



Economic Letter

Cheaper Crude Oil Affects Consumer Prices Unevenly

by Alexander Chudik and Janet Koech

ABSTRACT: The recent crude oil price decline is reflected in lower pump prices for gasoline. Other consumer prices are also affected, but the impact and the speed of transmission vary considerably.

Crude oil prices fell sharply in the last half of 2014, concluding a four-year period of relative price stability. Prices declined 41 percent between June and December 2014—from \$102.51 a barrel to \$60.70.

The steepness of the decline is second only to the collapse during the 2008 economic crisis, when oil fell from \$129 to \$37 per barrel within six months. Since summer, crude oil prices as measured by U.S. refiners' acquisition costs have traded below \$50 a barrel (*Chart 1*).¹ Both Brent and West Texas Intermediate crude oil benchmarks dipped below \$40 in December 2015.

Unlike the 2008 episode, which was mainly demand driven, both demand and supply factors have played a key role in the recent period. On the supply side, U.S. shale production rose due to technological innovation, and Middle East oil output grew. On the demand side, sluggish global growth constrained consumer purchases.

U.S. consumers experience crude oil price drops largely at the pump. Consumers spent an average of \$2.17 per gallon for unleaded gas in November 2015, down from an average of \$3.60 per gallon in the summer of 2014.²

Oil Price Changes

Economists call the impact of oil price shocks on inflation a “pass-

through” effect. The pass-through depends on several factors, both direct and indirect.

Direct effects reflect the transmission of crude oil price changes to the prices of refined oil products such as gasoline and heating oil. The extent to which the pass-through affects consumers depends, among other things, on the share of household spending on refined oil products relative to total outlays.

Indirect effects reflect changes in the cost of producing goods and services that use refined oil products as an input. These changes show up in the final cost of goods and services and affect nonenergy categories of consumer prices.

To assess inflationary pressures on the U.S. economy, price changes in 178 components of the personal consumption expenditures (PCE) index were evaluated against price changes in crude oil as measured by the composite U.S. refiners' acquisition cost. Month-to-month changes in individual PCE components are statistically broken down into two components—those that can be explained by current and past oil price movements, and those that cannot.³

Price elasticities are a convenient way to measure price change pass-throughs. Price elasticities measure the percentage change in individual PCE components in response to a 1 percent change in the

Chart
1

Crude Oil Prices Decline Sharply in 2014



NOTE: The chart shows the evolution of U.S. refiners' acquisition cost of crude oil.

SOURCES: Energy Information Administration; Haver Analytics.

► Demand-driven price movements are likely to be especially relevant for nonenergy PCE components because an increase in global demand for oil will not only lead to higher oil prices, but also to a simultaneous increase in the utilization of resources.

price of crude oil. Because percentage change can be evaluated at various periods, it is possible to distinguish between short-run (typically one period) and long-run elasticities. Long-run elasticities are the focus of this examination.

Such analysis reveals that the PCE components responding most to crude oil price changes are, not surprisingly, in energy categories. Consumer energy expenditures represent only 5 percent of total PCE, with half coming from gasoline and the rest from electricity, natural gas, heating oil and petroleum-related lubricants and fluids (*Chart 2*).

Pass-through from crude oil price changes has an overall impact on all energy goods and services, but that effect varies according to the good or service. A 1 percent increase or decrease in crude oil prices results in a pass-through of 36 percent to the aggregate energy component of PCE. This implies that 36 percent of the 1 percent increase (decrease) is passed on to the aggregate energy component, which means that total energy prices change by 0.36 percent.

Gasoline, which has a hefty expenditure weight within energy goods and services, has a bigger response to oil price changes. A 1 percent increase (decrease) in crude oil prices results in a 0.6 percent increase (decrease) in gasoline prices. The heating oil response is similar, although its energy expenditure weight is only 4 percent.

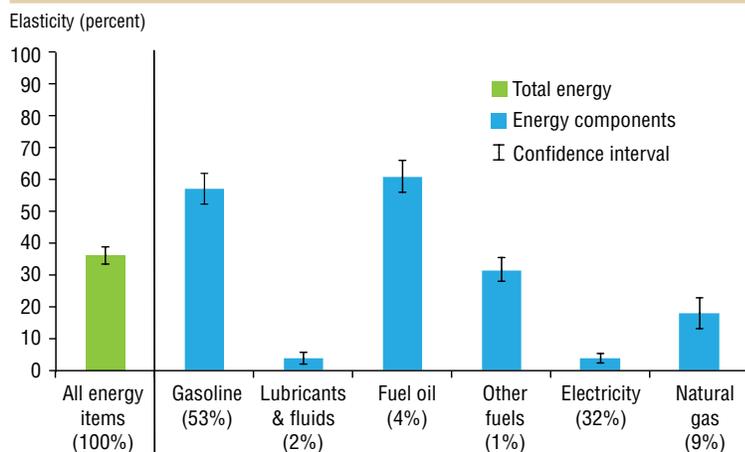
Crude oil represents only 47 percent of the retail cost of gasoline, while the remainder is taken up by refining, distribution and marketing costs, and taxes.⁴

Electricity and petroleum-related lubricants and fluids respond little to changes in oil prices, as seen in *Chart 2*. The prices of these products change 0.04 percent following a 1 percent change in oil prices. The chart also shows confidence intervals for each energy component, indicating a 90 percent chance that the price elasticities are within the estimated elasticity range (shown by the vertical lines on each bar in the graph). The tight confidence intervals imply that the statistical uncertainty of the estimates is relatively small.

Among nonenergy PCE components, the impact of crude oil prices is much smaller (*Chart 3*). Nonenergy categories make up 95 percent of PCE weight, and changes in these price categories in response to crude oil price movements reflect indirect or secondary effects.

The air transportation price index is the PCE category with the largest pass-through estimate among all nonenergy components. This is not surprising given that fuel is a large expense for this sector. The long-run pass-through for this sector is 13 percent, implying that a 1 percent change in oil prices results in a 0.13 percent change in airfares. The confidence interval quantifies that there is a 9-in-10 chance that the actual price change falls between 0.09 and 0.16 percent.

Chart 2 Long-Run Pass-Through Notable Among PCE Energy Components



NOTES: The chart shows estimates of long-run elasticities of the aggregate personal consumption expenditures (PCE) energy category and its components to crude oil prices, along with their 5 to 95 percent confidence intervals. The estimation sample is February 1977 through August 2015. Energy components do not total 100 percent due to rounding. SOURCE: Authors' calculations.

Overall, pass-through to individual nonenergy components is relatively small. For most categories, the elasticities are less than 3 percent—half of which are not statistically significant. The estimated pass-through for the aggregate nonenergy category is 1.4 percent. However, the confidence interval ranges from 0.2 to 2.3 percent, suggesting greater uncertainty regarding the pass-through.

Pass-through to nonenergy PCE components occurs when crude oil prices directly impact prices of gasoline and other energy items that are, in turn, used

as production inputs for most nonenergy products and services. A company's distribution costs, for instance, may be affected by gasoline price changes.

Additionally, crude oil price pass-through estimates can depend on the source of the crude oil price movements. Estimates of elasticities were computed based on price changes without regard to the source of these movements. Crude oil prices rise or fall because of changes in both the global demand and global supply of crude oil (and the expectations thereof).

The pass-through due to global demand-driven crude oil price changes can differ from the pass-through due to supply-side changes. Demand-driven price movements are likely to be especially relevant for nonenergy PCE components because an increase in global demand for oil will not only lead to higher oil prices, but also to a simultaneous increase in the utilization of other resources. This in turn diminishes global economic slack—the availability of various inputs—which can lead to higher consumer inflation for a broad range of price categories, resulting in greater pass-through.

Uneven Speed

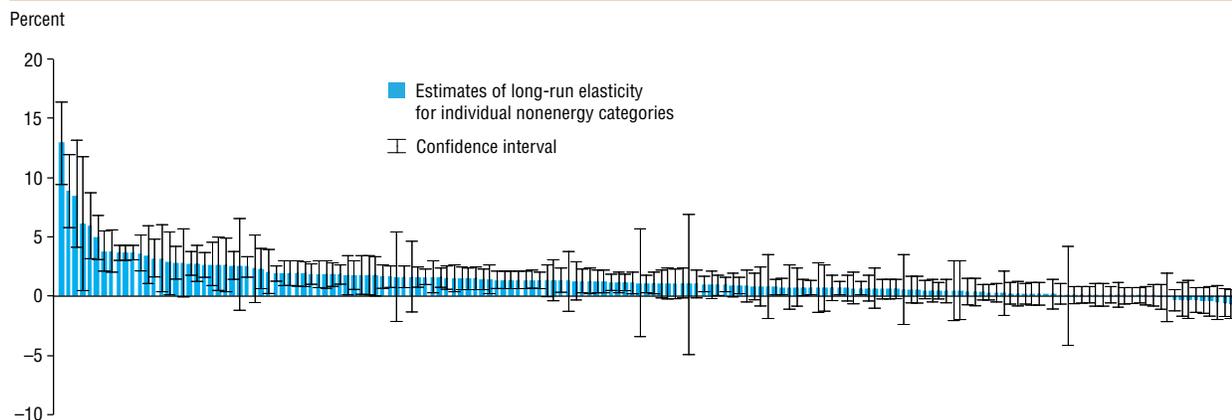
How long does it take consumers to realize the impact of a drop in crude oil prices in what they pay for energy and other products? Pass-through in the aggregate energy category is fast—about 80 percent of long-run pass-through is achieved within the first month after a crude oil price change (*Chart 4*).

By comparison, the transmission channel for pass-through to nonenergy categories is considerably slower—it takes about six months for 50 percent of the long-run pass-through to materialize and more than two years for consumers to realize the complete price adjustment.

Future Price Changes

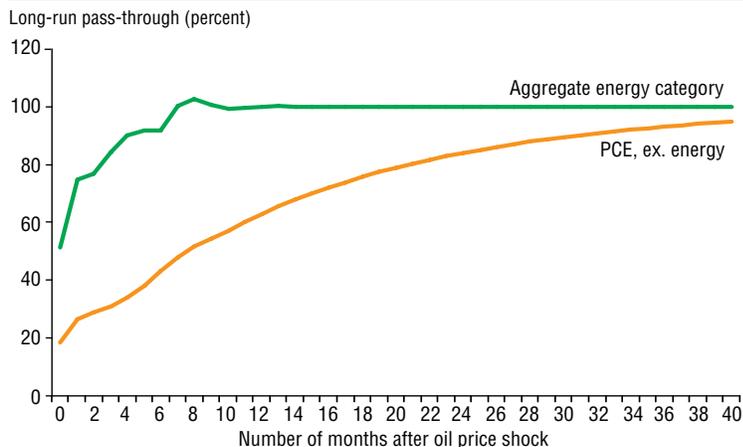
Changes in crude oil prices have profound effects on the U.S. and other

Chart 3 Long-Run Pass-Through Very Small Among PCE Nonenergy Components



NOTES: The chart shows estimates of long-run elasticities of the individual non-energy personal consumption expenditures categories to crude oil prices, along with their 5 to 95 percent confidence intervals. The estimation sample is February 1977 through August 2015. SOURCE: Authors' calculations.

Chart 4 Time Profile of Pass-Through Dramatically Differs Between Energy, Nonenergy Categories



NOTES: The chart shows the time profile of crude oil price pass-through to aggregate energy and nonenergy personal consumption expenditures (PCE) categories.

SOURCE: Authors' calculations.

economies. Recent crude oil declines redistributed income from oil exporting economies to oil importing economies. Producers receive less income from oil proceeds, while consumers benefit from cheaper prices and can spend more on other goods and services.

Additionally, the effects on consumer prices are significant. Estimates of oil price pass-through to individual components of the PCE index indicate that energy-related categories respond the most to crude oil price changes.

Many nonenergy price categories are also indirectly affected, though the long-run pass-through for nonenergy price categories is substantially smaller and materializes over a much longer period.

The outlook for crude oil prices is inherently uncertain. Futures contracts

for 12-month-ahead delivery suggest market expectations for crude oil prices fall within a wide range—\$24 to about \$101 per barrel, with 95 percent confidence. (There is a 1-in-20 chance of crude oil prices falling outside the interval). Consequently, the effects of crude oil prices on U.S. consumer prices in the next 12 months are difficult to predict even though crude oil price pass-through is, in some instances, quite tightly estimated.

Alexander Chudik is a senior research economist and advisor and Janet Koech is an assistant economist in the Research Department at the Federal Reserve Bank of Dallas.

Notes

¹ This crude oil price includes transportation and other fees paid by the refiner and is a weighted average of domestic and imported crude oil costs. It does not include the cost of crude oil purchased for the strategic petroleum reserve.

² The quoted gasoline price is the per-gallon average pump price for unleaded regular self-serve gas, reported by *Oil & Gas Journal*.

³ An autoregressive distributed lag (ARDL) model approach is used, where the dependent variables (individual components of PCE) are regressed on their p lags and contemporaneously on q lagged values of oil innovations. The number of lags (p and q) are chosen as an appropriate function of the available sample size—specifically, we set both p and q equal to the integer part of T raised to one-third, where T is the sample size (the number of available time periods). We also complement the ARDL approach with an alternative distributed lag (DL) approach, which is based on a similar set of regressions but omits the lags of the dependent variable. The two approaches are complementary because they both yield statistically sound (or consistent) estimates, but their relative performance could differ in finite samples. A more thorough discussion of the ARDL and DL methods and their relative merits can be found in “Long-Run Effects in Large Heterogeneous Panel Data Models with Cross-Sectionally Correlated Errors,” by Alexander Chudik, Kamiar Mohaddes, M. Hashem Pesaran and Mehdi Raissi, Federal Reserve Bank of Dallas Globalization and Monetary Policy Institute Working Paper no. 223, January 2015.

⁴ According to the Energy Information Administration, the retail price of regular gasoline as of October 2015 is broken down as follows: Crude oil accounts for 47 percent of the total price; refining, 15 percent; distribution and marketing, 19 percent; and taxes, 20 percent.

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Federal Reserve Bank of Dallas
2200 N. Pearl St., Dallas, TX 75201