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Applying the Effect of Domestic Regulations on Fossil Fuel Export Prices to Predict the Economic Impact of Amendments to the Paris Climate Agreement's Key Caveat

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Abstract: Even though American pollution regulations have led to decreased domestic fossil fuel-based energy consumption, the US still exports more fossil fuels than ever. The Paris Climate Agreement, in a relatively-unknown caveat, does not factor fossil fuel exports into a country's regulatory model because emissions are only considered for the country that ultimately burns them. Activists intend to remedy this stipulation, but in the meantime, countries can freely export fossil fuels with little or no regulatory authority from any international institution. While the positive effects of sustainable energy are obvious, there has been little quantitative research on the effects of regulation on fossil fuel exports. This study aims to fill that gap by analyzing the impact of past federal pollution legislation on financial stakeholders associated with the American fossil fuel export industry.

Background

Enhanced drilling technologies have resulted in a "domestic glut of oil and natural gas in the US" (Hazboun, 2019, p. 1347), prompting a sharp rise in exports. The United States has become a net exporter of oil, sending about 8.5 million barrels of oil per day out of the country, up from just 1.17 million barrels per day in 2005 (Energy Information Administration, 2022). In addition, natural gas exports rose five-fold between 2010 and 2020 (Brady, 2021), with a specific increase in liquified natural gas (LNG) exported via vessels. America's total LNG exports are at all-time highs, reaching 7.23 million metric tons of exports in January 2022 alone (Deluna, 2022). Further, America continues to be "one of the top exporters of coal in the world" (American Petroleum Institute, 2022, para 2), exporting over 69 million short tons of coal annually, although that is down from 126 short tons in 2012 (Energy Information Administration, 2022).

Many activists state that the ability to export fossil fuels is the fault of influences by global actors with a financial stake. Brady (2021, para 2) surmised that American stakeholders plan to export fossil fuels indefinitely because "In an increasingly controversial quirk, this is perfectly acceptable under the Paris Climate Agreement". The practice of fossil fuel export was permittedue to the requirement that emissions from fossil fuels only be counted for the country that ultimately burns them. In fact, the US Environmental Protection Agency (EPA) actively promoted American fossil fuel exports to the EU, claiming that they are cleaner than those potentially bought elsewhere, such as Russia (Inside Washington Publishers, 2019).

Other countries also take advantage of this stipulation in the Paris Agreement. For example, in 2017, Australia's share of global $C0_2$ emissions was 1.4%, but would be a whopping 5% if their exports were counted (Yanguas-Parra et al., 2019).In this instance, since Australia's fossil fuel exports are often consumed in developing countries and used for domestic heat and/or to sustain employment, debate has sprung up regarding the ethics behind amending the current policy. Boudet and Hazboun (2022) noted that "Despite the prominent role that fossil fuels play in climate change, the production and export of fossil fuels are rarely considered by governments as part of [their]climate policy" (p. 46).

It is no surprise that there are many stakeholders involved in the export of fossil fuels. Although the US has many private organizations exporting fossil fuels, central governments do the buying and selling, receiving 80% of international revenues from the export of oil and gas, with private organizations often receiving much less (Peszko et al., 2020). While federal authorization is required to export fossil fuels (Van et al., 2013; Henning, 2014) it is unlikely that the US will ban and/or prohibit this practice due to its membership in global trade institutions and the trade agreements it has in place. Van et al. (2013) confirmed that any outright federal bans on the export of fossil fuels are not plausible because "Restrictions on exports of fossil fuels could potentially have implications under international trade rules" (p. 2).

While the Paris Agreement does not monitor the export of fossil fuels, it does vaguely encourage countries to facilitate "finance flows consistent with a pathway towards low greenhouse gas emissions and

climate-resilient development" (Paris Agreement, 2015, Article 2C), but such terminology has prompted outcries for more specific language, as "Fossil fuel export has not come without controversy" (Boudet & Hazboun, 2022, p. 3). Some economic advocacy groups encouraging and developing supply-side climate policies to limit fossil fuel exports have emerged to counter the global fossil fuel trade (Day & Day, 2017; Lazarus & van Asselt, 2018; Gaulin & Le Billon, 2020; Ministry of Economic Affairs and Employment, 2021), but others have focused on capital and equity remedies (Gupta et al., 2020). Likewise, stakeholder groups have also emerged to press for amendments to the PA that will close these loopholes and include regulation of exports of fossil fuels in their methodologies (Boudet & Hazboun, 2022).

Legislation in the US regarding air emissions has been researched, crafted, and operationalized by the EPA since about 2011 (Ferguson, 2019).The EPA generally targets four fossil fuels characterized by high levels of carbon, including orimulsion, natural gas, coal, and petroleum. In particular, coal and petroleum are often thought of when discussing the dirty fossil fuels that have traditionally provided energy to Americans. The EPA continuously monitors these air emissions statistics and related data and has developed subsequent legislation in conjunction with this research.

The EPA's key federal guideline, The Clean Power Plan (CPP), is an ambitious energy policy focusing on a shift from carbon-based fuel to more renewable energy sources. Its first legislation phase was in 2011, when the EPA officially finalized the Cross-State Air Pollution rule, replacing the Clean Air Interstate Rule of 2005. The Cross-State Air Pollution rule was seen as a seminal law within the CPP, which regulated carbon emissions and was fully implemented and monitored starting in 2013. As the CPP was being enacted, many states had already been making plans to meet the new fossil-fuel emission reduction targets (Richardson et al., 2015). The CPP focused on three distinct regulations for carbon-emitting power plants "from new, modified, and existing… sources" and strictly regulated greenhouse gas emissions from coal-burning power plants, which then accounted for 40% of total US carbon emissions (McCubbin, 2014). "According to EPA, in 2013, 67% of the electricity used in the United States was generated by coal, natural gas, or other fossil fuels" (Fargotstein and Billingsley, 2015, p. 19). In response to the federal action at the time, the Union of Concerned Scientists (2016) noted that "all states across the country could greatly enhance their clean energy resources and affordably comply with the emissions reductions required" (p. 8). The EPA has been willing to continue the pursuit of research to revise existing methodologies regarding fossil fuel usage. For example, in 2017, the EPA revised its conclusions of benefits and costs from its 2015 model (Shouse, 2018).

While air quality regulations were intended to produce better air quality via the CPP, critics have described the related impacts on the national fossil-fuel industry's private sector as negative consequences. Because power plants that rely on electric generators or coal as their main fuel were targeted, the CPP was said to "have an uneven impact on the energy industry, boosting…some regions…while biting others" (Smith & Miller, 2015, p. 1). Critics claimed that national coal production would decrease by 242 million tons as a result (National Mining Association, 2017), hurting the well-being of those with a stake in the industry. While domestic regulations have overwhelmingly benefited citizens in general, one might still inquire about how factoring in domestic production of fossil fuels in the US has been buoyed by export markets. As such, it would be prudent to analyze domestic fossil fuel prices from the perspective of their overall inherent value in the global marketplace.

There has been little quantitative research on the effects of federal regulations on domestic fossil fuel prices in the global marketplace. To fill this gap, this study will assess the impact of past federal regulations in the domestic fossil fuel industry from the perspective of overall global market prices, overall domestic output, and other associated economic metrics. As such, gauging the impact on global prices might predict similar effects in other countries if the PA were to be amended to include exports in regulatory models.

Methodology/Results/Future Studies

Of the four fossil fuels that generally contain high levels of carbon: orimulsion, natural gas, coal, and petroleum, the latter two are usually thought of when discussing the dirty fossil fuels that have traditionally provided energy to Americans. In order to determine which fossil fuels to analyze, the North American Industry Classification System (NAICS) was utilized in this study.

The NAICS" is the standard used by Federal statistical agencies in classifying business establishments for the purpose of collecting, analyzing, and publishing statistical data related to the U.S. business economy" (United States Census Bureau, 2022). Its specific classifications are utilized in this study for the purposes of data mining. The NAICS's 3-digit classification system includes sectors in the US economy related to specialty trade and further divides up these units based on code order in two distinct super sector categories: 1) Goods Producing and 2) Service Producing. Since fossil fuels are utilized during the production process, the manufacturing category was selected. 21 subsectors of the goods-producing industries are classified (Industries

at a Glance, 2022). Of these, subsector 324, *Petroleum and Coal Products Manufacturing*, was used for purposes of this study (Parkinson, 2021) to locate economic statistics (2009-2019 annual data) associated with prices in the national fossil-fuel industries. From the NAICS subsector 324 description in the United States Bureau of Labor Statistics (BLS):

> *The Petroleum and Coal Products Manufacturing subsector is based on the transformation of crude petroleum and coal into usable products… "In addition, this subsector includes establishments that primarily further process refined petroleum and coal products and produce products, such as asphalt coatings and petroleum lubricating oils". (Industries at a Glance, 2022). Filtering further into this subsector are various "data series" statistics, all inter-related to the subsector.*

The BLS provides various economic subheadings under the heading "workforce statistics" by year (Parkinson, 2021). Four that most closely reflect the characteristics of American fossil fuel exports were selected for purposes of this study. Those metrics, whose accessible monthly and annual data date back to 2009, include export price, import price, producer price index (PPI), and output.PPI was chosen because it "measures the changes in prices that domestic producers receive for goods and services*"*(Parkinson, 2021), as the data for this subsector include industry-specific PPI and overall prices and all sales within the fossil fuel industry or elsewhere related to subsector 324. Using these annual statistics, this study then analyzed and contrasted statistics before and after 2013 (BLS Handbook of Methods, 2022), since the CPP took full effect in 2013.Table 1displays the data both before and after 2013. As seen, the total export price after 2013 decreased sharply from 157.15 to 106.70. In addition, import prices and PPI (general prices) decreased sharply, whereas total output increased.

Table 1.
Fossil Fuel Economic Metrics: Before and after the CPP was fully implemented

US Fossil Fuel Export Price and Related Metrics	**Before 2013**	**After 2013**
Export Price	157.15	106.70
Import Price	159.32	97.35
PPI	350.73	242.53
Output	103.58	112.14

Two-sample *t*-tests with a significance level of 0.05 were performed for each of the related metrics. As seen in Table 2,because all *p*-values are less than .05, they are deemed to be statistically significant, whereas the means of the two groups can be confidently labeled as dissimilar.

Table 2.
Economic Metrics: p-values before and after the CPP was fully implemented

US Fossil Fuel Export Price and Related Metrics	***p*-values from the two-sample t-tests**
Export Price	2.2*10^(-16)
Import Price	2.2*10^(-16)
PPI	2.2*10^(-16)
Output	3.53*10^(-4)

After the CPP was implemented, the prices of American fossil fuel exports decreased sharply. Since PPI analyzes changes in prices that domestic producers receive, it can be confidently noted that the overall prices of American fossil fuels decreased immediately after the implementation of this domestic regulation. Increased output should be noted, as it might signify additional drilling/mining by domestic producers. Speculation might arise as to whether similar federal regulations in other countries would prompt similar drops in both prices for domestic producers as well as a coinciding increase in output. The increases in output may then lead to further examination of those economic advocacy studies that encourage and develop supply-side climate policies to limit fossil-fuel mining and drilling. Certainly, if domestic regulations tend to trigger increased production of fossil fuels or increased drilling/mining, additional scrutiny is well deserved.

Further, the decrease in import prices merits subsequent studies to inquire into whether the US produces enough fossil fuels to hold global market power. If the CPP's regulations caused a decrease in domestic prices, global prices concurrently decreased. Future researchers should assess whether American domestic regulations can manipulate overall global fossil fuel prices, even with the ability to export to other markets.

Another avenue of future research is to investigate the effect of similar domestic regulation in other countries as well as the effect of fossil fuel exports and related prices to gauge whether it has a similar impact on

domestic fossil fuel prices in those countries. Those that advocate for amendments and revised methodologies in the PA to prevent exports of fossil fuels from being considered for the domestic country should take into account any effect of federal US regulations in lowering the price of fossil fuels in the world market, although increased output should still be considered as a potential negative unanticipated consequence. In addition, since the EPA tweaked the CPP and changed it to the Affordable Clean Energy rule in mid-2019, future studies should focus on whether and how the new provisions changed these trends.

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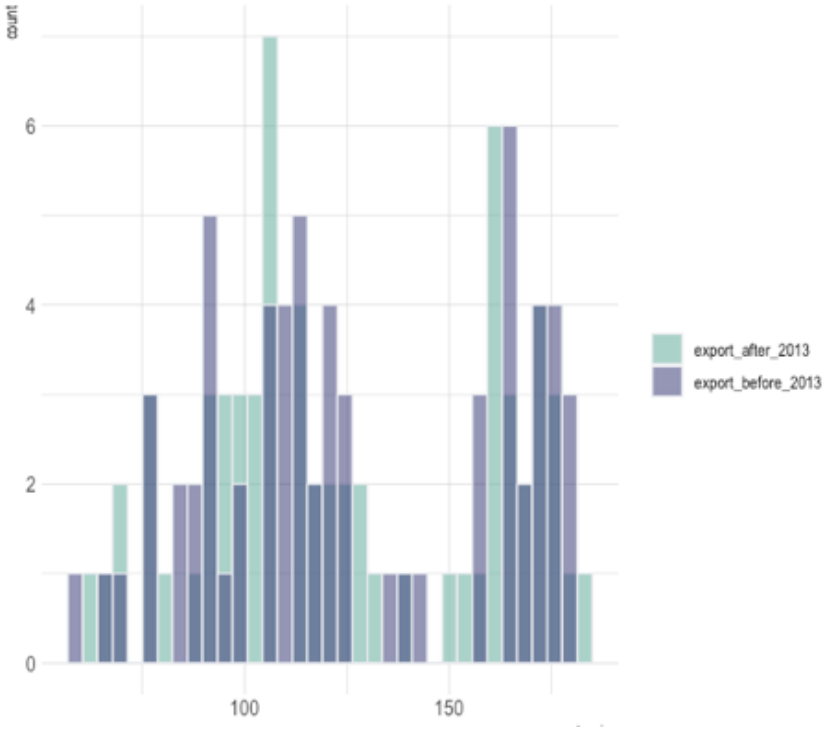
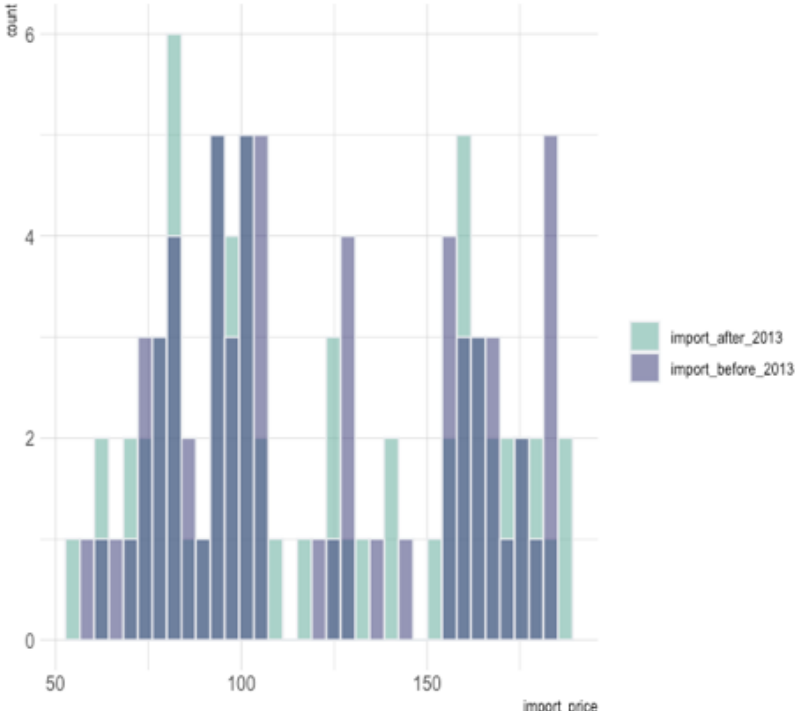
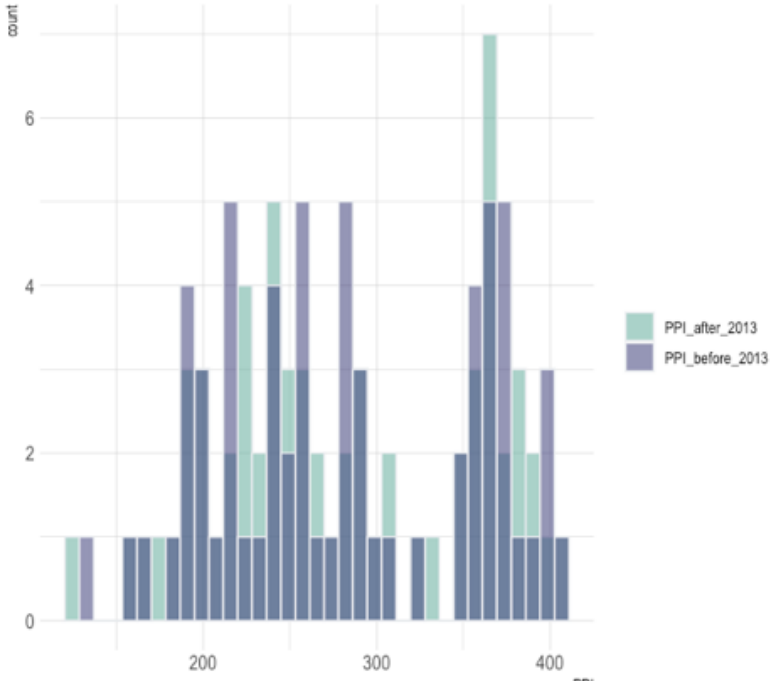
Appendix A.
Histogram of Export Prices



Appendix B.
Histogram of Import Prices



Appendix C.
Histogram of PPI



Appendix D.
Industries by Supersector

Goods-Producing Industries

• Natural Resources and Mining
• Agriculture, Forestry, Fishing and Hunting (NAICS 11)
• Crop Production (NAICS 111)
• Animal Production (NAICS 112)
• Forestry and Logging (NAICS 113)
• Fishing, Hunting and Trapping (NAICS 114)
• Support Activities for Agriculture and Forestry (NAICS 115)
• Mining, Quarrying, and Oil and Gas Extraction (NAICS 21)
• Oil and Gas Extraction (NAICS 211)
• Mining (except Oil and Gas) (NAICS 212)
• Support Activities for Mining (NAICS 213)
• Construction
• Construction (NAICS 23)
• Construction of Buildings (NAICS 236)
• Heavy and Civil Engineering Construction (NAICS 237)
• Specialty Trade Contractors (NAICS 238)
• Manufacturing
• Manufacturing (NAICS 31-33)
• Food Manufacturing (NAICS 311)
• Beverage and Tobacco Product Manufacturing (NAICS 312)
• Textile Mills (NAICS 313)
• Textile Product Mills (NAICS 314)
• Apparel Manufacturing (NAICS 315)
• Leather and Allied Product Manufacturing (NAICS 316)
• Wood Product Manufacturing (NAICS 321)
• Paper Manufacturing (NAICS 322)
• Printing and Related Support Activities (NAICS 323)
• Petroleum and Coal Products Manufacturing (NAICS 324)
• Chemical Manufacturing (NAICS 325)
• Plastics and Rubber Products Manufacturing (NAICS 326)
• Nonmetallic Mineral Product Manufacturing (NAICS 327)
• Primary Metal Manufacturing (NAICS 331)
• Fabricated Metal Product Manufacturing (NAICS 332)
• Machinery Manufacturing (NAICS 333)
• Computer and Electronic Product Manufacturing (NAICS 334)
• Electrical Equipment, Appliance, and Component Manufacturing (NAICS 335)
• Transportation Equipment Manufacturing (NAICS 336)
• Furniture and Related Product Manufacturing (NAICS 337)
• Miscellaneous Manufacturing (NAICS 339)
Service-Providing Industries
• Trade, Transportation, and Utilities
• Wholesale Trade (NAICS 42)
• Merchant Wholesalers, Durable Goods (NAICS 423)
• Merchant Wholesalers, Nondurable Goods (NAICS 424)
• Wholesale Electronic Markets and Agents and Brokers (NAICS 425)
• Retail Trade (NAICS 44-45)
• Motor Vehicle and Parts Dealers (NAICS 441)
• Furniture and Home Furnishings Stores (NAICS 442)
• Electronics and Appliance Stores (NAICS 443)
• Building Material and Garden Equipment and Supplies Dealers (NAICS 444)

- Food and Beverage Stores (NAICS 445)
- Health and Personal Care Stores (NAICS 446)
- Gasoline Stations (NAICS 447)
- Clothing and Clothing Accessories Stores (NAICS 448)
- Sporting Goods, Hobby, Book, and Music Stores (NAICS 451)
- General Merchandise Stores (NAICS 452)
- Miscellaneous Store Retailers (NAICS 453)
- Nonstore Retailers (NAICS 454)
- Transportation and Warehousing (NAICS 48-49)
  - Air Transportation (NAICS 481)
  - Rail Transportation (NAICS 482)
  - Water Transportation (NAICS 483)
  - Truck Transportation (NAICS 484)
  - Transit and Ground Passenger Transportation (NAICS 485)
  - Pipeline Transportation (NAICS 486)
  - Scenic and Sightseeing Transportation (NAICS 487)
  - Support Activities for Transportation (NAICS 488)
  - Postal Service (NAICS 491)
  - Couriers and Messengers (NAICS 492)
  - Warehousing and Storage (NAICS 493)
- Utilities (NAICS 22)

- Information
  - Information (NAICS 51)
    - Publishing Industries (except Internet) (NAICS 511)
    - Motion Picture and Sound Recording Industries (NAICS 512)
    - Broadcasting (except Internet) (NAICS 515)
    - Internet Publishing and Broadcasting (NAICS 516)
    - Telecommunications (NAICS 517)
    - Data Processing, Hosting, and Related Services (NAICS 518)
    - Other Information Services (NAICS 519)
- Financial Activities
  - Finance and Insurance (NAICS 52)
    - Monetary Authorities - Central Bank (NAICS 521)
    - Credit Intermediation and Related Activities (NAICS 522)
    - Securities, Commodity Contracts, and Other Financial Investments and Related Activities (NAICS 523)
    - Insurance Carriers and Related Activities (NAICS 524)
    - Funds, Trusts, and Other Financial Vehicles (NAICS 525)
  - Real Estate and Rental and Leasing (NAICS 53)
    - Real Estate (NAICS 531)
    - Rental and Leasing Services (NAICS 532)
    - Lessors of Nonfinancial Intangible Assets (except Copyrighted Works) (NAICS 533)
- Professional and Business Services
  - Professional, Scientific, and Technical Services (NAICS 54)
  - Management of Companies and Enterprises (NAICS 55)
  - Administrative and Support and Waste Management and Remediation Services (NAICS 56)
    - Administrative and Support Services (NAICS 561)
    - Waste Management and Remediation Services (NAICS 562)
- Education and Health Services
  - Educational Services (NAICS 61)

• Health Care and Social Assistance (NAICS 62)
• Ambulatory Health Care Services (NAICS 621)
• Hospitals (NAICS 622)
• Nursing and Residential Care Facilities (NAICS 623)
• Social Assistance (NAICS 624)
• Leisure and Hospitality
• Arts, Entertainment, and Recreation (NAICS 71)
• Performing Arts, Spectator Sports, and Related Industries (NAICS 711)
• Museums, Historical Sites, and Similar Institutions (NAICS 712)
• Amusement, Gambling, and Recreation Industries (NAICS 713)
• Accommodation and Food Services (NAICS 72)
• Accommodation (NAICS 721)
• Food Services and Drinking Places (NAICS 722)
• Other Services (except Public Administration)
• Other Services (except Public Administration) (NAICS 81)
• Repair and Maintenance (NAICS 811)
• Personal and Laundry Services (NAICS 812)
• Religious, Grantmaking, Civic, Professional, and Similar Organizations (NAICS 813)
• Private Households (NAICS 814)

