Box 1 A global energy market?

Until the mid-2000s, the price of natural gas in the world's key markets (United States, Europe, and Japan) was tied to oil prices. In addition to their prices moving in a synchronous manner, natural gas and oil were priced at similar levels in terms of energy content. In other words, natural gas and crude oil markets were integrated—though administered pricing mechanisms, not market forces. Coal, which was priced independently, traded at about one- third the price of oil in energy equivalent terms (box figure 1.1).

The energy price boom of the early 2000s changed all of this. First, it delinked U.S. natural gas prices from oil prices and from European and Japanese natural gas prices. Second, it generated a gap between WTI (the mid-continent U.S. price) and Brent (the international marker). Third, it linked U.S. natural gas and coal prices.

These trends now appear to be shifting once again. The WTI-Brent gap will close soon, perhaps as early as 2014, or 2015 at the latest. The coupling of U.S. natural gas and coal prices is likely to remain (and perhaps strengthen). Natural gas price convergence will depend on various investment and policy factors, thus it may take some time before it materializes. Analyzing the future relationship between natural gas and oil prices is more complex, and depends on whether induced innovation takes place—something that cannot be evaluated or projected.

Induced innovation in the extraction of natural gas through fracking and horizontal drilling techniques (often referred to as "unconventional" gas), primarily in the United States, was followed by supply increases in turn lowering U.S. natural gas prices. Low prices made gas an attractive alternative for some energy intensive U.S. industries, especially electricity generation, which are gradually switching from coal to natural gas. Indeed, the United States experienced a marked reduction in coal use—10.5 percent—from 2006-08 to 2009-11, while global consumption increased 9 percent. As a result, beginning in 2009, U.S. natural gas and coal have been traded at similar price levels in energy equivalent terms while diverging from European natural gas and Japanese liquefied natural gas (LNG) prices (box figure 1.2).

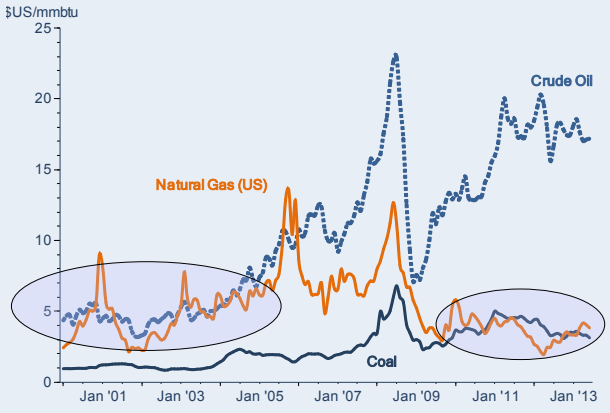
Will natural gas prices converge? There are numerous market (both demand and supply) and policy constraints, the removal of which is likely to induce coupling of natural gas prices in the longer term:

- **Supply—Increased unconventional gas supplies outside the United States.** Unconventional gas production has taken place almost exclusively in the United States. Yet unconventional natural gas reserves are plentiful in many regions, including South America, elsewhere in North America, and most importantly Asia Pacific. Industry estimates show that more than 40 percent of known global natural gas reserves recoverable at current prices and technology are unconventional. Reasons for the slow technology adoption include poor property rights, limited know-how, and environmental concerns.

- **Trade—construction of LNG facilities and gas pipelines**. Currently, 31 percent of natural gas crosses international borders—21 percent through pipelines and 10 percent in LNG form (by comparison, nearly two thirds of crude oil is traded internationally, 46 percent as oil and 20 percent as products). As more LNG facilities come on board and new gas pipelines are constructed, trade of natural gas will increase, thus exerting upward (downward) price pressure in producing (consuming) regions. Nevertheless, it should be noted that regardless of how much natural gas trade increases, LNG will be traded at much higher prices than gas through pipelines because of the high costs of liquefying and transporting.

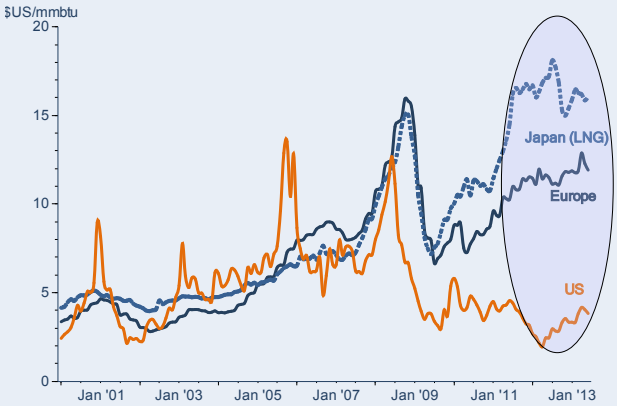
- **Demand—relocation of energy-intensive industries**. In addition to the substitution from coal to natural gas by energy-intensive industries in the United States, there is evidence that industries are moving to the United States to take advantage of the "natural gas dividend," in a way reversing the long-standing trend of American industries moving to Asia (and elsewhere) in response to the "labor cost dividend." Four energy-intensive industries that are taking (or will take) advantage of lower energy prices in

Box figure 1.1 Energy prices



Source: World Bank.

Box figure 1.2 Natural gas prices



Source: World Bank.

the United States are paper, aluminum, steel, and chemicals, whose energy costs as a share of total material costs range between 5 and 9 percent (the share for the U.S. manufacturing industry as a whole is 3 percent, four to five times higher than for agriculture; see box 3).

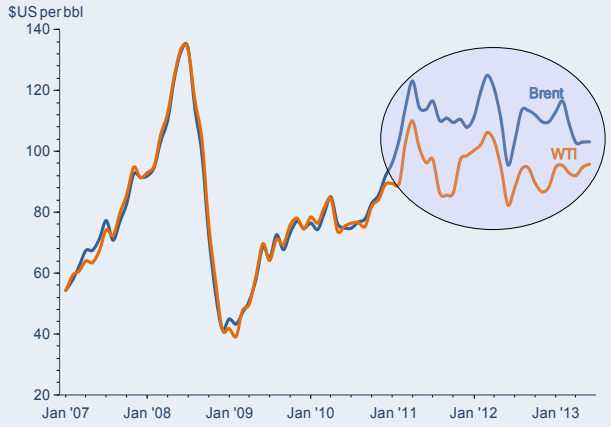
- **Substitute product—coal**. More trade in coal is likely to take place, thus further facilitating convergence of natural gas prices and also strengthening the convergence of coal and natural gas prices already underway. Indeed, between 2005 and 2012, global coal exports almost tripled (from 258 to 758 million tons), pushing coal traded as a share of production to almost 15 percent. Furthermore, anecdotal evidence points to even further increases. For example, a recent article (Bloomberg 2013) notes that Tata Power, India's second-largest electricity producer, is seeking coal supplies from the United States, Colombia, and Canada (which account for 13.9, 1.5, and 0.9 percent of global coal production, respectively; China's share is 50 percent).

- **Policies—U.S. energy exports, nuclear energy, property rights**. Three types of policies are expected to increase trade in natural gas and, consequently, price convergence. First, the United States is gradually **removing restrictions on energy exports**, most of which were introduced after the oil crisis of the 1970s in response to energy security concerns. Second, several countries are **reconsidering nuclear energy policies**, especially after the Tohoku accident in Japan; some plan to not replace aging nuclear power units, while others contemplate early decommissioning. The diminishing contribution of nuclear power to global energy consumption—already, there has been a decline from a peak of 6.4 percent in 2001 to 4.9 percent in 2011—will be replaced by coal, natural gas, and to a lesser extent renewables (see box table 1.1 for historical and current energy consumption shares). Third, countries with large unconventional reserves are likely to introduce policies to **strengthen property rights**, a key reason for not developing them.

Subsequent to the natural gas boom, fracking and horizontal drilling were applied to the U.S. oil sector, which, as expected, induced similar supply response. This increase in oil supplies, along with increasing crude inflows from Canadian oil sands, led to a decoupling of WTI from Brent, with the latter trading 18 percent above the former after January 2011 (box figure 1.3). Historically (1983-2005), WTI traded with a 6 percent premium over Brent, because the mid-continent U.S. was a "deficit" region. Following increased imports from Canadian oil sands during 2006-10, WTI and Brent traded on par. After January 2011, however, Brent has been traded with a premium over WTI following increased domestic shale oil supplies—it averaged 18 percent between January 2011 and May 2013. Although the premium declined recently, it may persist for another two years, until a new pipeline begins transferring surplus oil from Cushing, Oklahoma to the U.S. Gulf (some oil is currently moving by truck and rail). The WTI discount is likely to stabilize around 5 percent, (a mirror image of the pre-2006 premium) when the market reaches equilibrium—oil supply in the mid-Continent U.S. exceeds demand and the surplus moves to the Gulf at the lowest possible cost.

What about convergence of natural gas and oil prices? Because more than half of global crude oil supplies go to the transportation industry, the prospects of substitutability between crude oil and other types of energy will depend on the degree to which vehicles can switch from crude oil-base fuels to natural gas or electricity. As discussed in the previous edition of this outlook (World Bank 2013), contrary to the situation for natural gas, crude oil products have convenient distribution networks and refueling stations that can be reached by cars virtually everywhere in the world. Thus, in order for the transport industry to utilize natural gas at a scale large enough to make a dent in the crude oil market, innovations must take place such that the distribution and refueling costs of natural gas become comparable to those of crude oil. The second alternative, electricity, has its own drawbacks, namely, storage capacity and refueling time. Consider that if a truck with a net weight capacity of 40,000 pounds were to be powered by lithium-sulphur batteries for a 500-mile range, the batteries would occupy almost 85 percent of the truck's net capacity, leaving only 6,000 pounds of commercial space. Hence, as is the case for natural gas, for large-scale electricity use by vehicles, innovation in battery technology must take place.

Box figure 1.3 Brent and WTI prices



Source: World Bank.

Box table 1.1 Shares of global primary energy consumption (percent)

	Oil	Gas	Coal	Nuclear	Hydro	Other
1965-69	42.6	16.8	34.7	0.2	5.6	0.0
1970-74	47.3	18.6	27.7	0.9	5.4	0.1
1975-79	46.5	18.9	27.0	2.1	5.5	0.1
1980-84	41.4	20.3	28.3	3.7	6.2	0.1
1985-89	39.0	21.2	28.2	5.3	6.1	0.2
1990-94	38.7	22.3	26.3	6.0	6.3	0.4
1995-99	38.4	22.9	25.5	6.2	6.5	0.5
2000-04	37.3	23.4	26.4	6.1	6.1	0.7
2005-09	34.7	23.4	29.0	5.4	6.3	1.1
2010-11	33.1	23.7	30.3	4.9	6.4	1.6

Source: BP Statistical Review.
Note (1): "Other" includes biofuels, solar, wind, geothermal, and biomass
Note (2): The shares were calculated in oil equivalent terms