an analysis of causality. The results suggest that whenever there is cointegration, causality is from prices to speculative activity, and not vice versa. In the case of cotton, there is some evidence of two-way causality—although the absence of short-run causality from speculation to prices weakens the importance of this result. Finally, based on measured correlation coefficients, the model explains a much larger part of variations in speculation than variations in spot or futures prices.

All in all—and subject to the data limitations stressed at the outset—the results for the five commodities in the sample provide little support for the hypothesis that speculative activity (as measured by net long noncommercial positions) affects either price levels over the long run or price swings in the short run. In contrast, there is evidence (both across commodities and over time) that speculative positions follow price movements. These findings are consistent with the hypothesis that speculators play a role in providing liquidity to the markets and may benefit from price movements, but do not have a systematic causal influence on prices.

[7]For clarity, futures prices are omitted from the figure, but these generalizations apply equally well to the relationship between speculative positions and futures prices.

[8]Similar results are reported—using a different approach and sample—for energy futures markets by Sanders, Boris, and Manfredo (2004).

[9]The reason for this additional robustness check is that in the absence of cointegration, the short-run causality tests in the VECM may not be valid since the error-correction terms would be I(1).

[10]See Appendix 1.1 in the September 2005 *World Economic Outlook*.

ties. As discussed in Box 5.2, such agricultural reforms would have important implications for income in many developing countries, although the impact on world food prices is likely to be smaller than the year-to-year volatility from weather-related shocks.

Conclusion

Most of the recent increase in nonfuel commodity indices is due to metals. The current upturn in their prices has been amplified by rapid growth in emerging market economies, particularly in China. Over the medium term, however, metals prices are expected to retreat from recent highs as new capacity comes on stream, although probably not falling back to earlier levels—in part because higher energy prices have increased production costs. That said, the timing and the speed of the price reversal is uncertain, because with current high capacity utilization rates and low inventories, markets are very sensitive to even small changes in supply and demand.

This assessment has a number of implications for exporters of metals. Policymakers in exporting countries will need to ensure that the current income windfall is either largely saved—such as in the case of Chile—or used in a way that supports future growth in noncommodity sectors, for example, through investment in education, health, and infrastructure. Fiscal transparency should help to ensure that the most is made from any additional budget revenues. Governments, however, must be prepared for a decline in prices in the future and ensure that spending does not increase above sustainable levels in hard-to-reverse areas such as public sector wages.

The prices of agricultural commodities have increased much less than metals prices and for exporters of these commodities, the main policy question remains how to manage year-to-year volatility. Generally, governments of both exporting and importing countries should approach the volatility in commodity prices—including metals prices—from a "risk management" perspective and incorporate market information about prices and volatility into their fiscal planning and budgetary process. More broadly, governments in commodity-exporting countries should continue to aim at diversifying their economies to help reduce vulnerabilities to commodity price shocks. The IMF also stands ready to provide assistance in cases of extremely large and negative impacts of market volatility on external balances.[22]

Appendix 5.1. Model of Aluminum and Copper Markets

The main author of this appendix is Martin Sommer with consultancy support from Christopher Gilbert and contributions from Angela Espiritu.

The analysis of future price trends in this chapter is based on four integrated models of the demand, supply, and price of metals, and of industrial production. This appendix provides a description of each model.

Demand for Metals

The estimated model takes the following form:

$$\log C_{i,t} = c_i + \alpha_i \log C_{i,t-1} + (\beta_i + \omega_i Dummy_{2000}) \log IP_{i,t} + \gamma_i \log \frac{P_{t-1}}{CPI_{t-1}} + \varepsilon_{i,t},$$

where $C_{i,t}$ denotes metal consumption in country i at time t; c_i is a country-specific constant; $IP_{i,t}$ stands for industrial output in country i at time t; P/CPI is the real price of a metal (United

[22]The Exogenous Shocks Facility (ESF) is available to low-income countries that have defined (or are in the process of defining) their poverty reduction strategy. The assistance takes the form of short-term quick-disbursing concessional loans to meet immediate balance of payments needs. Alternatively, loans can also be provided under the Compensatory Financing Facility (CFF), which assists countries experiencing either a sudden shortfall in export earnings or an increase in the cost of cereal imports due to fluctuating world commodity prices.

Box 5.2. Agricultural Trade Liberalization and Commodity Prices

Rich countries provide hefty support to their agricultural producers in a variety of forms, which tends to raise domestic prices for these products and depress international prices. Such support—including import tariffs, production, and export subsidies, and direct payments to farmers—averages about 30 percent of farm receipts in OECD countries, and is particularly high for rice, sugar, milk, and grains (first table). Low- and middle-income countries also provide support to agricultural producers, mainly through import barriers.

A number of researchers have sought to estimate the magnitude of the increases in world prices of agricultural commodities that would result from cuts in rich-country agricultural support (second table). The estimates vary widely, reflecting differences in modeling approaches, the time frame considered, and the degree of liberalization (e.g., full versus partial reform). As shown, the magnitude of the price increases could be as large as 35 percent for some commodities, although the average percentage price increases are more modest: wheat (5.1), maize (4.6), beef (5.1), sugar (5.8), and rice (5.5). The world price of cotton, a key export of some poor countries in West Africa, is estimated to increase by between 2.3 and 35 percent, with an average estimate of about 13.5 percent. It is worth noting that the average size of the estimated price increases is less than the average year-to-year variation in prices.

These estimated price increases can be thought of as the short-run impact of liberalization. In the long run, the distribution of production and exports would shift across countries. In many OECD countries, liberalization would make it less attractive for farmers to undertake investment and expand production capacity, while agricultural land would be diverted to other uses. In contrast, producers in countries with a comparative advantage in agriculture (e.g., Australia, New Zealand, and Brazil) would expand production following the rise in world prices. It is even possible that the increases in commodity prices could cause some countries that are now importers of agricultural commodities to become exporters. Research has shown that the elimination of agricultural

Note: The main author of this box is Stephen Tokarick.

Support Provided to Various Agricultural Commodities in OECD Countries, 2004

	United States	European Union	Japan	All OECD
	Producer support estimate[1]			
Rice	18	39	82	75
Sugar	56	65	65	58
Wheat	32	39	85	33
Maize	27	43	. . .	31
Beef and veal	4	68	31	34
All commodities	18	33	56	30
	Nominal protection coefficient[1]			
Rice	1.08	1.00	5.46	3.76
Sugar	2.13	3.03	2.79	2.36
Wheat	1.01	1.06	5.50	1.08
Maize	1.15	1.38	. . .	1.20
Beef and veal	1.00	1.99	1.43	1.26
All commodities	1.11	1.29	2.20	1.28

Source: *Agricultural Policies in OECD Countries: Monitoring and Evaluation*, Organization for Economic Cooperation and Development, 2005.

[1]Producer support estimate is defined as the dollar amount of support provided to producers as a percent of the total value of production. The nominal protection coefficient measures the ratio of the prices received by producers of agricultural products to international prices.

Price Changes Resulting from Cuts in Agricultural Support in OECD Countries
(In percent)

	Range of Estimated Price Changes	Average of Estimated Price Changes	Coefficient of Variation of Prices 1990–2004	Average Year-to-Year Percentage Change of Prices[1]
Wheat	0.1–18.1	5.1	16.9	11.8
Maize	0.1–15.2	4.6	17.2	10.1
Beef	0.8–22.3	5.1	15.4	8.6
Sugar	1.1–16.4	5.8	23.9	14.1
Rice	0.1–10.6	5.5	19.6	11.8
Cotton	2.3–35.0	13.5	21.7	17.3

Sources: Mitchell and Hoppe (2006); Food and Agriculture Organization (FAO, 2004a); and staff estimates.

[1]Average of the absolute values of price changes.

Box 5.2 ***(concluded)***

support policies could also reduce the variability of international food prices. For example, Tyers and Anderson (1992) showed that the coefficient of variation in world food prices could be reduced by two-thirds if all countries ceased to insulate their domestic markets. This is because agricultural policies in rich countries are designed to prevent domestic prices from changing rapidly. Domestic supply shocks, such as droughts, are therefore offset through changes in trade volumes in order to keep domestic prices fairly stable. These changes in trade volumes tend to cause international prices to fluctuate to a much greater degree than they would in the absence of agricultural support policies.

Since liberalization of agricultural trade would raise world prices, the import bills of net food-importing countries would likely increase. The estimated price changes suggest that as a group, import bills would rise from between $300 million to $1¼ billion, depending on the degree of liberalization. While these magnitudes are small in aggregate—they represent less than 1 percent of total imports for these countries—a number of low-income countries could experience substantial increases in their import bills, and could require additional assistance to adjust to the higher international prices. For this purpose, in 2004, the International Monetary Fund (IMF) introduced the trade integration mechanism (TIM) to support countries that experience an adverse shift in their terms of trade as a consequence of multilateral trade liberalization, by making resources more predictably available under existing IMF arrangements. Of course, countries could also mitigate at least some of the impact of higher world food prices by reducing their import tariffs.

States CPI is used as a deflator); and $\varepsilon_{i,t}$ is a residual. This model is similar to the specification used by Gilbert (1995).

The model is estimated with ordinary least squares (OLS) using annual data for 17 country groups over 1960–2005. The demand equations do not impose any restrictions on the country-specific coefficients c, α, β, ω, and γ to allow for cross-country heterogeneity (Robertson and Symons, 1992). Consumption of metals is tightly linked to industrial production and the relationship is approximately linear (Figure 5.11). Given evidence provided by Chow tests on a time change in the elasticity of consumption with respect to industrial production for a few countries (such a parameter break may occur due to changes in the industrial structure), the model also contains a slope dummy that takes a value of one during 2000–05, and zero otherwise. The estimated coefficient on the slope dummy is small on average, but statistically significant for some countries—the dummy is therefore included in the model. The average estimated coefficients are reported in Table 5.7.[23]

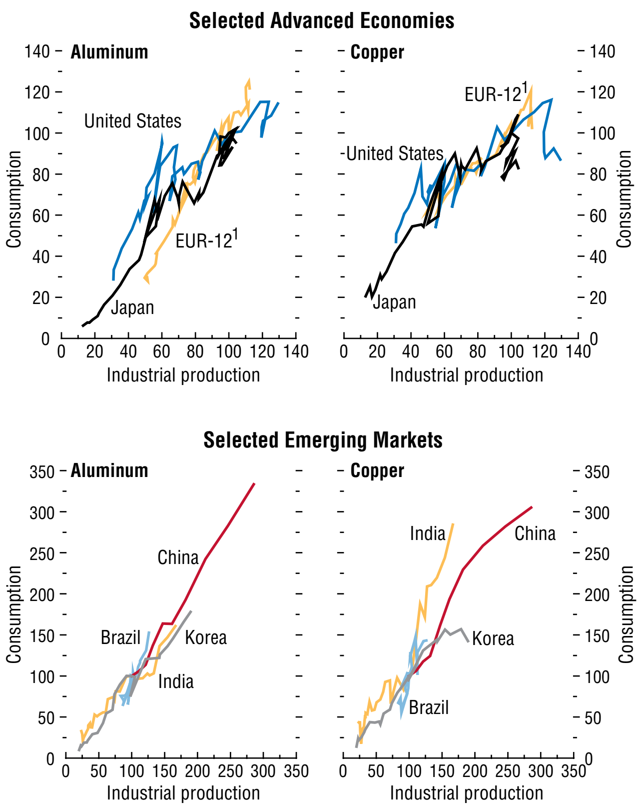
The consumption data used in the model are for primary refined consumption—secondary consumption of recycled metals is therefore not modeled explicitly. This approach is taken due to the lack of country-level data on secondary consumption. However, accounting for the secondary consumption and production would not materially change the price forecasts in Figure 5.10 (Ghosh, Gilbert, and Hughes Hallett, 1987).

The estimated parameter values are relatively robust with respect to a change in the sample period and alternative specifications of the real price term. The estimated price elasticity is similar when producer prices are used instead of consumer prices, or when the price term also

[23]Tests confirmed existence of a cointegrating relationship between consumption of metals and industrial production for most countries, which helps achieve consistency of estimates.

Figure 5.11. Consumption of Base Metals and Industrial Production, 1960–2005
(1996 = 100)

Consumption of base metals is tightly linked to industrial output.



Sources: World Bureau of Metal Statistics, *World Metal Statistics Yearbook* (various issues); and IMF staff calculations.
[1]Austria, Belgium, Denmark, Finland, France, Germany, Italy, the Netherlands, Norway, Sweden, Switzerland, and the United Kingdom. Industrial production for the group was aggregated using 2005 purchasing-power-parity adjusted real GDP values as weights.

contains a country-specific real exchange rate. In the reported specification, only United States CPI is used to deflate metals prices to simplify forecasting. The impact of this simplifying assumption on the forecast of global metal consumption is very small given the low estimated price elasticity and—in the case of the missing exchange rate term—the tendency for the errors to offset each other across countries. In line with the literature, the equations for metal demand do not include prices of other metals, as substitution across metals is almost negligible in the short term and only modest in the medium term.[24]

Production Function

The supply of metals is based on the expert assessment of the Australian Bureau of Agricultural and Resource Economics (ABARE, 2006) and a price elasticity term. For each metal, ABARE reports its supply projection taking into account the pipeline of existing supply expansion projects. This supply path is adjusted as follows whenever the simulated price differs from that used by ABARE:

$$S_t = S_t^{ABARE}\left(\frac{S_{t-1}}{S_{t-1}^{ABARE}}\right)^{1-\delta}\left(\frac{P_t}{P_t^{ABARE}}\right)^{\delta}.$$

In this equation, S_t stands for the metal supply at time t, and P_t is the metal price. Variables with a superscript *ABARE* denote projections of the Australian Bureau. This specification was initially used by Gately (2004) and a similar approach was also used in the IMF's study of the oil market in Chapter IV of the April 2005 *World Economic Outlook*. Given the considerable uncertainty about the price elasticity of metal supply,

[24]Product specifications are embedded into production techniques and metals cannot be changed in most uses except at significant cost. In the long term, substitution may be considerable as relative price changes lead to purchases of new tools, retooling, and research and development activity (Ghosh, Gilbert, and Hughes Hallett, 1987). However, the fit and statistical properties of the estimated equations are very satisfactory, and any substitution across metals resulting from the recent price developments is not likely to be important over the forecast horizon considered in this study.

Table 5.7. Estimates of Metal Demand

$$\log C_{i,t} = c_i + \alpha_i \log C_{i,t-1} + (\beta_i + \omega_i Dummy_{2000}) \log IP_{i,t} + \gamma_i \log \frac{P_{t-1}}{CPI_{t-1}} + \varepsilon_{i,t}$$

	Aluminum	Copper
c	−0.113	−0.736
α	0.174	0.389
β	1.128	0.921
ω	0.008	0.000
γ	−0.050	−0.037
Adjusted R^2	0.85	0.87
LM serial correlation (p-value)	0.39	0.40
White heteroskedasticity (p-value)	0.52	0.51
Sample	1960–2005	1960–2005
Number of observations	464	464
Memorandum:		
Long-term elasticity of demand with respect to industrial production		
Advanced economies[1]	1.0	0.7
Emerging markets[2]	1.2	1.6
Long-term elasticity of demand with respect to price		
Advanced economies[1]	−0.03	−0.04
Emerging markets[2]	0.00	−0.04

Source: IMF staff estimates.

Note: Reported ordinary least squares (OLS) coefficient estimates and regression statistics (with the exception of the number of observations) are simple averages across all 17 estimated equations. Estimates have a non-normal distribution and standard errors are therefore not reported. The elasticities of demand are weighted by 2005 metal consumption shares.

[1]Canada, EUR-12 (Austria, Belgium, Denmark, Finland, France, Germany, Italy, the Netherlands, Norway, Sweden, Switzerland, and the United Kingdom), EUR-4E (Greece, Ireland, Portugal, and Spain), Japan, Oceania (Australia, New Zealand), and the United States.

[2]Argentina, Brazil, China, Indonesia, India, Korea, Mexico, Russia, Thailand, Turkey, South Africa.

the parameter δ is assumed to be uniformly distributed between 0.03–0.05. Over a five-year period, this translates into the price elasticity of supply of about 0.16–0.26 for permanent price shocks,[25] and elasticity of about 0.02–0.04 for price changes that only last one year.

Price Equation

The price equation relates the current real price of metals to the following explanatory variables:

$$(\log P_t - \log CPI_t) = c_0 + \phi(\log P_{t-1} - \log CPI_{t-1}) + \chi \log(USD/SDR)_t + \mu t + \kappa(\log C_{t-1} - \log S_{t-1}) + \nu_t,$$

where c_0 is a constant, USD/SDR is the exchange rate of U.S. dollar to SDR,[26] t is the time trend, and $\log C_t - \log S_t$ reflects the market balance (i.e., the difference between world consumption and production). The model is estimated with OLS using annual data over 1960–2005. The fit of the estimated equations for aluminum and copper is high (Table 5.8). That said, the model does not fully capture the price behavior during cyclical peaks, which suggests that at low inventory levels, prices respond to fundamentals in a nonlinear fashion.[27] In 2005, the price of aluminum and copper were above their values fitted by the model by 7 and 14 percent, respectively, and in 2006, the deviations were 32 and 58 percent. While large, these deviations are comparable with those experienced during earlier cycles (Box 5.1 finds little evidence that speculative investments have been a significant driver of nonfuel commodity price movements). This uncertainty about the link between actual price movements and the model's explanatory variables is explicitly taken into account when generating the price forecast in Figure 5.10 in the main text.

Industrial Production Growth

Finally, for each of the 17 country groups, equations (denoted *IP* below) were estimated to build a link between industrial production and GDP growth rates. The equations were estimated over a shorter sample, 1990–2005, because the relationship between industrial

[25]The responsiveness of metal supply to prices is therefore assumed to be the same or greater than in the April 2005 *World Economic Outlook* oil study.

[26]The exchange rate term is included because metal prices are denominated in the U.S. dollars. As a simplifying assumption, the nominal exchange rate is used instead of the real exchange rate—U.S. consumer prices and SDR-based consumer prices have a very similar dynamics.

[27]The available time series for inventories are short and are subject to large measurement error—their inclusion in the price equation was not successful.

Table 5.8. Estimates of Price Equations

$(\log P_t - \log CPI_t) = c_0 + \phi(\log P_{t-1} - \log CPI_{t-1})$
$+ \chi \log(USD/SDR)_t + \mu t + \kappa(\log C_{t-1} - \log S_{t-1}) + \nu_t$

	Aluminum	Copper
c_0	30.523***	24.282*
	(8.397)	(12.349)
ϕ	0.500***	0.682***
	(0.116)	(0.116)
χ	0.809**	0.594
	(0.311)	(0.466)
μ	–0.015***	–0.012**
	(0.004)	(0.006)
κ	1.457***	2.168**
	(0.533)	(0.883)
Adjusted R^2	0.91	0.77
LM serial correlation (p-value)	0.20	0.47
White heteroskedasticity (p-value)	0.38	0.61
Sample	1960–2006	1960–2006
Number of observations	46	46

Source: IMF staff estimates.
Note: Equations were estimated by ordinary least squares (OLS). Data for 2006 refer to the average for January–June. *** denotes statistical significance at the 1 percent level, ** denotes statistical significance at the 5 percent level, and * denotes significance at the 10 percent level.

Table 5.9. Equation for Industrial Production

$\Delta \log IP_{i,t} = k_i + \lambda_i \Delta \log GDP_{i,t} + \upsilon_{i,t}$

	Advanced Economies[1]	Emerging Markets[2]
k	–0.018***	–0.017*
	(0.006)	(0.009)
λ	1.526***	1.434***
	(0.207)	(0.122)
Adjusted R^2	0.76	
LM serial correlation (p-value)	0.58	
White heteroskedasticity (p-value)	0.57	
Sample	1990–2005	
Number of observations	252	

Source: IMF staff estimates.
Note: Reported ordinary least squares (OLS) coefficient estimates and regression statistics (with the exception of the number of observations) are simple averages across estimated equations. Standard errors are in parentheses. *** denotes statistical significance at the 1 percent level and * denotes significance at the 10 percent level.
[1]Canada; EUR-12 (Austria, Belgium, Denmark, Finland, France, Germany, Italy, the Netherlands, Norway, Sweden, Switzerland, and the United Kingdom); EUR-4E (Greece, Ireland, Portugal, and Spain); Japan; Oceania (Australia, New Zealand); and the United States.
[2]Argentina, Brazil, China, Indonesia, India, Korea, Mexico, Russia, Thailand, and South Africa.

production and GDP changes over time (Figure 5.8 in the main text).

$$\Delta \log IP_{i,t} = k_i + \lambda_i \Delta \log GDP_{i,t} + \upsilon_{i,t}.$$

In the equation, k_i and λ_i are country-specific parameters and $\upsilon_{i,t}$ is a residual. OLS coefficient estimates for the main country groups are reported in Table 5.9.

Price Forecast

The estimated equations were used to prepare a forecast for aluminum and copper prices during 2006–10. The main inputs into the model are GDP forecasts for each country group from the *World Economic Outlook* (in turn, helping to determine future demand for metals) and ABARE supply projections (which contain information about forthcoming supply).

Given the GDP forecast, industrial production is calculated for each country group. Together with the previous period's price, industrial production determines the current demand for metals.[28] Supply is predetermined using the ABARE forecast and the deviation between the actual price and the price assumed by ABARE. The current market balance (the difference between world consumption and production) then helps to determine the next period's price, together with the exchange rate and CPI index. Table 5.10 reports the baseline consumption growth for aluminum and copper over the forecast period.

The fan chart (Figure 5.10 in the main text) is generated by a stochastic simulation as follows. Residuals are drawn randomly from the three estimated equations for metal demand, price, and industrial production, and are added to the

[28]Consumption in the rest of the world (about 10 percent of the total) is assumed to rise at the rate of previous year's world consumption growth. In the case of copper, elasticities of consumption with respect to industrial production were estimated for a few countries at unsustainably high levels of 2.5–5 (Argentina, Indonesia, Mexico, and Russia)—in part because the sample period for these countries is short. The countries are included in the rest-of-the-world group for the purpose of forecasting copper prices.

Table 5.10. Consumption of Metals
(Annual percent change)

	1993–2002	2002–05	2005–10 (forecast)
Aluminum	3.8	7.6	5.6
Copper	3.5	3.8	4.8
Memorandum:			
World GDP	3.5	4.8	4.9

Source: IMF staff estimates.

forecasted values of industrial production, metal demand, and price in each year. In the equations for metal demand and industrial production, the residuals are drawn jointly across all 17 country groups to preserve the contemporaneous cross-country correlation structure. In general, the uncertainty about the future price path also reflects the uncertainty about future global growth and the speed of supply additions. Additional randomization is therefore performed as follows: (1) the world GDP growth rates are assumed to be two-piece uniformly distributed around the WEO baseline, with the maximum global growth rate exceeding the baseline by ½ percentage point and the minimum growth rate underperforming the baseline by 1 percentage point; (2) the actual metal supply growth (net of price changes) is assumed to deviate from projected ABARE supply growth by up to 1 percent every year; and (3) the medium-term elasticity of metal supply with respect to prices is assumed to be uniformly distributed between 0.16 and 0.26.

Data Definitions and Sources

The main author of this section is Angela Espiritu.

- *Nonfuel commodities* are defined as industrial metals, food, beverages, and agricultural raw materials. In terms of the SITC (Revision 3) classification,[29] nonfuel commodities are the commodity groups with codes 0, 1, 2, 4, 67, and 68. Precious metals and stones are excluded from the analysis.
- *Country coverage.* The econometric analysis is based on data for 14 countries and 3 country groups. The individual countries are Argentina, Brazil, Canada, China, India, Indonesia, Japan, Korea, Mexico, Russia, South Africa, Thailand, Turkey, and the United States. The country groups are EUR-12 (Austria, Belgium, Denmark, Finland, France, Germany, Italy, the Netherlands, Norway, Sweden, Switzerland, and the United Kingdom); EUR-4E (Greece, Ireland, Portugal, and Spain); and Oceania (Australia and New Zealand).
- *Commodity prices.* Price data are primarily from the IMF's Commodity Price System database (CPS).[30] In general, the CPS commodity data are available since 1957. Data from Cashin, Liang, and McDermott (2000) were used to extend the coverage of CPS as necessary.[31] The data for 2006 are generally an average of January–June prices. Figure 5.2 presents the Grilli and Yang (1988) measures of long-term commodity prices over 1900–87. Due to definitional changes, the Grilli and Yang indices are not directly comparable with the data from CPS and Cashin, Liang, and McDermott (2000), and are therefore presented without any transformations or updates. Prices of metal futures were obtained from Bloomberg Financial Markets, LP (London Metal Exchange data as of August 28, 2006) and the July 19 and August 23 and 29, 2006 *Commodity Daily Briefings* from Barclays Capital.
- *General price indexes.* The historical data (since 1900) on the United States consumer price index are available from the Federal Reserve Bank of Minneapolis.[32] The United Nations'

[29]For the structure and definitions of SITC (Rev. 3), see the United Nations' website http://unstats.un.org/unsd/cr/registry/regcst.asp?Cl=14.

[30]For more information on the data, see http://www.imf.org/external/np/res/commod/index.asp.

[31]The average correlation coefficient between the aggregate indices of metals, food, and agricultural raw materials from CPS and Cashin, Liang, and McDermott (2000) is 0.94.

[32]See http://woodrow.mpls.frb.fed.us/Research/data/us/calc/hist1800.cfm for the data.

Manufactures Unit Value index measures the unit values of manufactured goods exports (SITC groups 5 to 8) by 24 developed market economies. Data prior to 1960 are from Cashin and McDermott (2002); data from 1960 onwards are from UNCTAD's *Handbook of Statistics* database.[33]

- *Commodity exports.* The data on commodity exports are from the World Bank's World Integrated Trade Solution database.[34] In Figure 5.1, the total exports of nonfuel primary commodities are expressed in percent of gross domestic product (GDP). Dependence on commodity exports is assessed using the average export-to-GDP ratio during the most recent five years of available data. A total of 171 countries are classified, of which 12 countries have the ratio of nonfuel commodity exports to GDP greater than 20 percent; 24 countries have the ratio between 10–20 percent; 56 countries between 5–10 percent; 39 countries between 2½–5 percent; 25 countries between 1–2½ percent; and 15 countries have the ratio below 1 percent.
- *Consumption and production of metals.* Data on metal consumption and production are from the World Bureau of Metal Statistics' *World Metal Statistics Yearbook* (1991, 1995, 2000, and 2005) and *Metal Statistics* (1970, 1975, 1980, 1985, and 1995). The data sets from the various editions were compiled together to create a time series for metal consumption and production for period 1960–2005. In the case of steel, the data were compiled using the same method using The International Iron and Steel Institute's *Steel Statistical Yearbook* (1983, 1985, 1990, 1995, 2000, and 2004). Finally, data on iron ore mining are from the British Geological Survey's *World Mineral Statistics 1998/2002* (2004) and *World Mineral Production 2000–04* (2006).
- *Consumption of agricultural commodities.* Data on consumption of agricultural commodities are, generally, from the United States Department of Agriculture (USDA).[35] Data for bananas, cocoa, shrimp, and wool are from the Food and Agriculture Organization's FAOSTAT database.[36] Data are typically available for period 1960–2005.
- *Output measures.* Data on purchasing power parity (PPP)-adjusted real GDP are from the World Bank's 2006 *World Development Indicators* (WDI) for the period 1970–2004.[37] These data are expressed in constant 2000 purchasing power-adjusted dollars. Two databases were used to extend the coverage of WDI data: where available, data from the Organization for Economic Cooperation and Development's databases,[38] and otherwise, *World Economic Outlook* database. The industrial production data were gathered from Haver Analytics, Global Insight, and national statistical agencies. The share of industrial value added in GDP is from WDI.
- *Other variables.* Population data are from following three sources: WDI, *World Economic Outlook* database, and the United Nations' Population Information Network database.[39] The United States dollar to SDR exchange rate is from the IMF's *International Financial Statistics.*

Appendix 5.2. Modeling the Relationship Between Speculation and Commodity Prices

The authors of this appendix are Sergei Antoshin and Hossein Samiei.

This appendix describes the estimation procedure for the analysis in Box 5.1 and presents a detailed discussion of the results.

[33]See http://www.unctad.org/Templates/Page.asp?intItemID=1890&lang=1 for more information.

[34]See http://wits.worldbank.org for more information.

[35]See http://www.fas.usda.gov/psd for the data.

[36]See http://faostat.fao.org for the data.

[37]See http://www.worldbank.org/data, and follow the link for World Development Indicators for more information.

[38]See http://www.oecd.org/statistics for more information.

[39]See http://www.un.org/popin/ for the data.

Methodology

A Vector Error Correction Model (VECM) is used to test for causality, given that both spot and futures prices, and speculative positions contain unit roots. The VECM allows the examination of both short- and long-run causality: the former is determined by the significance of the coefficients on the first difference terms and the latter by the significance of the coefficient on the error-correction term when a long-run cointegrating relation in levels exists.[40] The following model is estimated:

$$\Delta y_t = \alpha(\beta' y_{t-1} + \mu + \rho t) + \sum_{i=1}^{L-1}\Gamma_i \Delta y_{t-i} + \gamma + \varepsilon_t ,$$

where $y_t = (s_t, f_t, n_t)'$; and s_t, f_t, and n_t are, respectively, the logarithms of spot and one-year ahead futures prices, and the level of net long noncommercial positions; cointegration rank is 1; the number of VAR lags L is 3; α is a 3 × 1 vector of adjustment coefficients; β is a 3 × 1 cointegrating vector; $\{\Gamma_i\}_{i=1}^{L-1}$ are 3 × 3 matrices of VAR coefficients; and t is a linear time trend.

We test the null hypothesis of speculative positions causing spot and futures prices.[41] Average weekly data (Tuesday to Monday) are used for commodity prices (from Bloomberg) and weekly data for speculative positions for every Tuesday (proxied by net noncommercial positions from the CFTC—defined as positions taken by investors who do not use futures contracts for the purpose of hedging). The estimation period is September 1995 to June 2006. The model is estimated using rolling regressions, using the window length of 4.5 years (234 weeks), as a reasonable duration for a business cycle and to cover the time length of the recent run-up in prices. Shorter windows were also tried and the results were qualitatively similar. The results were also quite robust to changes in the number of lags (from 3 to 12), the trend specification, and the assumed number of cointegrating equations (from 0 to 2). Finally, given that in the absence of cointegration the short-run causality tests may not be valid, we also estimated the models by focusing only on the relationship between first differences. The results on short-run causality did not change.

Estimation Results

We first discuss the results for crude oil, using charts of the rolling estimates of parameters and confidence bands—to illustrate what the raw results of the exercise may look like—and then present all the results in a simple and summary fashion.

Crude Oil

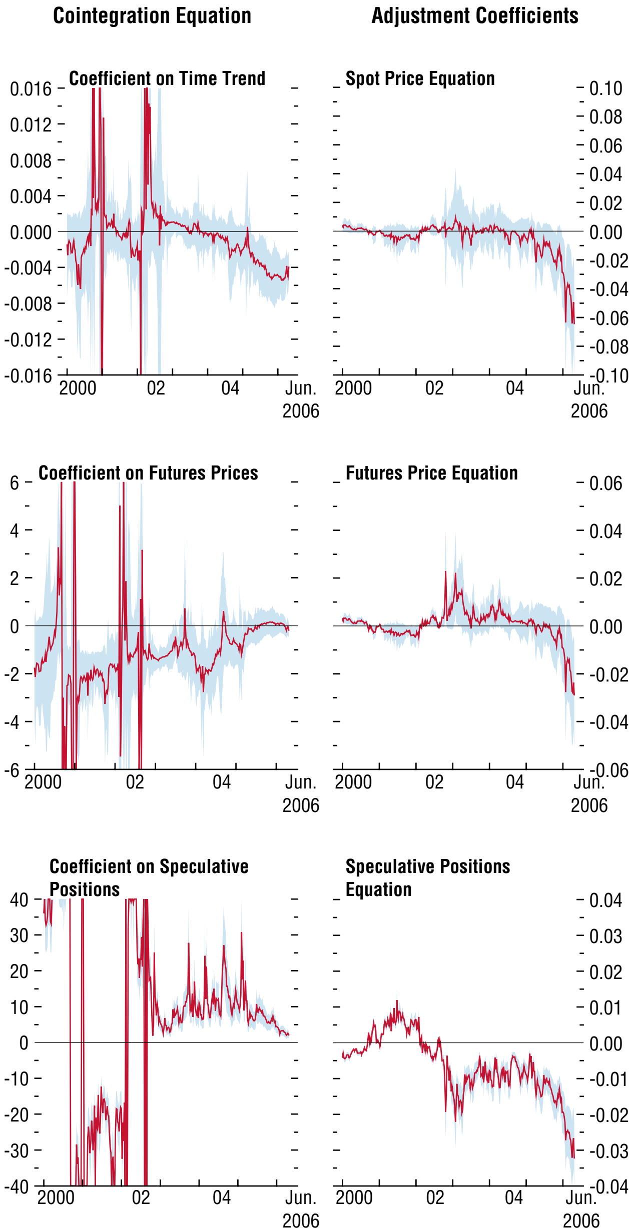
Figure 5.12 depicts the evolution of the long-run coefficients (left panels) and adjustment coefficients (right panels), and their confidence bands. The relationship is clearly unstable over time. However, the rolling values of the cointegration rank suggest that cointegration mostly exists, thus permitting the broad examination of long-run causality based on the significance of the adjustment coefficients. The results interestingly suggest that while the estimated adjustment coefficient in the speculative position equation is significantly different from zero for most of the period (zero lies mostly outside the 90 percent confidence band), the opposite is true for the spot and futures price equations. This means that when a long-run relationship holds, causality is from spot and futures prices to speculative positions.

The three panels in Figure 5.13 show the evolution of the short-run coefficients. Specifically, each figure shows the confidence bands around the estimates of the first or the second lag of the first difference of a variable in the equation for another. The results are surprisingly conclusive.

[40]More specifically, for any two variables x and y, y is said to cause x in the short run if Δy Granger-causes Δx—that is, given the past values of Δx, past values of Δy are useful in predicting Δx. Furthermore, if the adjustment coefficient in the equation for x is significant, then y is said to cause x in the long run.

[41]We do not carry out a joint test of significance for the first and second lags. Instead, we look at the p-values of individual coefficients and the explanatory power the equations (R^2). Note, however, that if one of the two lags is significant then they are likely significant jointly too.

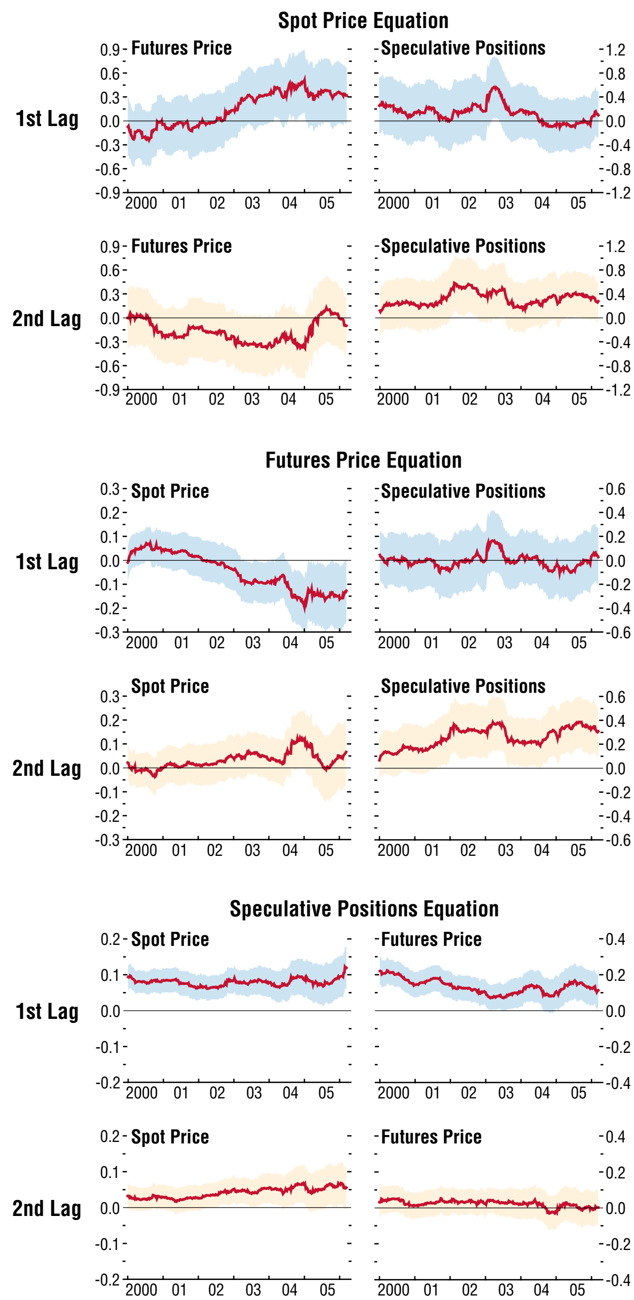
Figure 5.12. Crude Oil: Rolling Estimates of the Model's Long-Run Parameters[1]



Source: IMF staff estimates.
[1]Blue areas are 90 percent confidence bands. The Vector Error Correction Model is estimated with cointegration rank = 1, number of lags = 3, and a restricted trend. The cointegrating vector is estimated with the coefficient on the spot price set equal to 1. Rolling window length is 234 weeks. Dates on the x-axis correspond to period ending dates.

Figure 5.13. Crude Oil: Rolling Estimates of the Model's Short-Run Parameters[1]

(Coefficients)



Source: IMF staff estimates.
[1]Shaded areas are 90 percent confidence bands. The Vector Error Correction Model is estimated with cointegration rank = 1, number of lags = 3, and a restricted trend. The cointegrating vector is estimated with the coefficient on the spot price set equal to 1. Rolling window length is 234 weeks. Dates on the x-axis correspond to period ending dates.

Table 5.11. Summary of the Results from Rolling Regressions

	Spot Price Equation	Futures Price Equation	Speculative Positions Equation
Crude Oil			
Short-run coefficients			
Spot price	. . .	Rarely significant	Always significant
Futures price	Rarely significant	. . .	Always significant
Speculative positions	Rarely significant	Mostly significant	. . .
Long-run coefficients			
Cointegrating relation		Mostly present; rarely stable	
Adjustment coefficients	Never significant	Rarely significant	Always significant
R-squared average	0.06	0.08	0.36
Copper			
Short-run coefficients			
Spot price	. . .	Never significant	Always significant
Futures price	Rarely significant	. . .	Mostly significant
Speculative positions	Rarely significant	Rarely significant	. . .
Long-run coefficients			
Cointegrating relation		Mostly present; rarely stable	
Adjustment coefficients	Never significant	Never significant	Always significant
R-squared average	0.11	0.10	0.66
Sugar			
Short-run coefficients			
Spot price	. . .	Rarely significant	Always significant
Futures price	Sometimes significant	. . .	Always significant
Speculative positions	Rarely significant	Rarely significant	. . .
Long-run coefficients			
Cointegrating relation		Mostly present; mostly stable	
Adjustment coefficients	Rarely significant	Never significant	Always significant
R-squared average	0.06	0.05	0.48
Coffee			
Short-run coefficients			
Spot price	. . .	Never significant	Always significant
Futures price	Rarely significant	. . .	Mostly significant
Speculative positions	Rarely significant	Rarely significant	. . .
Long-run coefficients			
Cointegrating relation		Mostly present; rarely stable	
Adjustment coefficients	Sometimes significant	Sometimes significant	Mostly significant
R-squared average	0.06	0.05	0.56
Cotton			
Short-run coefficients			
Spot price	. . .	Rarely significant	Always significant
Futures price	Never significant	. . .	Always significant
Speculative positions	Never significant	Never significant	. . .
Long-run coefficients			
Cointegrating relation		Mostly present; mostly stable	
Adjustment coefficients	Mostly significant	Rarely significant	Always significant
R-squared average	0.13	0.11	0.55

Source: IMF staff calculations.

In the equation for the spot price (top panel), neither lags of futures prices and speculative positions are significantly different from zero for any reasonable length of time (i.e., confidence bands almost always include zero). In the equation for futures prices (middle panel) the second lag of speculation is often significant, but other variables are not. The magnitude of the impact of speculation on futures prices, however, is very small. Finally, in the equation for speculative positions (bottom panel) the first lags of spot and futures prices are almost always significant. Furthermore, the R^2 for this relationship is 36 percent, compared with 6–8 percent for the other two equations.

Other Commodities

Having examined the results for crude oil in detail, this section summarizes and compares the results for all commodities (Table 5.11).

We call a variable significant in the short-run relationship for another if at least one of its lags is significant at 5 percent. We then describe in the table the frequency of observing significance using the following terms (with the degree of significance in percent terms in parentheses): always significant (above 90 percent), mostly significant (60–90 percent), sometimes significant (40–60 percent), rarely significant (10–40 percent), and never significant (below 10 percent). As for the long-run relationship, we report the frequency of cointegration, the stability of the relationship, and the significance of the adjustment coefficient (using the rule in the previous paragraph), as well as the average value of the R^2s of the regressions. The results are discussed in Box 5.1.

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