


Border Adjustment Import Taxation


Impact on the U.S. Crude Oil and Petroleum Product Markets

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This white paper is an outgrowth of an August 15, 2016 article published by Philip K. Verleger, Jr. titled “Border Adjustment Import Taxation,” and available at www.pkverlegerllc.com.¹ That article provided an analysis of the border adjustment tax proposed by House Republicans in the context of the crude oil and petroleum products industry. This article, co-authored by Philip K. Verleger, Jr. with consultants at The Brattle Group (“Brattle”), further evaluates the impact of the border adjustment tax on the U.S. crude oil and petroleum products industry. While the authors acknowledge the funding support provided by Koch Companies Public Sector to offset the cost of performing this further analysis, all analyses, results, and views presented as well as any errors are the responsibility of the authors and do not represent the opinion or views of Brattle or its clients.

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¹ Philip K. Verleger, Jr., “Border Adjustment Import Taxation,” Notes at the Margin, August 2016, available at <http://www.pkverlegerllc.com/publications/notes-at-the-margin/border-adjustment-import-taxation-august-15-2016-1949/> (last accessed November 20, 2016).

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Executive Summary

The Tax Reform Task Force, created by the Speaker of the House, Paul D. Ryan, and spearheaded by the Chairman of the House Ways and Means Committee, Kevin Brady, has put forward a wide-ranging legislative plan—Tax Reform Task Force Blueprint (“the Blueprint”)—that would result in a comprehensive revision of the U.S. tax code. Included as part of the Blueprint were significant changes to how corporate income is taxed. Under this Blueprint, corporations would be taxed not on income as currently defined in tax law but rather on the firm’s net revenue. Furthermore, the tax would be limited to the territory of the U.S., meaning that revenue earned through exports would not be taxed and that expenditures on imported goods could not be excluded from the firm’s revenues. Any tax paid on domestic costs incurred by an exporter on export sales would be rebated to the exporter.

This proposed tax arrangement is highly unusual. No other country border adjusts their income tax. Most nations do impose a border adjusted value-added tax (“VAT”) on goods sold, however.

The enactment of the border adjustment tax proposed by the Tax Reform Task Force will have profound impacts on the U.S. economy. For example, the cost of electronic goods produced in China, Japan, and other Asian countries will increase. Some portion of the increase will likely be reflected in the retail prices. The cost of imported automobiles will also be affected, likely leading to price increases for Audi, BMW, Honda, Hyundai, Land Rover, Mercedes, Toyota, and Volkswagen products, as well as for prices of other automobiles manufactured abroad.

No sector, though, will be more affected than petroleum. The U.S. is and will remain a net importer of petroleum for the foreseeable future in certain regions, even though the nation will soon be “energy independent” on a net basis.² Consumers on the U.S. East Coast, the Upper Midwest, and the West Coast will continue to be supplied with imports of petroleum products, including gasoline, jet fuel, and heating oil. Refiners located in these regions will also rely on imports of crude oil from abroad. These imports of crude oil and petroleum products will be

² Philip K. Verleger, Jr., “The Amazing Tale of U.S. Energy Independence,” *The International Economy*, Spring 2012, pp. 8-11, 54-62, available at http://www.international-economy.com/TIE_Sp12_Verleger.pdf (last accessed December 12, 2016). This was the first article to announce the coming of U.S. energy independence.

offset by exports of crude oil and petroleum products made by firms located on the U.S. Gulf Coast.

The country's continued reliance on imports, as well as the offsetting increase in exports of crude oil and petroleum products, creates a situation where the passage of the border adjustment tax will lead to significant increases in the prices paid for petroleum products and the prices received by producers of domestic crude oil. This paper quantifies these impacts. According to our calculations, the retail price of gasoline would increase by 13 percent, or approximately \$0.30 per gallon, should the proposed border adjustment tax become law with a 20 percent tax rate. Retail prices of diesel fuel would rise by \$0.27 per gallon or approximately 11 percent.

These calculations assume that the world price of crude oil, as measured by Dated Brent, averages \$50 per barrel. A border adjustment tax, though, increases consumer exposure to higher crude oil prices. At a \$60 per barrel price, for example, the difference between retail prices in the absence of such a tax compared to the retail price with a border adjustment tax increases from \$0.30 per gallon to \$0.36 per gallon. Full details of the calculation are presented in Section III.C of the paper.

The proposed border adjustment tax would create a windfall for domestic oil producers. A company in the Permian Basin of Texas producing light crude oil would receive the world price of oil less any transportation costs free and clear of any taxes if the crude oil were sold to a buyer in China or any other foreign country. Taxes, though, would have to be paid if the crude oil were sold to a domestic producer. Under these circumstances, the Permian Basin company would insist on receiving a higher price for domestic sales. The price received would likely be close to \$62.50 per barrel if global prices were \$50. In effect, a 25 percent wedge between domestic and foreign prices would be imposed.³

Refiners operating on the U.S. Gulf Coast are subject to the same financial constraints. They would be able to sell diesel, gasoline, or jet fuel to foreign buyers without incurring any tax liability. Sales to domestic buyers, though, would subject them to a 20 percent tax on revenues. Thus they, too, would insist on receiving a 25 percent higher price from domestic consumers.

³ The tax wedge may seem surprising. However, we explain below that the domestic price must be equal to the global price divided by one minus the tax rate or $P_{us} = P_w / (1 - \tau)$ where P_{us} is the U.S. price, P_w the world price, and τ the tax rate. See Section III.B below.

The resulting price increases would have noticeable impacts on the U.S. economy. Higher gasoline prices would require consumers to reduce expenditures on other goods and services. An examination of consumer expenditure patterns suggests that if the border adjustment tax were imposed solely on the petroleum industry, at a \$50 per barrel crude oil price, it would lead to a 0.3 percent cut in consumer expenditures on other goods. This could lead to a 0.4 percent reduction in the U.S. nominal gross domestic product (“GDP”).⁴ The impact on consumer spending and U.S. GDP would be much larger at global crude oil prices higher than \$50 per barrel. For instance, were global crude prices to rise to \$90, as forecasted by the U.S. Energy Information Administration (“EIA”), the border adjustment tax would increase retail gasoline prices by \$0.55 above the prices that would exist without the tax.⁵ Such an increase could have very serious economic consequences.

It is this potential increased vulnerability of the economy to crude oil price shocks that should be of greatest concern to policymakers. While crude oil shocks are not discussed directly here, the paper lays out a formal way of carefully examining the impact.

Of course, the Blueprint proposes imposition of the tax on all sectors of the economy. Prices of a great many consumer goods would increase to some degree. Hence, the net effects of the border adjustment tax on consumer spending and GDP would be complex and far reaching, and would likely differ substantially from the petroleum specific calculations presented in this paper.

⁴ See Section III.C. See also *infra*, at footnote 38.

⁵ The \$90 per barrel price of crude oil is based on a ten-year average (2017-2026) of the EIA’s Annual Energy Outlook (“AEO”) 2016 forecast of Brent spot prices (in nominal dollars). See the EIA AEO Table 12 available at www.eia.gov/outlook/aeo/tables_ref.cfm (last accessed December 15, 2016).

I. Introduction

In their Blueprint, House Republicans have proposed a number of far reaching changes to the U.S. tax system.⁶ Although their proposal does not call for the institution of a VAT, sales tax, or other explicitly consumption-oriented tax, it does attempt to shift the nation's tax base away from income and towards consumption.⁷ The Blueprint proposes a number of substantial changes in business taxation, including immediate write-off of investments; a movement towards a territorial system in which businesses would pay U.S. taxes only on their U.S. earnings; the elimination of special interest tax breaks and tax subsidies; a reduction in the corporate tax rate from the current 35 percent to 20 percent; and the institution of a set of border adjustments whose overall effects are intended to replicate the outcome of instituting a 20 percent VAT that is assessed on U.S. consumed products and rebated when products are exported to a foreign country.⁸ These latter provisions are the subject of this white paper.

Under the proposal of the House Republicans, businesses that rely upon imported inputs would lose the ability to deduct the cost of these inputs in computing their taxable income. Because the Blueprint calls for the imposition of a flat 20 percent corporate tax rate, this provision would have the effect of increasing the effective cost of imported inputs by 25 percent.⁹

⁶ "A Better Way: Our Vision for a Confident America," Speaker of the House, June 24, 2016, available at <http://abetterway.speaker.gov/assets/pdf/ABetterWay-Tax-PolicyPaper.pdf> (last accessed November 9, 2016).

⁷ The Blueprint, at p. 15.

⁸ The Blueprint, at pp. 25 and 27.

⁹ As an illustration of the mechanics of this proposal, consider a U.S. manufacturer of a small appliance that sells an appliance for a wholesale price of \$250. The cost to the manufacturer of manufacturing and selling this appliance is \$200, and includes a \$50 motor, \$100 in other components, \$25 in labor, and \$25 in sales, general and administrative expense ("SG&A"). All components are manufactured in the U.S., which is also where labor costs are incurred. The manufacturer earns \$50 in pre-tax income for every unit he sells. Under the House Republican proposal, he would pay a 20 percent tax on that pre-tax income, for a total tax liability of \$10 per unit. His after-tax profit will be equal to \$40 per unit. The tax deduction for the cost of the motor would be 20 percent of the \$50, or \$10. The "after-tax" cost of the motor is effectively \$40 (*i.e.*, the cost of the motor "saves" the manufacturer \$10). Now suppose that this manufacturer decides to use an imported motor instead of the motor he previously sourced in the U.S. For simplicity we will assume that the imported motor costs the same as the domestically produced motor—\$50. Under the House Republican proposal, this manufacturer will not be able to deduct the cost of the imported motor in computing his taxable income. Thus, for every unit he sells, his taxable income will be equal to \$100 (\$250, minus the \$150 in non-motor costs). His

Under the proposal of the House Republicans, exports from the U.S. would not be subject to taxation.¹⁰ As a result, businesses that export would receive the equivalent of a tax rebate equal to 20 percent of the value of their exports.

The Blueprint argues that the proposed border adjustment tax would “level the playing field” by allowing “U.S. products, services, and intangibles to compete on a more equal footing in both the U.S. market and the global market.”¹¹ While the Blueprint does not describe the border adjustment tax as a VAT, it does state that the tax is intended to “counter the border adjustments that U.S. trading partners apply in their VATs.”¹² The identities of these partners are not disclosed. Nor is any effort made to estimate the fraction of U.S. trade that takes place with countries that rely on VATs.

The overall effect of these adjustments will be to provide tax benefits to exports, and to place tax penalties on imports, at least relative to current conditions. They can be described most charitably as a step away from free trade that is forced upon us by similar steps taken by unnamed trading partners. The border adjustment tax represents a form of trade restriction that is similar in effect, if not in mechanism of action, to import restrictions or import tariffs. The general effects of such trade restrictions are well understood. In a free trade regime, each country exports those goods and services in whose production it enjoys the greatest comparative advantages.¹³ Consumers everywhere benefit from the fact that all products are supplied in the most efficient manner possible.¹⁴ When preferences are provided to local producers, production

Continued from previous page

tax liability per unit will be equal to 20 percent of this amount, or \$20. His after-tax income per unit sold will be equal to \$250, less \$200 in costs, less \$20 in taxes, or \$30 per unit. Here, the manufacturer loses the \$10 tax deduction for the motor, effectively bearing the full cost of the motor, or \$50. Relative to the situation without the border adjustment tax, the cost of the motor for the manufacturer is 25 percent higher (\$50 vs. \$40).

¹⁰ The Blueprint, at p. 28.

¹¹ See *id.*

¹² See *id.*

¹³ Paul A. Samuelson and William D. Nordhaus, *Economics*, McGraw-Hill Irwin, Eighteenth Edition (2005), at pp. 295-297 (“Samuelson and Nordhaus: Economics”).

¹⁴ See *id.*

shifts from more efficient foreign producers to less efficient domestic producers. Local producers benefit. Consumers suffer.

The actual effects of the House Republican proposal will be more complex and more far-reaching. The Blueprint represents a major change in U.S. tax policy that can be expected to have significant consequences for U.S. consumers, and for U.S. businesses. We now live in a world of highly integrated global supply chains. Many of the goods consumed by Americans are imported from abroad. Many of the inputs relied upon by American businesses are also imported from abroad. Individual industries differ substantially in their reliance on imported inputs and components, in the extent to which their output is traded internationally, and for those that export, in their competitive advantages relative to producers based in other countries. The Republican proposal would bring about major changes in the relative prices of imported and domestically produced goods—changes that are likely to influence both consumer and producer behavior in complex and significant ways, and that can be expected to have far reaching economic and social implications. We do not take a position on whether these changes are desirable or undesirable, or whether on a net basis, implementation of the proposal would represent a gain or a loss for the economy.

In this report we analyze the likely impacts of the proposed border adjustment tax on the U.S. oil and petroleum products industry, and the subsequent impacts on consumers of its products, to illustrate the effect of this proposed policy.

II. The U.S. Crude Oil and Petroleum Product Markets

A. BACKGROUND ABOUT THE U.S. CRUDE OIL AND PETROLEUM PRODUCT MARKETS

Between 1970 and 2000, the U.S. was highly reliant on imports of crude oil and petroleum products (collectively “petroleum”) to meet its demand for these products. More recently, net imports of petroleum have declined. According to the EIA, in 2015, U.S. net imports of petroleum from foreign countries were equal to about 24 percent of U.S. petroleum consumption, the lowest since 1970.¹⁵

¹⁵ “Frequently Asked Questions,” U.S. Energy Information Administration, available at

In 1970, crude oil production in the U.S. peaked at 9.6 million barrels per day (“MBPD”). Over the next three decades, crude oil production in the U.S. declined steadily, reaching 5 MBPD in 2008.¹⁶ During this time, demand for refined petroleum products (also “petroleum products”), including gasoline, diesel, and jet fuel, and others, grew steadily.¹⁷ Demand for refined petroleum products grew by about 4.4 MBPD between 1985 and 2005.¹⁸ Thus, the U.S. had to meet much of its demand for crude oil and petroleum products through imports, with net imports of petroleum from foreign countries accounting for roughly two thirds of U.S. petroleum consumption in 2005.¹⁹

Starting in the mid to late 2000s, these trends reversed. Since 2008, crude oil production in the U.S. has grown by nearly 90 percent, from 5 MBPD to about 9.4 MBPD in 2015. See Figure 1 below. This growth has largely been driven by increased oil production from unconventional and tight oil resources, which have become more accessible because of technological innovations and advancements, such as horizontal drilling and hydraulic fracking techniques.²⁰

Continued from previous page

<http://www.eia.gov/tools/faqs/faq.cfm?id=32&t=6> (last accessed November 21, 2016). Net imports refer to imports minus exports. Petroleum products include gasoline, diesel fuel, heating oil, jet fuel, chemical feedstocks, asphalt, biofuels (ethanol and biodiesel), and other products.

¹⁶ After declining between 1970 and 1976, production grew modestly until 1985, when it began a steady decline until 2008. See Figure 1.

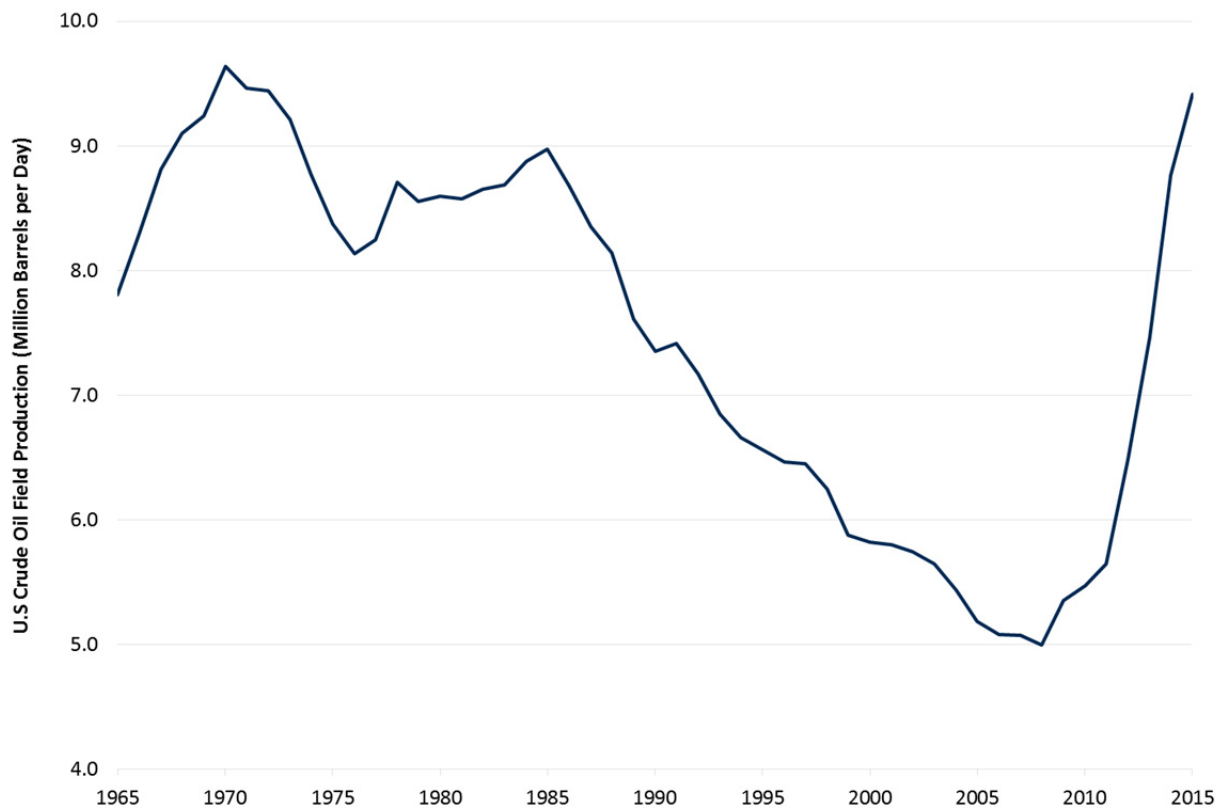
¹⁷ See Figure 2.

¹⁸ Demand for refined products increased from 14.2 MBPD in 1985 to 18.6 MBPD in 2005. See Figure 2.

¹⁹ Net imports of crude oil and refined petroleum products were 12.5 MBPD in 2005 (See Figure 3 and Figure 4), while demand for refined petroleum products was 18.6 MPBD (See Figure 2). $12.5 / 18.6 = 67\%$.

²⁰ U.S. tight oil production has grown from less than 0.4 MBPD in 2007 to more than 4.9 MBPD in 2015, driven largely by production from the Eagle Ford (Texas), Bakken (Montana and North Dakota) and Permian (West Texas) formations. See “Frequently Asked Questions,” EIA, available at <https://www.eia.gov/tools/faqs/faq.cfm?id=847&t=6> (last accessed November 22, 2016), see also “Shale in the United States”, EIA, available at http://www.eia.gov/energy_in_brief/article/shale_in_the_united_states.cfm (last accessed December 16, 2016).

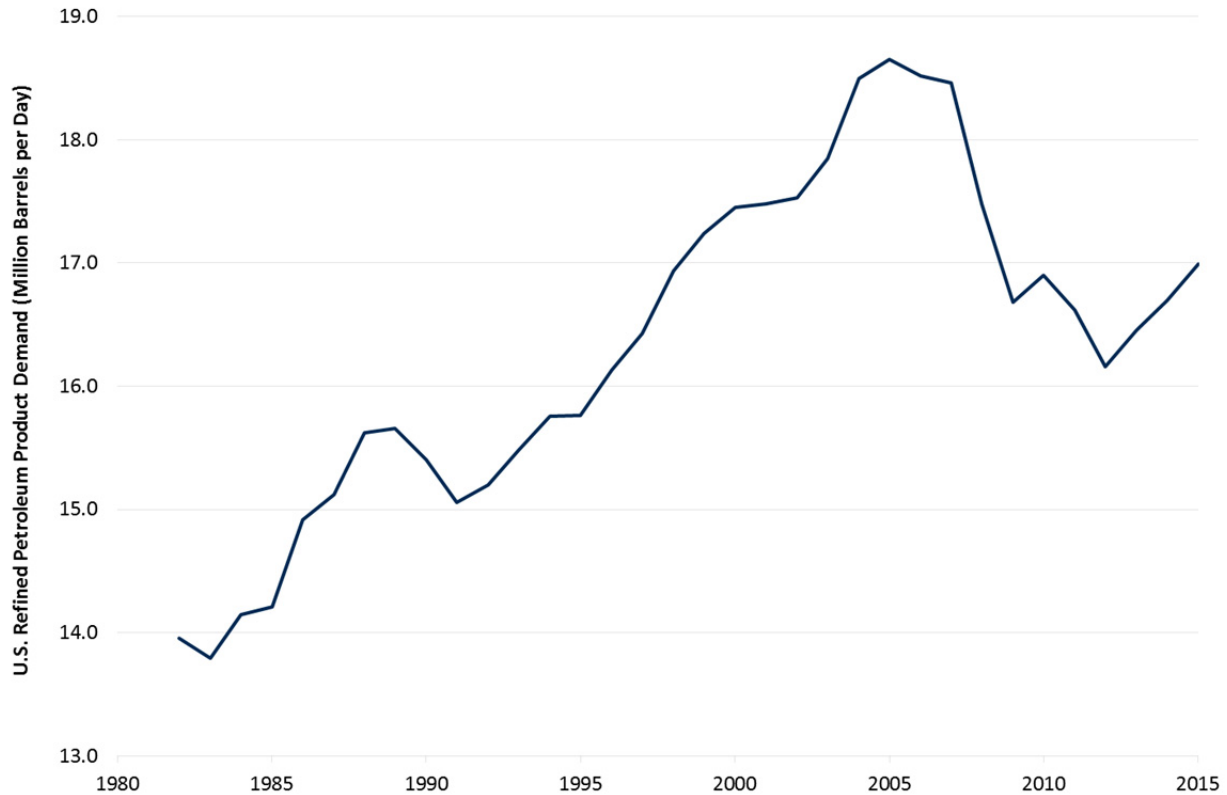
Figure 1: U.S. Crude Oil Production (1965-2015)



Source: PKVerleger LLC and The Brattle Group analysis of data from the U.S. Department of Energy, EIA.

In contrast, demand in the U.S. for refined petroleum products declined by 9 percent—from 18.7 MBPD in 2005 to 16.2 MBPD in 2012. See Figure 2 below. Multiple factors contributed to this decline, including a slow economic recovery after the global financial crisis of 2008; lower gasoline demand due to lower vehicle usage and more efficient vehicles; and renewable fuel mandates, which require biofuels such as ethanol to be blended into gasoline. Since 2012, U.S. demand for refined petroleum products has picked up again, and as of 2015 it was 17 MBPD.

Figure 2: U.S. Refined Petroleum Product Demand (1982-2015)

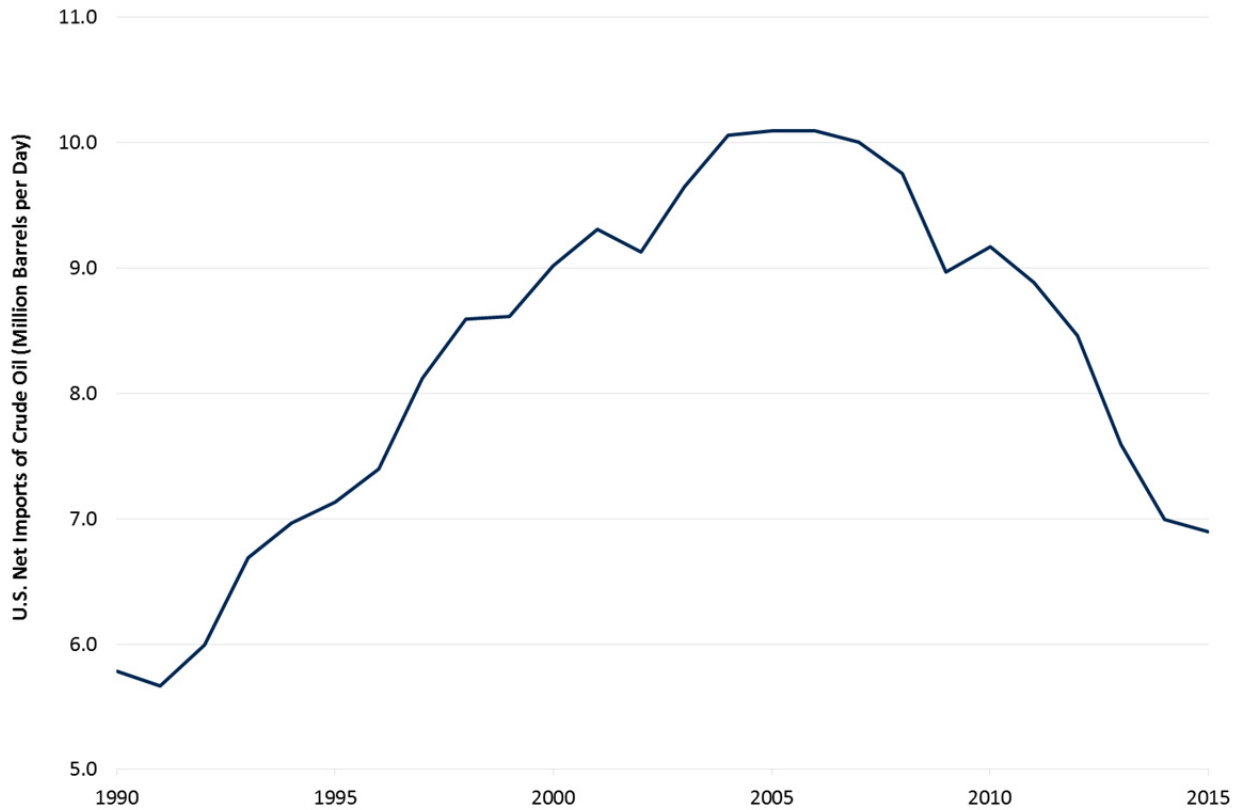


Source: PKVerleger LLC and The Brattle Group analysis of data from the U.S. Department of Energy, EIA.

The U.S. trade deficit for crude oil and refined petroleum products has shrunk in the last few years. This is, in part, because of the declining demand for refined petroleum products and increased production of crude oil in the U.S.²¹ Net imports of crude oil have decreased from about 10 MBPD in 2007 to less than 7 MBPD in 2015. See Figure 3 below.

²¹ In addition to the decline in domestic demand for refined petroleum products, the U.S. trade deficit for crude oil, as well as for refined petroleum products, has declined due to strong demand in some world regions, particularly for distillate (equivalent to diesel). This increased demand in other parts of the world has allowed the U.S. to increase its exports to these regions, thus improving its trade balance.

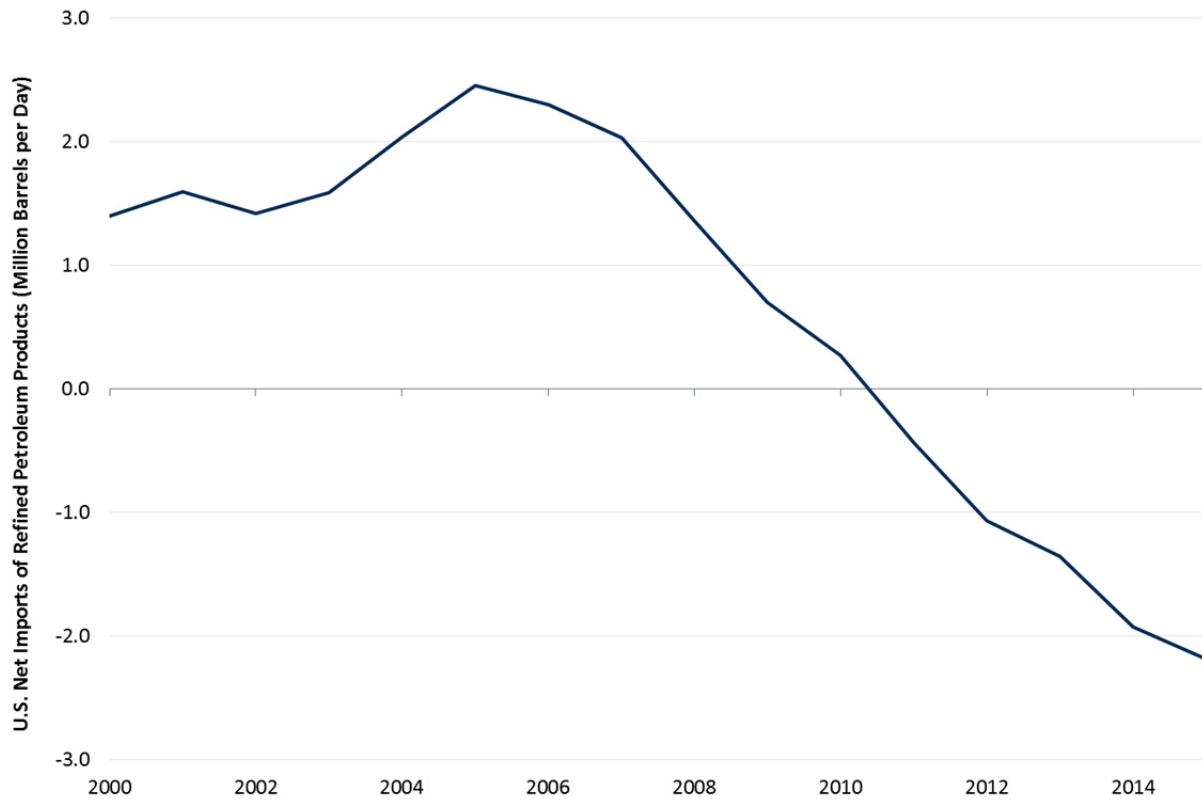
Figure 3: Net Imports of Crude Oil (1990-2015)



Source: PKVerleger LLC and The Brattle Group analysis of data from the U.S. Department of Energy, EIA.

Similarly, imports of refined petroleum products have steadily declined since 2005. In 2011, the U.S. became a net exporter of refined petroleum products. See Figure 4 below.

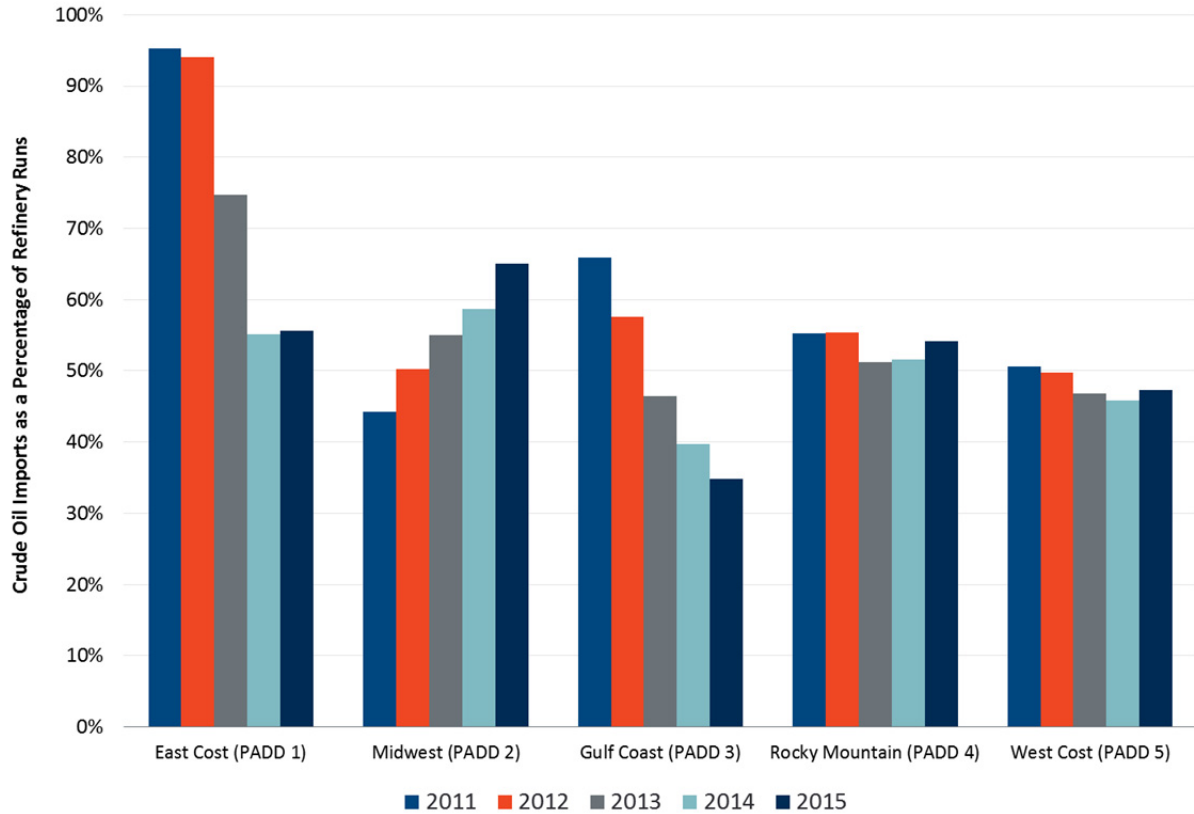
Figure 4: U.S. Net Imports of Refined Petroleum Products (2000-2015)



Source: PKVerleger LLC and The Brattle Group analysis of data from the U.S. Department of Energy, EIA.

However, it is well known that the U.S. continues to be a large importer of crude oil and refined petroleum products. Furthermore, the U.S. will remain a significant importer of refined petroleum products for years into the future even if the country becomes energy independent on a net basis. The reason is that some regions in the U.S., such as the East and West Coasts as well as the Upper Midwest, require imports of petroleum products and crude oil. In Figure 5 below we show crude oil imports as a percentage of crude oil refinery runs or “throughput” (i.e., refinery crude oil inputs) by geographic region. In 2015, crude oil imports accounted for as much as 65 percent of crude oil inputs into Midwest refineries, and about 55 percent in the East Coast and the Rocky Mountains. The imported crude oil share of inputs was about 47 percent in the West Coast and close to 35 percent in the Gulf Coast.

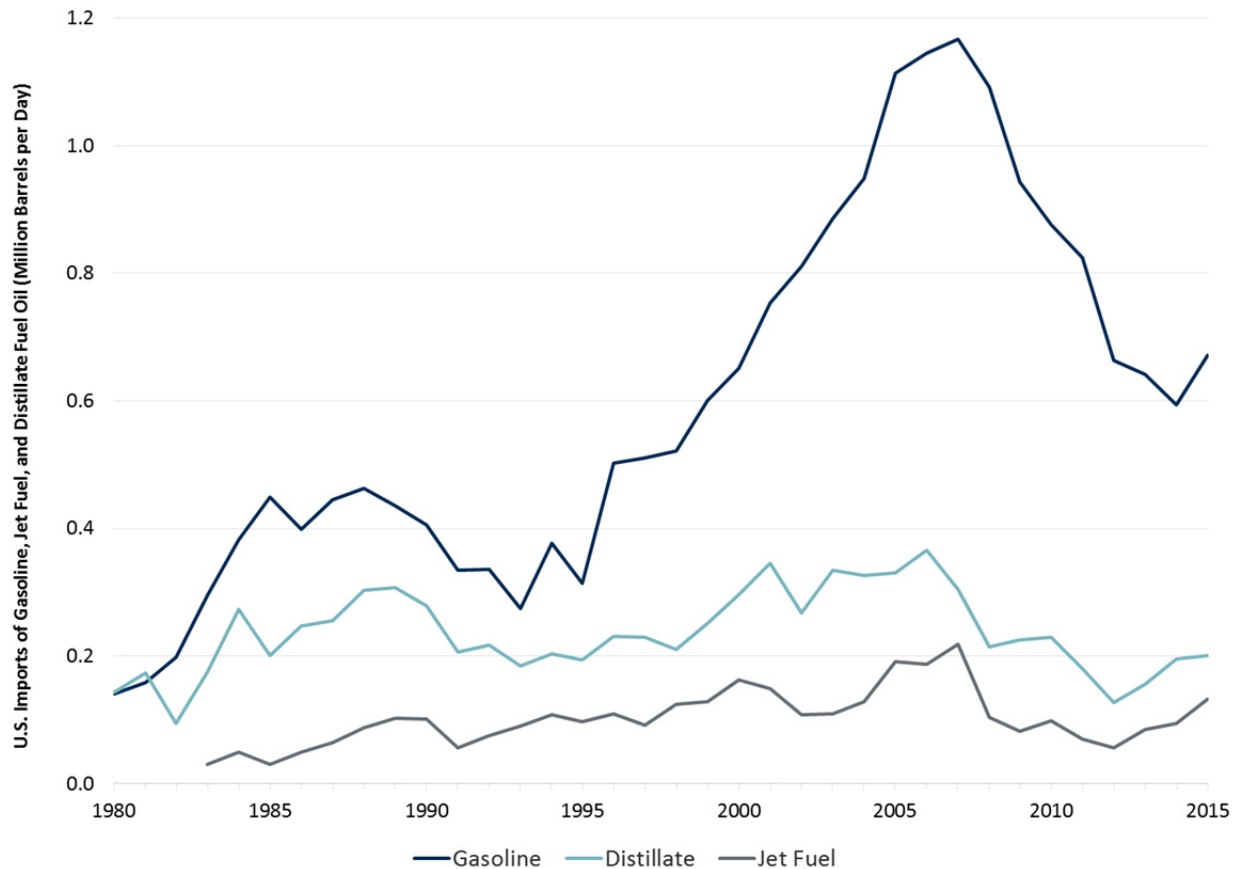
Figure 5: Crude Oil Imports as Percentage of Refinery Runs (2011-2015)



Source: PKVerleger LLC and The Brattle Group analysis of data from the U.S. Department of Energy, EIA.

Imports of petroleum products have varied over time. In Figure 6 below we trace U.S. imports of gasoline, distillate (*i.e.*, diesel), and jet fuel. In 2015, imports totaled 1 MBPD (gasoline imports were 0.67 MBPD, distillate imports were 0.2 MBPD, while jet fuel imports amounted to 0.13 MBPD).

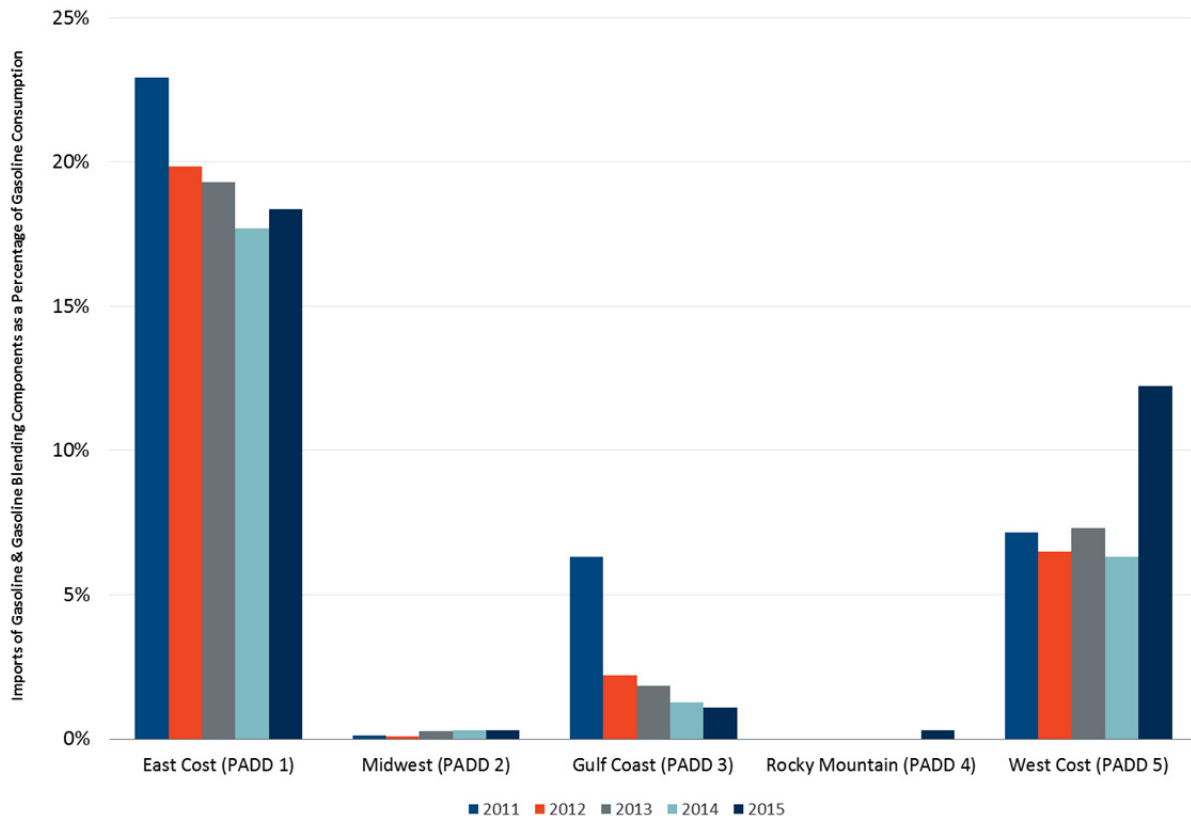
Figure 6: U.S. Imports of Gasoline, Distillate, and Jet Fuel (1980-2015)



Source: PKVerleger LLC and The Brattle Group analysis of data from the U.S. Department of Energy, EIA.

The largest fraction of U.S. gasoline imports go to the East Coast, which is dependent on these imports for its consumption. In Figure 7 we depict gasoline imports as a percentage of consumption by geographic region for the 2011 to 2015 period. In 2015, gasoline imports accounted for about 18 percent of consumption in the East Coast. They were about 12 percent of consumption in the West Coast, and the fraction was almost negligible in the Midwest, Rocky Mountains, and Gulf Coast.

Figure 7: Gasoline Imports as Percentage of Consumption (2011-2015)



Source: PKVerleger LLC and The Brattle Group analysis of data from the U.S. Department of Energy, EIA.

B. PRICING OF CRUDE OIL AND PETROLEUM PRODUCTS

Crude oil is a globally-traded commodity and, as such, worldwide demand and supply factors determine its price. There are three primary benchmarks for crude oil that serve as reference prices for crude oil: (1) West Texas Intermediate (or “WTI”), (2) Brent Blend (“Brent”), and (3) Dubai/Oman.²² WTI refers to light sweet crude oil that is extracted in the U.S., while Brent refers to light sweet crude oil that is extracted in the North Sea, and Dubai/Oman refers to heavy sour crude oil from Dubai, Oman, and Abu Dhabi. WTI serves as the main benchmark for crude

²² “Benchmark Plays an Important Role in Crude Oil Pricing,” U.S. Energy Information Administration, available at <http://www.eia.gov/todayinenergy/detail.php?id=18571> (last accessed November 21, 2016). The price of most crude oil is typically set at a differential (discount or premium) to one of these three primary benchmarks.

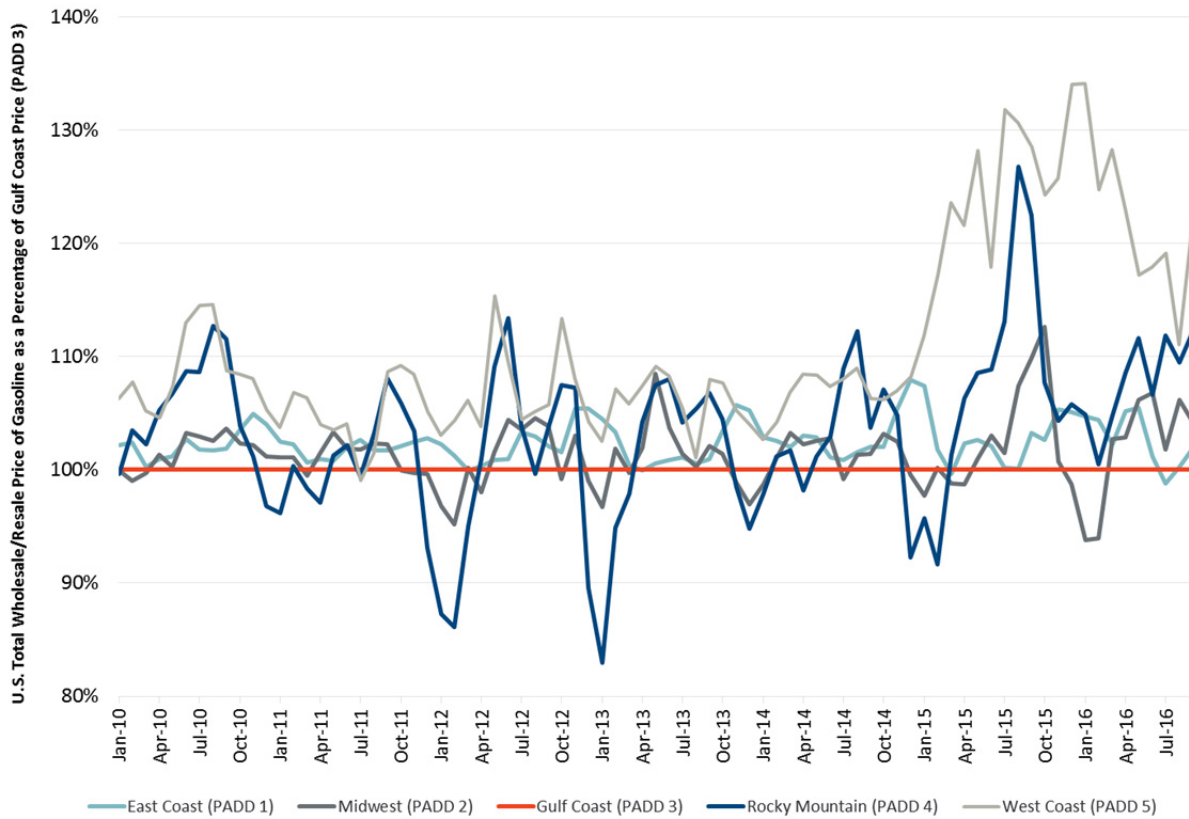
oil produced in the U.S. Other types of crude oil produced around the world are typically priced at an agreed upon differential to one of these three major benchmarks.²³

Similarly, refined petroleum products are also globally-traded commodities with their prices being driven by demand and supply dynamics in the world market for refined petroleum products. For instance, the wholesale price at which U.S. refiners can sell gasoline domestically is largely determined by the marginal cost of producing a gallon of gasoline around the world.²⁴ The wholesale price of gasoline in different regions in the U.S., particularly the Gulf Coast, Midwest, and the Rocky Mountain regions, are on average, very similar. See Figure 8 below. For example, between 2010 and 2016, the wholesale price of gasoline in the Midwest and the Rocky Mountain regions were about 1.5 percent and 3.2 percent higher, respectively, than in the Gulf Coast.

²³ The premium or discount is driven by several factors, including differences in quality and transportation costs.

²⁴ Marginal cost refers to the extra cost required to produce one extra unit of output (Samuelson and Nordhaus: Economics, at pp. 125-126, 735).

Figure 8: U.S. Total Wholesale/Resale Price of Gasoline as a Percentage of Gulf Coast Price (PADD3) (January 2010- July 2016)



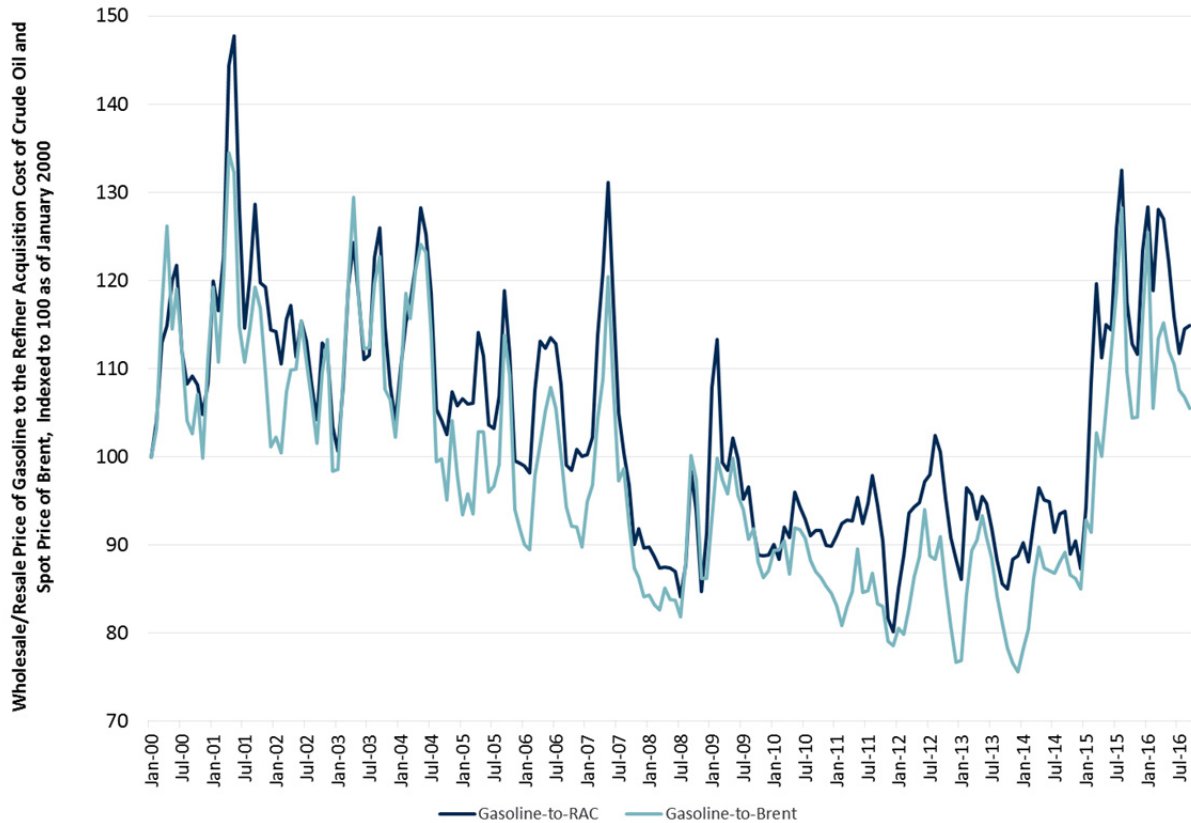
Source: PKVerleger LLC and The Brattle Group analysis of data from the U.S. Department of Energy, EIA.

Furthermore, prices of global crude oil and petroleum products are highly correlated. Netback relationships between crude oil and petroleum product prices are enforced by arbitrage.²⁵ In Figure 9 we depict the relationship between crude oil and gasoline prices over the last decade, and illustrate that the price of crude oil and gasoline closely track each other. The dark blue series represents the ratio of wholesale gasoline price to the refinery acquisition cost (“RAC”) of crude oil—the cost that refineries pay for crude oil, including transportation and fees. The light blue series is the ratio of wholesale gasoline price to Brent (both series indexed to 100 as of

²⁵ Philip K. Verleger Jr., “The Determinants of Official OPEC Crude Prices,” in *The Review of Economics and Statistics*, May 1982, pp. 177-183. Netback is calculated as revenues from the sale of all the petroleum products generated from one unit of crude oil less the cost of bringing that one unit of crude oil to the market (including transportation costs).

January 2000). Between 2000 and 2016, the correlation between crude oil and gasoline prices exceeds 98 percent.²⁶

Figure 9: U.S. Wholesale/Resale Price of Gasoline to the Refiner Acquisition Cost of Crude Oil and Spot Price of Brent (January 2000-July 2016, January 2000 = 100)



Source: PKVerleger LLC and The Brattle Group analysis of data from the U.S. Department of Energy, EIA.

The relationships discussed above illustrate how the various national and regional markets for crude oil and refined petroleum products are interconnected, and demonstrate the strength of the competitive market forces that tie the various prices together. Armed with these insights, we now analyze how the border adjustment tax would alter petroleum prices and quantities.

²⁶ We evaluated the correlation between crude oil and gasoline prices using a simple correlation coefficient.

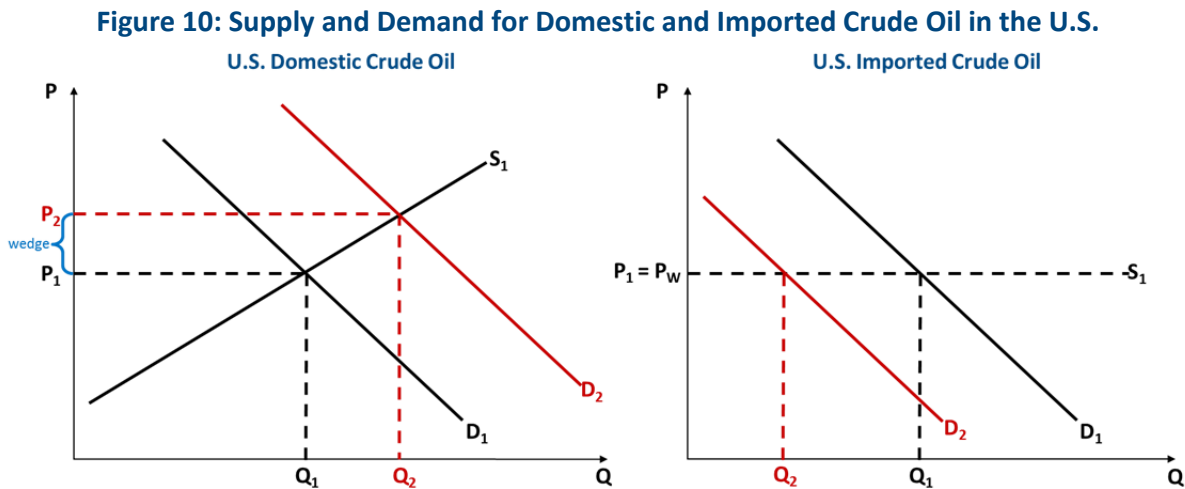
III. Economic Impact of the Proposed Border Adjustment Tax on the U.S. Crude Oil and Petroleum Product Markets

A. THEORETICAL ECONOMIC FRAMEWORK

In this section, we analyze the economic impact of the proposed border adjustment tax on the U.S. crude oil and petroleum product markets. The mechanisms through which the border adjustment tax affects the crude oil and petroleum product markets are different, and so are the subsequent impacts.

1. The Market for Crude Oil

Under the proposed border adjustment tax, refineries would prefer to use domestic crude oil because they would be able to deduct the cost of this domestic input from their taxable income. All else equal, the border adjustment tax would reward U.S. refiners using domestic crude oil as input. However, with increased demand for domestic crude oil, the price of domestic crude oil would increase. This is illustrated in the left panel of Figure 10— with the increase in demand for domestic crude oil from D_1 to D_2 , prices would increase from P_1 to P_2 .



Source: PKVerleger LLC and The Brattle Group

In contrast, as a result of the border adjustment tax, the demand for imported crude oil would decline, illustrated in the right panel of the figure above by the inward shift of the demand from D_1 to D_2 . As discussed previously, the price of imported crude oil, which corresponds to the world price of oil, is determined in the global market for crude oil. This is illustrated by the horizontal supply line (equal to the world price of crude oil)—changes in U.S. demand for imported crude oil would have a small or minimal effect on the price for imported crude oil.

While the demand for imported crude oil in the U.S. would decrease, as a result of the border adjustment tax, the price of imported crude oil in the U.S. (P_1) would continue to be the same as the global or world price, P_w .

Producers of domestic crude oil would, though, be under no obligation to sell their production to domestic refiners if they are able to tap export markets. Recall that under the Blueprint, U.S. exports are no longer subject to taxation. Thus a producer of domestic crude oil who receives \$50 per barrel at the wellhead would be obligated to pay a tax per barrel of \$10 if the oil is sold to a domestic buyer but *no tax* if the oil is sold to a buyer in Mexico, Latin America, or any other part of the world. With \$50 per barrel crude oil, the producer would be indifferent between accepting \$62.50 per barrel from a domestic buyer or \$50 per barrel from a foreign buyer.²⁷

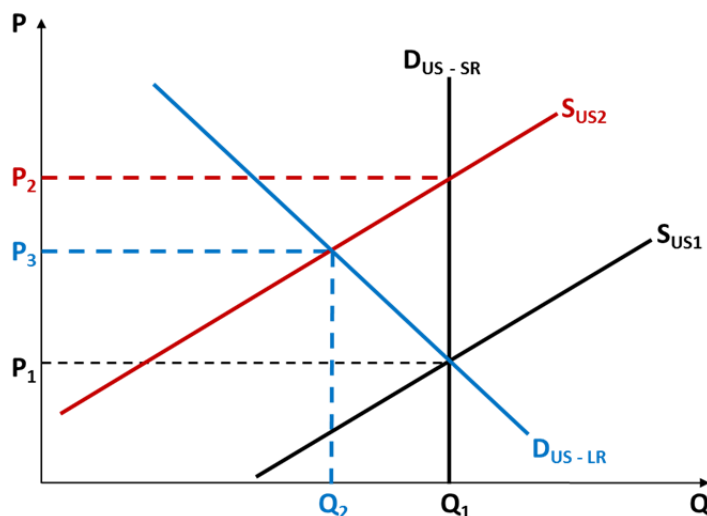
2. The Market for Petroleum Products

Under the proposed border adjustment tax, businesses that sell imported products, or use imported inputs in their production processes, would no longer be able to deduct costs associated with those imports from their taxable income. This means that the cost of imported gasoline for gasoline suppliers (such as blenders, traders, and refiners) would increase.²⁸ These suppliers of refined products in the U.S. would attempt to pass this increased cost to consumers by raising the retail price. The increase in the retail price of gasoline is illustrated in Figure 11 below, by the shift in the supply of gasoline from S_{US1} to S_{US2} .

²⁷ At a domestic price of \$62.50 the U.S. producer would receive \$50 per barrel after deduction of the tax. This calculation assumes that transportation costs are identical. Difference in transportation costs would require small adjustments.

²⁸ A “blender” is a company that buys gasoline blendstocks to produce final gasoline of different qualities and grades. A trader is a company that buys and sells commodities, such as crude oil or petroleum products to profit from possible price arbitrage across products, geographic locations, or time. For purposes of this paper, a “trader” is a company that imports and/or exports crude oil or petroleum products to sell to consumers or refiners. Similarly, for purposes of this paper, a blender and a trader perform similar functions, namely, they import and/or export blendstocks and/or crude oil.

Figure 11: U.S. Supply and Demand for Refined Petroleum Products



Source: PKVerleger LLC and The Brattle Group

In the short run, the demand for gasoline is “inelastic”—consumption of gasoline is insensitive to changes in prices. This is illustrated, in the figure above, by the vertical short run demand D_{US-SR} —consumption of gasoline is Q_1 regardless of the price. Thus, under the border adjustment tax, the new equilibrium would be at the intersection of the new supply curve (S_{US2}) and the demand curve (D_{US-SR}), with gasoline prices having increased from P_1 to P_2 and the quantity of gasoline consumed remaining the same.²⁹

Over time, however, consumers would respond to the price increase from the border adjustment tax, and adjust their consumption of gasoline by changing their behavior, including their commuting patterns (e.g., carpooling, using public transportation, etc.), or by purchasing more efficient vehicles. Thus, in the long run, the demand for gasoline would be “elastic” or sensitive to price. In the figure above, this long run elastic demand is represented by a downward sloping demand curve D_{US-LR} , and illustrates that in the long run, consumers reduce consumption of gasoline as the price of gasoline rises. The new long-run equilibrium, the intersection of supply and demand, S_{US2} and D_{US-LR} , would be at a lower quantity (Q_2). While the price increase in the long run would be lower than that in the short run (P_3 is lower than P_2), the long-run impact of the border adjustment tax is still a higher price of gasoline for consumers (P_3 is above the original price, P_1).

²⁹ Market equilibrium of supply and demand represents a balance between all the different buyers and sellers (Samuelson and Nordhaus: Economics, p. 27).

Suppliers that rely solely on product imports must pass on all of the increase in costs to maintain margins. In those areas such as Maine and Massachusetts where there is no competition from domestically produced product the full cost increase would be passed on to consumers, less perhaps a small reduction in distributor margins. In much of the country this import parity constraint would lead to domestic prices increasing by most of the cost increase, and lower consumption of gasoline.

As is the case with crude oil, under the proposed border adjustment tax, gasoline suppliers would be under no obligation to sell their production in the domestic market if they are able to export refined petroleum products. A supplier that sells gasoline in the domestic market would have to pay taxes, while the same gallon of gasoline would be tax exempt if it is sold to other countries. The supplier would thus be indifferent between selling at a higher price in the domestic market (to compensate for the tax) or at a lower world price in a foreign market.

B. CALCULATING THE EFFECT OF THE BORDER ADJUSTMENT TAX

As we noted earlier, the proposed border adjustment tax is not an explicit tariff or fee on imports as one might initially assume. The inability of businesses to deduct the cost of an imported input under a tax rate of 20 percent would appear to be similar to a tariff of 20 percent. However, as we briefly discussed before and as we will illustrate in some detail here, the border adjustment tax with a tax rate of 20 percent actually raises the effective cost of imports by a greater amount—25 percent.

In this section we illustrate the impact of the border adjustment tax on the market and prices for petroleum products and crude oil. The basic idea that guides our analysis is the concept of “breakeven analysis.” That is, the impact of the border adjustment tax can be evaluated by determining the price that would leave a firm, such as a gasoline importer or a refiner, indifferent (on an after-tax profit basis) between the situations with and without the border adjustment tax. In order to isolate the impact of the border adjustment tax in our analysis, we do not consider the proposed change of the corporate tax rate from 35 percent to 20 percent. Instead, we assume that before the border adjustment tax firms can deduct both domestic and imported inputs from the 20 percent tax rate, while after the border adjustment tax only domestic inputs can be deducted.

1. The Market for Crude Oil

Consider a U.S. refinery that could process domestic or imported crude oil. For simplicity, we assume that domestic and imported crude oil trade at the same price and are of the same quality. We also assume that the refinery incurs the same operation costs when processing domestic or imported crude oil. We also assume that the refinery is a price taker in the petroleum products market (i.e., it cannot set those prices). For simplicity, we further assume that the refinery produces a single refined petroleum product (i.e., gasoline). Under the current tax regime, the after-tax profit per barrel of domestic crude oil is:

$$(1) \quad \Pi = (1 - \tau) \times (P_g - P_d - C)$$

where P_g is the price of gasoline that the refiner takes as given, P_d is the price of a barrel of domestic crude oil, C represents the refinery operation costs, and τ is the tax rate.

Similarly, the after-tax profit per barrel of imported crude oil is given by:

$$(2) \quad \Pi = (1 - \tau) \times (P_g - P_m - C)$$

where P_m is the price of an imported barrel of crude oil.

Under these assumptions, it follows that the refinery would make the same after-tax profit per barrel processing domestic or imported crude oil under the current tax regime. This is because the profit in equation (1) is the same as the profit in equation (2).

After the border adjustment tax policy is implemented, the after-tax profit on a barrel of imported crude oil becomes:

$$(3) \quad \Pi' = (1 - \tau) \times (P_g - C) - P_m$$

It can be easily verified that the profit per barrel of imported crude oil is lower than for domestic crude oil (by comparing equations (1) and (3)). The border adjustment tax rewards refiners that process domestic crude oil to the detriment of refiners that process imported crude oil so long as the price of domestic crude oil does not reflect the domestic producer's opportunity to earn a higher price by exporting. In this situation, refiners would prefer to process more domestic crude oil than imported crude oil, and would bid up the price of domestic crude oil to the point at which the refiners would be indifferent between processing domestic and imported crude oil.

That is, the after-tax profit per barrel of domestic and imported crude oil would become the same. From equations (1) and (3), it can be shown that

$$(4) \quad P_d^* = \frac{P_m}{(1-\tau)}$$

With a 20 percent tax rate, a barrel of domestic crude oil would trade at a premium of 25 percent to imported crude oil. Thus, if the imported price of crude oil is \$50 per barrel, U.S. crude oil would trade at as high as \$62.50 per barrel for those producers that are able to export their production rather than selling to domestic producers. In Table 1 below we show the impact and potential windfall for domestic oil producers (for several different prices of imported crude oil).

Table 1: Impact of Border Adjustment Tax on Domestic Crude Oil Prices

Price of Imported Crude Oil (\$/barrel)	Price of Domestic Crude Oil (\$/barrel)
[1]	[2]
\$40.00	\$50.00
\$50.00	\$62.50
\$60.00	\$75.00
\$70.00	\$87.50
\$80.00	\$100.00

Source: PKVerleger LLC and the Brattle Group

Notes:

[1]: Assumed world price of crude oil.

[2]: 1.25 x [1], based on a 20% corporate tax rate.

2. The Market for Petroleum Products

Consider a blender that imports gasoline or gasoline blendstocks, and sells the final gasoline product to the East Coast. As we discussed earlier, the East Coast will remain a net importer of gasoline. We assume this blender has determined its profit-maximizing price for a gallon of gasoline to be P_g based on the cost it pays to import a gallon of gasoline blendstock, P_w , in world markets. As we described earlier, the price at which U.S. refiners can sell gasoline domestically is largely determined by the marginal cost of producing a gallon of gasoline around the world, and gasoline typically sells for similar prices in different regions of the country (see Figure 8 above). In that sense, blenders that import gasoline to the East Coast are marginal suppliers in the U.S. market and will be the price setters for the U.S. domestic market.

We also assume that the blender incurs other operating costs per gallon of C .³⁰ Finally, we assume that the blender sells Q_g gallons of gasoline, and pays a tax rate, τ on its profits. The blender's after-tax profit is given by:

$$(5) \quad \textit{Profit} = (1 - \tau) \times (P_g - P_w - C) \times Q$$

The profit on a per gallon basis, Π , is given by:

$$(6) \quad \Pi = (1 - \tau) \times (P_g - P_w - C)$$

Now, suppose that a border adjustment tax policy is implemented so that the blender cannot deduct the cost of the imported gasoline from its taxable income. The after-tax profit (on a per gallon basis), Π' , then becomes:

$$(7) \quad \Pi' = (1 - \tau) \times (P_g - C) - P_w$$

To achieve the same per gallon profit with and without the border adjustment tax, the blender raises its sale price from P_g to P_g^* so that the after-tax profit becomes:

$$(8) \quad \Pi^* = (1 - \tau) \times (P_g^* - C) - P_w$$

Setting (6) = (8) and solving for the difference in the sale price before and after the border adjustment tax, we find that:

$$(9) \quad P_g^* - P_g = \frac{\tau}{(1-\tau)} \times P_w$$

That is, the increase in sale price that makes the blender indifferent to the change in tax policy is equal to the tax rate divided by one minus the tax rate times the price of the imported gasoline or blendstock. With the tax rate at 20 percent, $\frac{\tau}{(1-\tau)}$ equals 25 percent.

In Table 2 below we show the required increase in the sale price that the blender requires in order to make the same profit per gallon with and without the border adjustment tax at different prices for imported gasoline blendstocks. For example, if the world price of gasoline blendstocks

³⁰ We assume that the company buys gasoline free on board so that C includes, for example, freight.

is \$1.50 per gallon, then under the border adjustment tax policy the blender would increase its sale price by \$0.38 per gallon to maintain the same level of profitability it had without the tax change. Similarly, if the world price of gasoline blendstocks is \$2.00 per gallon, then the increase in sale price that the blender would require to make the same profit with and without the border adjustment tax is \$0.50 per gallon.

Table 2: Required Increase of Sale Gasoline Price for Blender

World Price of Gasoline Blendstocks (\$/gallon)	Required Increase in Sale Price (\$/gallon)
[1]	[2]
\$1.50	\$0.38
\$1.75	\$0.44
\$2.00	\$0.50
\$2.25	\$0.56
\$2.50	\$0.63

Source: PKVerleger LLC and The Brattle Group.

Notes:

[1]: Assumed world price of gasoline blendstocks.

[2]: $0.25 \times [1]$, based on a 20% corporate tax rate.

In the next section we discuss the extent to which these impacts of the border adjustment tax are passed on to consumers (via retail prices).

C. IMPACT OF THE ADOPTION OF THE BORDER ADJUSTMENT TAX

Empirical analysis presented in the Appendix below allows us to assess the impact of the adoption of the border adjustment tax on gasoline and diesel prices. The analysis defines clearly the relationship between the prices of crude oil and the price of products. Further, it quantifies the impacts on retail prices of changes in spot prices due to the border adjustment tax.

Given the uncertainty regarding the level of future crude oil prices, we examine four cases here: \$40, \$50, \$60, and \$90 per barrel of Brent crude oil.³¹ We begin by establishing the spot prices of gasoline and distillate fuel that would prevail under each of the four cases. To do this we use a

³¹ See supra, at footnote 5.

framework initially introduced by Verleger which links prices of petroleum products to crude oil.³² Verleger posited that crude oil prices followed petroleum product prices (which at the time was a controversial view). His analysis was based on the fact that the buyers of crude oil, namely refiners, use elaborate models to determine the value of the crude oil on which they bid. These models, referred to as *netback models*, take prices from highly competitive product markets and generate estimates of the maximum amount a refiner would be willing to pay for crude oil.

We use the estimated parameters for the model (see Appendix below for details) to determine the spot prices of New York Harbor gasoline and diesel that would prevail if Brent were to trade for \$40, \$50, \$60, or \$90 per barrel. The spot prices are shown in rows [A] and [B] on the left side of Table 3 below (columns [1] through [4]). We then repeat the exercise with the border adjustment tax imposed. The results are shown in columns [5] through [8].

³² See *supra*, at footnote 25

Table 3: Impact of the Border Adjustment Tax on Crude Oil, Gasoline, and Diesel Prices

	Price of Brent (\$/bbl)				Price of Brent (\$/bbl)			
	Before Border Adjustment Tax				After Border Adjustment Tax			
	\$40	\$50	\$60	\$90	\$40	\$50	\$60	\$90
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
[A] Spot Price of Gasoline (\$/gal)	\$1.19	\$1.49	\$1.78	\$2.68	\$1.49	\$1.86	\$2.23	\$3.35
[B] Spot Price of Diesel (\$/gal)	\$1.15	\$1.43	\$1.72	\$2.58	\$1.43	\$1.79	\$2.15	\$3.22
[C] Refinery Acquisition Cost (\$/bbl)	\$35.26	\$43.39	\$51.52	\$75.91	\$43.39	\$53.56	\$63.72	\$94.21
[D] Retail Price of Gasoline (\$/gal)	\$2.16	\$2.40	\$2.64	\$3.37	\$2.40	\$2.71	\$3.01	\$3.92
[E] Retail Price of Diesel (\$/gal)	\$2.17	\$2.39	\$2.60	\$3.25	\$2.39	\$2.66	\$2.93	\$3.74

Source: PKVerleger LLC and The Brattle Group

Notes:

- [1] - [4]: Prices for [A] through [E] that would prevail before implementation of the border adjustment tax at Brent prices of \$40, \$50, \$60, and \$90, respectively.
- [5] - [8]: Prices for [A] through [E] that would prevail after implementation of the border adjustment tax at Brent prices of \$40, \$50, \$60, and \$90, respectively.
- [A] - [B]: Estimated spot prices for gasoline and diesel under the four Brent scenarios, with and without the border adjustment tax. These spot prices are estimated using the relationship between the average spot prices observed in the last twelve months with available data (Nov 2015-Oct 2016) and the average predicted Brent price for the same time period, calculated using coefficients from the regression described in the Appendix (see Table A-3).
- [C]: Estimated RACs for the four Brent scenarios, with and without the border adjustment tax. The RACs are estimated using the average Brent price observed in the last twelve months with available data (Nov 2015-Oct 2016) and the coefficients from the regression of change in RAC on change in Brent discussed in the Appendix (see Table A-2).
- [D] - [E]: Estimated retail prices for gasoline and diesel under the four Brent scenarios, with and without the border adjustment tax. These retail prices are estimated using the average spot retail prices observed in the last twelve months with available data (Nov 2015-Oct 2016), the estimated spot prices shown in [A] and [B], and the coefficients from the regression of change in retail prices on change in spot prices for gasoline and diesel discussed in the Appendix (see Table A-1).

Columns [1] and [5] compare the results for the \$40 per barrel Brent case; columns [2] and [6] compare the results for the \$50 per barrel Brent case; columns [3] and [7] compare the results for the \$60 per barrel Brent case; and columns [4] and [8] compare the results for the \$90 per barrel Brent case. The spot prices in rows [A] and [B] are calculated using regression parameters of the relationship between those spot prices and Brent (see Table A-3 in the Appendix). RACs (row [C]) are calculated using the regression parameter of the relationship between Brent and the Refinery Acquisition Cost shown in Table A-2 in the Appendix. We calculate retail prices of gasoline and diesel (rows [D] and [E]) using the regression parameters of the relationship between retail and spot prices for gasoline and diesel (see Table A-1 in the Appendix). We find that the border adjustment tax increases retail prices between 10 and 16 percent, depending on the level of crude oil prices.

In Table 4 below, we provide estimates of the impact of the border adjustment tax on consumer expenditures for gasoline and other motor fuel. For this calculation, we use the average

expenditures on gasoline and other motor fuel for the four quarters ending September 30, 2016 as published by the U.S. Bureau of Economic Analysis (“BEA”).³³ According to the most recent release, annual consumer expenditures for gasoline and other motor fuel averaged \$241 billion for the twelve month period considered. This can be converted to 289 million gallons a day of gasoline and other motor fuel using the average retail price of gasoline of \$2.29 per gallon for that period. Total U.S. consumption of gasoline and diesel are of course significantly greater. The most recent data published by the EIA puts the four week average of gasoline supplied at 8.934 MBPD for the week ended December 9, 2016 while the amount of distillate supplied was 3.924 MBPD.³⁴ Thus, the BEA’s estimate of consumption represents only 54 percent of the total gasoline and distillate supplied.³⁵ Adjusting the BEA expenditures using the EIA consumption data suggests that the amount spent on fuel consumption may total \$446 billion per year when purchases by trucking companies, fleet owners, and others (such as purchases for home heating) are added.³⁶

In calculating the impact of the border adjustment tax on consumer expenditures though, we use the BEA estimate—which is conservative—because this is the amount of gasoline and other motor fuel purchased only by consumers. Confronted with increases in the price of gasoline, consumers would reallocate spending as described below (and in Table 4). Some businesses faced with increases in the cost of gasoline or diesel may pass the full amount forward to consumers, but at this juncture we cannot estimate the full impact, including the impact to businesses. Further research would be required.

³³ The data were drawn from “Table 2.4.5U. Personal Consumption Expenditures by Type of Product,” Series Name: DGASRC, U.S. Bureau of Economic Analysis, available at <https://www.bea.gov/iTable/iTable.cfm?ReqID=12&step=1#reqid=12&step=3&isuri=1&1203=2017> (last accessed December 15, 2016).

³⁴ See “Petroleum & Other Liquids: U.S. Weekly Product Supplied,” U.S. Energy Information Administration, available at http://www.eia.gov/dnav/pet/pet_cons_wpsup_k_4.htm (last accessed December 15, 2016). This reports products supplied, not products consumed. There is a timing difference because the products supplied go to terminals and other distribution points where they are subsequently delivered to consumers.

³⁵ $8.934 \text{ MBPD (Gasoline)} + 3.924 \text{ MBPD (Distillate)} = 12.86 \text{ MBPD of Supply of Gasoline and Distillate (540 million gallons a day)}$. Thus, the BEA’s 289 million gallons a day corresponds to 54% of the EIA amount ($289 / 540 = 54\%$).

³⁶ $\$446 \text{ billion} = \$241 \text{ billion} / 0.54$.

Table 4: Estimated Impact on Gasoline and Other Motor Fuel Consumption Expenditures

Price Elasticity	Retail Price of Gasoline (\$/gal) Before Border Adjustment Tax				Retail Price of Gasoline (\$/gal) After Border Adjustment Tax				
	\$2.16	\$2.40	\$2.64	\$3.37	\$2.40	\$2.71	\$3.01	\$3.92	
[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	
<i>Panel A: Estimated Consumer Expenditures on Gasoline (billions of dollars)</i>									
[A]	-0.05	\$228	\$253	\$277	\$347	\$253	\$283	\$312	\$398
[B]	-0.10	\$229	\$252	\$274	\$338	\$252	\$280	\$307	\$383
[C]	-0.20	\$230	\$251	\$270	\$322	\$251	\$275	\$297	\$354
<i>Panel B: Estimated Increase in Consumer Expenditures on Gasoline (billions of dollars)</i>									
[D]	-0.05					\$24	\$30	\$35	\$51
[E]	-0.10					\$23	\$28	\$33	\$45
[F]	-0.20					\$20	\$24	\$27	\$32

Sources: PKVerleger LLC and The Brattle Group analysis; personal consumption expenditures from BEA Table 2.4.5U.

Notes:

[1]: Results for Panels A and B are shown using three price elasticities of demand for gasoline.

[2] - [9]: Panel A shows total annual estimated consumer expenditures on gasoline and other motor fuel, in billions of dollars, under the modeled gasoline prices shown above. We use the price of gasoline only for this analysis because most consumer expenditure on fuel is for gasoline. Panel B shows the estimated annual increase in consumer expenditures on gasoline and other motor fuel, in billions of dollars, that results from the implementation of the border adjustment tax under each modeled gasoline price.

We estimate changes in gasoline and other motor fuel consumption that would occur under the four retail price scenarios we discussed previously, assuming price elasticities of demand for gasoline of -0.05, -0.10 and -0.20.³⁷ The estimated impacts of the border adjustment tax proposal are shown in “Panel B” of Table 4 (rows [D], [E], and [F] under columns [6] through [9]).

We find that, if the border adjustment tax was imposed solely on the petroleum industry, the adoption of this tax could boost consumer expenditures on gasoline and other motor fuels by \$30-35 billion per year if price elasticity is low and crude oil prices are between \$50 and \$60 per barrel, resulting in a corresponding reduction of consumption of other goods and services by the same amount. This would represent 0.28 percent of total personal consumer expenditures.³⁸ It could lead to a decline in GDP of 0.4 percent under a standard expenditure multiplier of about

³⁷ We consider a range of price elasticities of demand for gasoline consistent with the literature.

³⁸ Consumption expenditures over the four quarters ending September 2016 were \$12.6 trillion.

2.00.³⁹ As discussed previously in the Executive Summary, the Blueprint proposes imposition of the border adjustment tax on all sectors of the economy. With the border adjustment tax, prices of many consumer goods would increase to some degree. Hence, the net effects of the border adjustment tax on consumer spending and GDP would likely differ substantially from the petroleum-specific impacts presented in this paper.

IV. Appendix: Empirical Estimation of the Impact of the Border Adjustment Tax on Petroleum Product Prices

A. PASS-THROUGH OF COSTS FROM IMPORTED SPOT PRICES TO RETAIL PRICES OF GASOLINE AND DIESEL

The basic approach we follow here is to test the linkage between the price of imported crude oil and petroleum products, and the domestic retail prices of petroleum products. As we noted earlier, it is well known that the U.S. is a large importer of petroleum products, and it is expected to remain a significant importer of petroleum products for the foreseeable future.⁴⁰

We begin by noting that there is a basic arbitrage relationship between crude oil and petroleum products. The arbitrage relationship is driven by the competitive conditions in both crude oil and petroleum product markets. Refiners are generally price takers in product markets—they cannot affect the spot prices of gasoline or distillate fuel oil. A refiner located on the Gulf Coast will have the opportunity to sell to either a domestic or foreign buyer. Buyers will have alternative supply opportunities. Prices paid to the refiner will reflect the results of the competitive bidding. Note, however, that the adoption of the export component spelled out in the Blueprint will change the refiner’s behavior because no tax will be paid on sales to foreign buyers.

The refiner is also a buyer of crude oil in a competitive market. Refiners will assess the relative value of various crude oil options using models which generate a prediction of the estimated worth of each type of crude oil based on product prices. These “netbacks” will influence the bids

³⁹ Using a multiplier of 2, the impact of \$35 billion equals \$70 billion, or 0.4 percent of nominal GDP (which was \$18.4 trillion over the last four quarters ending September 2016).

⁴⁰ See Figure 5, Figure 6, and Figure 7, and related discussion above.

the refiners offer. These models will be altered if the tax proposed in the Blueprint is adopted to reflect the differences in incentives for domestic as compared to imported crude oil.

The effect of these changes will be to raise the prices of products in the spot market for petroleum products and crude oil. Prices of crude oil will rise for the reasons discussed above. Prices of petroleum products will rise as well. Arbitrage relationships should make the per barrel price change the same for both if identical tax rates and export incentives apply to both crude oil and petroleum products.

Retail prices will increase significantly; very similar to the change in spot prices of crude oil and petroleum products. Past economic studies have confirmed this result. This hypothesis was tested extensively during the ten-year period between 1971 and 1981 when petroleum product prices were governed by regulations. Several studies were published at the time. They are cited in Kalt's thorough review.⁴¹

One study was prepared by the RAND Corporation in 1977.⁴² The authors argued that the U.S. was a price taker in world markets: "U.S. petroleum product prices are set, not by FEA [Federal Energy Administration], but by world market conditions and one could conceptually show this equality, once proper adjustments had been made for transportation costs, tariffs, true exchange rates and other factors."⁴³ Statistical tests offered by RAND Corporation analysts appeared to confirm their conclusion.

The tests used in the studies of price control impacts compared statistically the movement of U.S. prices and foreign prices. We use a similar test in this white paper. We begin by noting that at the margin, the implementation of the border adjustment tax would raise the cost of imports of petroleum products by 25 percent if we assume that the tax rate is 20 percent. Thus, a firm that relies entirely on imported petroleum products or inputs would face a 25 percent increase in its inputs. It would need to pass these costs onto consumers.

⁴¹ Joseph P. Kalt, *The Economics and Politics of Oil Price Regulation: Federal Policy in the Post Embargo Era*, MIT Press, 1983, Chapter 4. Kalt concludes that the subsidy created by the entitlements program was passed through to gasoline prices.

⁴² Charles E. Phelps and Rodney T. Smith, "Petroleum Regulation: The False Dilemma of Decontrol," The RAND Corporation, January 1977.

⁴³ See *id.*, at p. 24.

The statistical question relates to the impact of a price increase for imported petroleum products. Would domestic prices of imported petroleum products rise by the full amount? As discussed in the previous section, the theoretical answer to the question is “yes” if imports are the marginal supply source. We test this hypothesis empirically below.

We conduct this empirical test through a regression analysis of the retail price of petroleum products (gasoline or diesel) and the spot price of the same product that would fully reflect the tax. The statistical model is as follows:

$$(A1) \quad Retail_t = \alpha + \beta Spot_t + \varepsilon_t$$

Where $Retail_t$ is the retail price of gasoline or diesel fuel and $Spot_t$ is the spot price of the same product. Due to expected autocorrelation issues, we estimate the statistical equation in first difference form as follows:

$$(A2) \quad \Delta Retail_t = \alpha + \beta \Delta Spot_t + \varepsilon_t$$

We then test the equation’s robustness by comparing the predictions generated by a dynamic simulation using the estimated parameters. Thus, the predicted retail price (“ $PredR_n$ ”) for period n is equal to the actual retail price in period $t = 1$ plus the sum of changes in the spot prices for periods 0 to n .

$$(A3) \quad PredR_n = n\alpha + \beta \sum_{i=1}^n \Delta Spot_i + Retail_{t=0}$$

This is a harsh statistical test because there is no constraint on the forecast. It is possible that the estimated parameters can cause the dynamic simulation of price to diverge significantly from the actual price. In the standard regressions, the equation is estimated twice, with and without the constant, α , forced to zero. The estimates of the constant are not statistically different from zero, as expected.

We then estimate these equations for the retail price of gasoline and over-the-road diesel. Retail price data is from the Department of Energy’s Monthly Energy Review (“MER”). The MER contains data on retail gasoline prices for all areas and all types as well as retail prices for regular reformulated gasoline in all areas. For our analysis, we use the retail price of reformulated

gasoline. The estimate includes taxes. We measure spot prices using the New York Harbor barge price for reformulated gasoline (referred to as “RBOB”).⁴⁴ This is one of the most liquid product markets in the U.S.—and the market that would reflect the full amount of any border adjustment tax. Similarly, we also use MER data for over-the-road diesel and New York Harbor barge prices for low-sulfur distillate fuel (the equivalent of diesel). Here the data also include taxes. The New York Harbor barge prices for reformulated gasoline and low-sulfur distillate fuel have been compiled over time by PKVerleger LLC.

We regress retail prices for reformulated gasoline against the New York Harbor price for reformulated gasoline. Similarly, we regress retail prices for over-the-road diesel against the New York Harbor price for low-sulfur distillate fuel (or diesel). In Table A- 1 below we report the results from the regressions. For the estimated specifications, the change in the spot price of reformulated gasoline explains 67 percent of the change in the retail price of reformulated gasoline while for diesel fuel the change in the spot price explained 68 percent of the change in the retail price. Clearly, the approach used by Kalt and the RAND Corporation more than thirty years ago still works.

Table A- 1: Regression Results of Change in Retail Price of Petroleum Products on Change in Spot Price of Petroleum Products

	Dependent Variable: Change in Retail Price			
	Gasoline		Diesel	
	[1]	[2]	[3]	[4]
Change in Spot Price	0.814*** (0.053)	0.814*** (0.053)	0.755*** (0.048)	0.755*** (0.048)
Constant	-0.0003 (0.011)		-0.0002 (0.009)	
Observations	117	117	117	117
R ²	0.669	0.669	0.683	0.683
Adjusted R ²	0.667	0.667	0.680	0.680

Source: PKVerleger LLC and The Brattle Group.

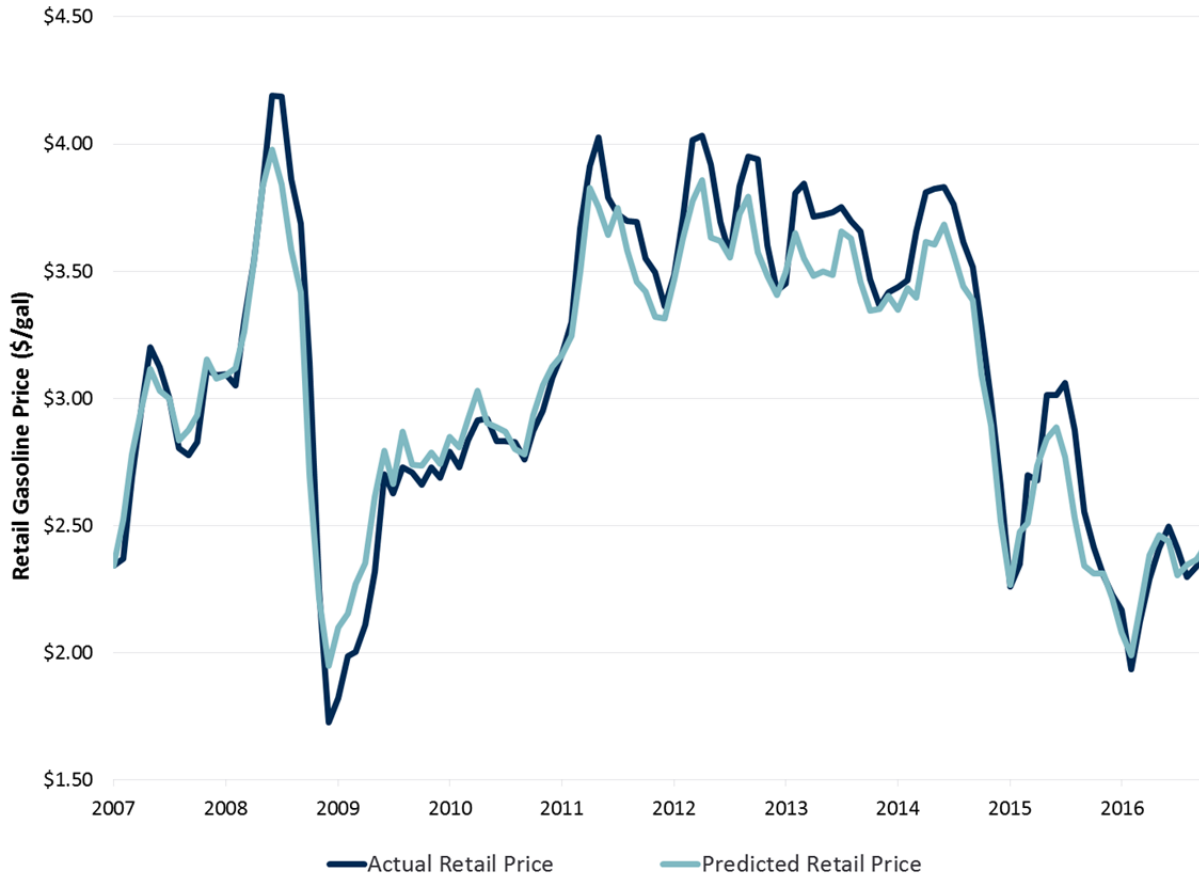
Notes:

*p<0.1; **p<0.05; ***p<0.01. Standard errors shown in parentheses.

⁴⁴ RBOB stands for reformulated gasoline blendstock for oxygen blending.

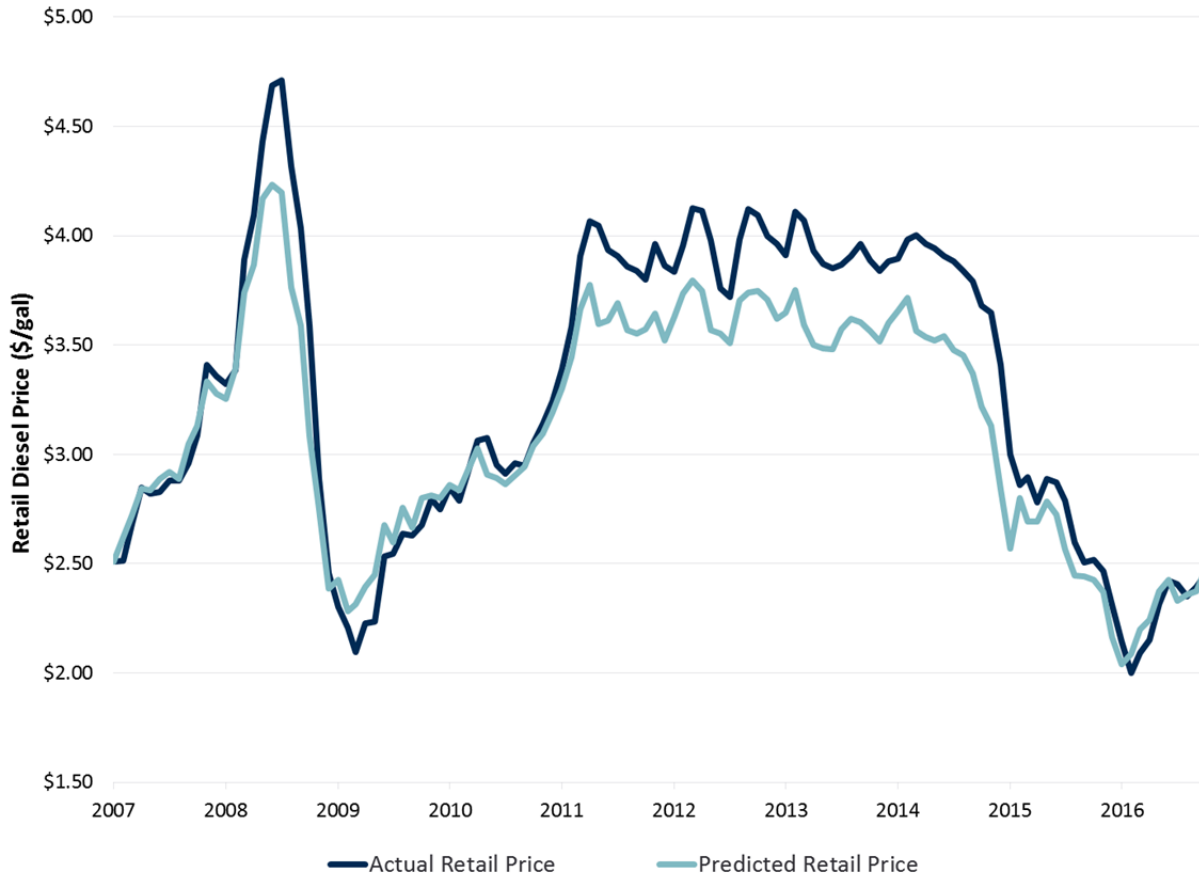
In Figure A- 1 and Figure A- 2 below we show the results from our simulation analysis. In Figure A- 1 we show the actual retail gasoline price and the value predicted in the dynamic simulation; in Figure A- 2 we show the same results for diesel.

Figure A- 1: Actual and Predicted Retail Gasoline Prices (January 2007-October 2016)



Source: PKVerleger LLC and The Brattle Group analysis of data from the U.S. Department of Energy, EIA.

Figure A- 2: Actual and Predicted Retail Diesel Prices (January 2007-October 2016)



Source: PKVerleger LLC and The Brattle Group analysis of data from the U.S. Department of Energy, EIA.

We also consider the fact that distillate (or diesel) is essentially a domestic product produced from crude oil, while gasoline prices are set by the price of imported gasoline. As we show below, the empirical evidence demonstrates that the increase in the RAC of crude oil rises less than the full amount of the increased cost of imported crude oil.

We test this proposition by conducting a regression of the RAC of crude oil and the Brent crude spot price. The regression takes a similar form as the one described above:

$$(A4) \quad \Delta RAC_t = \theta + \gamma \Delta Brent_t + \varepsilon_t$$

We report the regression results in Table A- 2 below. The estimated value of the constant θ is not statistically different from zero, as should be expected. It is suppressed in the final regression used in the analysis.

Table A- 2: Regression Results of Change in RAC on Change in Brent Spot Price

	Dependent Variable: Change in RAC	
	[1]	[2]
Change in Brent Spot Price	0.813*** (0.018)	0.813*** (0.018)
Constant	0.009 (0.079)	
Observations	353	353
R ²	0.857	0.857
Adjusted R ²	0.857	0.857

Source: PKVerleger LLC and The Brattle Group.

Notes:

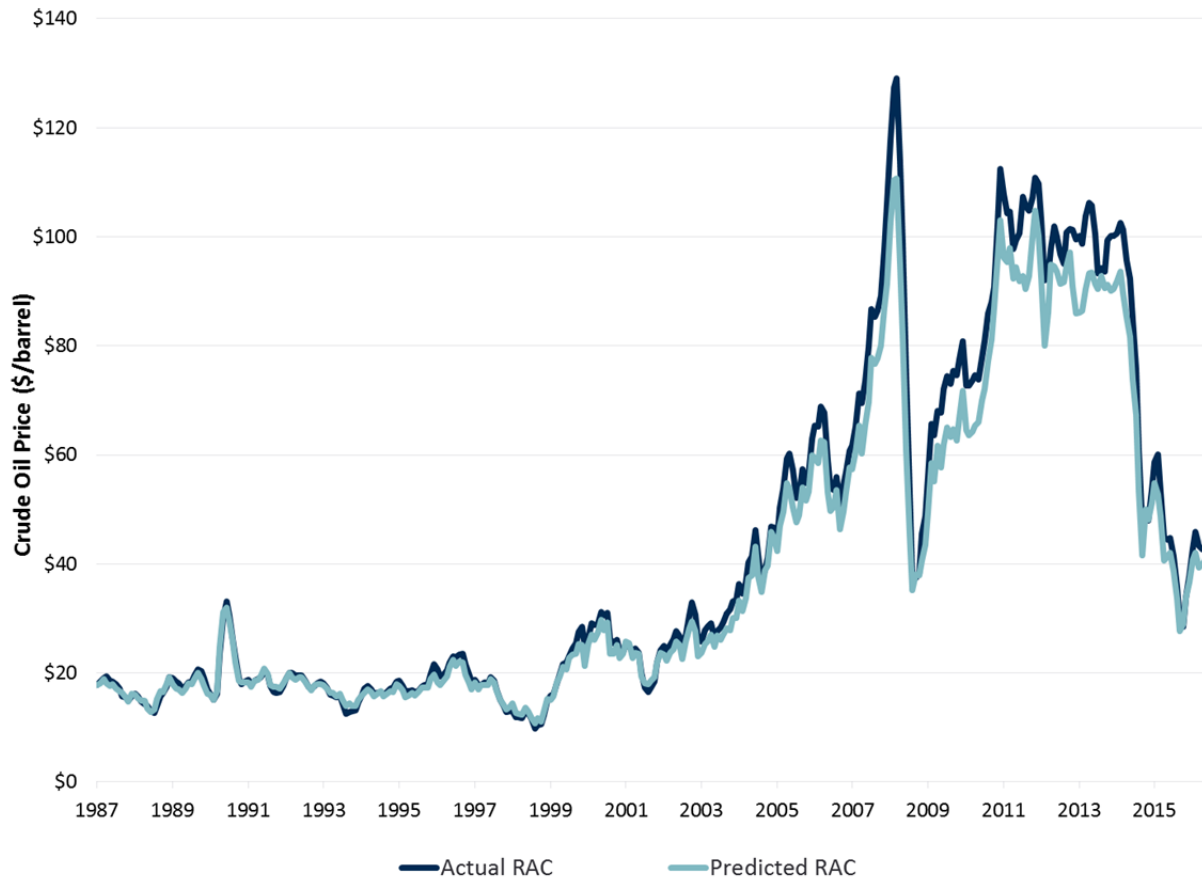
*p<0.1; **p<0.05; ***p<0.01. Standard errors shown in parentheses.

In the regression we use monthly RAC data for crude oil and the spot Brent price. We estimate the regression from May 1987 to October 2016. The results show that the RAC increases or decreases \$0.81 per barrel for every \$1.00 change in the Brent price. Additionally, the Brent price change explains 86 percent of the RAC change. To test the reliability of the regression, we calculate predicted RAC (“ $PredRAC_t$ ”) values using this formula:

$$(A5) \quad PredRAC_t = \hat{\gamma}\Delta Brent_t + PredRAC_{t-1}$$

where $\hat{\gamma}$ is the statistical estimate of γ . Thus, the predicted RAC value for October 2016 is the sum of all changes in the Brent price from June 1987 to October 2016 times the coefficient $\hat{\gamma}$ plus the RAC value in May 1987. The relationship held through the entire period, despite the absence of error correction, as we show in Figure A- 3 below.

Figure A- 3: Actual and Predicted RAC Based on Brent Spot Prices (May 1987-October 2016)



Source: PKVerleger LLC and The Brattle Group analysis of data from the U.S. Department of Energy, EIA.

B. THE RELATIONSHIP BETWEEN CRUDE OIL AND PETROLEUM PRODUCT PRICES

We propose the following linear relationship:

$$(A6) \quad PBrent_t = \delta + \varphi PGasoline_t + \tau PDistillate_t + \varepsilon_t$$

where $PBrent_t$ is the price of Dated Brent, $PGasoline_t$ is the New York Harbor Barge spot price of gasoline and $PDistillate_t$ is the New York Harbor spot price of distillate.

We estimate the model in first difference, namely:

$$(A7) \quad \Delta PBrent_t = \delta + \varphi \Delta PGasoline_t + \tau \Delta PDistillate_t + \varepsilon_t$$

We show the regression results in Table A- 3 below. The estimated equation explained 85 percent of the variation in Brent spot price.⁴⁵

Table A- 3: Regression Results of Change of Dated Brent on Change in Gasoline and Distillate Prices

	Dependent Variable: Change in Brent Spot Price	
	[1]	[2]
Change in Gasoline Spot Price	0.249*** (0.05)	0.249*** (0.05)
Change in Diesel Spot Price	0.612*** (0.057)	0.612*** (0.056)
Constant	-0.034 (0.254)	
Observations	117	117
R ²	0.847	0.847
Adjusted R ²	0.844	0.845

Source: PKVerleger LLC and The Brattle Group.

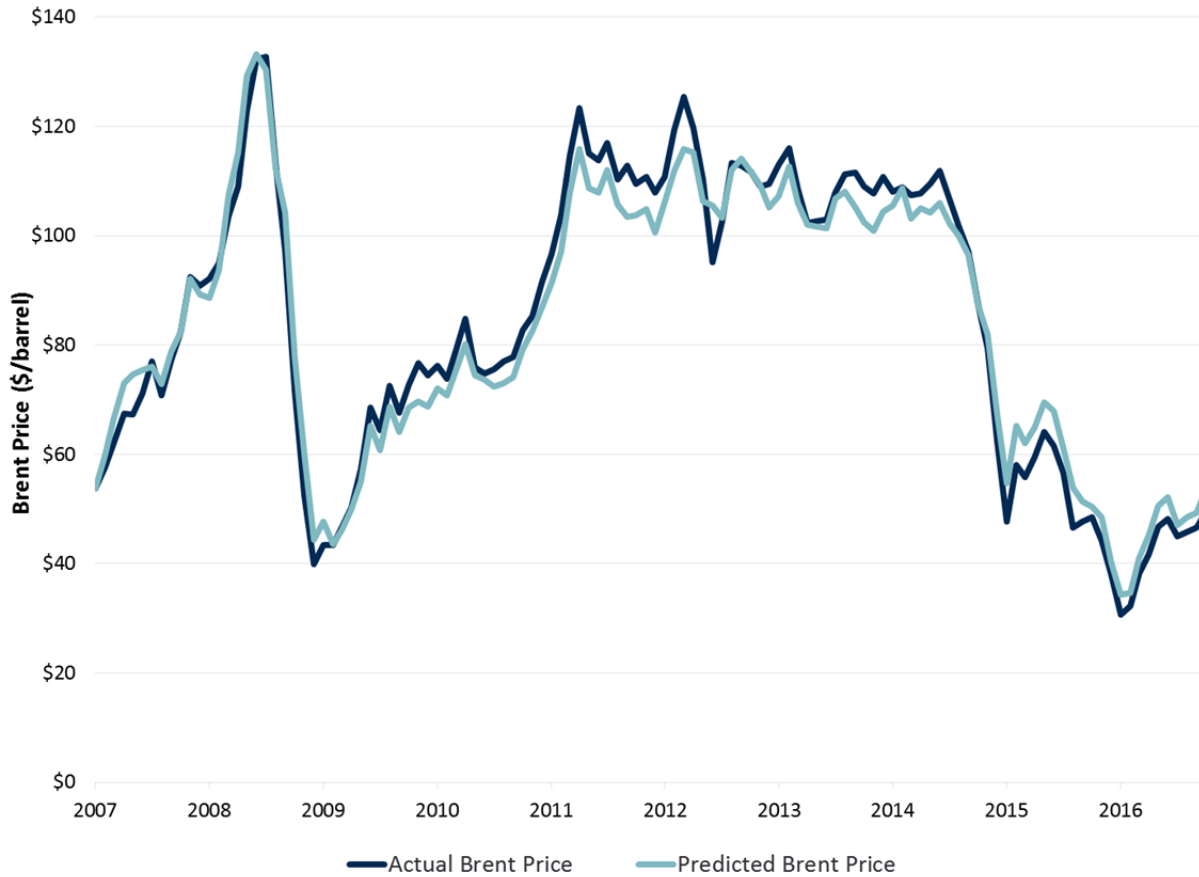
Notes:

*p<0.1; **p<0.05; ***p<0.01. Standard deviations shown in parentheses.

After we estimate equation (A7), we dynamically simulate the price of Brent using the same method described earlier (see, for example, equations (A2) and (A3)). The simulation covers the period January 2007 to October 2016. In Figure A- 4 we compare actual and predicted dated Brent prices, and show that the relationship held through the entire period despite the absence of error correction.

⁴⁵ The regression period was limited by the fact that the two key products did not trade before 2006.

Figure A- 4: Actual and Predicted Dated Brent (January 2007-October 2016)



Source: PKVerleger LLC and The Brattle Group analysis of data from the U.S. Department of Energy, EIA.

This relationship demonstrates empirically the fundamental link between petroleum products and crude oil prices. The relationship should be expected in a competitive market as arbitrage between petroleum products and crude oil prices eliminates the opportunity for any of the parties to earn excess profits.

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