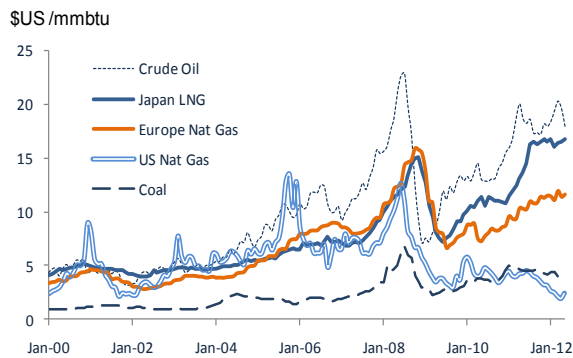


### Box Comm.1 Induced Innovation, Price Divergence, and Substitution

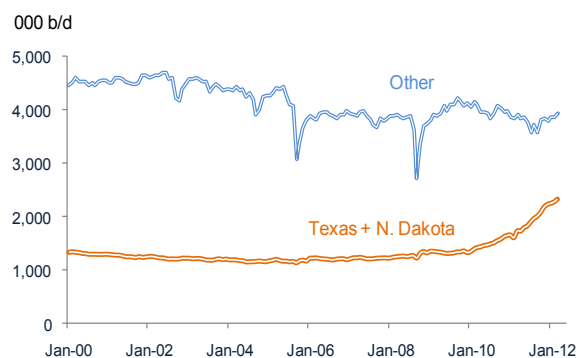
Because large and sustained changes in commodity prices often alter the relative prices of inputs, they induce innovations that support more efficient production or consumption of substitute (or the same) products. The induced innovation hypothesis was originally proposed by Hicks (1932), who noted that "... a change in the relative prices of the factors of production is itself a spur to invention and to inventions of a particular kind—directed at economizing the use of a factor which has become relatively expensive." The hypothesis has been studied extensively (see, for example, Ahmad (1966) and Kamien and Schwartz (1968) for the theoretical considerations; Binswanger (1974) for an application to agriculture, and Newell, Jaffee, and Stavins (2000) and Popp (2002) for applications to energy). In the context of the post-2005 commodity price boom, high energy prices induced significant increase in shale gas exploration and production in the U.S., in turn, causing natural gas prices to fall to just 12% of crude oil prices from near 75% in the decade of the 2000s (box figure Comm 1.1). High energy prices also induced exploration in oil-bearing shale plays, especially in North Dakota and Texas, thus increasing oil production in (box figure Comm 1.2). On the consumption side, high oil prices have triggered new vehicle efficiency standards and alternative/hybrid vehicles that are set to further reduce gasoline demand.

Box figure Comm 1.1 Energy prices



Source: World Bank

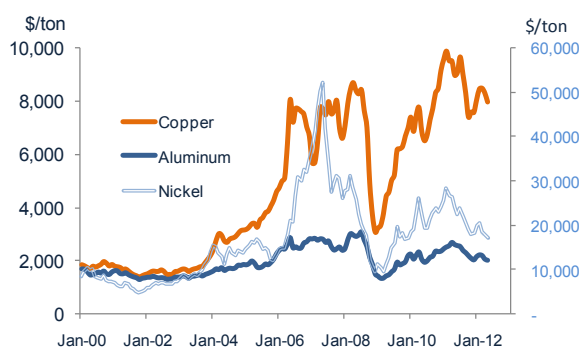
Box figure Comm 1.2 U.S. Crude oil production



Source: IEA

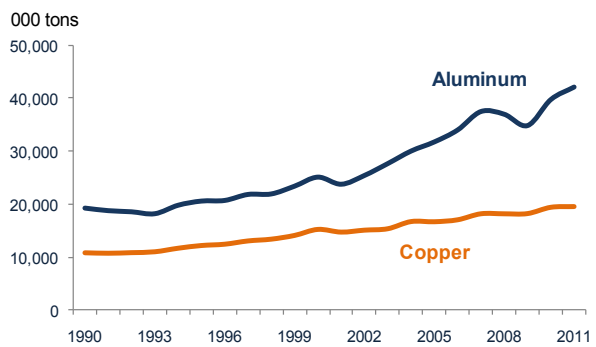
Similar trends have taken place in metals. Copper and aluminum traded at similar price levels 10 years ago, but high copper prices (box figure Comm 1.3) induced substitution to other materials, e.g., aluminum coated wiring and plastic tubing. Aluminum—a light-weight strong metal—continues to displace steel in autos and other applications. Consequently aluminum's volume growth over the past ten years has been nearly four times that of copper (box figure Comm 1.4). And, the nickel price boom caused China to import low grade ores from the Philippines and Indonesia to produce nickel pig iron and reduce refined nickel imports.

Box figure Comm 1.3 Refined metal prices



Source: World Bank.

Box figure Comm 1.4 Refined metal consumption



Source: World Bureau of Metal Statistics