

London Economics International LLC

Taking a look ahead: The long-term impacts of a crisis on oil demand

Marie Fagan Chief Economist London Economics International marie@londoneconomics.com



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2	A look backward
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Introduction > Overarching question



When the economy recovers, what should we expect from oil demand?

- Global oil demand has collapsed owing to measures to contain the COVID-19 pandemic
- The question is, to what degree will it come back?

Percentage of vehicle miles traveled ("VMT") in the United States, by purpose of trip



Source: US Department of Transportation, Federal Highway Administration, 2017 National Household Travel Survey. https://nhts.ornl.gov/vehicle-miles

- The temporary lock-down could have permanent repercussions for example:
- "In the United states we waste 6 billion gallons (about 390,000 b/d) of gasoline a year in traffic congestion." Amy Myers Jaffe, Council on Foreign Relations
- Even if travel to work fully recovers, it is only 21% of VMT



Measuring the drivers of global oil demand: Purpose of the research, approach

LEI conducted an in-depth analysis of oil supply and demand shocks since the energy crisis of the 1970s. We looked at 40 years of data to learn how demand responds after a crisis

Purpose of the research

- LEI was engaged by the Columbia University Center on Global Energy Policy ("CGEP") to conduct a study of income and price elasticities of demand for crude oil and refined products
- Income and price elasticities of demand play a key role in crude oil demand forecasting
- The research for CGEP provides the foundation for this presentation

Approach

 LEI's approach was to examine data for oil demand, oil prices, and GDP over four decades, for 25 OECD countries, 18 non-OECD countries, and 5 oilproducing countries. LEI examined data trends, and developed econometric models to identify the impact of economic activity and oil prices on oil demand Introduction > Key takeaways



- Even though there has been decades-long growth in global crude oil demand, the rate of growth has slowed
- The oil-intensity of economic activity has declined—but this was not a steady erosion of oil demand per dollar of GDP
- It was, instead, several step changes
- Sometimes it happened in response to an energy crisis, in other cases it was the result of structural changes in the makeup of economic activity
- After each step change, oil intensity did not recover, even after many years
- Long-term growth in demand will be at a slower pace



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A look backward > Historical stair-step



The oil-intensity of the global economy: Not a steady decline, but a descending staircase







The stairstep decline was driven by structural changes in OECD and non-OECD economies

Oil consumption per unit of GDP



OECD countries were instrumental in the decline in global oil intensity in the first two decades non-OECD countries drove the decline in global oil intensity in the last two decades







The impact of economic activity > Measurement

Measuring the impact of economic activity on oil demand

- The impact of economic activity on oil demand is referred to as the "income elasticity of oil demand"
 - At the same time GDP is growing (or not, as in a recession), there are other factors, especially the oil price, which can impact oil demand
 - Oil prices are volatile, and are closely watched by both consumers and producers
 - There is no consensus on exactly how much impact oil prices or economic activity each have on oil demand
 - Decades of economic/econometric studies have provided a variety of estimates of elasticitiy
 - Estimates vary depending on the time period and countries studied
 - LEI's research covers 40 years and 48 countries, to be as comprehensive as possible

The impact of economic activity > Oil prices fluctuate



Oil prices cycle through ups and downs; we need to account for their impact on demand

Brent crude price



We use econometric analysis to isolate the impact of GDP on oil demand, from the impact of oil prices on oil demand



Highlights of LEI's econometric results





Price elasticity

Note: The econometric models used to generate these results were dynamic, symmetric, fixed-effects models using panel data with total oil demand and total GDP. See Appendix for model specification. Shaded bars indicate not significant at 95%

- Elasticity refers to the % change in oil demand from a 1% change in GDP or oil price
- Income elasticity of oil demand is larger in absolute value than price elasticity; which indicates that income matters more to demand than oil prices
- Income and price elasticities are both smaller in absolute value for the 1997-2016 period than the 1977-1996 period
- This means both income and prices now matter less to oil demand than in the past

A lower income elasticity of oil demand implies flatter growth of oil demand—even when economies recover from a recession



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A look forward > The path to peak oil demand



Two trends can reduce global oil demand after a crisis: Demand resets at a lower level, AND it may also grow at a slower rate

- 1) Downward ratchet re-sets oil demand
- 2) Lower oil intensity of global GDP means slower future growth



Peak demand may be closer than projected before the crisis, with implications for oil company strategy

A look forward > Getting back into balance

This time is different—and the same

 In the 1970s and 1980s, global oil demand declined owing to high oil prices AND a recession

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> High oil prices incentivized oil production



Source: https://www.thebalance.com/what-is-cost-push-inflation-3306096

 Market re-balanced as economy recovered and oil production increased

- This time is different- demand is down strictly on economic activity, NOT on high oil prices
 - Low oil prices won't do much to help oil demand. The recovery of oil demand all depends on the economy



Source: https://insideevs.com/news/317678/low-gas-prices-in-uscontinue-to-hamper-electric-vehicle-sales/

- In the near term, getting the market "back into balance" depends on producers cutting back
- But it is also the same—once oil intensity declines, do not expect it to come back

A look forward > Policy implications



Implications for policies around climate change, economic development, and geopolitics

Re-set of oil demand supports efforts to "flatten the climate curve"

- Carbon tax- a source of revenue, too
- Lower fuel subsidies
- Green bailout/government investment
- Some oil-dependent economies already have long-term plans to diversify- they might fast-forward such plans
 - Saudi Arabia's National Transformation Program
- Ongoing struggles for revenue in oildependent economies could lead to more regional unrest
 - Incentives to damage one another's oil producing capability





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Appendix > Data definitions



Definition of country groups used in LEI's econometric analysis

Group	Countries included
OECD	Australia, Austria, Belgium, Canada, Chile, Denmark, Finland, France, Germany, Greece, Ireland, Israel, Italy, Japan, Korea, Mexico, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Turkey, United Kingdom, United States
Non-OECD	Argentina, Brazil, Colombia, Ecuador, Peru, Trinidad & Tobago, Algeria, Egypt, South Africa, China, China Hong Kong, India, Indonesia, Malaysia, Pakistan, Philippines, Singapore, Thailand
Oil producers	Iran, Kuwait, Qatar, Saudi Arabia, United Arab Emirates

Appendix > Econometric models



Econometric approach: LEI tested four model specifications

Model specifications	Static	Dynamic
Symmetric	$InCon_{ct} = \alpha + \beta_{1}In P_{t} + \beta_{2}InGDP_{ct} + \beta_{i}[Dummy_{ct}] + \epsilon_{ct}$	$InCon_{ct} = \alpha + \beta_{1}LnP_{t} + \beta_{2}LnGDP_{ct} + \beta_{3}LnCon_{ct-1} + \beta_{i}[Dummy_{ct}] + \varepsilon_{ct}$
Asymmetric	$LnCon_{ct} = \alpha$ + $\beta_1 LnPMax_t + \beta_2 LnPRec_t + \beta_3 LnPCut_t$ + $\beta_4 LnGDPMax_{ct} + \beta_5 LnGDPRec_{ct}$ + $\beta_6 LnGPDCut_{ct}$ + $\beta_i [Dummy_{ct}]$ + ϵ_{ct}	$LnCon_{ct} = \alpha + \beta_{1}Ln Con_{ct-1}$ + $\beta_{2}LnPMax_{t} + \beta_{3}LnPRec_{t} + \beta_{4}LnPCut_{t}$ + $\beta_{5}LnGDPMax_{ct} + \beta_{6}LnGDPRec_{ct}$ + $\beta_{7}LnGPDCut_{ct}$ + $\beta_{i}[Dummy_{ct}]$ + ϵ_{ct}

where:

 $LnCon_{ct} = log of demand for oil, in country c in year t$

 $LnGDP_{ct} = log of real GDP$, in country c in year t

LnPrec = cumulative sub-maximum increases in ln(real oil price) (and similarly for LnGDPrec)

LnPmax = cumulative increase in maximum observed ln(real oil price) (and similarly for LnGDPmax)

LnPcut = cumulative declines in ln(real oil price) (and similarly for LnGDPcut)

Dummy = matrix of dummy variables for all countries except one (fixed-effects model)

 ϵ_{ct} = error term

 $\alpha,\,\beta 1,\,\beta 2,\,etc.,\,are$ the coefficients to be estimated



The extensive literature on oil demand drivers reveals a variety of approaches



Short-term versus long-term elasticities

In the near term, consumers can (and probably want to) adjust only partially to price changes. A widely-used way to capture this effect is to use a dynamic adjustment model



Potential asymmetry of responses to oil price changes

Do consumers respond more strongly to rising oil prices than to falling oil prices? A number of researchers looking at oil demand found asymmetric responses



Panel data versus time series data

Using panel (combined cross-section and time series data) helps avoid the problem that the global oil price could be dependent on (endogenous to) global, OECD, or non-OECD demand for oil. However, the price is probably exogenous to an individual country's demand for oil, so using country-level data may help avoid this endogeneity problem

Appendix > Reference

$\mathcal{F}_{\mathbf{E}}$ LEI's research on oil demand is publicly available

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Up the down staircase: What history teaches us about oil demand after a crisis¹



Originally prepared for Columbia University School of International and Public Affairs, Center on Global Energy Policy by London Economics International LLC

June 4, 2019

Abstract, added April 29, 2020: Although the scale of oil demand destruction from the Covid-19 pandemic is unprecedented, it does not mean there are no precedents to help us think about what oil demand will look like after the crisis passes. Marie Fagan, Chief Economist at London Economics International ("LEI") and a colleague completed a study of 40+ years of global oil supply and demand shocks, which provides insights as to how oil demand responds after a crisis. This study examines economic growth, and oil demand and prices (crude oil, gasoline, and diesel) at the country level for OECD, non-OECD, and oil-producing countries. Based on examination of the data, econometric analysis, and a review of the literature, what history teaches us is that declines in global oil intensity come in large stair-steps, not gradually. Once oil intensity drops down a stair-step, it does not fully recover to previous levels, even after many years.

Background: LEI was engaged by the Columbia University School of International and Public Affairs, Center on Global Energy Policy ("CGEP") to prepare an econometric study of income and price elasticities of demand for crude oil and key refined products. This extensive study was provided to CGEP in the LEI report "Oil demand: Up the down staircase" November 19, 2018. This document provides highlights of the detailed study.

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¹ Original title: "Oil demand: Up the down staircase"

Fagan, Marie. "Up the Down Staircase: What History Teaches Us about Oil Demand after a Crisis" (May 4, 2020). USAEE Working Paper No. 20-440. Available at SSRN: <u>https://ssrn.com/abstract=3592443</u>

Appendix > LEI Expertise



LEI is active across the value chain and has a comprehensive understanding of the issues faced by the private sector and regulators alike



Asset Valuation, Price Forecasting & Market Analysis

- Exhaustive sector knowledge and a suite of state-of-the-art proprietary quantitative modeling tools
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 - Convert findings into efficiency targets mutually acceptable to utilities and regulators



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 - Process management
 - Document drafting and stakeholder management

Appendix > LEI clients worldwide

$\overline{\mathrm{LE}}$ LEI has energy sector clients around the world

