Special Focus

How important are China and India in global commodity consumption?

How important are China and India in global commodity consumption?

The surge in commodity prices during the 2000s has at times been attributed to rising demand from China and India. There are important, lesser-known nuances, however, to the role of China and India in commodity markets, which are explored in this Focus. First, demand from China and, to a lesser extent India, significantly raised global demand for metals and energy—especially coal—and less so for food commodities. China's consumption of metals and coal surged to roughly 50 percent of world consumption in this period, and India's consumption to a more modest 3 percent (metals) and 9 percent (coal). Second, this pattern reflected differences in growth models and income elasticities. In particular, an increase in GDP or industrial production has tended to raise metals and energy demand more so than food. Third, if the two countries catch up to OECD levels of per capita commodity consumption, or if India's growth shifts towards industry, demand for metals, oil, and coal could remain strong. In contrast, given that the level of per capita consumption of food in China and India is already comparable with the world, pressures on food commodity prices are likely to ease as their population growth—one of the key determinants of food commodity demand—slows.

The super-cycle

Global commodity prices underwent an exceptionally strong and sustained boom beginning in 2000. Unlike a typical price cycle, this boom has been characterized as a "super cycle", i.e., a demand-driven surge in commodity prices lasting possibly decades rather than years (Figure F.1). Some researchers say this is the fourth "super cycle" of the past 150 years (Cuddington and Jerrett 2008; Erten and Ocampo 2013; Jacks 2013; and Stürmer 2013).[1]

The price boom has been attributed to strong growth in emerging markets. During 2002-12 emerging markets grew 6 percent per year, the highest rate in any 10-year period over the past four decades. Analysts have focused on the two most populous countries, China and India, which grew at an annual pace of 10.3 and 7.4 percent, respectively. By 2014, the two countries together accounted for over one-third of global population and one-sixth of global GDP. Over the medium-term, growth in both countries is likely to continue to outpace advanced country growth, despite a carefully managed slowdown in China.

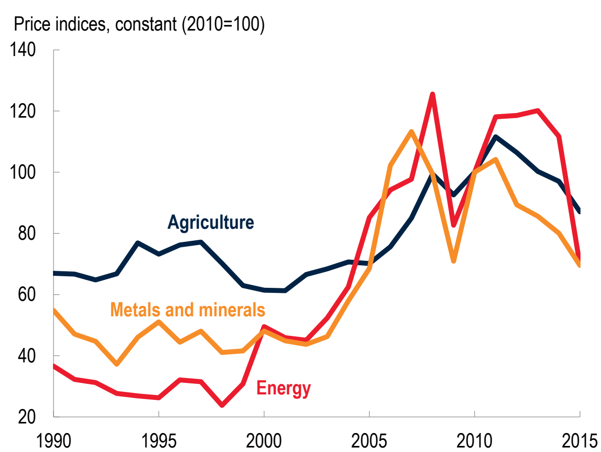
The role of China and India in global commodity markets came to the fore in the context of the 2008 food price spikes. Some argue that rapid income growth in emerging economies, including China and India, was a key factor behind increases in food commodity prices after 2007 (Krugman 2008; Wolf 2008; and Bourne 2009). Others point to the broadly stable share of China and India in agricultural food commodity consumption (Alexandratos 2008; FAO 2008; Alexandratos and Bruinsma 2012; Sarris 2010; Baffes and Haniotis 2010; FAO 2009; and Lustig 2008).[2]

TABLE F.1 Consumption growth during the commodity price boom

	China	India	ROW	World
Change from 2001-02 to 2011-12, percent				
Primary energy	329.2	136.9	3.2	57.8
Crude oil	97.8	52.6	7.3	14.6
Coal	147.4	92.7	3.9	54.4
Metals	329.2	136.9	3.2	57.8
Grains	25.0	16.5	24.6	23.9
Edible oils	94.4	65.2	65.2	70.4
Population	*5.6*	*15.1*	*14.3*	*12.6*
GDP	*171.6*	*107.8*	*24.9*	*33.5*
Industrial production	*298.3*	*112.5*	*14.6*	*34.5*
Share of world during 2011-12, percent				
Primary energy	21.9	4.4	73.7	100
Crude oil	11.2	4.0	84.8	100
Coal	50.4	7.6	42.0	100
Metals	42.9	3.5	53.6	100
Grains	22.8	9.6	67.6	100
Edible oils	20.2	11.4	68.4	100
Population	*19.2*	*17.5*	*63.2*	*100*
GDP	*10.0*	*2.6*	*87.4*	*100*
Industrial production	*19.1*	*2.6*	*78.3*	*100*

Source: World Bank, BP Statistical Review, of World Energy World Bureau of Metals Statistics, U.S. Department of Agriculture.
Note: ROW refers to the World excluding China and India.

FIGURE F.1 Commodity price indices



Source: World Bank.
Note: Last observation is 2015 (as of June 2015).

This *Special Focus* explores the role of China and India in global commodity consumption since 2000. In particular, it seeks to address the following questions:

- How have China and India contributed to global commodity consumption?
- What explains diverging contributions of these countries to global commodity consumption?
- How will growth in China and India impact global commodity consumption?

How have China and India contributed to global commodity consumption?

Demand from China and, to a significantly lesser extent India, has tilted global commodity consumption towards coal and metals during 2000-14. In contrast, their consumption of agricultural commodities has grown broadly in line with global averages.

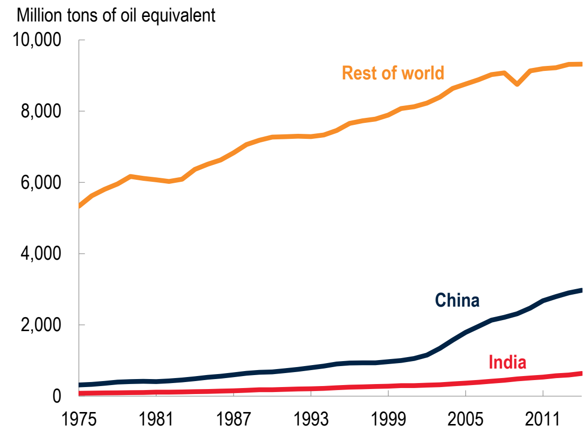
Energy. China's primary energy consumption during 2000-14 tripled and India's doubled (though from a much lower base, Figure F.2). Together they account for 28 percent of global energy consumption. China's energy demand growth has slowed to 3 percent in 2014 while India's growth has remained robust.

China's and India's energy consumption growth has been driven mainly by coal (Figure F.3). Together, the two countries accounted for nearly all of the increase in global coal consumption over the period. Today, China consumes half of the world's coal, up from less than one-third in 2000, and India consumes almost one-tenth, more than double its 2000 share. In recent years coal consumption in China has slowed significantly as a result of slower economic activity, efforts to improve air quality, and increased use of other fuels such as oil, natural gas, nuclear, renewables, and hydropower.

Although China's share in global oil consumption has more than doubled since 2000 (from 4.8 to 11.1 mb/d), it remains a modest 12 percent while India's share amounts to 4 percent (Figure F.4).

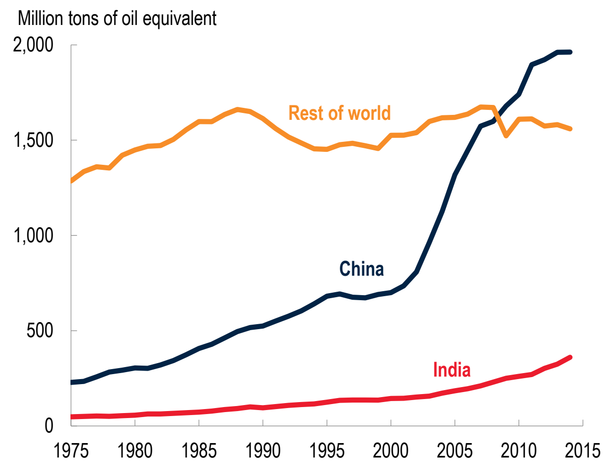
Metals. China's metal consumption soared during 2000-14 while India's grew at a measured pace. China's metal consumption growth alone accounted for nearly all of the net increase in global consumption in 2000-14, whereas India accounted only for 5 percent of the global increase. As a result, China's share of world metals consumption more than tripled from 13 percent in 2000 to 47 percent in 2014 (Figure F.5).

FIGURE F.2 Primary energy consumption



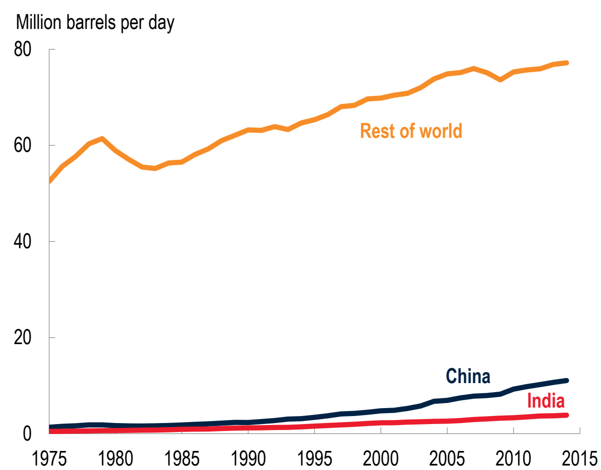
Source: BP Statistical Review of World Energy.
Note: Last observation is 2014. Primary energy consists of crude oil, natural gas, coal, nuclear, hydroelectric, and renewables.

FIGURE F.3 Coal consumption



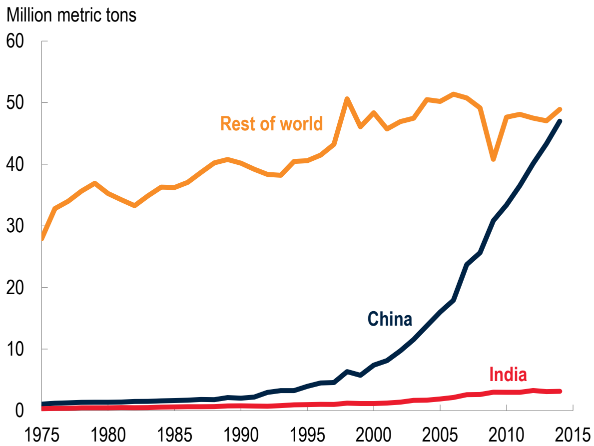
Source: BP Statistical Review of World Energy.
Note: Last observation is 2014.

FIGURE F.4 Crude oil consumption



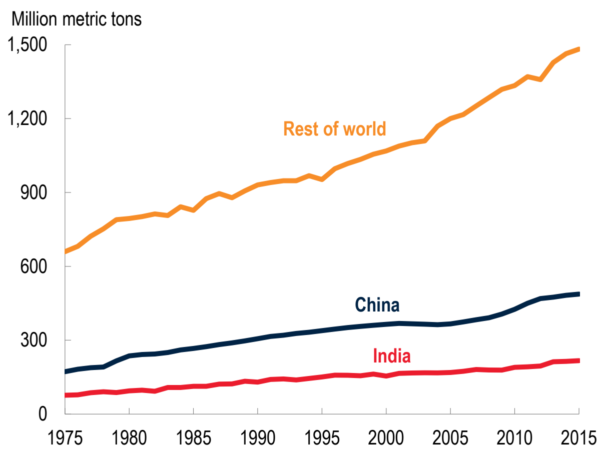
Source: BP Statistical Review of World Energy.
Note: Last observation is 2014.

FIGURE F.5 Metal consumption



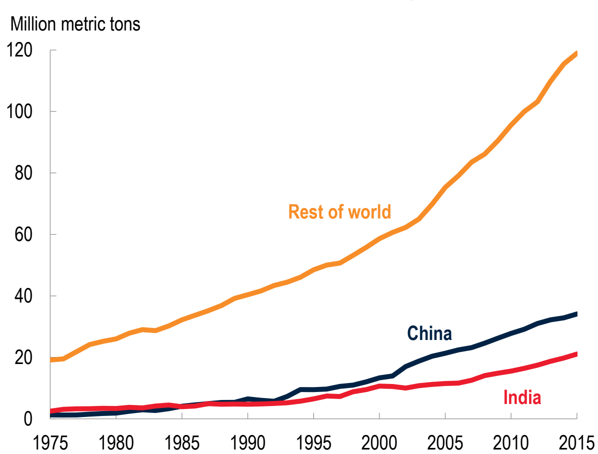
Source: World Bureau of Metal Statistics.
Note: Last observation is 2014. The six metals are: aluminum, copper, lead, nickel, tin, and zinc.

FIGURE F.6 Grain consumption



Source: U.S. Department of Agriculture.
Note: Last observation is for the 2015-16 crop year (denoted as 2015). The three grains are: wheat, maize, and rice.

FIGURE F.7 Edible oil consumption



Source: U.S. Department of Agriculture.
Note: Last observation is 2015. The edible oils are: coconut, cottonseed, palm, palmkernel, peanut, rapeseed, and sunflower seed.

Agriculture. In contrast to coal and metals, China's and India's consumption of most agricultural commodities—especially for grain such as maize, rice, and wheat—grew broadly in line with global consumption over the past two decades, leaving their share of world consumption virtually unchanged at about 22 percent and 10 percent, respectively (Figure F.6).[3] In an exception among agricultural commodities, China's share of global edible oils consumption rose almost one-and-a-half fold (to one-fifth in 2014) while India's remained around one-tenth (Figure F.7).

What explains diverging contributions of the two countries global commodity consumption?

The diverging impact of China's and India's expansion during the 2000s on individual commodity markets reflects different income elasticities and, for metals specifically, different growth engines in China and India.

Income elasticities. Consumption of industrial commodities, including metals and coal, tends to respond to economic activity whereas consumption of food commodities (especially grains) is mainly associated with population growth. While China's and India's share of the global population has remained broadly stable at 37 percent, their share of global economic activity has tripled from 5 percent in 2000 to 16 percent in 2014. As a result, their demand for highly-income elastic commodities, such as primary energy and metals, has grown more rapidly than their demand for less income-elastic commodities, such as grains.

- **Metals.** The income elasticity of metals consumption exceeds unity (see, for example, Labys, Achouch, and Terraza 1999, Issler, Rodrigues, Burjack 2013, and Baffes and Savescu 2014).
- **Energy.** The income elasticity of energy has been estimated to be around unity (Webster, Paltsev, and Reilly 2008).
- **Grains.** The income elasticity of most agricultural commodity consumption is typically less than unity. Thus, the response of *real* food commodity prices to income could be negative depending on the changes in inflation (Box 1).
- **Edible oils.** Among agricultural commodities, edible oils are an exception. Their consumption is typically more strongly correlated with income than consumption of other agricultural commodities since growing incomes are associated with increased food consumption in restaurants and in

processed form—both with higher edible oil content compared to home-cooked meals.[4]

Growth models. Consumption of primary energy and, especially, metals is strongly correlated with industrial production. The industry-led nature of China's growth between 2000-14, compared with India's, partly accounts for China's stronger surge in metals consumption. Industry (infrastructure, manufacturing, and construction) accounted for almost half of China's growth but only about one quarter of India's growth during 2000-14. As a result, China's share of global industrial production increased five-fold during the past two decades and is now eight times higher than that of India (Figures F.8 and F.9).

How will growth in China and India impact global commodity consumption?

The outlook for the role of China and India in global commodity consumption is shaped by two factors: potential for catchup with advanced country per capita consumption and the outlook for growth and population in both countries.

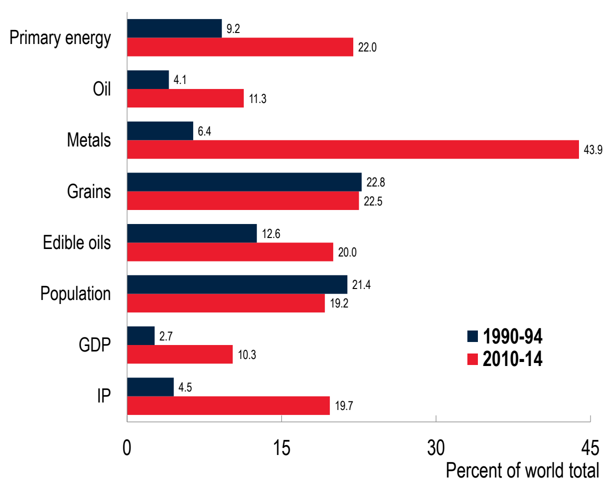
Per capita consumption. China still stands well below OECD levels of per capita consumption of primary energy; somewhat below for grains and edible oils; and in line with the OECD average for metals (Figures F.10-F.12).[5] India's per capita consumption of primary energy, metals, grains, and edible oils is considerably below both OECD and world averages. Should China's per capita commodity consumption move towards OECD levels, global primary energy demand could rise significantly. A corresponding shift in India would also boost demand for energy and metals.

Growth and population outlook. China's growth is expected to slow gradually below 7 percent by 2017, and beyond, with a shift away from industry-led growth towards more services-based growth (Figure F.13). In contrast, India's growth is expected to be sustained above 7 percent until 2017. Despite the slowdown in China, growth in both countries is expected to remain well above advanced country growth, which is likely to remain on the order of 2-3 percent. At the same time, China's population growth is expected to decline further over next decade to about 0.3 percent per annum, according to the UN's population statistics. India's population is expected to grow faster than China's at roughly 1 percent over the next decade.

On balance, these factors may herald some shifts in global consumption:

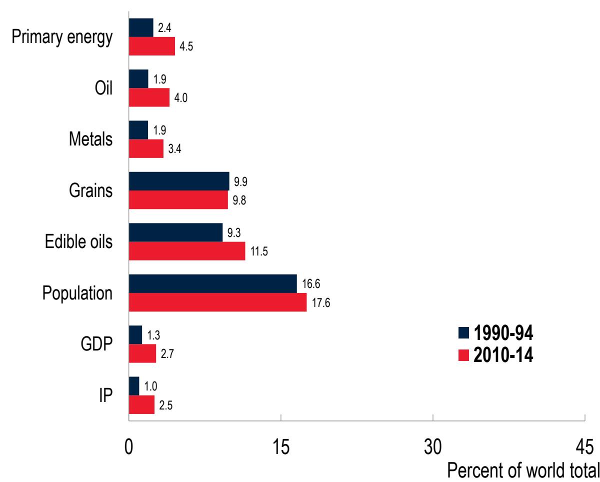
- **Easing metals consumption.** As China moves towards more services-led growth, and absent a significant shift in India's growth engines, metals consumption may slow.
- **Rising energy consumption.** Growth in India may encourage a catch-up from low per capita energy consumption. China, while on par with the world average, may also increase its per capita consumption as income grows.
- **Modest growth in agricultural commodity consumption.** Consumption of agricultural

FIGURE F.8 China's consumption of key commodities



Source: World Bank, BP Statistical Review of World Energy, World Bureau of Metals Statistics, U.S. Department of Agriculture.
Note: IP denotes Industrial production.

FIGURE F.9 India's consumption of key commodities



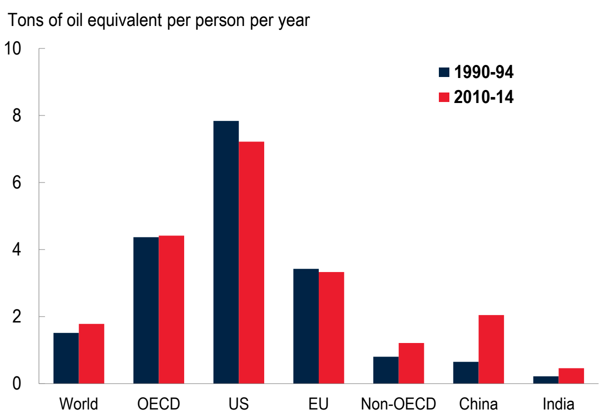
Source: World Bank, BP Statistical Review of World Energy, World Bureau of Metals Statistics, U.S. Department of Agriculture.
Note: IP denotes Industrial production.

commodities by China and India is close to the world average. Continued robust population growth in India could offset some of the slowdown in population in China and support agricultural commodity consumption.

Endnotes

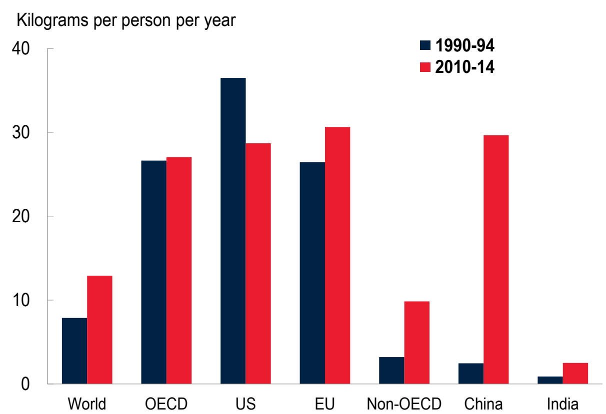
1. Schumpeter identified three long cycles in modern capitalism that also corresponds to commodity super cycles (Erten and Ocampo 2012). First, during 1786–1842, a reflection of the industrial revolution. Second, 1842–1897, characterized by the technological advancements in various industries, including railways, steamships, textiles, and clothing, the "railroadization" cycle. Third, starting in 1897, associated with the opportunities involving steel, electricity, organic chemicals, the internal combustion engine, automobiles, "electrification" cycle. Cuddington and Jerrett (2008) identified three super cycles in metals prices: 1890–1911 (driven by urbanization and industrialization in the United States), 1930–51 (European reconstruction), and 1962–77 (Japanese expansion).
2. In fact, Deaton and Drèze (2008), noted that despite growing incomes, caloric intake in India has declined since the early 1990s.
3. Grain consumption includes both human and animal feed, thus accounting for growth in animal products, including milk and dairy.
4. Increased consumption with rising incomes may, however, not be reflected in rising prices. This reflects the high substitutability of edible oil crops with other food crops because of the use of similar inputs, including land, similarly-skilled labor and machinery.
5. The high per capita averages for grains in the U.S. and edible oils in the OECD for 2010-14 partly reflect production of biofuels (primarily maize-based ethanol in the United States and edible oil-based biodiesel in the EU).

FIGURE F.10 Primary energy consumption



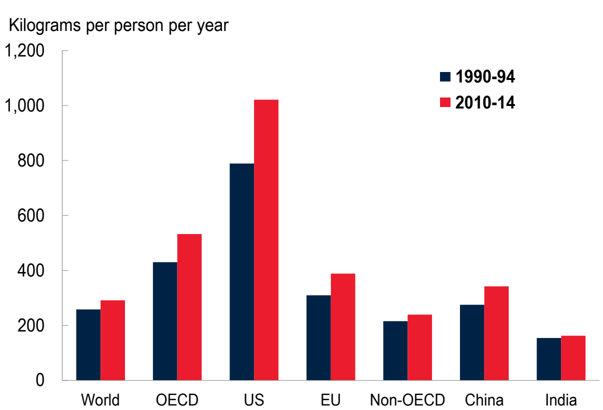
Source: BP Statistiical Review of World Energy, UN, OECD, Eurostat.
Note: Primary energy consists of crude oil, natural gas, coal, nuclear, hydroelectric, and renewables expressed in tons of oil equivalent.

FIGURE F.11 Metals consumption



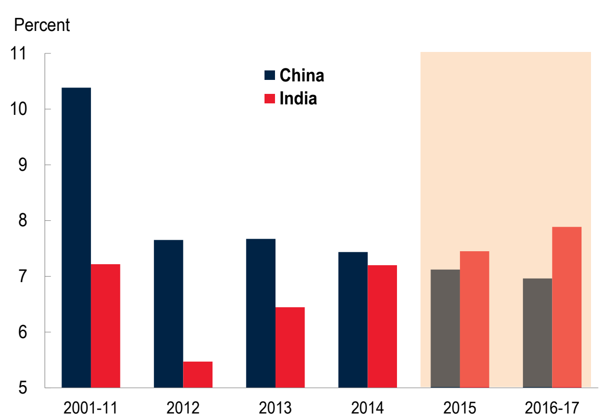
Source: World Bureau of Metal Statistics, UN.
Note: Aggregate of aluminum, copper, lead, nickel, tin, and zinc.

FIGURE F.12 Grain consumption



Source: U.S. Department of Agriculture, UN.
Note: Aggregate of wheat, maize, and rice. Refers to human, animal feed, and industrial use. The surge in US consumption reflects biofuels.

FIGURE F.13 Growth in China and India



Source: World Bank.
Note: The growth rates for 2015 and 2016-17 are forecasts reported in *Global Economic Prospects* (World Bank 2015).

BOX 1 Why does income negatively affect agricultural commodity prices?

Although income growth in emerging economies has been cited as a key driver of the past decade's food price increases, the views on the strength of such relationship are not uniform (see Figure F.14 for agriculture and manufacturing price indices). As early as the mid-19th century, the German statistician Ernst Engel observed that poor families spend a greater proportion of their assets on food compared to wealthier counterparts, thus leading to Engel's Law of less-than-unitary income elasticity of food commodities. Almost a century later, Kindleberger (1943, p. 349) argued that "[t]he terms of trade move against agricultural and raw material countries as the world's standard of living increases … and as Engel's Law of consumption operates."

Kindleberger's thesis was empirically verified by Prebisch (1950) and Kindleberger (1958) himself; it was also emphasized by Singer (1950). By some accounts, the declining terms of trade associated with food commodities—to be coined later the Prebisch-Singer hypothesis—formed the intellectual foundation on which the post-WWII industrialization policies were based, that is, taxation of primary commodity sectors in favor of manufacturing products, especially in developing countries.

Modeling Food price trends

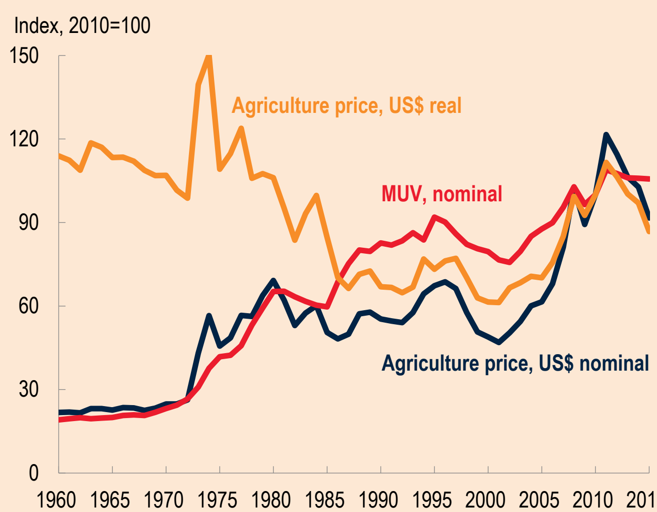
The testable implications of the relationship between Terms of Trade and income can be examined within a 2-sector, closed-economy framework as a move from equilibrium E_1 to E_2, in response to an exogenous positive shock on income (Figure F.15). Let Q_i^F, Q_i^M and P_i^F, P_i^M denote consumption and prices of the primary and manufacturing commodities in period i, and Y_i denote income, i = 1, 2. Income level in the first period, Y_1, is consistent with consumption bundle [Q_1^F, Q_1^M] and a price ratio of (P_1^F, P_1^M). As income increases to Y_2 in period 2, it leads to a consumption bundle of [Q_2^F, Q_2^M] and a price ratio of (P_2^F, P_2^M). Now assume neutral technical change and non-homothetic preferences such that the increase in the consumption of the manufacturing commodity is larger than its primary commodity counterpart, (Q_2^M-Q_1^M> Q_2^F-Q_1^F). These assumptions imply that (P_2^F/P_2^M) < (P_1^F/P_1^M), hence the inverse ToT-income relationship consistent with Kindleberger's thesis and, by extension, Engel's Law. Conversely, under homothetic preferences and biased technical change against primary commodities, a positive ToT-income relationship will emerge (this outcome is not shown in Figure F.15).

To identify the impact of income on the ToT of agricultural commodities, this section summarizes estimates from a reduced-form econometric model which conditions the ToT-income relationship on various sectoral and macroeconomic fundamentals.

The model takes the following form:

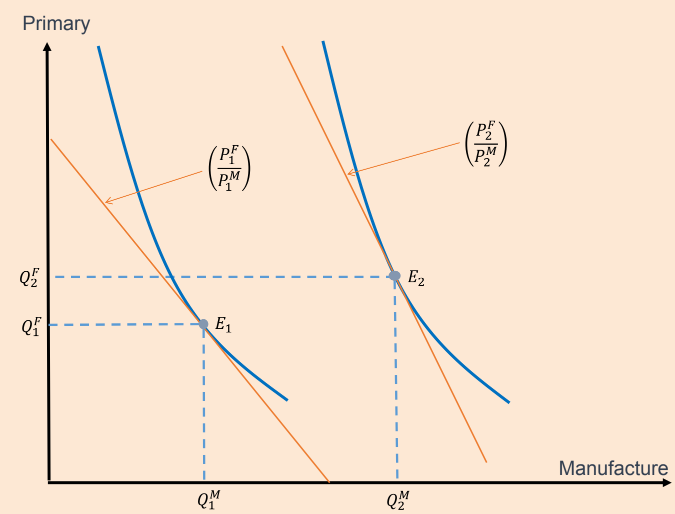
$$\log(P_t^i) = \beta_0^i + \beta_1^i \log(Y_t) + \beta_2^i R_t + \beta_3^i \log(X_t) \; - $$
$$+ \beta_4^i \log(S_{t-1}^i) + \beta_5^i \log(P_t^E) + \varepsilon_t^i.$$

FIGURE F.14 Nominal agricultural and manufacturing price indices (2010 = 100)



Source: World Bank.
Note: Real agricultural price is the ratio of nominal agricultural prices divided by the MUV, referred to as ToT in the analysis.

FIGURE F.15 A 2-sector model for agricultural and manufacturing prices



Source: World Bank.
Note: The 2-sector model assumes unbiased technical change and non-homothetic preferences.

P_t^i is the real price of commodity i (i = maize, soybeans, wheat, rice, palm oil, and cotton). Y_t denotes real income (proxied by GDP), R_t denotes the real interest rate, X_t is the US$ exchange rate, S_t^i denotes the stock-to-use ratio of commodity i, and P_t^E is the real price of crude oil. For each commodity i equation, the β_j^is are parameters to be estimated and ε_t^i is the error term. Because the variables (except interest rate) are expressed in logarithmic levels, the estimated parameters can be interpreted as elasticities.

Results

The model is applied to five food commodities (maize, soybeans, wheat, rice, and palm oil) and cotton. All commodity prices have been deflated by the Manufacturing Unit Value index. For the real interest rate, the 3-month U.S. Treasury Bill, adjusted by the U.S. Consumer Price Index, was used. The exchange rate was represented by the U.S. dollar Real Effective Exchange Rate against a broad basket of currencies. Income is proxied by the real GDP of middle-income countries measured in PPP terms. Results of the model, which was estimated both in OLS and in a panel (random effects) framework, are reported in Table F.2.

In all six equations the parameter estimate of income was negative and highly significant, with values ranging within a remarkably tight band (between –0.44 for soybeans and –0.71 for rice, palm oil, and cotton). The panel estimate was –0.48, indicating that a 10 percent increase in the income of low- and middle-income countries reduces the real price of agricultural commodities by about 5 percent. This result, is consistent with Engel's Law. Baffes and Etienne (2014), who used a similar methodology but an Autoregressive Distributed Lag model, found that the negative ToT-income relationship is robust to various income measures. Based on a literature review of more than 40 papers, they concluded that the declining ToT hypothesis is supported in about half of the papers.

In addition to the income-ToT relationship, the model provides interesting results on the effect of other macroeconomic and sectoral variables. Results of the exchange rate effect on food prices are consistent with expectations in terms of sign, but only rice is highly significant. Yet, the panel parameter estimate is significantly different from zero (–0.46, t-statistic = –1.81). These results are consistent with the literature (Lamm 1980, Gardner 1981, and Baffes and Dennis 2015).

TABLE F.2 **Parameter estimates**

	Maize	Soybeans	Wheat	Rice	Palm oil	Cotton	Panel
Constant	7.91***	5.85**	5.41**	14.20***	7.83***	8.08***	7.50***
	(4.02)	(2.47)	(2.45)	(6.07)	(2.70)	(3.21)	(4.89)
Income	-0.60***	-0.44***	-0.49***	-0.71***	-0.71***	-0.71***	-0.48***
	(5.28)	(3.10)	(3.73)	(4.98)	(4.17)	(4.50)	(4.59)
Real interest rate	-0.02	-0.06***	-0.06***	-0.04**	-0.06***	-0.05***	-0.01
	(0.98)	(3.53)	(3.76)	(2.00)	(2.86)	(2.80)	(1.25)
Real exchange rate	-0.41	-0.21	0.05	-1.44***	-0.13	-0.16	-0.46**
	(1.16)	(0.50)	(0.13)	(3.41)	(0.26)	(0.36)	(1.81)
Stock-to-Use ratio (lag)	-0.48***	-0.21***	-0.46***	-0.49***	-0.42***	-0.40***	-0.37***
	(6.90)	(3.72)	(4.62)	(5.10)	(3.80)	(3.80)	(8.05)
Real oil price	0.15***	0.13**	0.11*	0.15**	0.30***	0.10	0.15***
	(2.99)	(2.06)	(1.93)	(2.54)	(3.58)	(1.45)	(3.22)
R-square	0.67	0.50	0.50	0.70	0.53	0.60	0.59
No of observations	55	50	55	55	50	55	310

Source: Baffes and Haniotis (2015).
Notes: All variables (except interest rate) are expressed in logarithmic terms. The dependent variable is the logarithm of the nominal price divided by the price of manufacture goods. Because of data unavailability, the regressions for soybeans and palm oil begin in 1965 (the rest span in 1960-2014). The last row, Panel, reports estimates from a random effects model. The *R-square* for the Panel refers to the overall *R-square* (the within and between *R-squares* are 0.51 and 0.69, respectively). Absolute *t-statistics* in parentheses, * = 10 percent, ** = 5 percent, *** = 1 percent.

The real interest rate has a negative impact on all prices (except maize), but it is small in magnitude. The panel parameter estimate, -0.01, however, is not statistically different from zero. Interestingly, the weak relationship between interest rates and commodity prices is not uncommon in the empirical literature (Gilbert 1989; Frankel and Rose 2010; and Frankel 2014). Other studies (Anzuini et al. 2010; Akram 2009) found a moderate effect.[2]

Among sectoral fundamentals, the stock-to-use ratio estimates are, as expected, negative and highly significant, with a panel estimate of -0.37. These estimates are remarkably similar to findings reported elsewhere (Baffes and Dennis 2015; Bobenrieth, Wright, and Zeng 2012; and FAO 2008).

The estimate of oil price was significantly different from zero in all six equations with the panel estimate at 0.15, implying that a 10 percent increase in oil prices is associated with a 1.5 percent increase in agricultural prices. The strong relationship between energy and non-energy commodity prices has been established long before the post-2004 price boom (Gilbert 1989; Hanson et al. 1993; Borensztein and Reinhart 1994; Chaudhuri 2001; Baffes 2007, Moss et al. 2010).[3]

Last, an important aspect from the model is the actual impact of lower stocks and higher oil prices to agricultural commodity prices. The elasticities for the oil price and stocks-to-use ratio are 0.15 and -0.37, both significant at the 1% level (t-values equal to 3.22 and 8.05, respectively). During the commodity boom, real oil prices increased by 146 percent while the stock-to-use ratio (average of wheat, maize and rice) declined by 26 percent. Thus, while the decline of stock-to-use ratio contributed 10 percentage points [10% = -0.37*(-26%)] to the increase in real food prices, the contribution of the oil price increase was more than twice as much, 22 percentage points [22% = 0.15*(146%)]. Therefore, despite the fact that the stock-to-use ratio elasticity was more than twice that of the oil price elasticity, its effect was less than half.

Conclusion

Based on a reduced-form price determination model and annual data since 1960, this box established the negative relationship between income and real agricultural prices. The results also showed that the price of energy and the stocks-to-use ratio, a proxy of supply conditions, matter as well. Among macroeconomic variables, while exchange rates appear to have an effect on commodity prices, a similar effect could not be established for interest rates, despite the extensive discussion in the literature that the low interest rate environment and quantitative easing of the past few years have been an instrumental force behind the commodity price boom. Interestingly, the weak interest rate-commodity price relationship is prevalent in the literature. It is conjectured here that, while the lower cost of capital may induce a rightward shift on the demand schedule, it may also induce a rightward shift to the supply schedule due to the lower cost of input financing, thus rendering the relationship between interest rates and commodity prices ambiguous.

Endnotes

1. The theoretical underpinnings of this model are outlined in Holtham (1988) and Deaton and Laroque (1992). Among various empirical applications of such a model, Gilbert (1989) looked at the effect of developing countries' debt on commodity prices; Pindyck and Rotemberg (1990) examined comovement among various commodity prices; Reinhart (1991) and Borensztein and Reinhart (1994) analyzed the factors behind the weakness of commodity prices during the late 1980s and early 1990s; Frankel and Rose (2010) analyzed the effects of various macroeconomic variables on agricultural and mineral commodities; Baffes and Dennis (2015) and Baffes and Etienne (2014) examined the relative importance of key drivers on food price trends during the past five decades.
2. Baffes and Savescu (2014) found a positive relationship between nominal interest rates and metals prices and argued that, while the lower cost of capital may induce a rightward shift on the demand schedule, it may also induce a rightward shift to the supply schedule due to the lower cost of input financing, thus rendering the interest rate-price relationship ambiguous.
3. Yet not all studies concur with a strong oil/non-oil price relationship. Saghaian (2010) established a strong correlation among oil and food prices but not a causal link. Gilbert (2010) found a correlation between oil and food prices, but noted that it could be a result of common causation, not a causal link. Zhang et al. (2010) found no short-run (and very limited long-run) relationship between fuel and agricultural commodity prices. Reboredo (2012) concluded that grain prices are not driven by oil prices. The mixed evidence on the energy/non-energy price link could reflect the frequency of the data used in the analysis or the presence of biofuels (Baffes 2013). Zilberman et al. (2013) noted that higher frequency ("noisier") data are associated with weaker correlations. On the other hand, an exogenous shock pushing crude oil prices down under a mandated ethanol/gasoline mixture would increase fuel consumption, push ethanol and maize prices down, thus leading to a negative relationship between food and oil prices (De Gorter and Just 2008).

References

Akram, Q. F. (2009). "Commodity prices, interest rate, and the dollar." *Energy Economics*, 31, 838-851.

Alexandratos, N. (2008). "Food price surges: Possible causes, past experience, and long-term relevance." *Population and Development Review*, 34, 599-629.

Alexandratos, N., and J. Bruinsma (2012). *World agriculture towards 2030/2050: The 2012 Revision.* ESA Working Paper No. 12-03. Agricultural Development and Economics Division, Food and Agriculture Organization of the United Nations, Rome.

Anzuini, A., M.J. Lombardi, and P. Pagano (2013). "The impact of monetary policy shocks on commodity prices." *International Journal of Central Banking*, 9, 125-150.

Baffes, J. (2007). "Oil spills on other commodities." *Resources Policy*, 32, 126-134.

Baffes, J., and T. Haniotis (2015). "A decade of high agricultural prices." *Mimeo*. The World Bank, Washington, D.C.

Baffes, J., and A. Dennis (2015). "Long-term drivers of food prices." In *Trade policy and food security: Improving access to food in developing countries in the wake of high food prices*, ch. 1, pp. 13-33, ed. I. Gillson and A. Fouad. Directions in Development, World Bank, Washington, D.C.

Baffes, J., and X.L. Etienne (2014). "Reconciling high food prices with Engel and Prebisch-Singer." International Conference on Food Price Volatility: Causes and Consequences, Rabat, Morocco, February 25-26, 2014.

Baffes, J., and C. Savescu (2014). "Monetary conditions and metals prices." *Applied Economics Letters*, 21, 447-452.

Baffes, J., and T. Haniotis (2010). "Placing the recent commodity boom into perspective." In *Food prices and rural poverty,* ch.2, pp. 40-70, ed. A. Aksoy and B. Hoekman. Centre for Economic Policy Research and the World Bank, Washington D.C.

Bobenrieth, E., B. Wright, and D. Zeng (2012). "Stocks-to-Use ratios as indicator of vulnerability to spikes in global cereal markets." *Agricultural Economics,* 44, 1-10.

Borensztein, E., and C.M. Reinhart (1994). "The macroeconomic determinants of commodity prices." *IMF Staff Papers*, 41, 236-261.

Bourne, J.K. Jr. (2009). "The global food crisis: The end of plenty." *National Geographic,* June.

Chaudhri, K. (2001). "Long-run prices of primary commodities and oil prices." *Applied Economics*, 33, 531-538.

Cuddington, J.T., and Daniel Jerrett (2008). "Super cycles in real metal prices?" *IMF Staff Papers*, vol. 55, pp. 541-565.

Deaton, A., and J. Dréze (2008). "Nutrition in India: Facts and interpretations." *Economic and Political Weekly*, 44, 42-65.

Deaton, A., and G. Laroque (1992). "On the behaviour of commodity prices." *Review of Economic Studies*, 59, 1-23.

De Gorter, H., and D.R. Just (2009). "The economics of a blend mandate for biofuels." *American Journal of Agricultural Economics*, 91, 738-750.

Engel, E. (1857). "Die Productions-und Consumtionsverhdltnisse des Königreichs Sachsen." *Zeitschrift des Statistischen Bureaus des Königlich Sächsischen Ministerium des Inneren*, 8–9, 28–29.

Erten, B., and J.A. Ocampo (2013). "Super cycles of commodity prices since the mid-nineteenth century." *World Development*, vol. 44, pp. 14-30.

FAO, Food and Agriculture Organization of the United Nations (2009). *The state of agricultural commodity markets: High food prices and the food crisis—experiences and lessons learned.* Food and Agriculture Organization, Rome.

FAO, Food and Agriculture Organization of the United Nations (2008). "Soaring food prices: Facts, perspectives, impacts, and actions required." Technical report presented at the Conference on *World Food Security: The Challenges of Climate Change and Bioenergy*, June 3-5. FAO, Rome.

Frankel, J.A. (2014). "Effects of speculation and interest rates in a 'carry trade' model of commodity prices." *Journal of International Money and Finance,* 42, 88-112.

Frankel, J.A., and A.K. Rose (2010). "Determinants of agricultural and mineral commodity prices." In *Inflation in an era of relative price shocks*, pp. 9-51, ed. R. Fry, C. Jones, and C. Kent. Sydney, Australia: Reserve Bank of Australia and Centre for Applied Macroeconomic Research.

Gardner, B. (1981). "On the power of macroeconomic linkages to explain events in U.S. agriculture." *American Journal of Agricultural Economics*, 63, 871-878.

Gilbert, C.L. (1989). "The impact of exchange rates and developing country debt on commodity prices." *Economic Journal,* 99, 773-783.

Gilbert, C.L. (2010). "How to understand high food prices." *Journal of Agricultural Economics*, 61, 398-425.

Hanson, K., S. Robinson, and G.E. Schluter (1993). "Sectoral effects of a world oil price shock: economywide linkages to the agricultural sector." *Journal of Agricultural and Resource Economics*, 18, 96-116.

Hochman, G., D. Rajagopal, G. Timilsina, and D. Zilberman (2011). "The role of inventory adjustments in quantifying factors causing food price inflation." Policy Research Working Paper 5744, World Bank, Washington, D.C.

Holtham, G.H. (1988). "Modeling commodity prices in a world macroeconomic model." In *International commodity market models and policy analysis*, ed. Orhan Guvenen. Boston, MA: Kluwer Academic Publishers.

Issler, J.V., C. Rodrigues, and R. Burjack (2014). "Using common features to understand the behavior of metal-commodity prices and forecast them at different horizons." *Journal of International Money and Finance*, vol. 38, pp. 310-335.

Jacks, D. (2013). "From boom to bust: A typology of real commodity prices in the long run." NBER Working Paper 18874. Cambridge, MA.

Kindleberger, C.P. (1958). "The terms of trade and economic development." *The Review of Economic and Statistics*, 40, 72-85.

Kindleberger, C.P. (1943). "Planning for foreign investment." *American Economic Review*, 33, 347-354.

Krugman, P. (2008). "Grains gone wild." Op-Ed, *New York Times*, April 7.

Labys, W.C., A. Achouch, and M. Terraza (1999). "metal prices and the business cycle." *Resources Policy*, vol. 25, pp. 229-238.

Lamm, M.R., Jr. (1980). "The role of agriculture in the macroeconomy: A sectoral analysis." *Applied Economics*, 12, 19-35.

Lustig, N. (2008). "Thought for food: The challenges of coping with soaring food prices." Working Paper no 155, Center for Global Development, Washington, D.C.

Moss, C.B, G. Livanis, and A. Schmitz (2010). "The effect of increased energy prices on agriculture: A differential supply approach." *Journal of Agricultural and Applied Economics*, 42, 711–718.

Pindyck, R.S., and J.J. Rotemberg (1990). "The excess co-movement of commodity prices." *Economic Journal,* 100, 1173–1189.

Prebisch, R. (1950). *The economic development of Latin America and its principal problems.* United Nations, New York.

Reboredo, J.C. (2012). "Do food and oil prices co-move?" *Energy Policy*, 49, 456-467.

Reinhart, C.M. (1991). "Fiscal policy, the real exchange rate, and commodity prices." *IMF Staff Papers*, 38, 506-524.

Roberts, M.J., and W. Schlenker (2013). "Identifying demand and supply elasticities of agricultural commodities: Implications for the US ethanol mandate." *American Economic Review*, 103, 2265-2295.

Saghaian, S.H. (2010). "The impact of the oil sector on commodity prices: Correlation or causation?" *Journal of Agricultural and Applied Economics*, 42, 477-485.

Sarris, A. (2010). "Trade-related policies to ensure food (rice) security in Asia." In *The rice crisis*, pp. 61–87, ed. D. Dawe. Earthscan, London.

Singer, H.W. (1950). "The distribution of gains between investing and borrowing countries. *American Economic Review*, 40, 473-485.

Stürmer, M. (2013). "150 Years of boom and bust-What drives mineral commodity prices?" German Development Institute, Discussion Paper 5/2013. Bonn.

Webster, M., S. Paltsev, and J. Reilly (2008). "Autonomous efficiency improvement or income elasticity of energy demand: Does it matter?" *Energy Economics*, 30, 2785-2798.

Wolf, M. (2008). "Food crisis is a chance to reform global agriculture." *Financial Times*, April 27.

World Bank (2015). *Global Economic Prospects: The global economy in transition*. The World Bank, Washington, DC.

Zhang, Z., L. Lohr, C. Escalante, and M. Wetzstein (2010). "Food versus fuel: What do prices tell us?" *Energy Policy*, 38, 445-451.

Zilberman, D., G. Hochman, D. Rajagopal, S. Sexton, and G. Timilsina (2013). "The impact of biofuels on commodity food prices: Assessment of findings." *American Journal of Agricultural Economics*, 95, 275-281.