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Analysis of the Impact of the Net Zero Movement on International Trade

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Abstract: The net-zero carbon emission mission raised by UNFCCC accelerated the already looming shortage of various key metals in the construction of renewable energy facilities, such as copper for the construction of solar panels. Using basic econometric tools through Stata, this paper studied the effect on copper prices related to the net-zero campaign, aiming at both establishing the validity of such an effect and quantifying its scale. Relevant data from FRED demonstrates that this effect drives up copper price at a high significance level and quantifies it to be 2440.636 USD per metric ton. This effect also seems to be lagging into future periods, and a staggered events analysis suggests that the growth in copper price due to the net-zero campaign will decelerate in the near future. Potential flaws are discussed, and several valid and valuable future research directions are also raised.

Keywords: net-zero, copper shortage, International trade

1. Introduction

On June 5, 2020, the UNFCCC initiated the "Race to Zero" campaign, which aimed to achieve the goal of reaching carbon-neutrality by 2050 [1]. The key component to the success of this campaign is to reach carbon-neutrality in energy consumption, which accounts for 37 percent of global Green House Gas (GHG) emissions in 2022, the largest among all sectors [2]. The importance of having carbon-neutral energy generation is reinforced by the beginning of the transition into an electric-powered transportation system in recent years, which increases the demand for more energy that ultimately needs to be produced in a carbon-neutral way as well. Hence, studying the transition to carbon-neutral production in the energy sector can be very important for the net-zero campaign.

Currently, there are various methods to produce renewable energy, which includes hydropower, wind power, solar power, and other less prevalent ones. Among these methods, wind and solar power are considered relatively cheaper alternatives to displace high-carbon sources such as oil and coal [3]. Demand for carbon-neutral energy production has a very high potential if the 2050 carbon-neutrality prospect can be fulfilled, as in 2021 the total energy consumption in the world was around 176,431 terawatt-hours, of which about 84.3% was produced by fossil fuels, putting the total amount of energy that needs to be substituted at around 148,731 terawatt-hours [4]. Such a large volume of fossil fuel energy that needs to be displaced would cause an increase in the demand for renewable energy generators, for example, wind turbines and solar panels, on a similar scale. This paper analyzed the effect of the net-zero campaign on the prices of metals used to build such renewable energy generators, especially copper, using reliable real-world data.

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2. Method

The difference-in-difference method is used to study the effect of the net-zero campaign on the market prices of affected metals such as copper. The main reason for choosing the difference-in-difference method is that it would demonstrate most clearly the effect of an event or treatment, which is central to the topic this paper discusses.

In this paper, copper is the treatment group, and the treatment is defined here as the initiation of the "Race to Zero" campaign. The reason for using the net-zero campaign as the treatment is that the campaign states a target of net-zero carbon emissions by 2050, which generates a clear increase in demand for renewable energy, and it translates to increased demand in metals such as copper, zinc, aluminum, and others. This treatment is defined to be administered on June 1, 2020, the most approximate date from the data to June 5, 2020, when UNFCCC initiated the "Race to Zero" campaign.

Market prices for iron ore are used as the control group. The reason for this choice is that: 1) it can be assumed to have a parallel trend with copper as they have roughly the same industrial applications other than renewable energy; 2) it doesn't receive the "treatment", as the volume of iron production at 2.68 billion tons in 2021 is much larger than that of copper at 21.2 million tons, thus the effect of net-zero on iron ore would be relatively insignificant against its high level of demand [5, 6].

Although the available market prices go back to 1990, the earlier data would not be relevant enough to be included in this paper, as it is too far away from the surge in renewable energy development and might contain effects of shocks unrelated to the topic of this paper. Hence, only data between 2016 and 2023 are included.

The data used in this paper is mainly from Federal Reserve Economic Data published by the Federal Reserve Bank of St. Louis, which is processed with Stata [7, 8]. Reports and statistics from governments and/or UN organizations, from reputable data suppliers, and from verified internet sources are also used as complementary information.

3. Results

The graphs generated by Stata include both the result from raw observed FRED data and the result in which both groups are set to start from the same point in the Linear-trends model. Figure 1 confirmed that a parallel trend exists between the two groups, and it also indicates that the treatment has a significant effect on the outcome variable for the treatment group than the control group, with the gap between the two widen more rapidly after the point of treatment.

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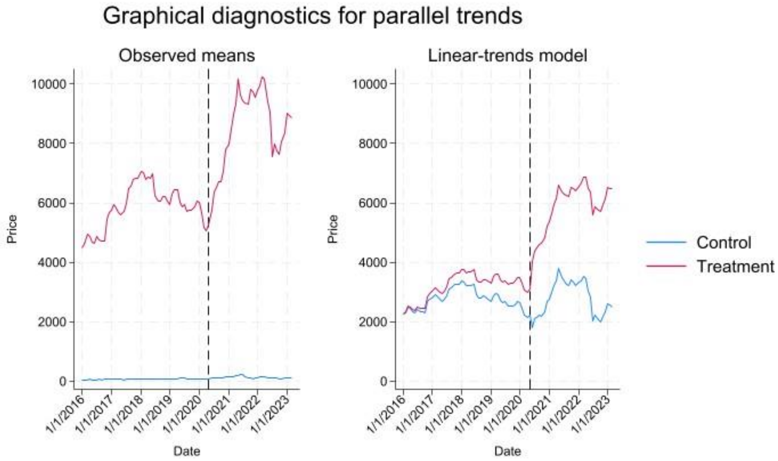

Figure 1: Graphical Diagnostics for Parallel Trends. The control group is the price of iron ore, treatment group is the price of copper. Units in USD per metric ton. Source: FRED [7, 8].

Regression analysis of the data is listed below in Table 1. Based on this table 2440.636 is the coefficient of the difference-in-difference indicator, and the result is sufficiently significant from their p-values.

Table 1: Regression Analysis of Market Prices. Results are rounded. Units in USD per metric ton.

Copper Price	Coefficient	Robust Standard Error	t	P>|t|
Date	0.211	0.0568	3.72	0.000
Copper	5862.762	92.118	63.64	0.000
did	2440.636	255.329	9.56	0.000
Constant	-4502.076	1235.101	-3.65	0.000
R-squared	RMSE			
0.9668	663.14			

Source: FRED [7, 8].

The Copper variable indicates whether the observation is about copper or about iron-ore, and thus also means whether the observation is treated or not. An observation about copper prices, thus received the treatment, will have a value of 1 for the Copper variable, while the one about iron ore prices will have a value of zero. The Date variable indicates the effect of every passing month on market prices, and an OLS model is assumed, meaning that each month is assumed to have the same level of effect on market prices, which is not a practical assumption in reality. The did variable is the difference-in-difference indicator, which is obtained by having Copper multiplying an unshown variable time that equals 1 when it is later than June 1, 2020 (the approximated initiation date for the "Race to Zero" campaign). Hence only observations that is both in the treatment group (Copper prices) and receives the treatment (after the initiation of the "Race to Zero" campaign) will have the value 1 instead of 0.

Panel Data Regression for the FRED data is listed below in Table 2. Based on this table 2660.877 is the coefficient of the difference-in-difference indicator.

Table 2: Panel Data Regression of Market Prices. Coefficients for all date variables are omitted. Units in USD per metric ton.

Copper Price	Coefficient	Robust Standard Error	t	P>|t|
did	2660.877	.	.	.
Date	(omitted)			
R-squared	Within	Between	Overall	
	0.8353	1.0000	0.4649	

Source: FRED [7, 8].

The main reason for the difference between the two regressions is that the former also considers the effect of the treatment, as well as that it assumes a linear functional form for the time variable.

The Staggered Events regression is listed below in Table 3. It depicts the lead and lag coefficients with lag 0 being the point of initiation of the "Race to Zero" campaign.

Table 3: Staggered Events Regression of Market Prices.

	Coefficient	Standard Error	t	P>|t|
Lead 4	-648.73	806.11	-0.80	0.57
Lead 3	-107.08	75.48	-1.42	0.39
Lead 2	502.47	767.46	0.68	0.62
Lag 0	-66.92	82.73	-0.81	0.57
Lag 1	1927.77	2482.30	0.78	0.58
Lag 2	1603.41	2155.79	0.74	0.59
Constant	2995.89	634.46	4.72	0.13
R-squared	Adjusted R-squared	RMSE		
0.94	0.88	1288		

Units in USD per metric ton. Results are rounded. Source: FRED [7, 8].

4. Discussion

In this part, the results obtained from this paper are discussed in greater detail, focusing in particular on how they may or may not be applicable to reality, as well as potential future directions of research that might enhance such applicability.

4.1. Interpretation

Both Table 1 and Table 2 produce positive coefficients for the difference-in-difference variable, meaning that the initiation of the "Race to Zero" campaign does seem to have significant influences on copper price. The two coefficients, 2440.636 and 2660.877, are also roughly on the same level, so regression analyses indicate that the net-zero campaign drives up copper prices by around 2400 to 2600 USD per metric ton due to increased demand emerged from this campaign. Since Table 1 achieves enough significance while Table 2 does not, the result from Table 1, 2440.636 USD per metric ton, is more reliable.

Staggered Event regression in Table 3 shows that the lag terms decrease in value, suggesting that the effect of the net-zero campaign on copper price is lagged. This can be said to fit with real world developments as the number of participants in the net-zero campaign, as well as specific policies or actions these participants take to translate their initiatives into demand in copper, take time to be implemented. Based on Table 3, it seems that the lag effect has already reached its peak, declining from 1927.77 to 1603.41, suggesting that the increase in copper price from the net-zero campaign is more likely to decelerate in the near future.

4.2. Errors

The major errors in this paper include both econometrical and applicational ones. On the econometrical side, the most prominent error is perhaps the failure of Table 2 and Table 3 to achieve enough significance. Choices of the range of data to include might also contain flaws, as including too much data would be too rigid to extrapolate, and including too little data would not capture the underlying trends of the data.

On the applicational side, the choice of iron-ore might be open to debate, since its prices are on a much lower level than copper prices, and it is assumed to not receive the treatment only because the treatment effect is assumed to be too small to be significant: a change in that assumption would force another control group to be chosen.

4.3. Future Improvements

One major direction of improvement would be to add realistic mechanisms such as monopolies, speculative purchases, and business cycles into the regressions. These mechanisms would likely be more prominent in the future given that the current world reserve would only support consumption of copper at the current rate for a little more than 40 years, according to data from the U.S. Geological Society [9]. Such a shortage will trigger additional action from the actors in global copper trade, thus making the mechanisms mentioned above more conspicuous.

Another direction for improvement can be combining econometric results with real world issues. For example, econometric results about copper prices can be combined with trade policies in the copper industry, and perhaps this combination can shed some light on optimizing such policies.

5. Conclusion

In conclusion, there is strong evidence that the initiation of the net-zero campaign drives up the copper price by 2440.636 USD per metric ton. This effect is not instantaneous, but continues into future periods, and seems to have a decreasing trend within the available data. Hence, it seems that growth in copper price in the future will decelerate. This result connects with observations of increased numbers of practical policies and actions being put in place to promote less carbon emission over time. The major errors of this paper include not obtaining sufficient significance for the coefficients and, probably, using iron ore as the control group. Besides addressing these issues, future directions for improvement include adding important mechanisms of copper trade into the regression formulae, as well as connecting economic data with past policies to give potential advice.

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