2022

Enbridge Line 5 | Shutdown Impacts on Transportation Fuel

PREPARED FOR CONSUMER ENERGY ALLIANCE BY WEINSTEIN, CLOWER & ASSOCIATES

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Contents

1. Executive Summary

In 2021, Weinstein, Clower and Associates prepared an assessment of the potential economic and fiscal impacts that Midwestern states will bear if Michigan politicians succeed in forcing the shutdown of Enbridge's Line 5 pipeline, which carries light crude oil and natural gas liquids from northwestern Wisconsin, through the state of Michigan, and terminates in Sarnia, Ontario. That analysis focused on the loss of jobs and economic activity in Michigan, Ohio, Indiana, and Pennsylvania due to removing these energy resources as inputs into many important regional industries. Among others industries impacted by the possible closure of Line 5, the most harmed industry would be petrochemical refiners, especially those near Toledo, Ohio, that rely on Line 5 for feedstocks. The possible loss of production at the BP-Husky and PBF-Energy refineries would have a devastating impact on the supply of transportation fuels in their regional markets. Our analysis examines how this negative shock to local gasoline and diesel supplies will impact regional fuel prices and the implications of rising fuel costs for regional consumers.

If Line 5 shuts down, families and businesses across the Midwest will spend at least $23.7 billion more on gasoline and diesel over the following five years due to the resulting loss of production at area refineries. The regional market may eventually adjust to the disruptions caused by a Line 5 shutdown. However, such shifts will not happen quickly, given the time it takes for state and federal regulators to review and permit options such as expanding refining capacity or rerouting pipelines. Alternatives, such as using rail or trucks to replace the lost production of transportation fuels for regional markets, ignore capacity constraints at other refineries, the scarcity of railroad rolling stock, and the severe national shortage of qualified truck drivers.

Our key assumptions include the following:

- The closure of Line 5 will directly impact the feedstocks of several Midwestern refineries, plus additional facilities in Canada that are not included in this analysis. Based on public testimony, two refineries in the Toledo, Ohio, region will be severely impacted.
- There is no recent historical precedent for government actions forcing the sudden, simultaneous shutdown of multiple energy production facilities. Therefore, the analysis focuses on historical lessons of fuel price impacts from natural disasters. The academic and professional literature on the impacts of regional refinery closures on transportation fuel prices is surprisingly thin. The most relevant studies look at fuel prices that attend temporary refinery shutdowns during and immediately after major hurricanes. We find these events to be the most analogous to shuttering Line 5 for one important reason: other disaster events, such as refinery accidents, do not usually strike multiple refineries simultaneously.
- Toledo regional refineries produce 30% of the gasoline and 35% of diesel consumed in Ohio, and 42% of gasoline sold in Southeastern Michigan. The impact of both Toledo refineries' production loss combined with reductions in other regional refinery feedstocks,

will have a profound effect on the market that supplies gasoline and diesel to this region. These refineries also provide jet fuel to regional airports, especially Detroit International. The potential loss of air transportation services is covered in another report prepared by the Consumer Energy Alliance.

- There is little slack supply capacity in the existing refining industry and certainly no meaningful alternative capacity to replace the output of two major refineries located on the infrastructure network that supplies transportation fuels to Ohio, Michigan, Indiana, and Pennsylvania. Proponents of closing Line 5 have proclaimed that alternative transportation assets, such as over-land pipelines, can be built or that other refineries could expand production. That may be true in the long-term (10+) years; but in the meantime, the supply side of the regional gasoline and diesel markets will be devastated.
- Based on previous studies of disaster-related fuel production disruptions, we conservatively estimate that the closure of Line 5 will spark a 9.47% to 11.66% regional (U.S.) increase in fuel prices.[1] This increase is independent of any other market conditions, such as the surge in fuel prices observed over the past 12 months that are tied to international oil markets and logistical challenges caused by the pandemic.
- Based on energy consumption data from the U.S. Energy Information Administration and current at-the-pump fuel prices reported by Gas Buddy, we calculated total potential annual baseline spending on transportation fuels for the four states included in this analysis. Fuel consumption is based on 2019 data to more accurately represent normalized (post-pandemic) markets.
- The fuel price increases will be most severe in Michigan and Ohio because of the relative reliance on refineries served by Line 5. The fuel price impacts in Indiana and Pennsylvania are adjusted to account for their gasoline and diesel markets being supported by other suppliers.
- Based on a long history of energy price research, the demand for gasoline and diesel fuel will not be affected by the assumed price increases. Demand for transportation fuel is largely inelastic, even under relatively large price swings. Trucks and trains must deliver goods and consumers must go to work, shop, and insist on leisure and family travel. At the time this report is being prepared, about 15% of US employees are still not commuting due to the pandemic; but this reduction in transportation fuel demand by commuters has been more than offset by rising freight transportation as home delivery of goods has risen significantly since the onset of COVID-19.

Even using very conservative estimates, households, businesses, and governments will spend billions more for gasoline and diesel with the closure of Line 5. The economic pain of this welfare loss will be exacerbated by consumer prices currently rising at their fastest pace in more than 40 years. Though weekly earnings increased substantially in nominal terms during 2021, when adjusted for inflation, real earnings fell by 2.3%. Forcing consumers in the Midwest to pay more for gasoline and diesel would be adding insult to economic injury.

Table ES1: Increased Transportation Fuel Expenditures by State After Closure of Enbridge Line 5 (annual, millions of dollars)

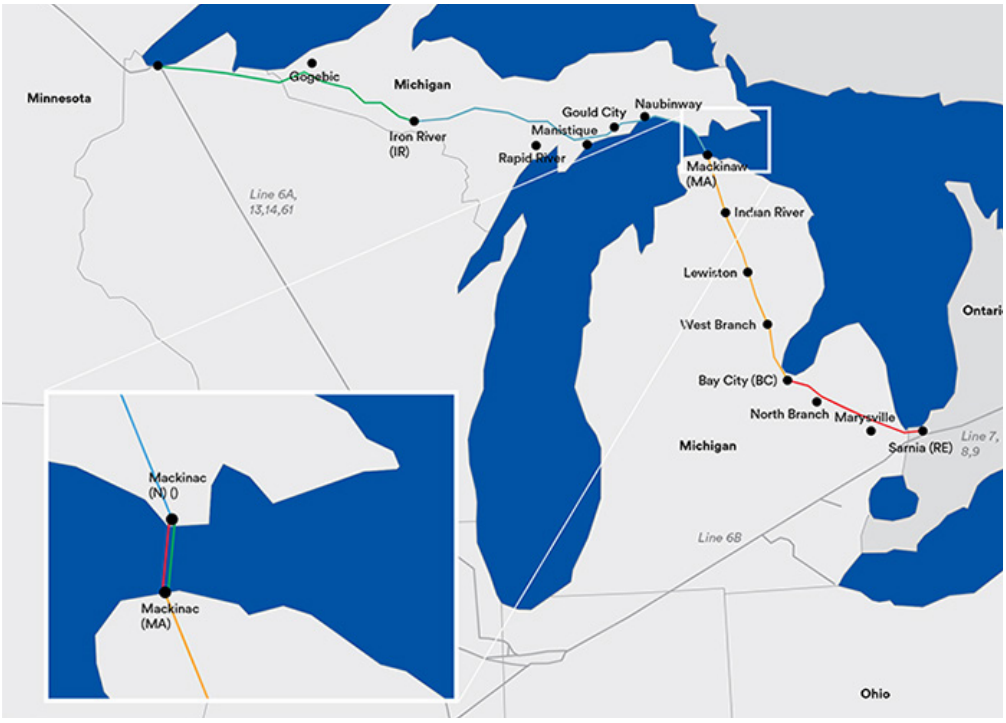
	Lower Bound			Upper Bound		
	Diesel	Gasoline	Total	Diesel	Gasoline	Total
Ohio	$743.3	$1,469.9	$2,213.2	$915.2	$1,809.8	$2,725.1
Michigan	$418.7	$1,391.1	$1,809.8	$515.1	$1,712.8	$2,228.3
Indiana	$83.14	$137.6	$221.1	$102.7	$169.5	$272.2
Pennsylvania	$188.2	$324.1	$512.2	$231.7	$399.0	$630.7
Region	$1,433.6	$3,322.8	$4,756.3	$1,765.1	$4,091.2	$5,856.3

Sources: U.S. Energy Information Administration; Gas Buddy; Weinstein, Clower & Associates

2. Background

Enbridge Line 5, constructed in 1953, is a major pipeline carrying light crude oil and natural gas liquids (NGLs)—mainly propane—from northwestern Wisconsin, through the state of Michigan, and terminating in Sarnia, Ontario (see Figure 1). It is part of a large pipeline network transporting liquid hydrocarbons from Western Canada, mainly the Province of Alberta, into the American Midwest where the product is delivered to refineries, steam crackers, and propane processors.

Figure 1: Route of Enbridge Line 5



Though the pipeline has operated for almost 70 years with no leaks or breaks in the Straits of Mackinac, the current governor of Michigan, Gretchen Whitmer, ordered a shutdown of Line 5 in May of 2021. She argues that because a four-mile segment of the pipeline runs under the Straits of Mackinac between Lakes Michigan and Huron, a rupture could potentially spill huge amounts of oil into the Great Lakes and cause an economic and environmental disaster. Enbridge Energy Company has filed a lawsuit arguing the Governor doesn't have jurisdiction to shut down the pipeline, while five members of the Michigan congressional delegation and Canadian Prime Minister Justin Trudeau are pressing the Biden administration to keep Line 5 operational.

Refineries in Michigan, Ohio, Pennsylvania, Ontario, and Quebec would lose about 45% of their crude oil input in the event of a Line 5 closure. The closure of Line 5 will reduce the ability of area refineries to maintain current production levels or force them to secure alternative sources of feedstocks. It is not possible from publicly available data to ascertain how each refinery may respond, but the result will be higher prices for transportation fuels. By using alternative (non-Line 5) feedstock sources, under any reasonable scenario the cost of that feedstock will rise dramatically, and those costs will be passed onto consumers through higher transportation fuel prices. The refineries could choose to lower production levels proportionate to their Line 5 take. This reduction in regional transportation fuel supplies will cause prices to rise along normal supply-demand economic principles. We discuss the availability of alternative fuel sources below. Because of the extremely high fixed costs of operating a refinery, the loss of Line 5 feedstocks may make Toledo-area refineries financially unsustainable, which would exacerbate regional supply challenges in a post-Line 5 market.[2] This analysis uses publicly available data and insights from professional and academic literature to estimate the costs of transportation fuel price increases for consumers in Michigan, Ohio, Indiana, and Pennsylvania that would likely attend the closure of Line 5.

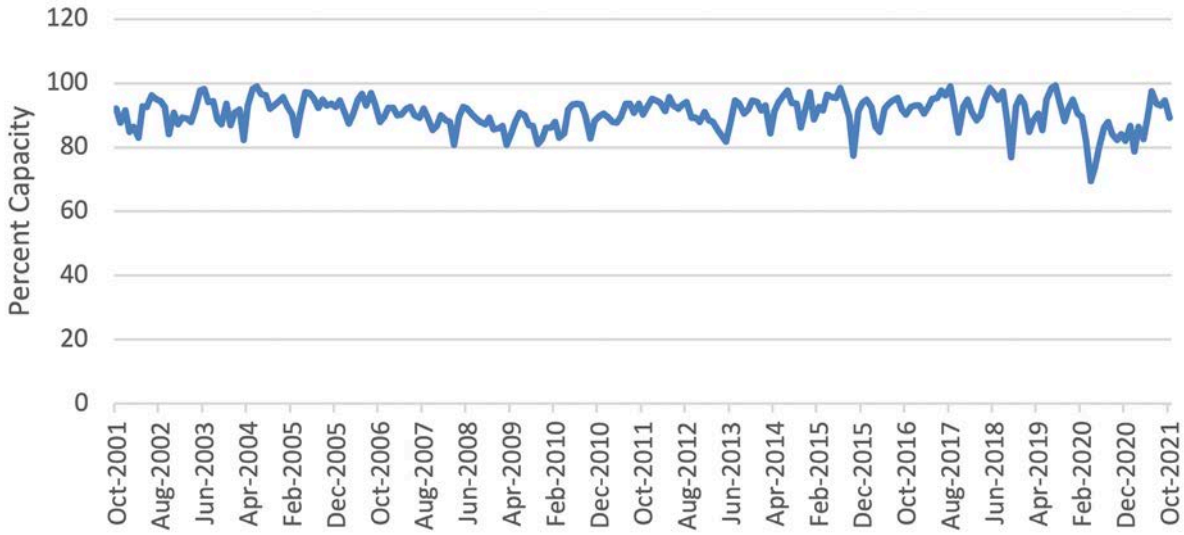
3. Capacity Constraints in the Production and Distribution of Transportation Fuels

It has been suggested that the closure of Line 5 will have little real impact on energy markets because the oil and natural gas liquids transported through the pipeline can be sourced through other transportation modes or other pipelines. Moreover, any lost capacity in the production of refined products could be replaced by increasing output at other refineries. Neither of these alternatives appear to be economically or logistically feasible.

Capacity utilization at U.S. refineries can vary substantially during the year, reflecting seasonality in travel behavior. Of course, usual patterns of seasonality have been disrupted by the COVID-19 pandemic. Figure 2 shows the monthly utilization of refinery capacity for all products located in the PADD 2 region for a twenty year period ending in October 2021, the latest data available. The PADD 2 region covers a very large area extending from the upper Midwest through Oklahoma. It includes three of the states covered in this analysis, Ohio, Michigan, and Indiana. As Figure 1 shows, except for periods of recession or during the COVID-19 pandemic, there is little slack capacity in this region's refinery network. Capacity utilization almost reaches 100% on a regular basis during high-demand months. Pennsylvania is a part of the western edge of PADD 1 and covers the northeastern corner

of the country. This region also has high utilization rates with peak demand regularly reaching the mid-90 percentages, in normal economic times. This suggests there is little slack capacity that could immediately respond to the loss of production capacity at Line 5-supplied refineries. Moreover, the last major refinery to be built in the U.S. was the Marathon facility in Garyville, Louisiana, that opened in 1977.[3] Capital costs and regulatory hurdles means that production capacity is not likely to provide any replacement products to the study region for at least five to ten years.

Figure 2: Capacity Utilization of PADD 2 Refineries



Source: U.S. Energy Information Administration

Switching the mode of moving transportation fuels to replace the lost production in Toledo and other parts of the region makes little economic sense. While we were unable to find comparative cost analyses across modes specifically focused on the transportation of gasoline or diesel, there have been studies on the cost of transporting other petroleum products. The most conservative (smallest difference) of the reports we found was produced by the Congressional Research Service[4] and concludes that rail transportation is two to three times the cost of moving the same volume of petroleum materials by pipeline. We found no direct comparison with transportation costs between truck and pipeline modes. While trucks serve as the "last mile" delivery to retail locations for most of the nation's gasoline and diesel, they are not cost-effective over longer distances.[5]

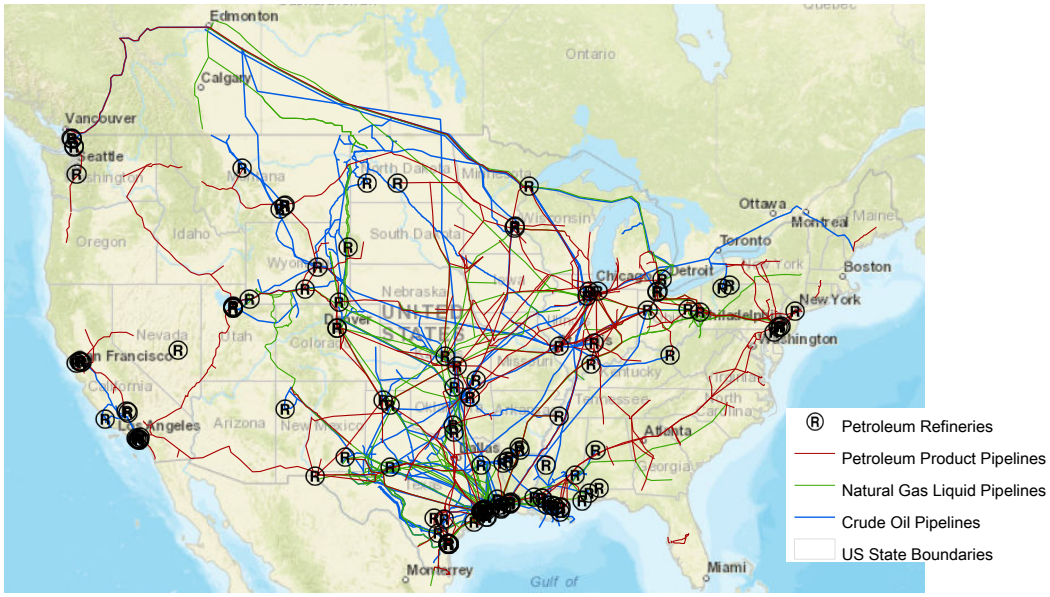
Recent public discourse has included suggestions that regional transportation fuels supplies could be sustained using rail and truck shipping modalities. This ignores current market conditions for both modes. Railroads do not have hundreds of spare tank cars waiting to be used. In addition, recent surges in demand for rail services leave little slack power equipment or labor resources, and there is no guarantee that the fixed rail tracks could efficiently connect regional fuel outlets with more distant refineries. Finally, the biggest challenge to the assumption that shifting transportation modes would cure regional fuel supply challenges is the failure to recognize the severity of the shortage of truck drivers in today's labor market. This is, by some measures, the largest labor gap in the nation, and it will get worse. Labor market experts expect that more than 400,000 truck drivers will either retire or exit the occupation over the next five years. With constrained supplies of equipment and labor, the effective cost of switching transportation modes to replace lost regional production of transportation fuels will require outbidding other existing users of these services and cause further price spikes.

The final consideration of alternative sources of gasoline and diesel to replace lost regional production would be through existing or new pipelines. There has been much written in recent months about underutilization of existing petroleum pipelines in the U.S. A building spree has added an exceptional amount of pipeline capacity over the past several years. Since 2010, the Energy Information Administration identifies 220 completed petroleum pipeline projects in the U.S. While some of these projects terminated or passed through the study area for this analysis, including those that just touched one state, these projects account for only 2.5% of total current capacity. Importantly, only two of the 12 pipeline projects that added capacity in the study area are designated to carry gasoline and/or diesel products. One is an intrastate (49-mile) line from Harpster to Lima, Ohio. The other is a "reversal" project of the RIO pipeline that is carrying transportation fuels from Lima, Ohio, westward to other Midwest markets. If Ohio fuel supply is currently being used to support demand in states to the west, it is unlikely that there is available supply to bring back to Ohio. Moreover, this is a relatively small line that lacks the ability to move large volumes of gasoline and diesel and certainly couldn't offset the losses from a shuttered Line 5.

As shown in Figure 3 below, while there are multiple product pipelines crossing the study region, most have been in place for many years and have market-established directional flows that are not easily changed. Figure 3 also shows a north-south product pipeline connecting to a refinery in West Virginia. This is a small operation with capacity of just 22,000 barrels per day.[6] News articles related to a major fire at this refinery in late May 2021 do not show this facility producing transportation fuels, so it can't be considered a potential source of replacement product lost in western Ohio refineries.

Based on data provided on refinery websites and in communications submitted to the Michigan Public Service Commission, western Ohio refineries supply 30% of gasoline sold in Ohio, 35% of Ohio diesel sales, and 42% of gasoline sales in Southeastern Michigan. Plus, as noted previously, Ohio refineries are supplying states to the west through recent pipeline changes and there is also product flowing through the pipeline network to western Pennsylvania. The closure of Line 5 and subsequent impacts on Ohio refineries will significantly reduce transportation fuel supplies in Michigan and Ohio and have a lesser, but important, impact on fuel availability in Pennsylvania and Indiana.

Figure 3: Refineries, Crude Oil, and Refined Product Pipelines



4. Impacts on Transportation Fuels Prices

If the supply of any good or service falls, and demand stays the same or rises, prices for those goods or services will increase. In theory, as prices rise, consumers will reduce demand. However, it has been clearly demonstrated in the U.S. economy that unless gasoline and diesel prices rise dramatically, there is little change in total demand.[7] If oil prices go up because of political tensions in the Middle East, which results in a 20-cent, or even 50-cent per gallon increase in gasoline prices, total demand will change little. Workers still need to go to work (before and after the pandemic), families must shop for groceries and other goods, and most of these families are unlikely to tell the kids the trip to Disney World is cancelled because of higher gasoline prices. The same applies to diesel fuel. Trucks and trains need to deliver the goods we are buying, and farmers have equipment that must operate. The price of transportation fuels is largely inelastic – prices increase and we simply allocate more of our household or business budgets to fuels.[8] Given that there do not appear to be any viable short-term fuel replacement resources for the products that are produced from the oil currently transported through Line 5, the question is how much will prices increase for gasoline and diesel fuel?

In a search of the professional and academic literature, we found no research reports focused on the impacts of transportation fuel supply disruptions at an appropriate scale – multiple refining facilities in one region shutting down simultaneously with the supply disruption lasting for multiple years.[9] In March 2005, a series of incidents at very large BP refinery located in Texas City measurably impacted the nation's supply of several petroleum-based products. The BP refinery represented about 3% of total U.S. refining capacity at that time. The drop in supply was blamed for a 1.5% increase in gasoline futures prices.[10] While informative, other factors such as levels of strategic reserves available at that moment, limited the observed market impact of the refinery accident.

There are data showing the impacts of temporary refinery shutdowns or actual damages related to natural disasters, particularly hurricanes, on transportation fuel prices. Refinery disruptions from Hurricane Katrina precipitated a 49-cent per gallon rise in the cost of gasoline. Hurricane Harvey caused price spikes ranging from 25 cents to 28 cents per gallon. Based on the cost of fuel at the time of these events, prices increased between 9.47% and 11.66% due to the disruptions in refinery operations.[11] Importantly, the increase in the retail price of gasoline due to disaster-induced supply

constraints endures much longer that the actual refinery shutdowns.[12] Therefore, we assume that since the refineries in the Toledo area could close permanently, those states most reliant on these refineries, namely Ohio and Michigan, will see long-term transportation fuel price increases that will last until alternative supply sources come to market – at least a five-year period. As noted previously, Indiana and Pennsylvania fuel markets will not be impacted as much by the closure of Line 5. To be conservative, we have assumed that the price impacts for these states will be more modest at 1.42% to 1.74% in Indiana and 1.88% to 2.33% in Pennsylvania.

It has been suggested that the closure of Line 5 will have little real impact on energy markets because the oil and natural gas liquids transported through the pipeline can be sourced through other transportation modes or other pipelines. Moreover, any lost capacity in the production of refined products could be replaced by increasing output at other refineries. Neither of these alternatives appear to be economically or logistically feasible.

5. Costs to Consumers

Using the assumed unit price increases noted in the previous section, we have estimated the total cost impacts of rising fuel prices on all consumers: households, businesses, and governments. The analysis uses pre-pandemic (2019) fuel consumption data by state from the Energy Information Administration. These data are shown in Table 1 below.

Table 1

Transportation Fuel Consumption (millions of barrels, 2019)

	Diesel / Distillates	Gasoline
Ohio	51.4	119.6
Michigan	30.1	111.0
Indiana	38.6	72.3
Pennsylvania	60.3	116.0

Source: Energy Information Administration

To assess total costs, we obtained current (1/13/2022) data on regional retail gasoline and diesel fuel prices (see Table 2).[13] There are broad expectations that transportation fuel prices will rise in the coming year due to ongoing tensions in the Middle East as well as increased demand associated with recovery in national and international travel markets. Any armed conflict in Ukraine will push prices even higher. The cost increase estimates presented below are independent of any other market or non-market factors. No matter what level prices for gasoline and diesel rise to in the coming months or years, closing Line 5 will cause those prices to rise even higher.

Table 2

Transportation Fuel Retail Prices ($/gallon, January 13, 2022)

	Diesel / Distillates	Gasoline
Ohio	$3.636	$3.090
Michigan	$3.497	$3.151
Indiana	$3.622	$3.191
Pennsylvania	$3.923	$3.512

Source: Energy Information Administration

Applying the assumed range of fuel price increases to consumption and pricing data, regional consumers of transportation fuels can expect to pay between $4.7 billion and $5.8 billion more each year for gasoline and diesel (see Table 3).

Table 3

Increased Transportation Fuel Expenditures by State After Closure of Enbridge Line 5 (annual millions of dollars)

	Lower Bound			Upper Bound		
	Diesel	Gasoline	Total	Diesel	Gasoline	Total
Ohio	$743.3	$1,469.9	$2,213.2	$915.2	$1,809.8	$2,725.1
Michigan	$418.7	$1,391.1	$1,809.8	$515.1	$1,712.8	$2,228.3
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Sources: U.S. Energy Information Administration; Gas Buddy; Weinstein, Clower & Associates

The jump in transportation fuel prices will not be borne evenly across all consumer groups. But given current macro-economic trends, most of these higher costs will likely be passed on to households. Based on research into broader energy price inflation, these cost increases will further push up food prices, especially for beef, pork, and corn.[14] We estimate combined grocery and restaurant prices will rise an additional 0.2% to 0.3% on top of any other inflationary pressures in the economy.

> Higher energy costs will depress farm incomes and be most keenly felt among lower-wage workers, the same group that has experienced the worst economic dislocations from the pandemic.

In the longer term, rising transportation fuel prices will have negative impacts on regional economic competitiveness, particularly in manufacturing and related logistics services. These energy cost increases will lower economic growth rates, especially in Michigan and Ohio, for years to come. Households are already enduring the highest rate of inflation in 40 years with real wages and earnings declining over the past year. Adding further injury by enacting policies that will directly result in higher energy costs and the loss of thousands of regional jobs makes little economic sense. The closure of Line 5 would be the wrong action at the wrong time.

[1]This analysis focuses on Michigan, Ohio, Indiana, and Pennsylvania. Line 5 supplies feedstock to a least six Canadian refineries with a combined total refining capacity of about 757,000 barrels per day. The loss of Line 5-supplied inputs to production will impact the availability of transportation fuels which will drive up prices for Canadian consumers and will contribute to additional spillover effects in Midwestern markets.

[2]One of the Toledo-area refineries has publicly stated that closing Line 5 would likely force a permanent shutdown of their facility.

[3]A small, specialized facility (condensate splitter) opened in south Texas in 2019 with a total capacity of 35,000 barrels per day. The combined production of the two Toledo refineries is almost ten times that production level.

4Frittelli, J. et al (2014, Dec. 4). U.S. Rail Transportation of Crude Oil: Background and Issues for Congress. Report # R43390.

[5]Allison, E & Mandler, B. (2018). Transportation of Oil, Gas, and Refined Products. Petroleum and the Environment, Part 15/24. American Geosciences Institute. Available at https://www.americangeosciences.org/geoscience-currents/transportation-oil-gas-and-refined-products

[6]Energy Information Administration

[7]A 2010 article, which is among the most recent we found, reviews price elasticities in freight transportation that address overall demand and modal choice (rail, truck, other). However, the studies cited covering the U.S. were mostly conducted before transportation deregulation in the late 1970s and early 1980s. Summing the impacts of fuel prices across studies in many countries, there is a drop in fuel usage with rising fuel prices, but some of that is a result of mode change, which may not be applicable for this research. [DeJong, et al (2010). The price sensitivity of road freight transport – a review of elasticities. Available online.] However, a 2011 study in Transportation Planning and Technology (Samimim, et al in Volume 34, Issue 8) found that even if fuel prices rise 50%, there is little shift in freight transportation modes between road and rail.

[8]This is especially true when there is underlying volatility in gasoline prices. [Lin, C. & Prince, L. (2013). Gasoline price volatility and the elasticity of demand for gasoline. Energy Economics, 38, 111-117.

[9]The OPEC oil embargo of 1973-1974 certainly had an impact of fuel supplies, but this was a global event and not comparable for purposes of this analysis. In 1947, a ship docked in Texas City exploded. Secondary explosions and fires destroyed much of the city and severely damaged refineries located there, but there was no specific data we could find to sufficiently gauge the impact of fuel prices.

[10]Mouawad, J. (March 25, 2005). Oil prices rise again after explosion at Texas refinery. New York Times. Available at https://www.nytimes.com/2005/03/25/business/oil-prices-rise-again-after-explosion-at-texas-refinery.html

[11]In August 2015 the BP Whiting refinery had an unexpected shutdown that disrupted the regional supply of gasoline. Prices spiked by more than 25% and did not return to "normal" prices for several weeks. Regional rules about summer formulations exacerbated this price spike. Still, this example shows that our assumed price increases used in this analysis are reasonable and perhaps conservative in nature. The data are reported in the Risk Analysis for the Straits Pipelines: Appendices, prepared by Michigan Technical University, September 15, 2018.

[12]Lewis, M. The temporary wholesale gasoline price spikes have long-lasting retail effects: The aftermath of Hurricane Rita. Journal of Law and Economics, 53(3).

[13]The analysis recognizes that some large consumers of transportation fuels have contracts for discounted prices. However, they will likely see price increase of similar magnitude, which means the overall estimated range of total cost increases is reasonable.

[14]Sands, R. & Wescott, P. (2011). Impacts of Higher Energy Prices on Agriculture and Rural Economies. U.S. Dept. Agriculture, Economic Research Service, Report # 123.

6. About the Authors

BERNARD L. WEINSTEIN, Ph.D.

Bernard L. Weinstein retired on January 1, 2021 as Associate Director of the Maguire Energy Institute and an Adjunct Professor of Business Economics in the Cox School of Business at Southern Methodist University in Dallas. From 1989 to 2009, he was Director of the Center for Economic Development and Research at the University of North Texas, where he is now an Emeritus Professor of Applied Economics.

Dr. Weinstein studied public administration at Dartmouth College and received his A.B. in 1963. After a year of study at the London School of Economics and Political Science, he began graduate work in economics at Columbia University, receiving an M.A. in 1966 and a Ph.D. in 1973. He has authored or co-authored numerous books, monographs and articles on the subjects of economic development, energy security, public policy and taxation, and his work has appeared in professional journals such as Land Economics, Challenge, Society, Policy Review, Economic Development Quarterly, Policy Studies Journal, and Annals of Regional Science. His op-eds have been published in The New York Times, The Wall Street Journal, The Washington Times, Investor's Business Daily, The Financial Times, The Los Angeles Times, The Hill and a number of regional newspapers and magazines.

From 2011 to 2014, he was a Fellow with the George W. Bush Institute, and is currently an Associate of the John Goodwin Tower Center for Political Studies at SMU and a Fellow of Goodenough College in London.

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Dr. Clower has authored or co-authored over 200 articles, book chapters, and research reports reflecting experience in economic and community development, economic and fiscal impact analysis, labor market analysis, housing, transportation, land use planning, and economic forecasting. His scholarly articles have appeared in Economic Development Quarterly; Urban Studies; Economic Development Review; Regional Studies, Regional Science; the Australasian Journal of Regional Studies; Regional Studies Regional Science, Sustaining Regions; and Applied Research in Economic Development. His most recent publication is the textbook Globalization, Planning and Local Economic Development with Prof. Andrew Beer (Taylor-Francis, London).

Dr. Clower received a B.S. in Marine Transportation from Texas A&M University in 1982, a M.S. in Applied Economics from the University of North Texas in 1992 and a Ph.D. in Information Sciences from the University of North Texas in 1997, specializing in information policy issues and the use of information resources.

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