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An Inquiry into the Effect of the 2014 Russian Sanctions on European Gasoline Markets

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I. Introduction

During March 2014 the world witnessed one of the most overt signs of geo-political aggression since the end of the Cold War. It was during this month that the Russian Federation formally annexed the previously Ukrainian territory of Crimea. This event resulted in ripples throughout the international community, drawing strong condemnation from the United States (U.S.), European Union (EU), Australia, Japan, and many other countries (Khlebnikov 2014). Eventually, in response to perceived Russian expansion, these countries placed economic sanctions upon Russia for its actions (Dreyer and Popescu 2014). The purpose of these sanctions was to showcase displeasure with Russian involvement in Ukraine and Crimea and ultimately to persuade Russia to allow Crimea to remain a part of Ukraine (Newsroom – European Commission 2017). In retaliation, Russia enacted counter sanctions within the agricultural sector against sanctioning countries (Reuters 2016). With the resulting deterioration of Russian relations with Western nations, these sanctions are among the most important topics in the international relations sphere. As these sanctions were so recently enacted, there has been little study of the resulting economic effects of these sanctions on EU countries. As there are many EU countries who rely heavily upon trade with Russia for energy, defense, and financial products, it is safe to assume that there should be some form of loss trade for these countries. This loss trade should be magnified for countries as one moves geographically closer to Russia due to existing trade ties.

This is the purpose of my study, to better equip foreign policy makers to better understand the consequences of the 2014 Russian Sanctions for countries that choose to enact them. By adding to knowledge of potential unintentional effects of the 2014 Russian Sanctions, I hope to spur more informed conversations amongst foreign policy makers worldwide.

Russia, at 41% of total trade, is the EU's number one trading partner. Many Eastern European nations especially rely upon Russia for energy imports due to Russia's large involvement in energy markets (BBC News 2014). By analyzing the relationships between EU nations and Russia within the energy sector, I aim to answer the following question: did the 2014 Russian Sanctions result in a positive price effect on

the average price of unleaded and diesel fuel for EU nations highly dependent upon Russian crude oil imports? My alternative hypothesis (H^1) expects the 2014 Russian Sanctions to result in a price effect on the average monthly price of unleaded and diesel fuel for EU nations highly dependent on Russian crude oil imports. My null hypothesis (H^0) outlines my expectation that the 2014 Russian Sanctions had no price effect on the average monthly price of unleaded and diesel fuel for my tested nations.

To explore the effects of the 2014 Russian Sanctions, I have conducted a difference-in-differences analysis of historical unleaded and diesel gasoline prices. I have done this by forming two groups of nations from a 14-nation sample that will analyze the difference in gasoline prices between heavily reliant EU nations and nations that are less reliant on Russian oil imports. My data for my 14 EU nations spans from 2008 – 2015 and will focus on the average monthly price of unleaded and diesel gasoline. By looking at the interaction effect of time periods after the September 8th enactment of EU sanctions and EU nations that import 50% or more of their crude oil from Russia, I aim to identify and isolate any unintentional price increases resulting from the 2014 Russian Sanctions.

After testing my differences-in-difference model, my results were inconclusive for this current iteration. My model resulted in a holistically statistically significant result, however my difference-in-differences interaction variable, built to measure the effect of the sanctions on gasoline prices, was statistically insignificant. Therefore, I cannot reject the null hypothesis (H^0). Despite not being able to identify if the 2014 Russian Sanctions resulted in a positive price effect on the average monthly unleaded and diesel gasoline for highly dependent countries, this is still an informative result. This result leads me to believe that the EU use of international sanctions in response to Russian involvement in the 2014 Ukrainian Revolution did not lead to unintentional economic harm for European gasoline consumers. The increase in costs resulting from sanctions for Russian energy firms (Rosneft, Transneft, and Gazprom Neft) was not passed onto end users in the EU in a statistically significant manner. Other explanations for my findings include the possibility that due to simultaneous increases in the global supply of oil and decreases in global demand, EU gasoline consumers did not bear any unintentional price increases resulting from the 2014 Russian Sanctions.

II. Institutional Background

a. Historical-Political Background

Since the formal dissolution of the Soviet Union in 1991, the countries of Eastern Europe previously behind the Iron Curtain have endeavored to establish strong market economies. Some of these nations have been extremely successful, like Poland and the Czech Republic, while others have encountered developmental resistance, such as Bulgaria (D. William 2-27, 28-30). Despite transitional challenges, most countries in Eastern Europe have implemented strong democratic, legal, and economic institutions that have allowed them to effectively contribute to the European and global economies. As a symbol of these successes, 11 Central and Eastern European countries now count themselves as integrated parts of the EU. This integration with Western Europe has diversified economic ties and allowed Central and Eastern European nations to reduce dependency on Russia for economic health. In the same way, many of these Central and Eastern European nations value national and economic sovereignty highly due to memories of Soviet aggression in the 20th century (European Conference of Presidents of Parliament 2014). For the past 25 years, this sovereignty has not been challenged, but in recent years, this has begun to be challenged again.

On March 18, 2014, Russia annexed the previously Ukrainian territory of Crimea (TASS 2014). The annexation of this territory followed several significant political events in Ukraine, including the 2014 Ukrainian Revolution and Russian military intervention in the Crimean Peninsula (Gros and Mustilli 2016). The 2014 Ukrainian Revolution was initiated due to fears that the newly elected Ukrainian president, Viktor Yanukovich, desired to establish stronger ties with Russia. In the early months of 2014, riots broke out across the country to express displeasure with Yanukovich, which ultimately culminated in the development of a new government and the resignation and ousting of Yanukovich. During this chaos, Crimea opted to attempt to secede from Ukraine to seek annexation by the Russian Federation. This led Vladimir Putin, the Russian Prime Minister, to authorize military intervention within Crimea to secure the territory. Soon, unmarked Russian troops occupied large swaths of Crimea, stabilizing the peninsula (Yuhas 2014). By early March 2014, Crimea was under Russian control (Parfitt 2015). These

movements led to widespread backlash from many Western governments, amidst claims that the Russian Federation had illegitimately invaded Crimea to pursue expansionistic goals (Gros and Mustilli 2016). The specific details of whether Russian control of Crimea is legitimate continues to be a topic of great debate to this day, and is worthy of further analysis. However, this question is one not addressed by the scope of this paper. Following the establishment of Russian control of the Crimean Peninsula, the newly formed Pro-Russian Crimean government petitioned the Kremlin for annexation and inclusion within the Russian Federation. On March 18th, 2014, this petition was formerly granted, and Crimea ceased to be a part of Ukraine and became a part of Russia (TASS 2014).

In the following days, Western governments analyzed the military actions of Russia within the context of the 2014 Ukrainian Revolution and communicated with the new Ukrainian government in Kiev. Together, they deemed Russian actions in the region as overtly aggressive and in violation of Ukrainian national sovereignty (Newsroom – European Commission 2017). Thus, the United States, the EU, and Canada decided to enact joint economic sanctions upon the Russian Federation for their role in the Crimean Annexation/Invasion. The goals of economic sanctions in this context were three-fold: 1) to signal to Russian and domestic audiences of dissatisfaction with Russian intervention in Crimea, 2) to constrain Russia and Russian leaders from undertaking future actions in the region, and 3) to coerce the Russian government into changing or reversing existing policies in Crimea (Dreyer and Popescu 2014). Initial sanctions by the EU were instituted to pursue the first goal of signaling dissatisfaction with the Russian government due to Russian military force in Crimea and the perceived violation of the September 6th Minsk Ceasefire agreement (Dreyer and Popescu 2014). As these initial sanctions seemed to have little effect upon the Russian Federation, more stringent sanctions were deemed necessary. Together, over the course of the following months, the U.S., Canada, Switzerland, Norway, Australia, Japan, and many other nations joined the EU in developing economic sanctions targeting the Russian Federation (Khlebnikov 2014). These sanctions culminated with the official EU enactment of their sanctions on September 8th, 2014 (EU Official Journal 2014). Due to the nature of these sanctions being similar across all enacting

nations, and the focus of this study being the EU's economic ties with Russia, the EU sanctions will be primarily focused upon.

Summarized by Dreyer and Popescu of the European Union Institute for Security Studies, the EU sanctions developed include the following restrictions:

1. asset freezes and visa bans on 132 persons and 28 companies or other entities in Russia/Ukraine deemed responsible for the violation of Kiev's territorial integrity.
2. the suspension of preferential economic development loans to Russia by the European Bank for Reconstruction and Development (EBRD).
3. a ban on trading bonds and equity and related brokering services for products whose maturity period exceeds 30 days with some of Russia's biggest state-controlled banks (including Sberbank and Gazprombank), three Russian energy companies (including Rosneft, but not Gazprom in the case of the EU), and three Russian defense companies.
4. a ban on loans to five major Russian state-owned banks.
5. a two-way arms embargo.
6. a ban on exports of so-called dual-use items, i.e. civilian industrial goods that can be used as (or to produce) weaponry.
7. a ban on exporting certain energy equipment and providing specific energy-related services to Russia's new, innovative and technology intensive energy projects (e.g. Arctic and deep-water exploration, shale oil).

To answer the sanctions imposed upon them, Russia developed their own counter-sanctions. These counter-sanctions focused on restricting agricultural imports from the U.S. and EU. The sanctioned products include dairy products, meat, fish, and fruit. They do not include wine and spirits, beverages, or baby food (Stratfor 2015). The most important sanctions from the above list of EU sanctions are the first, third, and seventh restrictions. These EU sanctions specifically target the major Russian energy firms Rosneft, Transneft, and Gazprom Neft, and the politically powerful individuals associated with them (BBC News 2014). By designing sanctions to restrict capital raising and access to international markets, these sanctions severely hamper the financial flexibility of Rosneft, Transneft, and Gazprom Neft and result in higher costs for them. U.S. sanctions effect these firms similarly, but as my study is focused on EU sanctions, I will neglect further analysis of these sanctions (BBC News 2014). At the same time these sanctions were enacted, global prices for oil were falling due to increases in global supply and decreases in global demand, resulting in further harm to a Russian economy that relied on petroleum alone in 2014 for 63% of its total export value. (Tarver 2015, OEC 2017).

In summary, it is simpler to view the entire set of sanctions through the lens of industries. EU sanctions target Russian financial, defense, and energy markets. Russian counter-sanctions target Western agricultural markets.

b. Current Situation & Motivation

To this day, EU sanctions and Russian counter-sanctions continue to be in effect. The effectiveness of these sanctions to deter further Russian aggression are a point of spirited debate. A key facet that has yet to undergo critical examination is the effect of the 2014 Russian Sanctions upon the economies of Eastern European nations. Due to the geographical proximity of Central and Eastern European nations to Russia, the comparative economic size of Russia to Central and Eastern European nations, and the still significant trade ties between these nations and Russia, there is strong reason to believe that there may be unintended positive price effects for Central and Eastern European economies (Szczepański 2015). Many European nations particularly rely on Russia for energy imports because of low transportation costs resulting from proximity and the strength of the Russian energy sector (BBC News 2014). In simple economic terms, my logic is that the 2014 Russian Sanctions and countersanctions artificially increased costs within the Russian energy, finance, and defense sectors. These higher costs may have then been ultimately passed onto European nations particularly dependent on Russian imports, unintentionally harming these European nations. An attempt to prove the existence of these unintended effects upon Central and Eastern European economies will be the focus of this inquiry going forth.

As the sanctions continue to be in effect, this topic is a matter of only growing importance. With a new administration coming to power in the U.S., there is discussion that the extension of Russian Sanctions may be reevaluated, but at this time there has been no formal actions taken from either the U.S. or the EU (Kriesberg and Zhang 2017). A similar sentiment is shared by Mr. Putin and the Russian Federation, with no reconsideration of agricultural countersanctions in sight (Sputnik International 2015). For the foreseeable future, it seems that Crimea-related sanctions will stay in place, and therefore continue to be a point of extreme geo-political and economic tension for all affected nations (Shirreff 2016).

III. Literature Review

With our institutional background outlined, we turn now to a review of current academic research and price determination literature in order to begin to develop a workable model to explain the effects of how increased costs for Russian energy firms may affect gasoline prices for heavily dependent European nations. By analyzing previous studies that evaluate price-determination in multi-country settings, I aim to identify all requisite supply-side and demand-side inputs to inform my research. While there have been many studies conducted on gasoline price determination, there has been limited previous research on the interaction of gasoline price determination, European energy markets, and economic sanctions. Despite this limitation, there have been five primary academic resources that I have utilized to inform my research of this topic. For our price determination literature, we will reference U.S. Energy Information Administration's (EIA) reports. The EIA is the premier global source for international and domestic energy information. Therefore, we will first analyze the academic research and explain how it may inform a particular model before shifting to a review of EIA literature for similar model determination aims.

a. Academic Research

- i. Austrian Institute of Economic Research – *Disrupted Trade Relations Between the EU and Russia: The Potential Economic Consequences for the EU and Switzerland*

In June 2015, Dr. Elisabeth Cristen and Dr. Gerhard Streicher of the Austrian Institute of Economic Research (WIFO) published the most important contribution for the expanding study of the economic effects of 2014 Russian Sanctions on the European market. WIFO, founded by Friedrich Hayek and Ludwig von Mises, is a globally respected think tank which also happens to be the largest research institute for economics in Austria. Cristen and Streicher found, via using the most recent data available to them in December 2014, that there were sizeable effects of the Russian Sanctions upon the European market. These effects amounted to a total value added of €34 billion in short-run loss trade and €92 billion in long-run lost trade. These costs were a summation of lost exports, tourism, and a number of other factors. These other factors include the worsening of EU-Russia diplomatic relations, the recession of the Russian economy, and boycotts by non-sanctioned Russian companies (Cristen and Streicher 1).

Cristen and Streicher explain that it is difficult to separate these factors from one another to truly identify the effect of the sanctions implemented by the EU, U.S., and Canada and the corresponding counter-sanctions enacted by the Russian Federation. In order to attempt to isolate these effects, Cristen and Streicher used a multi variate model including the 27 EU countries, Russia, and Switzerland (Cristen and Streicher 1). Using this model, they found the following results:

“...the observed decline in exports and tourism expenditures of € 44 billion was estimated to have an impact on the economies of the EU 27 plus Switzerland of € 34 billion in value added in the short run, with employment effects of almost 0.9 million people. Switching to a longer-term view (additionally taking into account an income induced reduction in household consumption), the economic effects increase up to 2.2 million jobs (around 1 percent of total employment) and € 92 billion (0.8 percent of total value added), respectively.” (Cristen and Streicher 1)

Cristen and Streicher did not specifically focus on energy markets, but on the EU economy holistically. They also did not seem to consider the possibility that affected countries may shift their focus to non-affected markets via expansion to offset the costs of loss revenue in Russia. Furthermore, Cristen and Streicher discovered that geographical proximity to Russia correlated with higher effects of sanctions-related losses (Cristen and Streicher 3). I have accounted for geographical proximity in my model and difference-in-differences group determination through collecting data for countries that are geographically close to Russia.

Building upon Cristen and Streicher’s work, we can see that there is a relationship between geographical proximity to Russia and the negative effects of sanctions. Like the WIFO study, it is challenging to account for substitution effects for European nations within energy markets as supply chains are dynamic institutions and the reorganization of these supply chains could affect my ability to measure the true effect of sanctions upon specific national markets. We should expect to see the most sizeable price impacts of the 2014 Russian Sanctions in nations located geographically close to Russia, such as Estonia, Finland, and Poland, among others. I will utilize Cristen and Streicher’s example of using a multi-country model

so as to account for country-specific effects. This can be accomplished via the use of country-specific dummy variables. Finally, it is important to note the large cost of loss trade determined by Cristen and Streicher. At a cost of €34 billion in short-run loss trade and €92 billion in long-run loss trade for the EU, these figures only further contribute to the importance of this study (Cristen and Streicher 1). As the WIFO study attempted to quantify the cost of loss trade for all markets, it is possible that these costs could depress demand for petrol markets as well, and therefore affect my results. This effect has been considered for my model. As stated, the costs of sanctions-related loss trade are sizeable. The continued study of this topic is imperative as the Western world continues to grapple with the consequences of their foreign policy.

ii. Sir Arthur Lewis Institute of Social and Economic Studies – *Oil Price Pass-Through in Curaçao*

This 2007 Sir Arthur Lewis Institute academic research paper on how the price of oil is passed through to end users was also extremely informative for this research. Pau, Henriquez, and Carolina analyzed how oil price shocks affected gasoline prices for Curaçao. This study was conducted by analyzing rising oil prices during 2005. Pau and his associates discovered that higher crude oil prices resulted in higher inflation, dependent upon labor market flexibility and the ability of producers to pass on costs to end users. Similarly, they found that in competitive market economies, there is strong evidence to suggest full and automatic pass-through of international oil price shifts on local oil prices (Pau, et al. 82). Full pass-through contributes to better price signals. As such pass-through could result in volatile price swings, many nations engage in retail price smoothing, due to the importance of oil products to economies (Pau, et al. 82-83). As consumers prefer smoother prices, there tends to be a one quarter lag in observing the effect of oil volatility on gasoline prices. (Pau, et al. 93).

The findings of Pau, Henriquez, and Carolina inform my research by suggesting that I add in a one quarter, or three month, time lag into my analysis. This paper also supports my thoughts that oil prices will be passed through to end users at a significant level, whether totally or partially. It will be important to consider if European economies use similar price smoothing techniques like Curaçao. Due to the scope

of this paper and the vulnerability of oil markets in European economies to Russian supply, we will utilize a time lag, but will investigate specific smoothing policies in further research.

iii. Washington University & INSEAD - *An Econometric Model of Location and Pricing in the Gasoline Market*

Tat Y. Chan and P.B. Seetharaman of the Olin Business School at Washington University of St. Louis and V. Padmanabhan of INSEAD-Singapore conducted a study published on July 26th, 2006 analyzing how location and pricing affects the Singapore petrol market. More specifically, via an econometric model accounting for the geography of gasoline retailers and the relative pricing between competitors, Chan, Seetharaman and Padmanabhan were able to infer attributes of gasoline demand for Singaporean consumers. Their model incorporated population, median income, quantity of cars, airport proximity, downtown proximity, and highway proximity (Chan, et al. 2). The authors found that retail margins for gasoline retailers settled around 21%. Also discovered was that consumers would travel up to a mile in order to save 3 cents/liter. Furthermore, gasoline retailers are negatively influenced by the price of gasoline (Chan, et al. 2). Chan, Seetharaman, and Padmanabhan continue to reiterate the importance of these findings for policy makers when deliberating on gasoline and oil policy.

This joint Washington University and INSEAD study also reemphasized the importance of geography in explaining gasoline price changes. As I will account for country-level retail costs with fixed effects, I can set aside this part of Chan, Seetharaman, and Padmanabhan's model. This study also provides further evidence for the importance of including some form of a crude oil variable in my model. I will incorporate crude oil prices as a proportional variable to account for crude oil with respect to country-level unleaded and diesel gasoline prices.

iv. University of California Los Angeles & Georgetown University - *The Politics of Petroleum Prices: A New Global Dataset*

This joint UCLA-Georgetown study attempts to address the fact that retail gasoline prices are not commonly understood. In the past, it has been difficult to obtain country-level data on fuel prices. Ross, Hazlett, and Mahdavi therefore collected monthly pricing data from 157 countries to inform better pricing

policies (Ross, et al. 1). They found two policy trends as a result: 1) a reduction in *ad valorem* gasoline taxes and that most costs are passed on to consumers and 2) that the only countries with significant oil subsidies are oil exporters. *Ad valorem* taxes in this case refer to taxes as a percentage of the benchmark crude (Ross, et al. 1). Additionally, it is noteworthy that as a function of pricing policy, European countries and countries that were a part of the former Soviet Union held the highest prices (Ross, et al. 21).

The pricing data collected by Ross, Hazlett, and Mahdavi provides evidence for the importance of obtaining country-level pricing data. This study provides support for my use of country-level gasoline and diesel prices from the European Commission's Weekly Oil Bulletin. Also, this research provides evidence that the effects of the 2014 Russian Sanctions will be passed onto end users, as Ross, Hazlett, and Mahdavi found that most costs are passed on to consumers (Ross, et al. 1). As this study was focused on the development of a price dataset for more informed pricing policy, it is hard to pull further information to inform my model development. Even still, there is evidence here that should be considered.

v. KIEL Institute for the World Economy - *Friendly Fire: The Trade Impact of the Russia Sanctions and Counter-Sanctions*

Finally, one of the most influential pieces for this research was the 2016 KIEL Institute for the World Economy working paper "Friendly Fire: The Trade Impact of the Russia Sanctions and Counter-Sanctions." In this paper Mattheiu Crozet and Julian Hinz investigated the costs incurred by the sanctioning EU countries resulting from the implementation of sanctions upon Russia. Crozet and Hinz found that the majority of loss trade costs borne by the EU were not the result of the Russian Federation's counter sanctions on agricultural. This implies that the costs of loss trade are primarily caused by the EU's own sanctions upon Russian energy, finance, and defense sectors (Crozet and Hinz 2). Using French customs data, they discovered that the disruption in trade finance services was found to be one of the most significant causes of the total cost of loss trade (Crozet and Hinz 2). Crozet and Hinz utilized the following difference-in-differences found on pg. 25 to test for the effects of the 2014 Russian Sanctions:

$$\ln x_{idkt} = \theta_{itk} + \theta_{idk} + \theta_{dkt} + \beta S_{odt} + \epsilon_{idkt},$$

Crozet and Hinz explain that θ_{itk} represents time fixed effects, θ_{idk} represents firm*product*destination fixed effect, θ_{dkt} represents destination*product*time fixed effect, and βS_{odt} represents the impact of sanctions with time-varying fixed effects (Crozet and Hinz 25). Ideally, they hoped to compare the trend in French exports to Russia with exports from a nation that is not participating in Russian economic sanctions. The ideal data set would be set at the monthly level, however Crozet and Hinz found this to be unfeasible, and therefore used micro level trade data from France, their test country (Crozet and Hinz 25). A final notable point of “Friendly Fire: The Trade Impact of the Russia Sanctions and Counter-Sanctions” was that Crozet and Hinz found that French firms directly exposed to the effects of Russian Sanctions were not easily able to realign their supply chains towards other non-Russian customers (Crozet and Hinz 47). They use the term “trade diversion” as another way to describe a substitution effect. The following paragraph highlights these findings:

“Finally, we investigate whether affected French exporters diverted their sales to other markets after being hit with restrictions to the Russian market. Firms that were directly exposed to Russian counter-sanctions, i.e., previously exported certain agricultural or food products later targeted by counter-sanctions by the Russian Federation, were not able to recover their loss by expanding sales to new or existing destinations aside from Russia. These firms that were not directly hit by counter-sanctions, i.e., those previously exporting to the Russian Federation, did serve more markets afterwards, but did not increase flows to existing partner countries. Overall, trade diversion effects remain insignificant or very small in magnitude.” (Crozet and Hinz 47)

The findings of Crozet and Hinz are extremely useful in determining my own model specification. Unlike Crozet and Hinz, I have been able to collect useful monthly level data from multiple countries that have both participated in EU sanctions and yet differ in exposure to the Russian energy supply chain. We will

utilize a similar approach by using a difference-in-differences approach. Also important to note are Crozet and Hinz's findings of a lack of trade diversion in the European agricultural market (Crozet and Hinz 47). While I cannot confidently say that this lack of substitution will occur in oil markets, due to their global nature, it is still worthy of consideration. If I am unable to reject my null hypothesis, the existence of a substitution effect resulting from supply chain realignments may very well be possible. Two final points of consideration gathered from this study include the use of fixed effects and the existence of negative effects to EU economies resulting from their own trade sanctions. These contribute to my confidence in the method, purpose, and form of this research. However, as Crozet and Hinz focused their work on French agricultural firms, we find that there is a continued need for further detail and research in each sanctioned sector. I will pursue this here within the energy sector through this study of gasoline and diesel prices.

vi. Literature Summation

From our review of these five studies, I have established several important considerations for my analysis.

- WIFO
 - o Geographical proximity magnifies the effect of sanctions.
 - o Fixed effects should be used to account for country-specific factors.
- Sir Arthur Lewis Institute of Social and Economic Studies
 - o Market economies significantly pass through crude oil costs to end users.
 - o Oftentimes crude oil price volatility experiences a three-month lag before affecting end user gasoline prices.
- Washington University & INSEAD
 - o Geography affects pricing.
 - o A variable for the price of crude oil should be incorporated into any model for gasoline price determination.
 - o Gasoline demand is inelastic.
- University of California Los Angeles & Georgetown University
 - o Data should be designated at the country level where possible.
 - o Most costs are passed onto end users.
- KIEL Institute for the World Economy
 - o A difference-in-differences approach is particularly suited for analyzing the effects of the 2014 Russian Sanctions on European economies.
 - o It is important to be mindful of possible substitution effects.
 - o Again, fixed effects can appropriately account for country-specific factors.
 - o EU sanctions have caused significant negative effects for European economies.

b. EIA Price Determination Literature

i. Price Structure Overview

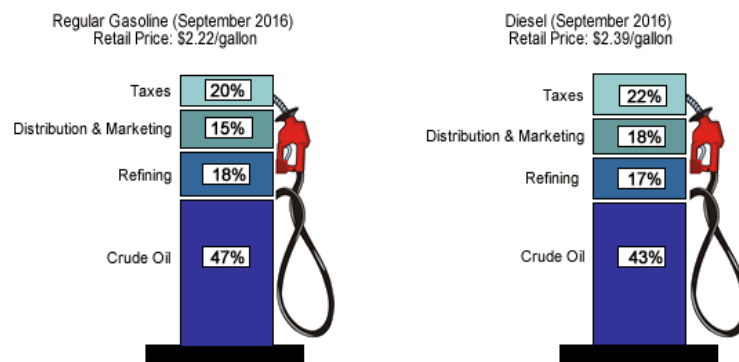
I will now provide a more in-depth review of how the price of gasoline is determined so as to complement my academic research. By determining other supply and demand factors that affect oil prices, we will be able to more clearly understand how a supply price shock could affect European nations' gasoline prices. If there are significant price determinants not related to crude oil, then these determinants would need to be accounted for in determining the effect of the 2014 Russian Sanctions on European gasoline markets. To determine price inputs, I will be referencing the U.S. Energy Information Administration's October 2014 report "What Drives U.S. Gasoline Prices?" While this report is targeted towards explaining the American gasoline market, the information it provides is valuable as a starting point in understanding European gasoline markets. To ease concerns about the applicability of this report, the EIA has found that due to gasoline and crude oil existing as globally traded commodities, prices and price shifts are highly correlated across global spot markets (EIA Sept. 2016).

As described by the EIA, the price of American gasoline is determined by four supply aspects:

- 1) The price of crude oil
- 2) Refining costs and profit margins
- 3) Retail and distributional costs and profit margins
- 4) Taxes

A visual representation (Fig. 1) of how each of these price inputs affects the final price of U.S. gasoline is provided below:

Figure 1 - EIA Gasoline Price Source Percentage Contributions



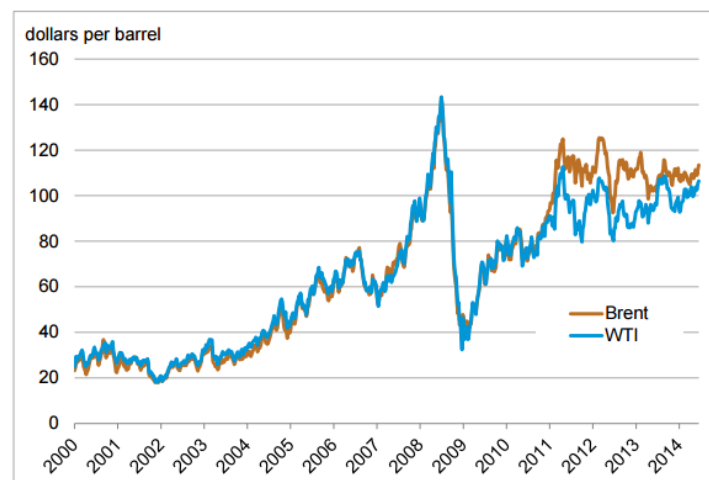
Source: EIA 2014

We will address each of these price determinants in turn.

ii. Crude Oil

The price of crude oil is the single largest driver of gasoline prices. American crude oil is determined by the spot price of the West Texas Intermediate (WTI) blend, while European oil is determined by the Brent crude spot price (EIA Sept. 2016). As these originate in the United States and European Union respectively, this is logical. The price of WTI and Brent are highly correlated as demonstrated by Figure 2:

Figure 2 – WTI-Brent Price Correlation



Source: EIA Sept. 2016

From their analysis, the EIA has determined that the Brent price is the main driver of spot markets, instead of WTI. Therefore, Brent is the main determinant of U.S. gasoline prices (EIA Sept. 2016). This fact only underscores the importance of understanding the price of Brent as an important consideration for European gasoline prices and my study too.

In the past five years, the price of Brent has moved violently from a high of \$125.81 in early 2012 to a low of \$28.94 only four years later in January 2016. Recently, Brent has been trading between \$50 - \$60 (Bloomberg 2016). Due to this extreme volatility, I expect to see similar movements in gasoline prices after a lag (EIA Sept. 2016, Pau, et al. 93). Global oil prices have felt strong downward pressure in recent times due to the emergence of a supply glut in the oil market due to four factors: 1) The strong U.S.

dollar, 2) the Organization of the Petroleum Exporting Countries' (OPEC) unwillingness to curb production, 3) an oversupply of global crude oil, and 4) declining global demand (Tarver 2015). As local gasoline prices are reflective of fluctuations in the international price of crude oil, Brent especially, I expect to see declines in the average monthly price of gasoline for my test and control groups resulting from global supply increases and global demand decreases. It will be important that I control for the Brent price so as to properly identify any positive price effect of the 2014 Russian Sanctions upon local European unleaded and diesel gasoline prices resulting from increases in costs for Russian energy firms. Therefore, due to the extreme explanatory power of the price of crude oil (Brent), it will be important to include this in my model. As Figure 1 shows, the price of crude oil made up 47% and 43% of the price of unleaded and diesel gasoline the American consumer paid for at the pump in September 2016 (EIA 2014). Therefore, it is imperative that my model incorporates the average monthly price of Brent to account for this for the European consumer. However, as this price explains such a high level of explanatory power, I will divide the average monthly price of Brent crude by the average monthly country-level price of gasoline and diesel. By taking this approach, I will develop a proportional variable that is not so powerful as to explain away the variability of gasoline prices. If I did not do this, it is likely that a pure Brent crude variable would explain all fluctuation in average monthly gasoline prices. As my true objective is to determine the effect of the 2014 Russian sanctions on each countries' average monthly gasoline and diesel prices, not the effect of crude oil on gasoline prices, this is a necessary step. I will collect the average monthly price of Brent crude from the EIA's website.

iii. Refining Costs & Profit Margins

Refining costs and their respective profit margins vary by country and region. This is the result of the different blends needed in each country and the allowed amount of pollution. Seasonal blends also affect refining costs due to the variety of ingredients associated with winter and summer blends (EIA Feb. 2016). Total EU refining capacity stands today at 15 million b/d, or around 16% of total global capacity (European Commission 2010). It is important to note that the quantity of refineries in Europe and their respective refining capacities has remained constant in recent years. Table 1 illustrates the quantity of

refineries in each EU country remaining from Table 3 and their respective crude oil capacity as recorded in 2010 by the European Commission's working paper *On Refining and The Supply of Petroleum Products in the EU*.

Table 1 – Sample Nations' Refining Capacities

Nation	Refinery Quantity	Total Refining Crude Capacity (kt/Year)	Total Refining Crude Capacity (b/d)
Slovakia	1	6,004,111	120,000
Poland	2	24,666,891	493,000
Estonia	0	-	-
Lithuania	1	9,506,510	190,000
Hungary	1	8,055,516	161,000
Bulgaria	1	8,806,030	176,000
Finland	2	12,783,752	255,500
Czech Republic	3	9,606,577	192,000
Croatia	0	-	-
Latvia	0	-	-
Romania	6	21,388,497	427,525
Italy	16	111,333,164	2,225,600
Austria	1	10,006,852	200,000
Germany	13	121,743,365	2,433,200

Source: European Commission 2010

For my study, I will not include a variable for refining costs and refining profit margins. As the quantity of refineries has remained constant over the last ten years, a variable for this determinant will not yield any additional explanatory power. For the demand side factors that affect refining profit margins, I aim to account for those with additional demand-side variables that will be explained later. I can use fixed effects to account for this variable as well, in order to ensure that it is not entirely neglected.

iv. Retail and Distributional Costs & Profit Margins

The third price determinant for retail unleaded and diesel gasoline prices is distribution and retail costs. These costs originate from the transportation of refined products to local areas of consumption. From the refinery, gasoline is typically delivered by a tanker truck to a gasoline station. Owners of retail outlets can vary. Sometimes they are owned by the upstream refineries, other times they are owned by large chains or independent businesses. Due to the locality of these businesses, they are subject to local market factors

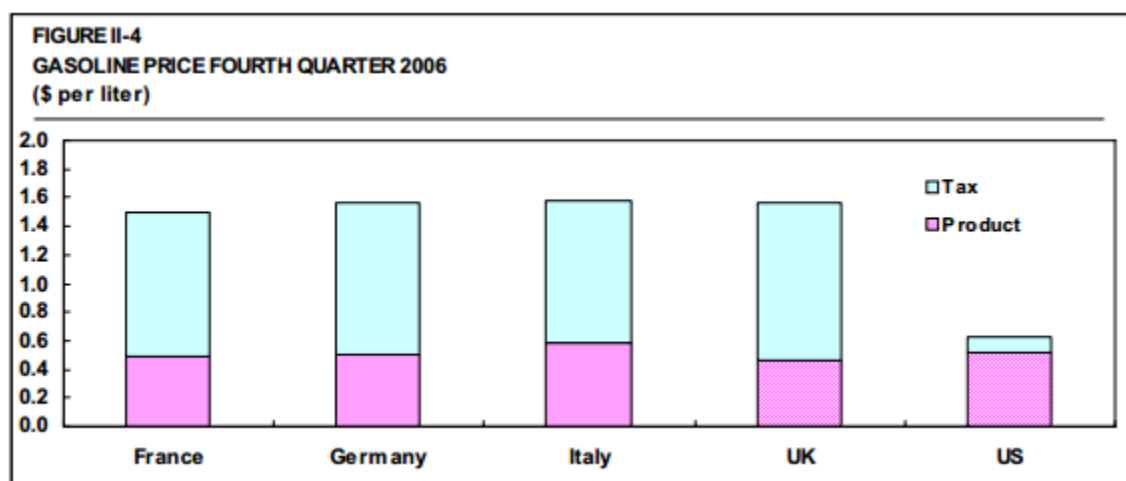
and conditions as well, and individual business strategies. Examples of local market factors include competition, wage rates, traffic patterns, and other final market characteristics and pressures (EIA Feb. 2016). However, the total effect on prices from this area remains between 13% - 18%, depending on if the gasoline sold is unleaded or diesel fuel (EIA 2014).

I will not include a variable for retail and distributional costs and their respective profit margins. Due to the diversity of this within each country and the data available, it is possible that these rates could be time variant, but the level of detail that this would require is outside the feasibility of this study. In place of a variable counting the quantity of retail outlets or the wage rates available, I will once again use fixed effects to account for all country-specific characteristics.

v. Taxes

Finally, taxes affect gasoline prices. Taxes applied to gasoline purchases in Europe are value-added taxes, often shortened to VAT (European Commission Oil Bulletin 2017). One of the key differences between the American and European gasoline markets is the difference in tax levels. European gasoline is generally taxed at higher rates than American gasoline. The difference in taxes is a key consideration as we determine the applicability of the EIA report to European markets. Figure 3 provides a visual representation of the difference between European and American gasoline taxation.

Figure 3 - European-U.S. Tax as a Percentage of Total Gasoline Price



Source: European Commission 2010

Despite the presence of significant taxes placed upon gasoline consumers in the EU, nominal VAT rates have remained remarkably constant over the last ten years, despite the volatility of the oil market. For all current EU countries, VAT rates for gasoline have changed by 3% or less since 2007. Many EU countries have not altered their gasoline VAT rate at all (European Commission Oil Bulletin 2017).

For the final EIA price determinant, I will not account for individual countries' gasoline and diesel tax rates. As nation-specific tax rates have remained consistent in the last decade, their lack of variability provides little explanatory power for my model. Due to the lack of change in rates, I will use country-level fixed effects to account for this possible variable as well. The use of fixed effects will ensure that the individuality of each nation's tax rates is considered, while allowing us to develop a model that will be directed towards explaining the effect of the 2014 Russian Sanctions on EU energy markets.

c. Gasoline Price Determination Summation

Each of these four EIA requirements incorporates demand and supply side pressures into the costs producers contribute to gasoline. Except for the proportional lagged Brent crude oil variable, these other EIA determinants are unchanging and will be accounted for by fixed effects, as noted above. This use of fixed effects is inspired by WIFO's Cristen and Streicher and KIEL's Crozet and Hinz. Also from the work of these studies, I will use a difference-in-differences approach and include countries in my sample that are geographically close to Russia and likely to experience strong loss trade from the 2014 Russian Sanctions (Cristen and Streicher 3, Crozet and Hinz 25). As we continue to develop our model, I will be sure to include a demand side variable that will be further explained in a following section.

IV. Russo-European Energy Relationships

Moving on from our literature review now, we must explore: 1) the Russian energy sector, 2) the EU's reliance on Russian crude oil, 3) the identification of European nations particularly dependent on Russian oil imports, and 4) the decision to focus on gasoline specifically. By understanding these four topics, we may better understand how EU sanctions of Rosneft, Transneft, and Gazprom Neft may affect European gasoline prices.

a. How is the Russian Energy Sector structured?

The Russian Federation is a critical member of international oil markets. Russia produces the third largest quantity of crude oil in the world at 12.4% (Statista 2015). Led by Rosneft, Lukoil, Surgutneftegaz, and Gazprom, the energy sector is especially important for the vitality of the Russian economy. In 2014, the energy industry totaled approximately 67% of total Russian export value. More specifically, Russian total export value is led by crude petroleum (35%), refined petroleum (20%), and petroleum gas (8%) (OEC 2017). Due to the extreme correlation of a healthy energy sector to the overall health of the Russian economy, I have chosen the sanctioned energy sector as the focus of my analysis. Despite this choice, further analysis of the effects of the 2014 Russian Sanctions upon agricultural, defense, and finance markets is needed and will be considered in the future. Returning to Rosneft, Lukoil, Surgutneftegaz, and Gazprom, these firms contribute 39%, 16%, 12%, and 10% of total oil production in Russia, respectively (EIA 2017). The following table displays a breakdown of Russian oil production.

Table 2 - Russian Oil Production by Company (2014)

Company	Thousand b/d
Rosneft	4,041
Lukoil	1,724
Surgutneftegaz	1,223
Gazprom (including Gazprom Neft)	997
Tatneft	528
Slavneft	334
Bashneft	355
Russneft	313
PSA operators	287
Novatek	120
Others	567
Total	10,491

Source: U.S. Energy Information Administration based on Eastern Bloc Research.

Source: EIA 2017

Another critical firm within this market is Transneft, which holds a near monopoly over the Russian pipeline system (EIA 2017). These companies are either directly state-owned and controlled, or closely tied to the Russian economy. Specifically, Igor I. Sechin, president of Rosneft, is one of the most prominent individuals sanctioned (BBC 6). Through sanctioning Sechin and Rosneft, Transneft, and Gazprom Neft, the EU has targeted some of the most important individuals and firms that contribute to the health of the Russian energy sector. Furthermore, European sanctions specifically targeting these companies no longer permit lucrative international partnerships. An effective example of business no longer permitted is the partnership between ExxonMobil and Rosneft to explore the Russian arctic for oil (Daiss 2016). The size and scope of these sanctions has effectively neutralized Western collaboration with the firms critical to the Russian energy sector.

b. How Reliant is the EU on Russian Crude Oil?

Due to their size and their trade relationships with Europe, Rosneft, Transneft, and Gazprom Neft are all critically linked to the EU energy market. First, the EU is extremely reliant on energy imports to satisfy its energy needs. The EU imports 53% of the energy it consumes, leaving it susceptible to supply shocks. Of crude oil imports, 30% originates from Russia (EIA 2017). In 2015, Rosneft, Transneft, and Gazprom Neft, combined with all other Russian energy companies, made available a total of 7.6 million barrels per day (b/d) of petroleum and other liquids for export. For Russia, 70% of these crude oil exports are destined for Europe, with a large percentage sourced by Germany, the Netherlands, Belarus, and Poland (EIA 2017). These percentages underscore the importance of this trade relationship.

While Russian companies are involved in all parts of the oil production process, they tend to focus on crude oil as opposed to more downstream activities, like refining, as it is a higher margin business. Refining is a lower margin activity, and can be completed anywhere. Refining tends to occur in the country that expects to use the refined products, due to the low margins involved. Due to this, I believe this aspect of Rosneft, Transneft, and Gazprom Neft's business most clearly showcases how Russian energy firms affect European end users. As Russia is at the beginning of the oil supply chain, and Europe

and Russia are so mutually dependent on one another, it is logical to expect that any shock to the Russian energy sector would cause cost ripples within the European crude oil and refined product markets as well.

c. Which European nations' gasoline supply is most dependent upon Russian crude oil imports?

i. Country Identification Overview

With the Russian energy dependency of the EU established, we now turn towards determining which EU nations would be particularly affected by a shock to supply costs. We know from the WIFO and Washington University & INSEAD studies that geography will heavily play into this, but can we be more specific in identifying nations that may be the most sizably affected by the 2014 Russian Sanctions? To determine which countries could be most locally affected by Russian oil costs increases and included in the analysis, we will look at three different aspects of trade: tanker and vehicular transport, pipeline transport, and Russian energy import percentages for EU nations. At this time it is important to note that oil markets are global markets, and while I have done my best to isolate the locality of energy markets and dependency, the global nature of these markets could ultimately affect this study and our country identification.

ii. Tanker & Vehicular Transportation

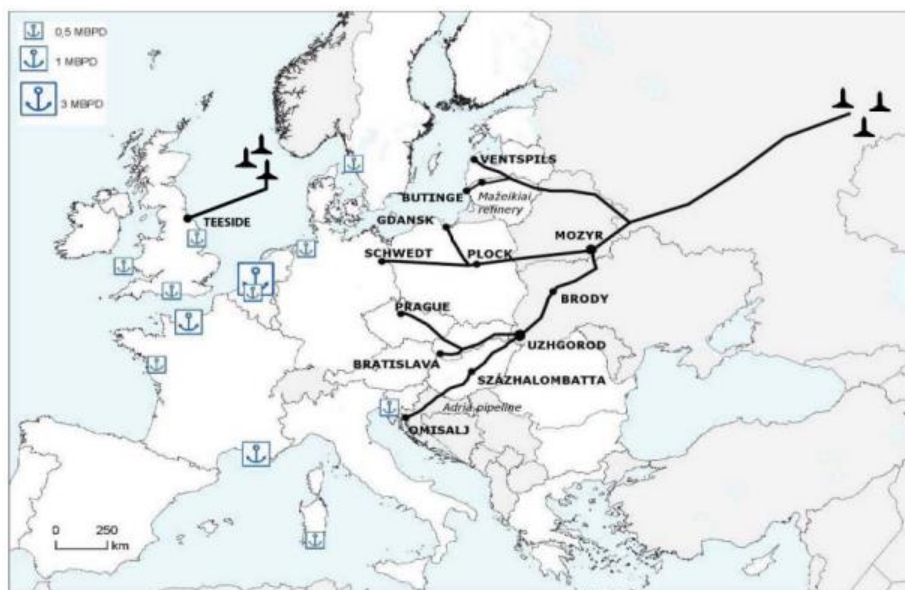
Most imported European oil is brought by tankers and vehicles. At 80% of total oil transportation, this is the main way oil is brought into Europe. Twenty percent of European oil is sourced through a pipeline (Bjørnmose, et al. 2009). Two Russian ports dominate the nation's oil export market – Primorsk and Novorossiysk. Primorsk, which is located near St. Petersburg, Russia on the Leningrad Oblast, is Russia's largest oil transportation port. It has a capacity of 1.3 million b/d which is loaded onto tankers and transported. Novorossiysk, situated on the Black Sea, has a loading capacity of over 1 million b/d (EIA 2017). Based upon geography, it is logical to assume that the majority of oil transported through Primorsk finds its way to European nations. The final destination of oil passing through Novorossiysk is vaguer, and while we could hypothesize that this oil is primarily destined for Turkey, Bulgaria, Romania, and other close-by nations, I cannot confirm this, and so will disregard the importance of this port for the sake

of this study. It is not practical to analyze all tanker and vehicular transportation patterns from the last decade to determine specifically which nations are disproportionately reliant upon Russian crude oil. Therefore, I do not find this to be an effective measurement for determining which countries may bear the weight of unintentional effects of the 2014 Russian Sanctions.

iii. Pipeline Transportation

Regarding pipelines, there are two only two pipelines that bring oil to be refined into gasoline into the EU – the Druzhba and Norpipe (Bjørnmose, et al. 2009). The Druzhba pipeline, which begins in South-eastern Russia, and is operated by Transneft, is the longest pipeline in the world. It has two arms. The northern branch runs through and sources refineries in Belarus, Poland, Germany, and the Baltic countries. The southern branch crosses and feeds refineries in Ukraine, Slovakia, Czech Republic, Hungary, and Croatia (Bjørnmose, et al. 2009). The Norpipe pipeline originates in Norway and concludes in the United Kingdom. It is owned by the Norwegian state-run firm Statoil. It is 354 kilometers long and utilizes 40 Mtons per year of oil (Bjørnmose, et al. 2009). In contrast, the Druzhba pipeline, which is approximately 4,000 km long, has a capacity between 85-100 Mtons, and transports about 65-70 Mtons per year (Bjørnmose, et al. 2009). These pipelines are shown in Figure 4:

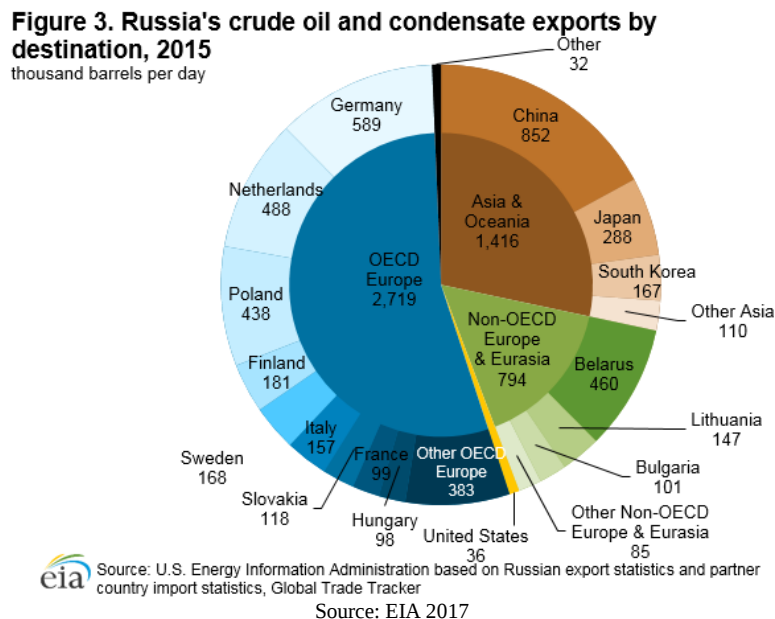
Figure 4 – Druzhba & Norpipe Pipeline Map



The longer pipeline originating in Russia is the Druzhba and the shorter pipeline originating in the North Sea is the Norpipe. These pipelines are connected to a myriad of smaller more regional pipelines, making the final destination of transported oil extremely unclear. Like tanker and vehicular transport, due to the limitations of this study and the lack of clarity regarding the final destination of the transported oil, I have not found this to be a practical measurement for determining which countries may bear the weight of unintentional effects of the 2014 Russian Sanctions. While only 20% of European oil is transported via pipeline, this is still a large percentage, and will therefore be considered for incorporation in further work on this topic and in model specification.

iv. Import Percentages

Figure 5 - Russian Oil Exports Destination Distribution



As we continue to determine which countries would bear the weight of an increase in Russian oil supply costs, it is important to note the trade relationships of specific EU countries to Russia. The preceding graphic (Fig. 5) illustrates the destination of Russian oil exports. I have found this method to be clearer than my analysis of tanker and vehicular transport or pipeline transport in understanding which European nations would be most affected by an increase in the supply costs of Russian oil. By understanding

historically which countries have relied disproportionately on importing Russian crude oil, we may be able to develop a framework which allows us to identify which nations we should expect to bear any unintentional costs of Russian Sanctions.

Table 3 details the percentage of oil imported by EU countries from Russia, total import value from all countries, and import value from Russia specifically. This information is sourced from 2014 data from MIT's Observatory of Economic Complexity.

Table 3 - European Oil Import Percentages by Country (2014)

Nation	EU Membership	Import Percentage from Russia	Total Import Oil Value from All Countries (Billions)	Import Value from Russia (Billions)	Import Value from Russia (Millions)
Belarus	No	100%	7.75	7.75	7,750
Slovakia	Yes	98%	3.6	3.53	3,528
Poland	Yes	93%	14.8	13.76	13,764
Estonia	Yes	93%	0.7	0.65	651
Lithuania	Yes	90%	5.16	4.64	4,644
Hungary	Yes	87%	4.38	3.81	3,811
Ukraine	No	87%	0.234	0.20	204
Bulgaria	Yes	82%	3.21	2.63	2,632
Finland	Yes	72%	8.04	5.79	5,789
Czech Republic	Yes	59%	4.63	2.73	2,732
Croatia	Yes	57%	1.48	0.84	844
Netherlands	Yes	35%	66.9	23.42	23,415
Latvia	Yes	33%	0.106	0.03	35
Romania	Yes	29%	4.43	1.28	1,285
Germany	Yes	28%	53.5	14.98	14,980
Italy	Yes	18%	38	6.84	6,840
Denmark	Yes	10%	2.82	0.28	282
Norway	No	10%	0.865	0.09	87
Austria	Yes	7%	5.98	0.41	407
France	Yes	7%	35.4	2.34	2,336
Belgium	Yes	5%	23.3	1.14	1,142

Source: OEC 2017

Based upon Table 3 and the goal of this study, I will disregard countries that do not possess EU membership (Belarus, Ukraine, and Norway). Based upon the preceding description of the structure of the oil supply chain and with this information, I expect Slovakia, Poland, Estonia, Lithuania, Hungary,

Bulgaria, Finland, Czech Republic, and Croatia to be most vulnerable to oil supply costs shocks. This determination has been made due to each of these countries dependence upon Russian imports registering above 50% and the quantity of oil imported. In further iterations of this project, I plan to experiment with lowering the 50% rate, and experimenting with different country groupings in order to further answer my research question. Holding all things constant as best I can, I expect any effect of the 2014 Russian Sanctions on gasoline prices to be most easily identifiable in nations 50% or more reliant on Russian crude oil imports. Conversely, I would expect the effect of 2014 Russian Sanctions to be smaller as nations decrease in reliance on Russia for their oil needs. Therefore, progressing with the 50% rate, I have selected these nine countries to form my test group for this analysis. For my test group, I have constructed a five-country sample of Latvia, Romania, Germany, Italy, and Austria. These countries, while potentially affected by the 2014 Russian Sanctions, are suited to be controls as they are not as highly reliant upon Russian crude oil imports based upon the Observatory of Economic Complexity's 2014 data. I find this method of import percentage analysis to be the most effective measure of understanding which EU nations may bear the weight of the 2014 Russian Sanctions through increased unleaded and diesel gasoline prices.

d. Why Gasoline?

Within the energy market, crude oil (crude petroleum), minerals, or refined petroleum products can be studied. I have chosen to focus on gasoline for this study as it is the refined oil product that is almost assuredly a part of the lives of all citizens of the nations affected by sanctions and countersanctions. As was explained in my Literature Review, the cost of crude oil is the main price determinant for the price of gasoline end consumers see at the pump (EIA 2014). Again, it is logical to expect that any increase in costs experienced by Rosneft, Transneft, and Gazprom Neft will be passed on to end users in countries that are reliant on Russian energy imports (Pau, et al. 93). Crude petroleum is not ideal for further analysis due to the multitude of global factors that affect prices. Minerals, although important for many industries, represent a small proportion of Russian exports, and are therefore not desirable for this study. Therefore, refined petroleum products are left. As stated, gasoline is a refined product used by most

people daily. Of gasoline products, this paper will focus on unleaded gasoline and diesel gasoline. It is typical in European markets for unleaded and diesel gasolines to be designated by their octane ratings – RON 95 (unleaded) and RON 98 (diesel) (European Commission Oil Bulletin 2017). Additionally, gasoline prices are subject to many more local factors than crude oil prices, and are easier to collect at a national level in order to determine price discrepancies. This information corresponds with my findings from the reviewed UCLA-Georgetown study (Ross, et al. 1).

V. Model Specification & Data Description

To build our final model, it is important we recall what how our research this far has influenced my model. From WIFO's Cristen and Streicher and KIEL's Crozet and Hinz, I will use fixed effects. Chan, Seetharaman, and Padmanabhan further affirmed the importance of inserting some form of a crude oil variable in my model. Drawing from Pau and others at the Sir Arthur Lewis Institute, I will build a three-month lag into our crude oil variable. From our review of EIA price determinants, I will utilize the previously stated fixed effects to account for refining costs and profit margins, retail and distributional costs and profit margins, taxes, and other time invariant country-specific factors. Also, our EIA research further emphasized the need to account for the explanatory power of crude oil prices. Finally, Crozet and Hinz informed us of the benefits of using a difference-in-differences analysis for analyzing the effect of the 2014 Russian Sanctions on European markets. To account for all other demand-side pressures, I will utilize GDP per Capita in my model.

From here, I will first explain my dataset. Second, I will provide a restatement of the justification of my difference-in-differences groups. Third, I will explain my model and the benefits and drawbacks of this particular approach. I will conclude this section with a statement of my formal research question and hypotheses.

a. Data Description

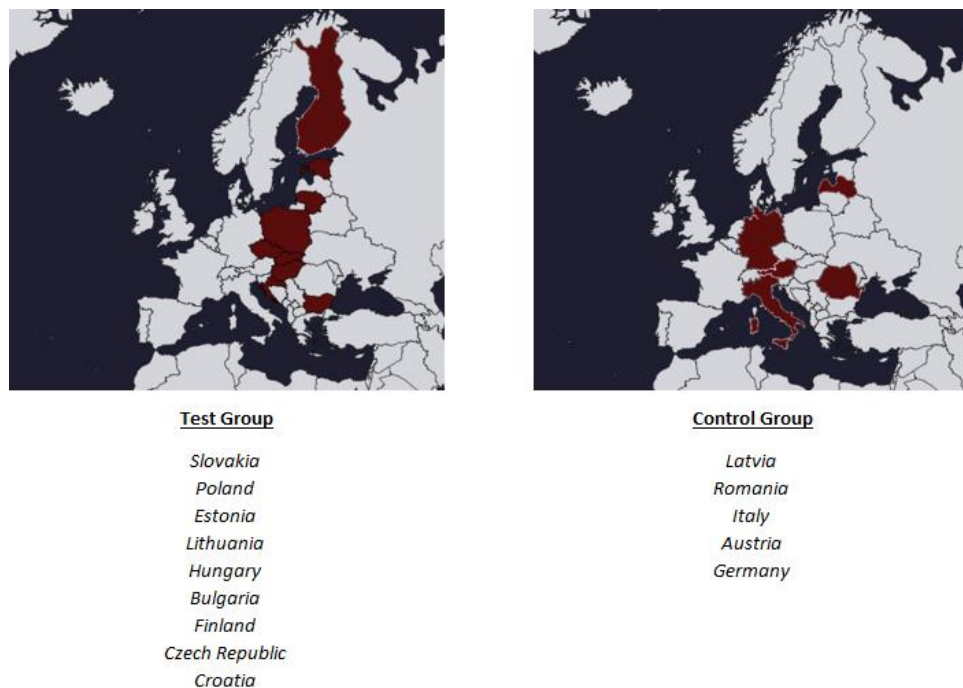
I will use the European Commission's Weekly Oil Bulletin as my base data set. This data set contains the average weekly gasoline and diesel price for 1000 liters for all EU countries from January 2008 – December 2015. To have a consistent time period, I will average the weekly prices for each country into

an average monthly price. Additionally, I have converted all prices to USD at the average monthly EUR/USD rate for each appropriate time period. Using these EUR/USD foreign exchange rates also accounts for macro-economic supply and demand pressures. To complement the European Commission's Weekly Oil Bulletin, I have sourced the average monthly price of Brent crude from the EIA and the average annual GDP Per Capita for each sample nation from the World Bank's World Development Indicators dataset.

b. Difference-In-Differences Groups

A difference-in-differences approach relies heavily on establishing the correct test and control group, so it is imperative that we align our test nations to the correct groups. As stated earlier, my test group will be EU countries that are 50% or more reliant on Russia for their supply of crude oil. My control group will be EU countries that are geographically similar but who do not possess such a large reliance on Russian oil, either due to internal production or a diversified supplier base. My test group will contain data for 9 countries. My control group will contain data for 5 countries. Figure 6 displays my test and control groups.

Figure 6 – Difference-in-Differences Country Group Map



With our groups established, I have constructed a working model which I believe will be able to explain any price increases of unleaded and diesel gasoline prices for my test group resulting increased costs of Rosneft, Transneft, and Gazprom Neft due to the 2014 Russian Sanctions.

c. Formal Model

RON 95 (Unleaded Gasoline) Model:

$$Y_{RON95it} = \beta_0 + \beta_{1RON95Proportion_{i,t-3}} + \beta_{2GDPPerCapita_{it}} + \beta_3 D_{Treatment_i} + \beta_4 D_{Post Sanctions_t} + \beta_5 D_{Treatment*Post Sanctions_{it}} + \beta_{FE} + \epsilon_{it}$$

RON 98 (Diesel Gasoline) Model:

$$Y_{RON98it} = \beta_0 + \beta_{1RON98Proportion_{i,t-3}} + \beta_{2GDPPerCapita_{it}} + \beta_3 D_{Treatment_i} + \beta_4 D_{Post Sanctions_t} + \beta_5 D_{Treatment*Post Sanctions_{it}} + \beta_{FE} + \epsilon_{it}$$

Explanatory Variables:

- 1) $Y_{RON95it}$ & $Y_{RON98it}$: The average monthly price of unleaded and diesel gasoline per country from January 2008 – December 2015, respectively. This variable is measured in USD.
- 2) β_0 : The constant term.
- 3) $\beta_{1RON95Proportion_{i,t-3}}$ & $\beta_{1RON98Proportion_{i,t-3}}$: Proportional variables dividing the average monthly price of unleaded and diesel gasoline (1000 liters) by the average monthly price of Brent crude. The average monthly price of unleaded and diesel gasoline was collected from the European Commission's Weekly Oil Bulletin. The average monthly price of Brent crude was collected from the EIA's databank and recorded in USD. This includes a three-month lag to account for the time that passes until oil prices may affect local gasoline prices. This variable is measured in USD.
- 4) $\beta_{2GDPPerCapita_{it}}$: A GDP per capita variable to capture the relative market demand of each nation. This information was collected annually from 2008 – 2015 from the World Bank. This variable was recorded in USD.
- 5) $\beta_3 D_{Treatment_i}$: A dummy variable to identify nations reliant on Russian oil imports above 50%.

- 6) $\beta_4 D_{Post\ Sanctions_t}$: A dummy variable to represent time periods after the final implantation of EU sanctions in September 2014.
- 7) $\beta_5 D_{Treatment*Post\ Sanctions_{it}}$: A dummy variable to identify the interaction effect between nations reliant on Russian oil imports above 50% and after the implementation of Russian Sanctions in September 2014.
- 8) β_{FE} : Fixed effects used for all countries in my data set to account for all country-specific characteristics such as tax rates, quantity of refineries, driving culture, and retail market qualities.
- 9) ϵ_{it} : My error term. My error term will be clustered by country.

The proportional variables – the ratio of gasoline to crude oil prices – will capture deviations in prices based on sanctions. I will use robust standard errors clustered by country. Additionally, the included GDP per capita variable accounts for a variety of population and income data I believe to provide additional explanatory power. As stated above, all data has been collected or set at a monthly time interval, beginning in January 2008 and ending in December 2015. Ideally, my model would possess data that is measured at a smaller time setting than monthly. I would like to include more granular demand side data and a variable that could more effectively account for oil shipped via tankers. I believe the inclusion of these variables could possess additional explanatory power, however collecting such information is not practical at this time. As I believe my model is the most feasible method of explaining price changes related to the Russian Sanctions on energy markets, this model will be acceptable for the purposes of this study.

d. Formal Research Question & Hypotheses

Research Question:

Did the 2014 EU sanctions on Russia for their involvement in the Crimean Annexation/Invasion have a positive price effect on the average price of unleaded and diesel fuel for EU nations with 50% or more dependence upon the Russian supply of crude oil imports?

My hypotheses:

H^0 : The 2014 Russian Sanctions had no price effect on the average monthly gasoline and diesel price for EU nations 50% or more reliant on Russian crude oil imports.

H^1 : The 2014 Russian Sanctions had a price effect on the average monthly gasoline and diesel price for EU nations 50% or more reliant on Russian crude oil imports.

VI. Empirical Results

1. Econometric Output

After running both RON 95 (Unleaded Gasoline) and RON 98 (Diesel Gasoline) Models, I found revealing results (Table 4). Both models showcased statistical significance at the 99% level, as shown by the high F-statistics. Most importantly, my difference-in-differences indicator, or the Interaction Dummy, was statistically insignificant. Due to this, I cannot reject my null hypothesis (H^0). For this iteration of this specific model, I have found no statistically significant price effect of the 2014 Russian Sanctions on the average monthly unleaded and diesel gasoline price of EU nations 50% or more reliant upon Russian crude oil imports. Important to consider the negative coefficient associated with my difference-in-differences indicator. This general downward trend could cloud any discernible sanction effect.

Table 4 – Consolidated Regression Output

Changes in Average Monthly RON 95 & RON 98 Prices for 14 EU Nation Sample

1/2008-12/2015 (in US\$)		
<i>Price Determinant</i>	<i>RON 95 Model</i>	<i>RON 98 Model</i>
Crude Price Proportion	4.97	-2.167
GDP Per Capita	0.037***	0.049***
Sanctions Time Dummy	-144.570***	-146.306***
Interaction Dummy (Test*Sanctions)	-1.331	-27.07
F-Statistic	25.88***	34.71***

These results suggest that any increased costs experienced by Rosneft, Transneft, and Gazprom Neft because of EU sanctions were not clearly passed onto EU consumers, as far as I can tell from my difference-in-differences analysis. Neither did I find my crude price proportion variable to be statistically significant. Interestingly enough, I found that GDP Per Capita and my Sanctions Time Dummy were both

statistically significant at the 99% level for both models. Holding all other price determinants constant, for a one USD increase in GDP Per Capita, the average monthly price of RON 95 and RON 98 increases by .037 and .049 USD, respectively. Similarly, holding all other price determinants constant, for a time period where the 2014 Russian Sanctions are enacted, the average monthly price of RON 95 and RON 98 decreases by 144.570 and 146.306 USD, respectively. Both models possessed a large explanatory power of the variation of the average monthly price of unleaded and diesel gasoline with an R^2 of .3491 and .4317 for RON 95 and RON 98 respectively.

After running these models, I ran an alternative set of models where I replaced the original dependent variables, $Y_{RON95_{it}}$ and $Y_{RON98_{it}}$, with price proportional variables, $Y \frac{RON95}{Brent Crude Average_{it}}$ and

$Y \frac{RON98}{Brent Crude Average_{it}}$, in order to see how my explanatory variables would explain changes in the ratio of

average unleaded and diesel monthly prices to Brent crude prices. This second set of models is as follows:

RON 95 (Unleaded Gasoline)/Brent Average Model:

$$Y \frac{RON95}{Brent Crude Average_{it}} = \beta_0 + \beta_1 GDPPerCapita_{it} + \beta_2 D_{Treatment_i} + \beta_3 D_{Post Sanctions_t} + \beta_4 D_{Treatment*Post Sanctions_{it}} + \beta_{FE} + \epsilon_{it}$$

RON 98 (Diesel Gasoline)/Brent Average Model:

$$Y \frac{RON98}{Brent Crude Average_{it}} = \beta_0 + \beta_1 GDPPerCapita_{it} + \beta_2 D_{Treatment_i} + \beta_3 D_{Post Sanctions_t} + \beta_4 D_{Treatment*Post Sanctions_{it}} + \beta_{FE} + \epsilon_{it}$$

After running the second models, I found similar results. There was still no statistical significance for my difference-in-differences indicator for either RON 95/Brent Average or RON 98/Brent Average models. This time however, my RON 95/Brent Average showcased a positive coefficient for the difference-in-differences indicator, while the RON 98/Brent Average coefficient remained negative. In contrast to the difference-in-differences indicator, my Sanctions Time Dummy variable was found to be statistically

significant at the 99% level for both updated models. GDP Per Capita was statistically significant at the 99% level for the updated RON 95 model, while being statistically insignificant for the updated RON 98 model.

2. Diagnostic Testing

After running my model and finding these results, I ran several diagnostic tests to check for robustness. I was concerned with multicollinearity, heteroskedasticity, and autocorrelation.

a. Multicollinearity

Multicollinearity occurs when two or more explanatory variables are highly correlated. Due to multicollinearity, my Treatment Group Dummy variable was dropped from my final regression output by Stata. I checked the remaining variables for multicollinearity by calculating the variance inflation factor (VIF) of each explanatory variable shown in my final regression output (Table 5).

Table 5 – Variance Inflation Test

Variance Inflation Test		
<i>Price Determinant</i>	<i>RON 95 Model</i>	<i>RON 98 Model</i>
L95	1.01	
L98		1.00
GDP Per Capita	1.24	1.24
Sanctions Time Dummy	2.24	2.23
Interaction Dummy (Test*Sanctions)	2.35	2.34
Mean VIF	1.61	1.61

Commonly held wisdom states that if the VIF factor for any explanatory variable is greater than 10, than that explanatory variable showcases strong evidence of multicollinearity. However, as shown above, none of my final explanatory variables showcased a VIF factor greater than 10. Multicollinearity is not present.

b. Heteroskedasticity

Heteroskedasticity occurs when the error term is not normally distributed. This can be remedied via the use of robust standard errors and the use of fixed effects. I have incorporated fixed effects into my model

and have clustered my standard errors at the country level. For further evidence of the normalness of my standard errors please see Appendix Figures 1 and 2 for a kernel distribution of my errors.

c. Autocorrelation

Autocorrelation occurs when the elements of a series are correlated with previous terms of the same series. Like heteroskedasticity, I have found evidence that my model is robust to autocorrelation via fixed effects.

VII. Implications & Further Considerations

1. Implications of Findings

Considering that my difference-in-differences variable was statistically insignificant for both of my models, I cannot reject my null hypothesis (H^0). What does this mean? Simply put, it means that I have not found a statistically significant positive price relationship between the enactment of the 2014 Russian Sanctions and average monthly unleaded and diesel gasoline prices for EU nations 50% or more reliant on Russian crude oil imports. I have not found that the increased costs endured by Rosneft, Transneft, and Gazprom Neft have been passed onto end users in Slovakia, Poland, Estonia, Lithuania, Hungary, Bulgaria, Finland, the Czech Republic, and Croatia. As general economic theory suggests, an increase in the costs of a supplier should result in increases in price for demand-side users. However, I did not see this.

This is an informative result. I was not able with the current data and methods to determine any unintentional price effects of the 2014 Russian Sanctions for EU gasoline markets. This knowledge should be accounted for in conversation among foreign policy leaders. Whether regarding the 2014 Ukrainian Revolution or some other international crisis, the applicability of this research remains if sanctions are under consideration for an aggressing nation. If with further research, and my results continue to be validated, then my results could give confidence to leaders to use international sanctions where appropriate to deter expansionist actions without fear of significantly affecting domestic prices. Similarly, it is important that sanctions are further analyzed to determine their legitimacy and

appropriateness as productive policy instruments. If further credited, then this only increases the diversity of policies with which leaders can respond with to prevent a conflict from escalating into a war.

2. Further Considerations

While I found that I was unable to reject my null hypothesis (H^0), I want to note that the preceding analysis is only the first iteration of research that will continue in the coming years. There are two realms of possible influencers that could contribute to me experiencing a type II error in this iteration. Despite my belief that I have included all necessary price factors, there is the possibility of model specification error, which occurs when a model is not specified correctly. This can bias the coefficients of my explanatory variables and skew my P-values. To attempt to determine the accuracy of my model specification, I ran a link test on the RON 95 and RON 98 models. Neither my RON 95 nor my RON 98 model showcased signs of model specification error. Neither of my models had a “_hatsq” variable that was statistically significant, leaving me unable to reject the assumption that the model was specified correctly. Appendix Tables 4 and 5 provide more detailed output of these tests. Despite the results of this test, I have identified two realms of possible influencers that could contribute to the possibility of a type II error in this iteration. The first realm encapsulates a variety of shifting global factors while the second realm considers the design of my empirical model. While I do not believe that these considerations could have seriously biased my results, I plan to give these realms further thought in future iterations of this research to ensure I do not fail to reject a false null.

a. Overview of Potentially Influential Global Factors

Within the global market, there are four factors that could have affected my results. The global nature of oil markets, global crude oil supply increases, global crude oil demand decreases, and the appreciation of the U.S. dollar could all skew my results. Three of these factors are supply-side influences, and one is a demand-side influence.

i. Global Nature of Oil Markets

Crude oil is a globally traded commodity, and is therefore subject to a variety of supply-side and demand-side factors that can make it extremely difficult to evaluate the effect of international policy. Due to the litany of these influences, it is challenging to isolate the effect of trade sanctions that affect only a few of the players within energy markets. The price of Brent crude oil accounts for a variety of nations and their respective markets, further diversifying and mitigating the effect of smaller shocks that only apply to a limited quantity of countries. The Brent crude oil price quickly adjusts for shocks, furthering the difficulty of analyzing smaller shifts to supply and demand. Although Russia is the third largest producer of crude oil at 12.4%, there are other nations who have greater influence on the price of gasoline and crude oil (Statista 2015). Additionally, 12.4% is a relatively small number once considered within the scope of the entire global market.

ii. Increases in Global Supply

During the timeframe of my study, January 2008 – December 2015, there were a variety of other important supply side developments that could have affected my findings. As stated in Petroleum Pricing Determinants section, the Brent crude oil price has shifted from a high of \$125.81 in early 2012 to a low of \$28.94 in January 2016 (Bloomberg 2016). Part of this is due to the increase in the global supply of crude oil, resulting from factors like the emergence of the American fracking industry and continued high output by OPEC. For example, the price of OPEC's benchmark crude oil has dropped 50% since the organization refused to cut production in their 2014 meeting in Vienna. This resistance to stabilizing oil markets has had a large effect on oil prices (Tarver 2015). Furthermore, the supply of oil seems to only be increasing. End of 2015 metrics placed production at over 9.35 million barrels per day, higher than February 2015's forecasted production of 9.3 million barrels per day (Tarver 2015). Due to OPEC's actions and the increase in production from American frackers, these elements have resulted in the establishment of a global oil supply glut. As stated above, oil markets are global, and due to the large effect of the price of crude oil on gasoline, this has led most nations to experience decreases in the price of unleaded and diesel gasoline. I have attempted to do my best to isolate the strong effect of these lower

prices on the average monthly price of unleaded and diesel gasoline, but the possibility remains that the downward pressure on prices has inadvertently affected my results.

iii. Decreases in Global Demand

Simultaneously, there has been a reduction in the global demand of crude oil and refined oil products.

Global demand of energy products is related to the growth prospects of high-use nations. Global growth among G7 nations and China has weakened in recent years, as evidenced by a weak 2015 G7 average GDP growth rate of 1.4% (World Bank 2017). Similarly, there signs that China, the world's largest oil importer, might be experiencing a slowing economy. This is inferred through the Chinese devaluation of the yuan. Finally, the emergence of more fuel-efficient vehicles, alongside these other factors, has placed downward pressure on global demand, further decreasing the price of crude oil. (Tarver 2015). This is reflected in the price of gasoline for all nations, including countries in my sample.

iv. Appreciation of the U.S. Dollar

Finally, the U.S. dollar has strengthened in recent years. 2015 marked a 12-year high for the U.S. dollar versus the euro. This has resulted in a rise in the U.S. dollar index and a decrease in the price of commodities (Tarver 2015). This decrease in commodity prices is directly linked to the fact that commodity markets are priced in U.S. dollars.

The four factors of the international nature of oil markets, increases in global supply, decreases in global demand, and the rise in value of the U.S. dollar are all influences that are difficult to control for and model appropriately. Therefore, I feel it is important to state that these global influencers may have affected my results.

b. Empirical Method Considerations

Outside of the global considerations for my study, there are four other factors that could have resulted in skewing my results. Misidentification of my difference-in-differences country groups, a short time horizon, incorrect variable manipulations, and the underestimation of refining costs and profit margins

could all introduce bias into my research. I hope to include these considerations in further study of how the 2014 Russian Sanctions interact with EU unleaded and diesel gasoline prices.

i. Difference-in-differences Country Group Misidentification

First, regarding my difference-in-differences groups, there exists the possibility of misidentification. I designed my groups based upon an import reliance of 50% or more crude oil imports from Russia. The 50% mark was an arbitrary percentage, designed to identify countries who showcased extremely high reliance upon Russian energy. For countries with smaller reliance percentages, say Germany at 28%, this import percentage is still an extremely high number. German prices should still be affected by an increase in costs for Rosneft, Transneft, and Gazprom Neft. I aim to experiment with a lower threshold percentage in further iterations of this research. Additionally, these percentages were computed based upon 2014 import numbers. It would be advantageous to look at an average of Russian crude oil import percentages over the last five years for my sample to determine a better system of country group determination.

ii. Limited Time Horizons

Secondly, I collected data from January 2008 through December 2015. This is a short time horizon, which afforded me a limited quantity of observations, especially for time periods after the September 8th, 2014 implementation of the final round of EU sanctions. As more data becomes available over the coming years, assuming the continued existence of Russian Sanctions targeting Rosneft, Transneft, and Gazprom Neft, I aim to include more observations in further iterations. This increase in data should provide additional power for understanding the longer-term effects of the 2014 Russian Sanctions.

iii. Inappropriate Variable Manipulations

Thirdly, it is possible that there exist better variable manipulations than the proportional variables I designed to account for the effect of crude oil upon unleaded and diesel gasoline prices. A longer lag than three months could be used. Also under consideration is the use of a differential or logarithmic manipulation to more appropriately account for crude oil, while still mitigating the large explanatory variable of crude oil on gasoline prices.

iv. Unaccounted Refining Costs and Profit Margin Effects

Lastly, refining costs and profit margins contribute 18% and 17% towards the cost of the average cost of a gallon of U.S. gasoline (EIA 2014). This is a large contribution. I leveraged fixed effects and a difference-in-differences technique to account for this price determinant in my model. However, it is possible that refining costs and profit margins are not time-invariant. A deeper analysis is currently outside the scope of this study, but will be undertaken in the future. I fear that refining costs and profit margins may not be time-invariant due to the historical effects of refining shocks upon U.S. gasoline markets. In 2005, when Hurricane Katrina struck the southern United States, several oil refineries were damaged and unable to operate for a time. This resulted in a negative supply shock to the U.S. gasoline market, which led to higher costs for end users. While no such natural disaster affected European energy markets during my data collection, we must pay attention to possibility that refining shocks can impact European gasoline markets. As stated, I hope to develop better methods in the future to model for any such events that could have affected the European refining sector.

VIII. Conclusion

The 2014 Ukrainian Revolution and the resulting economic sanctions enacted by the EU towards Russia were some of the most important geo-political events of this decade thus far. Due to the recent nature of these events and the strong trade ties between Russia and the EU, this is a topic of extreme seriousness and relevance. On September 8th, 2014, the EU's final round of Russian Sanctions was put into effect, targeting three sectors of the Russian economy – defense, finance, and energy. Due to the high use of gasoline in modern European economies, I chose to focus my study on the sanctioned energy sector, specifically the unleaded and diesel gasoline markets. Three Russian firms with strong governmental ties (Rosneft, Transneft, and Gazprom Neft) bore the brunt of the EU sanctions. The primary effect of these sanctions was a restriction of access to capital for these firms (BBC News 2014). This in turn should have resulted in higher costs for these firms. As the energy sector constitutes a large share of the entire Russian economy, and Rosneft, Transneft, and Gazprom Neft constitute a sizeable portion of the Russian energy sector, it is logical to expect for the increased costs to affect the entire Russian economy (EIA 2017, OEC

2017). The focus of my study was to determine if the increased costs experienced by Rosneft, Transneft, and Gazprom Neft were passed onto end gasoline users in the EU. As many EU nations' gasoline markets are highly reliant upon Russian oil imports, I hypothesized that this increase in costs would result in unintentionally higher costs of unleaded and diesel gasoline costs for EU users. I utilized a difference-in-differences model to identify two groups from a 14-nation sample. My groups – a test group, 50% or more reliant upon Russian crude imports, and a control group, less than 50% reliant on Russian crude oil imports. From this baseline, I developed a multi-country price determination model that utilized explanatory variables for the price of Brent crude oil and GDP per capita and dummy variables to account for post-sanctions times and highly dependent countries. All data was gathered as monthly averages per country from January 2008 – December 2015. From my difference-in-differences analysis, I found no statistically significant relationship between the enactment of the 2014 Russian Sanctions and both final unleaded and diesel gasoline prices for highly dependent EU nations. Due to the importance of this research, I plan to continue this analysis in the coming years to provide further findings. In conclusion, my goal was to provide Western foreign policy leaders with greater knowledge of the intentional and unintentional effects of the use of economic sanctions in response to perceived Russian aggression. I believe we have done this. I welcome inquiries of my results and look forward to greater discussion of this imperative topic.

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X. Appendix

The following appendix attempts to answer any unanswered questions begged by my research and provides secondary figures and tables that complement the preceding analysis.

a. Further Questions

Question 1 – Why did I not include RBOB Futures?

Gasoline is also an internationally traded commodity. Designated as a future contract, and most commonly known as RBOB Gasoline futures, the price of RBOB reflects global supply and demand as a spot price (Edwards 2014). Due to RBOB reflecting all supply and demand pressures, it is not considered as a viable explanatory variable for this study due to my focus on local European gasoline price fluctuations.

Question 2 – Why not focus on Russian natural gas imports?

Natural Gas, while similar in many respects to oil, is a much more complicated product to study. Natural gas is subject to many more seasonal factors than oil and contains greater supply chain complexity. Due to the limited scope of this study, and the limited seasonality and the inelastic nature of oil and gasoline, I have chosen to focus my efforts here at this time. In future studies I hope to include natural gas in my methodology to form a better picture of the impact of the 2014 Russian Sanctions on the entire Russo-European energy market.

b. Appendix Tables & Figures

Appendix Table 1 – Summary Statistics

Summary Statistics												
Test Group	RON 95 Average			RON 98 Average			GDP Per Capita			Brent Average		
	Observations:	96		Observations:	96		Observations:	14		Observations:	96	
	Mean	Std. Dev.	Variance	Mean	Std. Dev.	Variance	Mean	Std. Dev.	Variance	Mean	Std. Dev.	Variance
<i>Slovakia</i>	774.20	154.76	23950.66	859.45	182.52	33313.55	17442.24	966.67	934450.89	90.10	25.36	643.13
<i>Poland</i>	759.29	157.22	24718.13	828.64	180.08	32428.81	13198.20	910.41	828846.37	90.10	25.36	643.13
<i>Estonia</i>	756.61	159.43	25417.92	813.22	180.72	32659.72	17375.70	1808.40	3270310.56	90.10	25.36	643.13
<i>Lithuania</i>	793.72	163.88	26856.65	867.85	189.28	35826.92	14231.69	1531.47	2345400.36	90.10	25.36	643.13
<i>Hungary</i>	790.01	163.07	26591.82	867.61	181.89	33083.97	13540.76	987.47	975097.00	90.10	25.36	643.13
<i>Bulgaria</i>	775.63	171.19	29306.02	837.22	189.51	35914.04	7301.98	402.62	162102.86	90.10	25.36	643.13
<i>Finland</i>	809.05	158.86	25236.50	900.32	180.35	32526.12	48344.22	3158.32	9974985.22	90.10	25.36	643.13
<i>Czech Republic</i>	770.40	158.84	25230.15	860.94	178.03	31694.68	19994.66	1507.37	2272164.32	90.10	25.36	643.13
<i>Croatia</i>	772.37	171.59	29443.13	842.89	189.36	35857.21	13741.23	1163.49	1353708.98	90.10	25.36	643.13
Control Group												
<i>Latvia</i>	786.02	160.74	25837.35	851.30	185.73	34495.63	13972.54	1585.37	2513398.04	90.10	25.36	643.13
<i>Romania</i>	765.98	149.18	22254.67	846.12	173.91	30244.69	9122.84	699.60	489440.16	90.10	25.36	643.13
<i>Italy</i>	831.97	165.71	27459.80	885.17	190.71	36370.30	35876.16	2934.28	8609999.12	90.10	25.36	643.13
<i>Austria</i>	746.12	154.78	23956.85	615.07	111.51	12434.48	48786.65	2649.00	7017201.00	90.10	25.36	643.13
<i>Germany</i>	771.02	833.69	695039.02	833.69	187.17	35032.61	44219.22	2269.37	5150040.20	90.10	25.36	643.13

Appendix Table 2 – Full RON 95 Regression Output

RON 95 (Unleaded Gasoline) Model						
1/2008-12/2015 (in US\$)						
R^2	0.3491				$F(4,13)$	25.88
					$P\text{ Value}(F)$	0.0000
<i>Price Determinant</i>						
	<i>Coefficient</i>	<i>Robust Standard</i>	<i>T-Stat</i>	<i>P Value (T)</i>		<i>95% Confidence Intervals</i>
RON 98 Price Proportion	4.970	3.889	1.28	0.224	-3.431	13.371
GDP Per Capita	0.037	0.008	4.79	0.000	0.020	0.053
Sanctions Time Dummy	-144.570	26.296	-5.50	0.000	-201.379	-87.762
Interaction Dummy (Sanctions*Test)	-1.331	27.906	-0.05	0.963	-61.618	58.956
Constant	-68.818	198.822	-0.35	0.735	-498.347	360.710

Appendix Table 3 – Full RON 98 Full Regression Output

RON 98 (Diesel Gasoline) Model						
1/2008-12/2015 (in US\$)						
R^2	0.4317				$F(4,13)$	34.71
					$P\text{ Value (F)}$	0.0000
<i>Price Determinant</i>						
	<i>Coefficient</i>	<i>Robust Standard</i>	<i>T-Stat</i>	<i>P Value (T)</i>		<i>95% Confidence Intervals</i>
RON 98 Price Proportion	-2.167	5.523	-0.39	0.701	-14.098	9.763
GDP Per Capita	0.049	0.008	6.26	0.000	0.312	0.065
Sanctions Time Dummy	-146.306	24.785	-5.90	0.000	-199.851	-92.760
Interaction Dummy (Sanctions*Test)	-27.070	32.953	-0.82	0.426	-98.260	44.120
Constant	-197.013	204.943	-0.96	0.354	-639.765	245.739

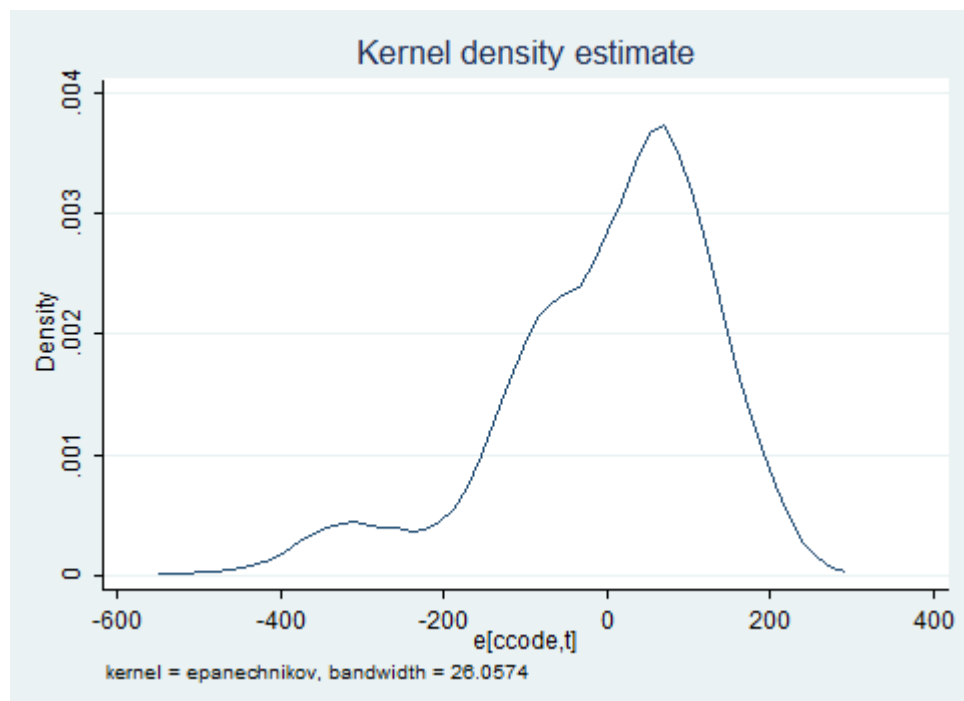
Appendix Table 4 – RON 95 Link Test

RON 95 (Unleaded Gasoline) Link Test							
R^2	0.2261				$F(2,1299)$	189.72	
					$P\text{ Value } (F)$	0.0000	
RON 95 Link Test Coefficient							
	Coefficient	Standard Error	T-Stat	P Value (T)	95% Confidence Intervals		
_hat	-0.360	1.318	-0.27	0.785	-2.946	2.226	
_hatsq	0.001	0.001	1.03	0.302	-0.001	0.003	
_cons	479.158	465.764	1.03	0.304	-434.574	1392.889	

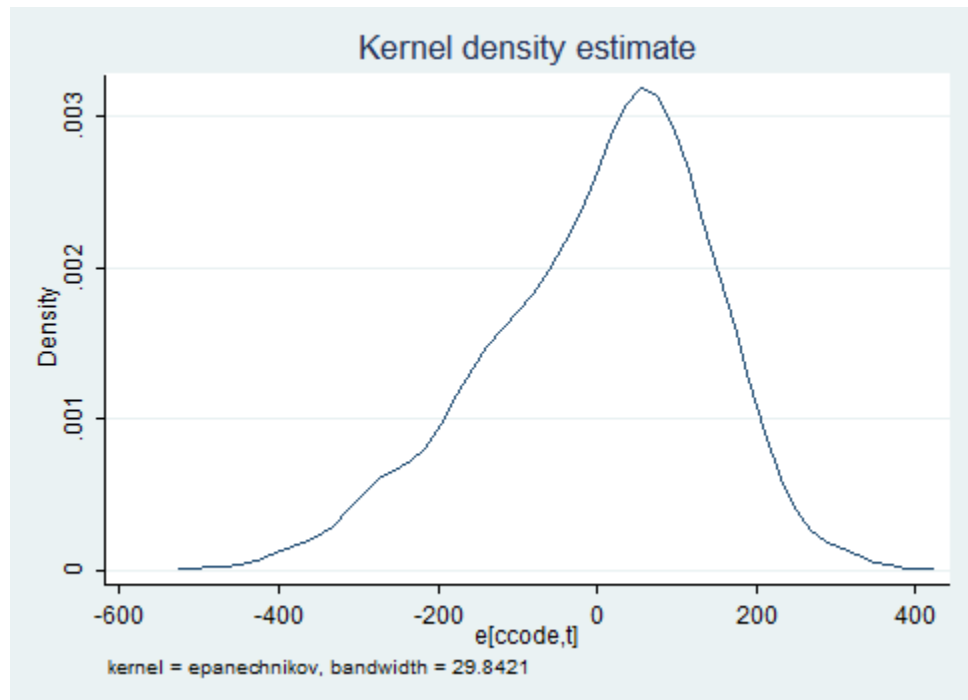
Appendix Table 5 – RON 98 Link Test

RON 98 (Diesel Gasoline) Link Test							
R^2	0.2585				$F(2,1299)$	189.72	
					$P\text{ Value } (F)$	0.0000	
RON 98 Link Test Coefficient							
	Coefficient	Standard Error	T-Stat	P Value (T)	95% Confidence Intervals		
_hat	1.413	0.990	1.43	0.154	-0.528	3.355	
_hatsq	0.000	0.001	-0.42	0.676	-0.002	0.001	
_cons	-157.033	377.649	-0.42	0.678	-897.902	583.835	

Appendix Figure 1 – RON 95 Kernel Density Estimate Distribution



Appendix Figure 2 – RON 98 Kernel Density Estimate Distribution



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